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Success and Barrier Factors in Agile Transformations

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ABSTRACT. Agile Methods have become an efficient way of working for organizations focused on delivering technological products. Despite the increased evidence on the success of Agile Transformations, scientific literature on this topic remains scarce. Quantitative methods were used to analyze the relation between Barriers and Success Factors and the importance of each one in explaining the success of an Agile Transformation. The results show that the Barriers *Using old and new approaches side by side, Lack of coaching, Gap between short and long term planning* and *Reverting to the old way of working* represent the Barriers that most contribute negatively to a successful Agile Transformation. The Success Factors *Concentrate on agile values, Allow teams to self-organize, Recognize the importance of the Product Owner role, Communicate the change intensively, Educate management on Agile* represent the Success Factors that most contribute positively to a successful Agile Transformation.

Keywords: Agile Methods, Agile Transformation, Large-Scale Agile

JEL Classification: M10, M15, O21

1. Introduction

Over the last years, project management and software development methods have undergone an evolution from Traditional Project Management methods, such as *Waterfall*, to Agile Methods, such as *Scrum*, and *Extreme Programming*. Although Agile Methods were originally designed for small projects and teams, they have been increasingly implemented by large organizations (Hossain, Babar & Paik, 2009) with emphasis on organizations from Information Technology (IT) sector (Boehm & Turner, 2005).

The study conducted by Forrester in 2006, where it interviewed decision makers in the IT sector, revealed that about 17% of organizations were already using Agile Methods, while more than half of the organizations were interested in implementing it (Schwaber, Laganza & D'Silva, 2007). Challenges such as rapidly react to changes in customer needs, pressure to reduce delivery time and quality improvement, are driving organizations to adopt these methods (VersionOne, 2016) as a way to develop projects and products with shorter delivery times and a greater focus on customer needs (Korhonen, 2013; Petersen & Wohlin, 2010).

Increasingly evidence about the benefits of these methods have been encouraging the adoption in large projects and in several teams of the same organization (Paasivaara, Behm, Lassenius & Hallikainen, 2018), which makes its implementation more challenging (Dybå & Dingsøyr, 2008; Leffingwell, 2007). Due to the complexity and high number of projects and people involved, this type of implementation has taken the designation of Large-Scale Agile Transformation or just Agile Transformation (Dikert, Paasivaara & Lassenius, 2016). This organizational change represents a challenging transformation (Svensson & Höst, 2005) and organizations are often unaware of the real significance of an Agile Transformation and the extent of behavioral change that is really needed to be successful (Schwaber et al, 2007).

According to Leffingwell (2007) and Dikert et al (2016), an Agile Transformation requires specific needs in terms of team coordination, initial architecture and project requirements analysis and presents challenges associated with distributed teams, since many large organizations have teams in different countries working on the same project. Despite these challenges, more and more organizations are choosing to implement Agile Methods in their teams, even though there are still a small number of scientific studies, with quantitative results on Agile Transformations, that could provide reliable data (Chow & Cao, 2008; Dikert et al, 2016; Paasivaara et al, 2018; Schwaber et al, 2007; Sillitti, Ceschi, Russo & Succi, 2005) and could indicate which are the most important variables and the most appropriate techniques to be implemented in these transformations (Hossain et al, 2009; Laanti, Salo & Abrahamsson, 2011).

The results of the systematic literature review conducted by Dikert et al (2016), revealed that only 6 of the 52 reports that were analyzed, used a scientific method as they represent experience reports published at Agile Conferences. The Agile Experts who attended the XP Conference in 2010, referred "Agile and large projects" as the most important research topic of the moment (Dingsøyr & Moe, 2018; Freudenberg & Sharp, 2010) and is one of the current topic on the agenda of the main global management forums (Rigby et al, 2016). In 2011, the term “Agile Project Management” for the first time stayed ahead of “Agile Software Development” research on Google Trends (Stettina & Horz, 2015).

Based on the Barriers and Success Factors referenced in the systematic review of the literature of Dikert et al (2016), the research questions of this study focus on identifying which variables related with Barriers and Success Factors better explains the success of an Agile Transformation in organizations operating in Portugal.

This study is structured as follows: section 2 contains the theoretical framework. Section 3 presents the objectives of the research, the population and sample characterization and research strategy. Section 4 presents the data analysis and then, guided by literature and our data analysis, section 5 presents the answers to research questions and discussion. Finally, section 6 presents the main conclusions, limitations and future lines of research.

2. Theoretical framework

In this section we presented an overview about previous work related with Agile Transformations. Firstly, we explained the transition to Agile Methods that has been taking place in project management and software development. Secondly, we presented why organizations are interested Agile Transformations in Large-Scale and what are its Barriers and Success Factors identified in previous studies.

2.1. Distinction between Agility and Agile Organizations

The concept of Agility is not recent and can be found in several literature. According to Conboy & Fitzgerald (2004), Agility is: "the continual readiness of an entity to rapidly or inherently, proactively or reactively, embrace change, through high quality, simplistic, economical components and relationship with its environment". Erickson et al (2005) define agility as follows: "Agility means to strip away as much of the heaviness, commonly associated with the traditional software-development methodologies, as possible to promote quick response to changing environments, changes in user requirements and accelerated project deadlines". To Suresh et al (2019), some of the most influential factors for Agility are multi-skilled and flexible people, informal learning and development, completeness and change of culture. For this research was considered the definition of Agility defended by Qumer, & Henderson-Sellers (2006): "Agility is a persistent behaviour or ability of a sensitive entity that exhibits flexibility to accommodate expected or unexpected changes rapidly, follows the shortest time span, uses economical, simple and quality instruments in a dynamic environment and applies updated prior knowledge and experience to learn from the internal and external environment".

Regarding Agile organizations, Kettunen and Laanti (2007) suggested that an organization needs to choose the agility it needs. Could be 1) to be fast and responsive to change, 2) to improve productivity in software development and 3) to create products with distinction and integrity. Different organizations could prioritize these goals in different ways and there are many different approaches to achieve them. These organizations need to adapt the way of working for applying knowledge management tools to overcome uncertainty (Tooranloo & Saghafi, 2018). To Booth & Harmer (1994) and Conboy (2009), Agile organizations are entities that learn fast and are effective and this mindset could be helpful for organizations focused on developing products and platforms (Raudberget et al, 2019). Gligor et al (2015) looked to Agile organizations as the ability to quickly adjust and Putnik & Putnik (2012) mentioned that these entities are more focused and oriented to respond to specific customer expectations, which makes them more efficient. Agile organizations thrive in complex and changing realities (Naslund & Kale, 2021) and respond quick in assemble its technology, employees, and management to respond to changing customer demands (Zain et al, 2005). For this research was considered the Agile Organizations definition indicated by Filipe et al (2016): "Organizations with the intentional response capability to enable efficient behavior in a highly turbulent environment, not only by reacting rapidly to change, but also through the organization's potential of action in anticipating and seizing opportunities, in particular through innovation and learning."

2.2. From Traditional Project Management Methods to Agile Methods

Traditional Project Management Methods are characterized by the sequential execution of the phases of a project (Pereira et al. 2020b). For the execution of software development projects, Nerur, Mahapatra & Mangalaraj (2005) indicate that Traditional Project Management Methods assume that software products are fully specified and built through meticulous and exhaustive planning. Boehm & Turner (2005), state that the practitioners of these methods assume that there are fully defined requirements for the products to be developed and that the results to be achieved are highly predictable (Pereira et al. 2021). Although these methods have strengths such as robustness and consistency, prescribing them in a cross-cutting way in all types of projects is increasingly being referred to as a disadvantage, since a single model may not be appropriate for all cases (Shenhar & Dvir, 2007).

On the other hand, Agile Methods derive from an iterative approach to the project (Conforto, Amaral, Silva, Ariani, & Kamikawachi, 2016), based on an "agile philosophy" described in the Agile Manifesto in 2001 (Fowler & Highsmith, 2005). They show substantially different way of working compared to Tradition Project Management Methods (Nerur & Balijepally, 2007; Thummadi et al, 2011), emphasizing change tolerance, incremental cycles and active end-user involvement (Dingsøyr et al, 2012). They are largely based on recurring activities (Pentland & Feldman, 2007), such as iterative delivery of increments or daily standup meetings (Schwaber & Beedle, 2001; Williams, 2012). Designed to accept and effectively manage changes throughout the project (Highsmith, 2004), Agile Methods tend to deliver value more frequently and are focused on improving product quality (Laanti et al, 2011).

The increasing emphasis that IT projects have placed on the strategy of organizations over the past 20 years has raised the need to increase their agility as a response to the constant transformation of the external environment (Conforto et al, 2016; Denning, 2018; Version One, 2016) and decrease the failure rates of IT projects, which were high in the early years of 2000 (The Standish Group, 2011). Most of the Agile Methods are designed to help organizations reducing costs, reducing waste and increasing employee satisfaction through quality processes (Costa et al, 2020) .

Extreme Programming (XP) and Scrum methods are among the most popular (Hamed & Abushama, 2013). XP presents a set of practices that allow efficient incremental development while Scrum is a more agile project management practice (Schwaber & Beedle, 2001), defined by team routines such as daily team coordination meetings, biweekly planning and review meetings with stakeholders, or retrospective reviews (Williams, 2012). Although Agile Methods are made of several Agile practices, all contribute to the same purpose (Larman & Basili, 2003) and promote the same principles such as the development of small and self-organized teams (Takeuchi & Nonaka, 1986). According to Boehm & Turner (2005), the Agile practices can be divided in three different groups: communication (for example metaphor and pair programming), management (for example, planning game and frequent delivery), and technical (for example, simple design, refactoring, and test-driven design).

In practice, many Agile projects implementations end up combining several Agile practices and should be adapted to the work context (Fitzgerald et al, 2006) although there is little guidance on how Agile teams should interact with each other in a Large-Scale Agile environment (Paasivaara et al, 2018).

2.3. Agile Transformations

According to the research of Petersen & Wholin (2010) who studied transitions of project management methods in small teams, Agile Methods raised less issues than Traditional Project Management Methods and suggests its

adoption result in better, cheaper and faster software development in complex environments (Petersen & Wholin, 2010). Other top reasons for organizations to start an Agile Transformation is to reduce the time to market (Gat, 2006; Goos & Melisse, 2008), to improve production speed and software quality (Korhonen, 2013). O'Connor (2011) and Denning (2018), mentioned that it is important to change old ways of working, made of slow and bureaucratic processes that lead to organizational bottlenecks. There is evidence that the ability to understand and implement Agile Methods at the project portfolio level has a positive influence on the identification of emerging strategies and project portfolio success of organizations (Kaufmann, Kock & Gemünden, 2020).

Although many practitioners promote the success of Agile Transformations, these cases represent complex, long-term and stepwise organizational changes (Dyba & Dingsøyr, 2008; Korhonen, 2013). In the last 20 years, several experts had been trying to find solutions to implement Agile Methods at Large-Scale through several frameworks. Scaling Agile Methods and finding the best practice is one of the most relevant research topics for practitioners (Reifer, Maurer & Erdogmus, 2003), although there is no consensus on the best practice to follow (Ebert & Paasivaara, 2017).

In 2005, the Large-Scale Scrum (LeSS) framework was created by Craig Larman and Bas Vodde (LeSS Works, 2020). In 2007, the Scaled Agile Framework (SAFe) was launched by Dean Leffingwell (2007), and in 2008, Jochen Krebs created Agile Portfolio Management (Krebs, 2008). In 2012 the Disciplined Agile Delivery (DaD) framework was launched by Scott Ambler & Mark Lines (Ambler & Lines, 2012) and finally, the Nexus framework, created by Ken Schwaber, in 2015 (Schwaber, 2015). The literature review of the Agile Maturity Models conducted by Ozcan-Top & Demirörs (2013) assessed the characteristics of five agile maturity models/ Frameworks from software process improvement and process assessment perspectives where the Agile Adoption Framework obtained the best assessment results.

However, scaling Agile within an organization does not need to apply a specific framework and the process should be tailored to the organization needs while keeping the alignment with Agile principles (Kalenda, Hyna & Rossi, 2018). To apply a specific framework in an organization it is critical to understand the causes of failure or success of an Agile Transformation (Pereira & Santos, 2020a). Some practices of these frameworks like Scrums of Scrums have been found to be inefficient in large projects and teams (Paasivaara, Lassenius & Heikkila, 2012) and sometimes the concepts and routines are inconsistent and are interpreted in different ways, which lead to misunderstandings (Conboy & Carrol, 2018). On the other hand, using Agile Methods on the team level is not enough due to dependencies that teams have to manage between each other (Laanti, 2008) and self-manage teams principle could reduce the ability to coordinate across teams effectively (Ingvaldsen & Rolfsen 2012).

Boehm & Turner (2005) identified three groups that work as Barriers in large organizations: 1) conflicts in the development process, 2) conflicts in the business process, and 3) people conflicts. According to these authors, the group of *People conflicts* is identified as the factor with the greatest negative impact on the success of transformation. Vlietland, Van Solingen & van Vliet (2016) mentioned that a project portfolio of multiple Scrum teams needs to have an appropriate governance model and identified six issues related with interdependent Scrum Teams: lack of coordination, mismatches in backlog priorities between teams, alignment issues, a lack of IT chain process automation, unpredictability of delivery to commitment and a lack of information visibility.

The implementation of Agile Methods in Large-Scale, requires coordinated management of resources and priorities (van Oosterhout, Waarts & Hillegersberg, 2006) and assumes greater complexity if the teams are not allocated fully to the project (Tengshe & Noble, 2007). The difficulty in carrying out these transformations is, in

part, related to the size of the organization, which often leads to inertia responsible for slowing down organizational change (Livermore, 2008). Kalenda et al (2018) identified change resistance, an unrealistic roll-out timeframe, quality assurance concerns, and integration into pre-existing non-agile business routines as the main challenges in scaling Agile.

On the other hand, is important to mention the Success Factors that work as enablers in Agile Transformations, according to the literature. The ability to change organizational culture has been identified as one of the Success Factors (Kettunen & Laanti, 2007) and is also important to clearly identify the main objectives each organization intend to implement Kettunen & Laanti (2007). Paasivara et al (2018), described four lessons learned to ensure successful transformations: 1) adopting an experimental approach, 2) stepwise approach to transformation, 3) creating a common agile approach, and 4) limiting the creation of agile teams. Lindvall et al (2004), indicates that the three most important factors are culture, people and communication tools. Fry & Greene (2007) identified executive commitment, dedicated teams, focus on principals, automatization and transparency as key takeways. Other study conducted by survey strategy, highlighted the importance of good personal relationships for coordinate teams (Begel et al, 2009).

It is also recommended, when scaling Agile, to use a Scrum of Scrum Masters instead of Program Managers, a single Product Owner and a single backlog for the whole program (Schwaber, 2004). Korhonen (2013) highlighted the culture, people and communication tools as Success Factors and Poppendieck & Poppendieck (2007) mentioned that the visibility given to an Agile Transformation improve team motivation and empowerment. Providing appropriate Agile training and ensure knowledge sharing are key elements for team members transitioning to the new way of working (Fry & Greene, 2007). Involve individual contributors since the beginning, train Product Owners, coach the team and work on test automation was also mentioned in this study as tasks that could benefit the team if applied as soon as possible in the Agile Transformation. The main advices that Fry & Greene (2007) gave for practitioners, based on their experience, was to not be afraid to change the entire organization at one time, get professional help and keep focus on coaching, project visibility, communication and technical excellence. The literature review conducted by Kalenda et al (2018), suggested company culture, prior agile and lean experience, management support and value unification as key Success Factors.

Despite the different methods available on the market, there is still a great lack of scientific studies indicating under which circumstances they should be implemented, what are the main Barriers and what are the Success Factors for their correct implementation (Paasivaara et al, 2018). Dikert et al (2016), also reveal in their systematic review of the literature that they found no scientific paper directly addressing the effects of an Agile Transformation, and it is necessary to gather further empirical evidence.

3. Methodology

3.1. Research issues

This research aims to collect empirical data regarding the Barriers and Success Factors of Agile Transformations executed in Portugal. The relationship between the problems, question research objectives and the results discussion is present in Table 1. The research questions are:

- *Research question 1:* What Barriers better explain the success of an Agile Transformation in organizations operating in Portugal?
- *Research question 2:* What Success Factors better explain the success of an Agile Transformation in organizations operating in Portugal?

Table 1
Identification of the research problem, general and specific research questions, research objectives and discussion of the results
Source: Authors elaboration

Research problem	General question	Specific research questions	Research objectives	Discussion of results with authors of literature
Lack of understanding about the characteristics of Agile Transformations, their Barriers and Success Factors	What variables better explain the success of an Agile Transformation?	*Question 1:* What Barriers better explain the success of an Agile Transformation in organizations operating in Portugal? *Question 2:* What Success Factors better explain the success of an Agile Transformation in organizations operating in Portugal?	Identify the frequency of occurrence of Barriers and Success Factors and how can they explain the success of Agile Transformations in organizations operating in Portugal	In response to the proposed future research agenda of Dikert et al (2016), it is intended to discuss the results obtained in this research, focusing on how the Barriers and Success Factors identified by the author explain the success of Agile Transformations

3.2. Research strategy

This study was conducted through a survey research strategy with questionnaire format for data collection (Saunders, Lewis & Thornhill, 2009), as it is one of the most suitable methods for standardized questions with the purpose of being interpreted in the same way by all respondents (Robson, 2002).

The survey strategy is also more suitable for explanatory studies that seek relationships between variables, in particular cause-effect relationships (Gill & Johnson, 2002).

The survey is self-administered and electronically mediated via internet (Saunders et al, 2009) through the Survey Monkey website (Survey Monkey, 2020b). The data collection period ran from 18-08-2020 to 02-11-2020, where 321 responses were collected. After the exclusion of 27 invalid cases, the remain 294 cases were valid for data analysis.

3.3. Population and sample characterization

The population of this study is made up of professionals with roles typically associated with project management and software development areas, that are or have been involved in an Agile Transformation, in Portugal.

To define the population in an accurate way, 97% of the roles represented in the 14th Annual State of Agile Report (VersionOne, 2020), one of the most relevant studies of Agile Methods, were taken as guideline. The represented roles are: 1) Scrum Master & Internal Coach, 2) Project Manager, 3) Development Leadership (VP/Director/Manager), 4) Development Team Member (Architect, Developer, QA, Tester, UI or UX Designer), 5) External Consultant/Trainer, 6) Product Owner/Product Manager, 7) C-Level Executive, 8) Business Analyst and 9) DevOps.

The next step was to quantify the population. The current number of Project Managers in Portugal was requested to the Project Management Institute Portugal (PMI Portugal) who indicated that there are approximately 2 000 Project Managers with Professional Project Manager certification (PMP's) in Portugal and that the market penetration rate of this certification is 2%. With this information was conducted a data extrapolation which allowed us to conclude that there are approximately 100 000 Project Managers in Portugal. To confirm the accuracy of this estimation, a triangulation of data was carried out on the Linked In website (Linked In, 2020),

where through the advanced search functionalities *filter by role* and *filter by country*, it was possible to confirm that there are approximately 92 600 Project Managers in Portugal, in October, 2020 (Linked In, 2020). For this study, it was considered the most conservative collected estimate of Project Managers (92 600).

Still in Linked In, the same advanced search functionalities were used to quantify the most representative roles that were identified. 31 000 Business Analysts, 7 800 Scrum Master, 6 900 Product Owners and 835 Agile Coaches were identified. The Development Leadership, Development Team Member, External Consultant/Trainer, C-Level Executive and DevOps profiles are too generic roles to be identified in Linked In and for this reason their quantification in the population of this study assumed the percentage of participation in the 14th Annual State of Agile Report study (VersionOne, 2020). Considering the roles identified via Linked In database, the estimate of individuals considered for the population of this study is 186 442.

The sample consists of 321 cases of Agile Transformations that occurred in Portugal and the margin of error is 5% for a 95% confidence level. The Survey Monkey tool (Survey Monkey, 2020a) was used to calculate the margin of error. The sampling technique used is convenience sampling.

4. Data analysis

The software used for the survey data analysis was the Statistical Package for Social Sciences (SPSS) version 27. The first action was to perform the numerical coding of each variable to facilitate the analysis and minimize errors (Saunders et al, 2009). The focus of the data analysis was trying to understand, through parametric statistical analysis what is the strength of the relationship between the independent variables - Barriers and Success Factors - and the dependent variable - Agile Transformation Success and if there is a statistically significant relationship between them (Berman-Brown & Saunders 2008). For statistical analysis purpose, both independent variables and the dependent variable were converted into ordinal variables in SPSS.

4.1. Variables types

The survey was made up of 9 questions with mandatory answers, in Portuguese or English language (Table 2). Each respondent was asked to answer, anonymously, the same set of ordered and sequential questions (de Vaus, 2002). According to the classification of the type of variables indicated by Dillman (2007), questions 1 to 6 are related with sample characteristics (Role, Experience, Sector, Size of the Organization, Agile implementation and predominant Agile Method) and are considered *Attribute* type variables. Questions 7 and 8 represent *Behavior* type variables once they contain data on what the organization or its employees have done in the past and how they have reacted to a particular phenomenon. Additionally, questions 7 and 8 represent the Barriers and Success Factors of Agile Transformations and, according to Cooper & Schindler (2008), are investigative questions that need to be answered to satisfactorily address each research question. To gain better understanding of the Barriers and Success Factors, both questions 7 and 8 are divided into 20 sub-questions for each, corresponding to 19 Barriers and 19 Success Factors, more the option “Other” for each one, all representing *Behavior* type variables.

Table 2
Identification and description of survey questions
Source: Authors elaboration

ID	Description of survey questions
P1	What is your role in the Organization where you used Agile Methods?
P2	What is your experience in working with Agile Methods in various teams and projects?
P3	What sector of the Organization has used Agile Methods?
P4	How many employees do you have, approximately, in the Organization where you used Agile Methods?
P5	Since when has the Organization implemented Agile Methods in its teams and projects?
P6	What is the predominant Agile Method in the Organization?
P7	In the transformation to Agile Methods that the Organization is performing (or has performed), how often do you observe (or have observed) the following Barriers?
P7.1	General resistance to change
P7.2	Skepticism towards the new way of working
P7.3	Lack of coaching
P7.4	Challenges in rearranging physical spaces
P7.5	Misunderstanding Agile concepts
P7.6	Lack of guidance from literature
P7.7	Reverting to the old way of working
P7.8	Interfacing between teams difficult
P7.9	Achieving technical consistency
P7.10	Interpretation of Agile differs between teams
P7.11	Using old and new approaches side by side
P7.12	Middle managers' role in Agile unclear
P7.13	Management in waterfall mode
P7.14	High-level requirements management largely missing in Agile
P7.15	Creating and estimating user stories hard
P7.16	Gap between long and short term planning
P7.17	Other functions unwilling to change
P7.18	Challenges in adjusting to incremental delivery pace
P7.19	Rewarding model not teamwork centric
P7.20	Other (please specify)
P8	In the transformation to Agile Methods that the Organization is performing (or has performed), how often do you observe (or have observed) the following Success Factors?
P8.1	Ensure management support
P8.2	Educate management on Agile
P8.3	Recognize the importance of change leaders
P8.4	Customize the Agile approach carefully
P8.5	Conform to a single approach
P8.6	Map to old way of working to ease adaptation
P8.7	Start with a pilot to gain acceptance
P8.8	Gather insights from a pilot
P8.9	Provide training on Agile Methods
P8.10	Coach teams as they learn by doing
P8.11	Engage everyone in the organization
P8.12	Communicate the change intensively
P8.13	Make the change transparent
P8.14	Create and communicate positive experiences in the beginning
P8.15	Concentrate on Agile values
P8.16	Arrange social events
P8.17	Align the organization
P8.18	Allow teams to self-organize
P8.19	Recognize the importance of the Product Owner role
P8.20	Other (please specify)
P9	How do you rate the success of the transformation to Agile Methods of the Organization?

4.2. Individual questions format

Each respondent was asked to identify an Agile Transformation that had occurred in Portugal, in which he was involved, as the starting point. To avoid ambiguity in this case identification, it was mentioned in the header of the survey as well as in the individual communication to each respondent, that they should selected the most recent

Agile Transformation, in cases where the respondent passed through several Agile Transformations. The respondent's involvement in these transformations was validated through the information available in Linked In and with question 5 of the survey *"Since when has the Organization implemented Agile Methods in its teams and projects?"*, which represents a control question that intends to confirm the respondent's experience in Agile Transformations and in the cases where the answer was "*Don't use and never tried to implement*" or *"Don't know"*, they were excluded from the study. 12 cases were excluded since it was selected one of these options.

According to Bourque & Clark (1992), when designing research questions, researchers must do one of three things: 1) adopt questions from other questionnaires, 2) adapt questions from other questionnaires, or 3) develop their own questions. In this questionnaire, the Barriers and Success Factors identified by Dikert et al (2016), were adapted for questions 7 and 8 once this is an in-depth study that aggregates the most recurrent Barriers and Success Factors founded in the scientific literature. Only the Barriers and Success Factors identified in 5 or more cases by Dikert et al (2016), were chosen for this questionnaire.

It should also be noted that most questionnaires are composed of open and closed-ended questions, with 6 types of closed-ended questions: list, category, evaluation, classification, quantity and matrix (Saunders et al, 2009). As described in Table 3, question 1 is an open-ended question, while questions 2 to 6 are closed-ended questions. Questions 7, 8 and 9, represent closed-type questions - matrix, and a Likert scale of 5 categories (Never, Rarely, Occasionally, Often, Always) has been used to rank the frequency of each Barrier and Success Factor (sub-questions of question 7 and sub-questions of question 8). For question 9, which aims to classify the success of each Agile Transformation, a Likert scale of 10 categories was used, where 1 represents *Failure* and 10 represents *Success*. Table 4 aims to characterize the investigative questions in the survey and summarize the relationship between them.

Table 3
Classification of response options for each question
Source: Authors elaboration

ID	Classification of response options
P1	Open ended question
P2	Closed-ended question - Category: <1 year / Between 1 and 2 years / Over 2 years and under 5 / Over 5 years
P3	Closed-ended question - Category: Public Administration, Banking and Insurance, Energy, Industry, Retail, Health, IT Services, Telecommunications, Transport and Logistics, Other (please specify)
P4	Closed-ended question - Category: 1-9 Employees | Microenterprise, 10-49 Employees | Small Business, 50-249 Employees | Medium Business, > 249 Employees | Large Business
P5	Closed-ended question - Category: Does not use and has never tried to implement, 1 - 3 months, 4 - 6 months, 7 - 11 months, 1 - 2 years, > 2 years, I do not know, Does not use but has tried to implement. Please specify which barriers you have encountered:
P6	Closed-ended question - Category: Agile Portfolio Management (APM) , Disciplined Agile Delivery (DaD) , Dynamic Systems Development Method (DSDM) , Extreme Programming (XP), Feature Driven Development (FDD) , Kanban , Large Scale Scrum (LeSS) , Lean , Nexus , Scaled Agile Framework (SAFe) , Scrum , Don't know , Other (specify)
P7.1 to P8.20	Closed-ended question - Matrix: Never, Rarely, Occasionally, Often, Always
P9	Closed-ended question - Evaluation: 1 (Failure) to 10 (Success)

Table 4
Relationship between research questions and survey questions
Source: Authors elaboration, adapted from Saunders et al (2009),

Research questions	Question 1: What Barriers better explain the success of an Agile Transformation in organizations operating in Portugal? Question 2: What Success Factors better explain the success of an Agile Transformation in organizations operating in Portugal?		
Type of research	Predominantly explanatory, trying to relate the Barriers and Success Factors to the success and failure of the Agile Transformations of the organizations operating in Portugal.		
Investigative questions		Variables required	Detail in which the data is measured
In the transformation to Agile methods that the Organization is performing (or has performed), how often do you observe (or have observed) the following Barriers?		Opinion on the frequency of occurrence of each Barrier	Never, Rarely, Occasionally, Often, Always
In the transformation to Agile methods that the Organization is performing (or has performed), how often do you observe (or have observed) the following Success Factors?		Opinion on the frequency of occurrence of each Success Factor	Never, Rarely, Occasionally, Often, Always

4.3. Internal validity

Despite the schedule restrictions, a pilot test was considered critical to 1) validate whether respondents understand the survey questions, 2) if there is a need to rephrase ambiguous questions, 3) validate the reliability of the questions and 4) verify that the layout is clear and appealing (Saunders et al, 2009). The pilot test was conducted between 01-08-2020 and 15-08-2020, where 12 Experts in project portfolio management and Agile Methods provided feedback on how to improve the survey. The identified improvements were added in the survey before sending to respondents, via email or Linked In. Below are some examples of suggestions for improvements*:*

[Expert 1]: *The first time I read question nº2, I confess that it was only after looking carefully at the answer options that I realized what was intended. I suggest a reformulation of the sentence for: "In your teams and projects, what is your experience in working with Agile methods in various teams and projects ?"*

[Expert 2]: *In question nº5, the Organization may not use it but may have already tried. The following item should be added in the possible answers: "If you don't use it and have tried, please indicate what didn't work".*

[Expert 3]: *In the introduction the term "traditional methods" is used and in the questions the terms "old way of working", "old approach", "traditional way" are used. I suggest standardizing the terminology to maintain consistency with the introduction.*

4.4. Internal consistency

To ensure the internal consistency of the data collected, a reliability analysis was performed on the survey questions. Through the reliability analysis, we could determine to what extent the answers to each question were correlated and how they contribute to the constructs that are to be analyzed in the research. This analysis provides a general index of internal consistency of variables and can also help identify problematic variables that should be excluded or variables that should be included. According to Rubin & Babbie (1997), the most common and effective method currently used to calculate the reliability of internal consistency is the Cronbach's Alpha coefficient. This coefficient is a direct function of the number of items and their intercorrelated magnitude and represents the lower limit of the test variance attributable to common factors among the items within each variable (Cronbach, 1951).

Only the variables categorized in the same way in the survey were included in the internal consistency analysis. Thus, all questions associated with Barriers and Success Factors (7.1 to 8.20) were included. For exploratory studies, it is agreed that a Cronbach's Alpha coefficient of 0.5 could be considered acceptable (Cronbach, 1951). The result of the reliability analysis (Table 5) presented a coefficient of 0.844 based on standardized items, thus presenting a high level of internal consistency.

Table 5
Cronbach's Alpha
Source: Authors elaboration with SPSS output

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0,843	0,844	38

4.5. Values distribution

The next step in data analysis was to validate whether the data collected from the sample would not produce spurious results (Saunders et al, 2009) by using the analysis of the distribution of values for the independent variables and the dependent variable.

Skewness measures were analyzed to assess distribution asymmetry and Kurtosis to assess the sharpness or flatness of the distribution compared to the normal distribution of each variable. Table 6, presents the Skewness and Kurtosis measures, ordered from highest to lowest Skewness value. Analyzing the Skewness indicator, we can state that the data reveal acceptable symmetry as the existing variation in symmetry is small, ranging from -0.615 to 0.113. The data distribution is negatively skewed since 84% of the variables have the Skewness measures with values <0. The Kurtosis measures has a negative value in all variables except B1 and B2, thus demonstrating that there is a flat data distribution with few extreme cases, which represents a platykurtic distribution (Dancey & Reidy, 2008). Skewness and Kurtosis values between -2 and +2 are considered acceptable to prove a normal distribution of the sample data (George & Mallery, 2010).

Table 6
Skewness and Kurtosis measures
Source: Authors elaboration with SPSS output

ID Variables	Skewness	SE Skewness	Kurtosis	SE Kurtosis
B4. Challenges in rearranging physical spaces	0,199	0,142	-0,882	0,283
B14. High-level requirements management largely missing in Agile	0,118	0,142	-0,541	0,283
B17. Other functions unwilling to change	0,070	0,142	-0,797	0,283
F6. Map to old way of working to ease adaptation	0,033	0,142	-0,614	0,283
B7. Reverting to the old way of working	-0,009	0,142	-1,008	0,283
B15. Creating and estimating user stories hard	-0,016	0,142	-0,436	0,283
B19. Rewarding model not teamwork centric	-0,085	0,142	-1,112	0,283
B18. Challenges in adjusting to incremental delivery pace	-0,101	0,142	-0,575	0,283
B9. Achieving technical consistency	-0,115	0,142	-0,295	0,283
B8. Interfacing between teams difficult	-0,146	0,142	-0,057	0,283
F3. Recognize the importance of change leaders	-0,171	0,142	-0,376	0,283
B16. Gap between long and short term planning	-0,185	0,142	-0,228	0,283
B6. Lack of guidance from literature	-0,200	0,142	-0,683	0,283
F16. Cherish Agile communities	-0,257	0,142	-0,910	0,283
F5. Conform to a single approach	-0,262	0,142	-0,393	0,283
F1. Ensure management support	-0,281	0,142	-0,011	0,283
F17. Align the organization	-0,302	0,142	-0,392	0,283
F18. Allow teams to self-organize	-0,324	0,142	-0,713	0,283
F4. Customize the Agile approach carefully	-0,333	0,142	-0,123	0,283
B3. Lack of coaching	-0,384	0,142	-0,273	0,283
B12. Middle managers' role in Agile unclear	-0,405	0,142	-0,582	0,283
F15. Concentrate on Agile values	-0,423	0,142	-0,309	0,283
F14. Create and communicate positive experiences in the beginning	-0,430	0,142	-0,382	0,283
B10. Interpretation of Agile differs between teams	-0,439	0,142	-0,381	0,283
F8. Gather insights from a pilot	-0,474	0,142	-0,718	0,283
B5. Misunderstanding Agile concepts	-0,478	0,142	0,652	0,283
F19. Recognize the importance of the Product Owner role	-0,481	0,142	-0,524	0,283
F2. Educate management on Agile	-0,484	0,142	-0,258	0,283
S1. How do you rate the success of the transformation to Agile methods of the Organization?	-0,485	0,142	0,391	0,283
F11. Engage everyone in the organization	-0,505	0,142	-0,482	0,283
B13. Management in waterfall mode	-0,509	0,142	-0,521	0,283
F10. Coach teams as they learn by doing	-0,510	0,142	-0,355	0,283
F13. Make the change transparent	-0,513	0,142	-0,439	0,283
F9. Provide training on Agile Methods	-0,514	0,142	-0,449	0,283

B11. Using old and new approaches side by side	-0,523	0,142	-0,517	0,283
F12. Communicate the change intensively	-0,547	0,142	-0,144	0,283
B2. Skepticism towards the new way of working	-0,596	0,142	0,204	0,283
B1. General resistance to change	-0,650	0,142	0,522	0,283
F7. Start with a pilot to gain acceptance	-0,661	0,142	-0,493	0,283

N=294
SE= Standard error

4.6. Correlation analysis

The correlation analysis between the independent variables was carried out to analyze whether there are redundant variables and what is the strength of the relationship between the Barriers and Success Factors (Table 7). Since there are no variables with a degree of correlation above 0.79, all independent variables were kept for analysis. The strength of the relationship between the 19 Barriers and 19 Success Factors identified by Dikert et al (2016) is diverse and the number of strong correlations between them is small.

According to Dancey & Reidy (2006), relations between variables with Pearson's correlation coefficient (r) ≥0.4 and <0.7 represent moderate correlations and relations with r ≥0.7 represent strong correlations. The F7. variables *Start with a pilot to gain acceptance* & F8. *Gather insights from a pilot* are the variables with strongest correlation (*r=0.*788). Follows *F14. Create and communicate positive experiences in the beginning* & F15. *Concentrate on agile values* (*r=0.*716) and *B1. General resistance to change* & B2. *Skepticism towards the new way of working* (*r=0.*710), also representing strong correlations. These correlations are statistically significant as the *p-value* is below the significance level (*p<0.*05).

Table 7 - Correlations

	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16	B17	B18	B19	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17	F18	F19	S1
B1	--																																						
B2	**,710****	--																																					
B3	,302**	,258**	--																																				
B4	,317**	,276**	,341**	--																																			
B5	,361**	,372**	,367**	,289**	--																																		
B6	,203**	,241**	,335**	,268**	**,423****	--																																	
B7	**,450****	**,432****	,384**	,336**	**,423****	,336**	--																																
B8	,331**	,320**	,318**	,276**	**,448****	,292**	**,442****	--																															
B9	,238**	,288**	,258**	,258**	**,406****	,234**	**,446****	**,453****	--																														
B10	,341**	,307**	,290**	,286**	**,439****	,279**	**,422****	**,412****	**,449****	--																													
B11	,320**	,345**	,185**	,217**	**,462****	,286**	**,510****	,364**	,329**	,374**	--																												
B12	,345**	,349**	**,458****	,373**	**,409****	,277**	**,425****	**,443****	,367**	**,404****	**,483****	--																											
B13	**,417****	,362**	,343**	,208**	**,418****	,178**	**,428****	,360**	,311**	,284**	**,401****	**,592****	--																										
B14	,286**	,357**	,299**	,228**	,385**	,248**	,288**	,351**	,317**	,278**	,294**	**,484****	**,461****	--																									
B15	,206**	,322**	,270**	,215**	,339**	,211**	,241**	,270**	,272**	,284**	,233**	,319**	,244**	**,527****	--																								
B16	,165**	,232**	,285**	,174**	,339**	,245**	,268**	,322**	,370**	,342**	,188**	,367**	,341**	**,456****	**,485****	--																						
B17	**,437****	,397**	,177**	,221**	,232**	,176**	**,408****	,303**	,346**	,358**	,235**	,306**	,270**	,230**	,253**	,233**	--																					
B18	**,464****	**,455****	,336**	,320**	**,428****	,242**	**,448****	**,405****	**,413****	**,426****	,340**	**,452****	,395**	**,418****	,340**	,369**	**,558****	--																			
B19	**,414****	,342**	,350**	,330**	,295**	,183**	,349**	,348**	,330**	,383**	,217**	,338**	,356**	,287**	,210**	,265**	,368**	**,462****	--																		
F1	-0,030	-0,072	-,160**	-,123*	-0,032	-,215**	-0,103	-0,052	-0,110	-0,075	-,132*	-,267**	-,161**	-0,097	-0,111	-,134*	-0,033	-0,111	-0,017	--																	
F2	0,025	0,008	-,123*	0,010	-0,043	-,210**	-0,088	-0,042	-0,114	-0,066	-,137*	-,208**	-,198**	-,152**	-0,052	-,165**	0,039	-0,043	-0,065	**,592****	--															
F3	0,017	-0,051	-,137*	-0,085	-0,098	-,196**	-0,087	-0,070	-,116*	-0,099	-,116*	-,280**	-,223**	-,115*	-0,081	-,176**	-0,042	-0,069	-0,056	**,575****	**,644****	--														
F4	0,093	0,040	-0,035	0,018	0,048	-0,085	-0,025	0,030	0,003	-0,024	0,015	-0,001	,121*	0,075	-0,008	-0,004	0,011	0,002	0,036	,150*	,173**	,218**	--													
F5	0,051	,137*	-0,085	0,014	0,045	-0,079	-0,068	-0,063	0,066	-0,031	-,161**	-,148*	-0,073	-0,038	0,052	0,004	0,054	0,009	-0,025	,159**	,223**	,245**	,266**	--												
F6	,143*	,128*	-0,067	0,071	0,048	0,058	0,091	0,002	0,059	0,038	0,081	-0,002	-0,024	-0,053	-0,018	-0,090	,115*	0,060	0,034	,117**	,186**	,177**	,184**	,362**	--											
F7	,133*	,125*	-0,013	0,007	-0,092	-0,081	-0,040	0,029	0,055	0,026	-0,001	-0,043	-0,028	-0,094	0,048	-0,055	0,104	0,080	,122*	,201**	,213**	,254**	,164**	,219**	,249**	--										
F8	0,087	0,061	-0,041	-0,004	-0,045	-0,104	-,156**	-0,075	0,017	-0,044	-0,043	-,143*	-0,054	-0,050	-0,012	-0,054	0,060	-0,008	0,078	,325**	,291**	,328**	,238**	,257**	,257**	**,788****	--								
F9	0,103	0,046	-,180**	-0,079	-0,099	-,294**	-0,102	-0,026	-0,035	-0,039	-0,090	-,149*	-0,039	-,133*	-,118*	-,135*	0,092	-0,002	-0,009	**,412****	**,526****	**,460****	,143*	,176**	,209**	**,410****	**,502****	--							
F10	0,064	0,045	-,240**	-0,078	-,118*	-,224**	-0,094	-0,043	-0,030	-0,085	-0,101	-,155**	-0,061	-,124*	-,115*	-,151**	0,082	-0,008	-0,071	,351**	**,486****	**,455****	,245**	,194**	,304**	,388**	**,480****	**,652****	--						
F11	-0,098	-,118*	-,222**	-0,110	-,280**	-,267**	-,171**	-,168**	-,167**	-,199**	-,192**	-,183**	-,192**	-,175**	-0,091	-,203**	-0,026	-,150**	-0,107	**,430****	**,412****	,398**	,167**	,145*	,228**	,380**	**,472****	**,541****	**,584****	--					
F12	-0,035	-0,049	-,221**	-,161**	-,184**	-,256**	-,185**	-0,112	-,116*	-,164**	-,205**	-,255**	-,194**	-,165**	-,124*	-,161**	-0,039	-,120*	-,121*	**,435****	**,514****	**,493****	,253**	,220**	,265**	,334**	**,429****	**,543****	**,641****	**,634****	--				
F13	-0,034	-0,057	-,209**	-,173**	-,209**	-,339**	-,218**	-,184**	-,178**	-,159**	-,204**	-,289**	-,203**	-,170**	-,148*	-,230**	-0,023	-,144*	-0,090	**,465****	**,512****	**,498****	,212**	,266**	,197**	,311**	**,465****	**,498****	**,554****	**,615****	**,666****	--			
F14	-0,053	-0,090	-,190**	-0,089	-,211**	-,262**	-,233**	-,241**	-,207**	-,185**	-,265**	-,333**	-,243**	-,190**	-0,114	-,259**	-0,107	-,159**	-,138*	**,431****	**,435****	**,429****	,171**	,232**	,249**	,383**	**,485****	**,508****	**,537****	**,597****	**,610****	**,701****	--		
F15	-0,045	-0,111	-,130*	-0,096	-,174**	-,313**	-,213**	-,167**	-0,107	-,144*	-,276**	-,244**	-,149*	-,137*	-0,105	-,177**	-0,055	-,154**	-0,065	**,477****	**,489****	**,492****	,242**	,263**	,201**	,357**	**,455****	**,574****	**,530****	**,548****	**,583****	**,657****	**,716****	--	
F16	-0,002	-0,027	-,193**	-0,057	-,175**	-,269**	-,241**	-,205**	-,134*	-,145*	-,203**	-,192**	-,208**	-,183**	-,154**	-,197**	-0,024	-,132*	-,126*	,368**	**,408****	,349**	0,080	,194**	,275**	,273**	,394**	**,481****	**,507****	**,492****	**,490****	**,597****	**,608****	**,639****	--	
F17	-0,071	-0,060	-,288**	-,132*	-,203**	-,254**	-,215**	-,280**	-,174**	-,176**	-,240**	-,280**	-,246**	-,159**	-,153**	-,271**	-0,028	-,153**	-0,105	,393**	,376**	,377**	,137*	,282**	,236**	,294**	**,443****	**,432****	**,472****	**,488****	**,493****	**,634****	**,672****	**,605****	**,686****	--
F18	-,142*	-,157**	-,235**	-,157**	-,268**	-,260**	-,225**	-,266**	-,147*	-,177**	-,273**	-,355**	-,280**	-,169**	-,138*	-,195**	-,126*	-,256**	-,176**	**,430****	,388**	**,466****	,139*	,124*	,147*	,221**	,352**	,356**	**,412****	**,502****	**,493****	**,505****	**,539****	**,535****	**,499****	**,512****	--
F19	-0,086	-0,066	-,152**	-,124*	-,188**	-,225**	-,193**	-,212**	-,119*	-,209**	-,168**	-,249**	-,155**	-0,073	-0,094	-,151**	-0,101	-,177**	-0,114	,366**	,351**	**,434****	,123*	,211**	,170**	,194**	,360**	,346**	**,405****	,358**	**,434****	**,484****	**,419****	**,521****	**,446****	**,481****	**,578****	--
S1	-,253**	-,227**	-,307**	-,211**	-,362**	-,272**	-,398**	-,314**	-,288**	-,302**	**-,434****	-,395**	-,350**	-,232**	-,193**	-,268**	-,209**	-,321**	-,239**	,377**	**,449****	,377**	,145*	,252**	,155**	,279**	,375**	,396**	,377**	**,464****	**,512****	**,509****	**,515****	**,578****	**,470****	**,493****	**,530****	**,511****	--

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
N= 294

4.7. Factor analysis

To comprehensively analyze the underlying relationships between the measured variables, Exploratory Factor Analysis technique (EFA) was used, which allows grouping a set of variables that are highly correlated between them and lowly correlated with others, grouping them into factors (Williams & Monge, 2001). This technique also aims at identifying the most representative variables of each factor (Kirch et al, 2017). EFA was conducted

in two models: Model 1 - *Barriers* and Model 2 - *Success Factors*. The analysis was divided into four distinct steps: 1) model validation, 2) factor extraction, 3) factor rotation, 4) results interpretation.

4.7.1. Model validation

To validate the model and confirm that the sample size is suitable for EFA, the Kaiser-Meyer-Olkin (KMO) test was used, which compares simple correlations with partial correlations observed between the variables (Dodge, 2008).

Kaiser (1974) recommends only accepting values ≥0,5 in the KMO test since values below this limit should lead to collecting more cases for the sample or choosing new variables. The KMO test result has the value 0.908 for Barriers and 0.922 for Success Factors (Table 8), which represent superb values, according to Hutcheson & Sofroniou, (1999) and confirms that EFA is appropriate for the sample data.

Bartlett's sphericity test (Table 8), measures whether EFA is appropriate for the problem and whether there is a strong enough correlation for factor analysis to be applied. In this case, as the *p*-value (sig) is lower than the significance level α=5% (α=0.001), we admit that the analysis is adequate and that there are significant correlations between some variables. (Bartlett, 1951).

Table 8
KMO and Bartlett's Test of Sphericity indicators
Source: Authors elaboration with SPSS output

		Barriers	Success Factors
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0,908	0,922
Bartlett's Test of Sphericity	Approx. Chi-Square	2152,255	3108,906
	df	171	171
	Sig.	0,000	0,000

4.7.2. Factors extraction

The adequacy of each variable was also analyzed individually. For this, the Measure of Sampling Adequacy (MSA) test, obtained through the anti-image matrix, was used, as well as the analysis of the communalities, which evaluates the proportion of variation of each variable explained by the factors extracted from the models. The anti-image matrix reveals reduced levels of adequacy of the variables if the value of the test is <0.5. No values below 0.5 were detected.

Regarding the communalities matrix (Table 9), the percentage of the variance of each variable explained in the extracted factors should be ≥0,5 for each variable, so that it represents significantly some factor of the model. Values <0.5 indicate that there may be a weak relationship with the extracted factors.

Through Table 9, we can observe that Barriers B6 and B8, present values 0.490 and 0.498, respectively. Regarding the Success Factors, the variables F4 and F19, present values of 0.439 and 0.491, respectively. Although the values of these variables are below 0.5, they are very close to this limit and further analysis is necessary to draw conclusions.

Table 9
Communalities
Source: Authors elaboration with SPSS output

	Initial	Extraction
Model 1 - Barriers		
B1. General resistance to change	1,000	0,773
B11. Using old and new approaches side by side	1,000	0,714
B14. High-level requirements management largely missing in Agile	1,000	0,698
B2. Skepticism towards the new way of working	1,000	0,675
B16. Gap between long and short term planning	1,000	0,661
B17. Other functions unwilling to change	1,000	0,654
B3. Lack of coaching	1,000	0,642
B15. Creating and estimating user stories hard	1,000	0,634
B18. Challenges in adjusting to incremental delivery pace	1,000	0,628
B13. Management in waterfall mode	1,000	0,624
B9. Achieving technical consistency	1,000	0,622
B12. Middle managers' role in agile unclear	1,000	0,610
B7. Reverting to the old way of working	1,000	0,603
B10. Interpretation of Agile differs between teams	1,000	0,570
B4. Challenges in rearranging physical spaces	1,000	0,569
B5. Misunderstanding Agile concepts	1,000	0,563
B19. Rewarding model not teamwork centric	1,000	0,519
B8. Interfacing between teams difficult	1,000	0,498
B6. Lack of guidance from literature	1,000	0,490
Model 2 - Success Factors		
F7. Start with a pilot to gain acceptance	1,000	0,811
F8. Gather insights from a pilot	1,000	0,791
F2. Educate management on Agile	1,000	0,723
F17. Align the organization	1,000	0,719
F3. Recognize the importance of change leaders	1,000	0,712
F14. Create and communicate positive experiences in the beginning	1,000	0,710
F16. Cherish Agile communities	1,000	0,690
F13. Make the change transparent	1,000	0,687
F15. Concentrate on Agile values	1,000	0,686
F5. Conform to a single approach	1,000	0,670
F9. Provide training on Agile methods	1,000	0,624
F1. Ensure management support	1,000	0,622
F12. Communicate the change intensively	1,000	0,617
F10. Coach teams as they learn by doing	1,000	0,598
F11. Engage everyone in the organization	1,000	0,598
F18. Allow teams to self-organize	1,000	0,566
F6. Map to old way of working to ease adaptation	1,000	0,524
F19. Recognize the importance of the Product Owner role	1,000	0,491
F4. Customize the Agile approach carefully	1,000	0,439

Extraction Method: Principal Component Analysis.

The next step in this process was to extract the number of factors for the Barriers and the Success Factors (Table 10). A Principal Component Analysis was performed, with orthogonal *Varimax* rotation of the factors. Since the sample size is larger than 250 cases and the average of communalities is larger than 0.6, the Kaiser criteria was followed (Kaiser, 1974) and all factors with Eigenvalues>1 were retained: five factors for the Barriers and four factors for the Success Factors. These factors explain 61.8% and 64.6%, respectively, the total model variance for Barriers and Success Factors, which represent acceptable values.

Table 10
Total variance explained
Source: Authors elaboration with SPSS output

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
Model 1 - Barriers									
1	7,155	37,658	37,658	7,155	37,658	37,658	2,679	14,102	14,102
2	1,387	7,301	44,959	1,387	7,301	44,959	2,397	12,618	26,720
3	1,167	6,143	51,102	1,167	6,143	51,102	2,378	12,517	39,237
4	1,032	5,430	56,532	1,032	5,430	56,532	2,311	12,161	51,398
5	1,006	5,297	61,829	1,006	5,297	61,829	1,982	10,431	61,829
6	0,908	4,782	66,611						
7	0,709	3,733	70,343						
8	0,665	3,502	73,846						
9	0,613	3,229	77,074						
10	0,592	3,118	80,192						
11	0,547	2,881	83,073						
12	0,528	2,781	85,854						
13	0,516	2,715	88,569						
14	0,478	2,517	91,086						
15	0,423	2,228	93,314						
16	0,408	2,148	95,462						
17	0,330	1,738	97,199						
18	0,286	1,504	98,704						
19	0,246	1,296	100,000						
Model 2 - Success Factors									
1	8,446	44,451	44,451	8,446	44,451	44,451	4,911	25,849	25,849
2	1,496	7,874	52,325	1,496	7,874	52,325	3,025	15,921	41,769
3	1,222	6,432	58,757	1,222	6,432	58,757	2,664	14,024	55,793
4	1,113	5,859	64,616	1,113	5,859	64,616	1,676	8,823	64,616
5	0,868	4,567	69,183						
6	0,846	4,453	73,636						
7	0,712	3,745	77,381						
8	0,602	3,167	80,548						
9	0,562	2,957	83,505						
10	0,434	2,286	85,791						
11	0,411	2,164	87,955						
12	0,400	2,104	90,059						
13	0,339	1,783	91,841						
14	0,324	1,703	93,544						
15	0,305	1,606	95,150						
16	0,281	1,481	96,632						
17	0,263	1,382	98,013						
18	0,207	1,089	99,102						
19	0,171	0,898	100,000						

Extraction Method: Principal Component Analysis

4.7.3. Results interpretation

The interpretation of the factors was made through the Rotated Component Matrix (Table 11), obtained after the *Varimax* rotation. In each line of the table, were selected for each factor loadings ≥ 0,4 that represent the variables that contribute the most to the respective factor. Based on these assumptions created for the models, none of the variables presented values <0.4.

Table 11

Rotated Component Matrix
Source: Authors elaboration with SPSS output

	Factor				
	1	2	3	4	5
Model 1 - Barriers					
B1. General resistance to change	0,800				
B2. Skepticism towards the new way of working	0,723				
B17. Other functions unwilling to change	0,637				
B18. Challenges in adjusting to incremental delivery pace	0,554				
B19. Rewarding model not teamwork centric	0,517				
B11. Using old and new approaches side by side		0,775			
B13. Management in waterfall mode		0,612			
B12. Middle managers' role in Agile unclear		0,542			
B5. Misunderstanding Agile concepts		0,513			
B7. Reverting to the old way of working		0,479			
B9. Achieving technical consistency			0,716		
B10. Interpretation of Agile differs between teams			0,654		
B8. Interfacing between teams difficult			0,511		
B15. Creating and estimating user stories hard				0,759	
B14. High-level requirements management largely missing in Agile				0,737	
B16. Gap between long and short term planning				0,729	
B3. Lack of coaching					0,727
B4. Challenges in rearranging physical spaces					0,686
B6. Lack of guidance from literature					0,577
Model 2 - Success Factors					
F17. Align the organization	0,806				
F16. Cherish Agile communities	0,796				
F14. Create and communicate positive experiences in the beginning	0,735				
F15. Concentrate on Agile values	0,689				
F13. Make the change transparent	0,688				
F18. Allow teams to self-organize	0,678				
F19. Recognize the importance of the Product Owner role	0,633				
F11. Engage everyone in the organization	0,534				
F12. Communicate the change intensively	0,524				
F2. Educate management on Agile		0,788			
F3. Recognize the importance of change leaders		0,771			
F1. Ensure management support		0,720			
F7. Start with a pilot to gain acceptance			0,876		
F8. Gather insights from a pilot			0,812		
F9. Provide training on Agile Methods			0,533		
F10. Coach teams as they learn by doing			0,483		
F5. Conform to a single approach				0,797	
F6. Map to old way of working to ease adaptation				0,669	
F4. Customize the Agile approach carefully				0,583	

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 6 iterations.

To confirm the internal consistency of each factor, the analysis of Cronbach's Alpha was performed for each factor (Table 12). We could conclude that the Barriers presented in Factors 1 and 2 have a high level of internal consistency while the Factors 3 and 4 present acceptable values. Factor 5 presents unacceptable internal consistency. Regarding the Success Factors, Factors 1 and 2 present a high level of internal consistency while Factor 3 presents an acceptable value. The Cronbach's Alpha value for Factor 4 has an unacceptable consistency.

Table 12

Cronbach's Alpha of the factors extracted for the Barriers and Success Factors
Source: Authors elaboration with SPSS output

	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
Model 1 - Barriers			
Factor 1	0,797	0,810	5
Factor 2	0,803	0,807	5
Factor 3	0,699	0,700	3
Factor 4	0,742	0,742	3
Factor 5	0,574	0,479	3
Model 2 - Success Factors			
Factor 1	0,918	0,919	9
Factor 2	0,820	0,820	3
Factor 3	0,800	0,797	4
Factor 4	0,530	0,527	3

4.8. Multiple linear regression model

Since this research is an exploratory study that aims to identify the Barriers and Success Factors that better explain the success of an Agile Transformation, it is appropriate to conduct a multiple linear regression analysis, where the relationship between the multiple independent variables (Barriers and Success Factors) and the dependent variable (Agile Transformation Success) is determined, and where the relative predictive importance of the independent variables is defined (Williams & Monge, 2001). According to McClave, Benson & Sincich (1988), the multiple linear regression model, assuming that there are k independent variables, could be described as follows:

$$y = \beta_0 + \beta_1\chi_1 + \beta_2\chi_2 + ... + \beta_k\chi_k + \mathcal{E}$$

where y is the dependent variable and $\chi_1, \chi_2, ..., \chi_k$ are the independent variables and β_i is the regression coefficient and $\mathcal{E}$ is the random error component. The value of the coefficient β_i determines the contribution of the independent variable χ_1, as the other variables χ are held constant and β_0 is the intercept with y. In this study, multiple linear regression analysis was performed in two dimensions - Barriers and Success Factors. The above translates into the following equation for Barriers:

$$y = \beta 0 + \beta_1 B_1 + \beta_2 B_2 + ... + \beta_k B_{19}$$

where y is the dependent variable Agile Transformation Success and β_i is the partial regression coefficient for $_i$ Barrier (B).

In the case of Success Factors, it translates into the following equation:

$$y = \beta 0 + \beta_1 F_1 + \beta_2 F_2 + ... + \beta_k F_{19}$$

where y is the dependent variable Agile Transformation Success and β_i is the partial regression coefficient for $_i$ Success Factors (F). First, all 19 independent variables of the Barriers were simultaneously inserted in each model

to calculate the coefficients, considering the interaction with the other variables (coefficient b). It is expected to see a relationship with negative direction between the Barriers and the Agile Transformation Success: the higher the frequency of occurrence of a certain Barrier, the lower the Agile Transformation Success. The same procedure was performed for the Success Factors dimension, where the 19 variables were inserted in the regression model. In this case, it is expected to see a relationship with positive direction between the Success Factors and Agile Transformation Success: the higher the frequency of occurrence of a certain Success Factor, the higher is the Agile Transformation Success. In Table 13, we can observe that only Barrier B11 and Success Factors F15, F2, F19, F12 and F18 have an acceptable level of significance ($p \leq 0,05$) in the presence of the remaining variables of each model.

Table 13
Regression coefficients, level of significance and collinearity
Source: Authors elaboration with SPSS output

	b	SE b	β	t	Sig.	Tolerance	VIF
Model 1 - Barriers							
(Constant)	11,249	0,565		19,894	0,000		
B11. Using old and new approaches side by side	-0,375	0,106	-0,236	-3,523	0,001	0,569	1,756
B16. Gaps between short and long term planning	-0,177	0,127	-0,090	-1,394	0,164	0,620	1,614
B3. Lack of coaching	-0,169	0,114	-0,094	-1,476	0,141	0,638	1,568
B7. Reverting to the old way of working	-0,162	0,115	-0,100	-1,403	0,162	0,505	1,980
B12. Middle managers' role in Agile unclear	-0,129	0,118	-0,083	-1,092	0,276	0,441	2,268
B5. Misunderstanding Agile concepts	-0,116	0,155	-0,052	-0,744	0,458	0,535	1,870
B13. Management in waterfall mode	-0,110	0,105	-0,074	-1,046	0,297	0,515	1,943
B18. Challenges in adjusting to incremental delivery pace	-0,099	0,122	-0,059	-0,817	0,415	0,484	2,064
B6. Lack of guidance from literature	-0,098	0,094	-0,061	-1,032	0,303	0,736	1,359
B8. Interfacing between teams difficult	-0,049	0,133	-0,024	-0,369	0,713	0,621	1,610
B1. General resistance to change	-0,048	0,157	-0,025	-0,307	0,759	0,401	2,492
B9. Achieving technical consistency\	-0,037	0,134	-0,018	-0,276	0,783	0,617	1,621
B10. Interpretation of agile differs between teams	-0,022	0,125	-0,011	-0,177	0,860	0,609	1,643
B19. Rewarding model not teamwork centric	-0,010	0,084	-0,008	-0,124	0,901	0,650	1,538
B4. Challenges in rearranging physical spaces	0,008	0,088	0,005	0,092	0,927	0,740	1,351
B17. Other functions unwilling to change	0,021	0,110	0,013	0,193	0,847	0,593	1,687
B15. Creating and estimating user stories hard	0,025	0,117	0,014	0,217	0,828	0,604	1,655
B14. High-level requirements management largely missing in Agile	0,112	0,125	0,062	0,895	0,372	0,538	1,860
B2. Skepticism towards the new way of working	0,122	0,149	0,063	0,820	0,413	0,438	2,284
Model 2 - Success Factors							
(Constant)	1,890	0,511		3,698	0,000		
F15. Concentrate on Agile values	0,344	0,128	0,203	2,692	0,008	0,331	3,024
F2. Educate management on Agile	0,340	0,113	0,196	2,997	0,003	0,440	2,274
F19. Recognize the importance of the Product Owner role	0,297	0,095	0,184	3,113	0,002	0,540	1,852
F12. Communicate the change intensively	0,269	0,122	0,154	2,208	0,028	0,388	2,579
F18. Allow teams to self-organize	0,264	0,097	0,169	2,720	0,007	0,487	2,051
F5. Conform to a single approach	0,156	0,089	0,087	1,745	0,082	0,750	1,332
F11. Engage everyone in the organization	0,129	0,099	0,085	1,297	0,196	0,438	2,283
F17. Align the organization	0,107	0,113	0,066	0,944	0,346	0,384	2,603
F7. Start with a pilot to gain acceptance	0,056	0,102	0,040	0,547	0,585	0,351	2,847
F14. Create and communicate positive experiences in the beginning	0,040	0,126	0,024	0,320	0,749	0,322	3,102
F8. Gather insights from a pilot	0,033	0,113	0,024	0,296	0,767	0,286	3,491
F16. Cherish Agile communities	0,026	0,097	0,018	0,264	0,792	0,403	2,482
F9. Provide training on Agile Methods	-0,014	0,102	-0,009	-0,142	0,887	0,432	2,316
F13. Make the change transparent	-0,034	0,120	-0,021	-0,284	0,777	0,335	2,987

F4. Customize the agile approach carefully	-0,037	0,106	-0,017	-0,351	0,726	0,822	1,216
F1. Ensure management support	-0,062	0,118	-0,032	-0,529	0,598	0,528	1,894
F6. Map to old way of working to ease adaptation	-0,077	0,085	-0,045	-0,905	0,366	0,767	1,304
F3. Recognize the importance of change leaders	-0,172	0,114	-0,097	-1,511	0,132	0,459	2,181
F10. Coach teams as they learn by doing	-0,204	0,112	-0,125	-1,827	0,069	0,403	2,482

a. Dependent Variable: S1. How do you rate the success of the transformation to Agile Methods of the Organization?

To optimize the models, a stepwise screening procedure was carried out to present as few variables as possible with an acceptable level of significance ($p \leq 0,05$) and, at the same time, the ones that better explain the success of an Agile Transformation. Once again, this procedure was performed in two dimensions, for the Barriers and Success Factors. With this procedure, we can identify which variables identified by Dikert et al (2016) better predict the outcome of the dependent variable – Agile Transformation success.

The results showed that Barriers B16, B11, B3 and B7 and Success Factors F18, F2, F19, F12 and F15, ordered by importance in each model (Table 14), present the best coefficients (b), representing the variables with the greatest contribution to explain each model, for a significance level of $p \leq 0,05$.

Table 14
Optimization of regression coefficients, level of significance and collinearity
Source: Authors elaboration with SPSS output

	b	SE b	β	t	Sig.	Tolerance	VIF
Model 1 - Barriers							
(Constant)	11,003	0,441		24,945	0,000		
B11. Using old and new approaches side by side	-0,485	0,093	-0,306***	-5,235	0,000	0,737	1,357
B3. Lack of coaching	-0,284	0,100	-0,158**	-2,840	0,005	0,816	1,226
B16. Gap between long and short term planning	-0,249	0,105	-0,126*	-2,371	0,018	0,885	1,129
B7. Reverting to the old way of working	-0,239	0,101	-0,148*	-2,364	0,019	0,643	1,556
Model 2 - Success Factors							
(Constant)	1,905	0,349		5,464	0,000		
F15. Concentrate on Agile values	0,421	0,102	0,249***	4,128	0,000	0,520	1,924
F18. Allow teams to self-organize	0,280	0,091	0,179**	3,085	0,002	0,562	1,779
F19. Recognize the importance of the Product Owner role	0,280	0,091	0,173**	3,080	0,002	0,597	1,674
F12. Communicate the change intensively	0,244	0,102	0,140*	2,398	0,017	0,559	1,789
F2. Educate management on Agile	0,216	0,092	0,125*	2,358	0,019	0,674	1,483

a. Dependent Variable: S1. How do you rate the success of the transformation to Agile Methods of the organization?

The p-value of F-test was then analyzed to confirm whether the models are significant. With a p-value from zero to three decimal places, (0.000) models 1 and 2 indicate that are statistically significant. With F-values of 27,233 for Model 1 - Barriers and 48,074 for Model 2 - Success Factors, we can conclude that each of the final models significantly improves our ability to predict and explain the success of Agile Transformations (Table 15).

Table 15
F-test
Source: Authors elaboration with SPSS output

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	233,943	4	58,486	27,233	,000b
	Residual	620,646	289	2,148		
	Total	854,588	293			
2	Regression	388,775	5	77,755	48,074	,000c
	Residual	465,814	288	1,617		
	Total	854,588	293			

Variable Dependent: S1. How do you rate the success of the transformation to Agile Methods of the organization?
b. Predictors: (Constant), B16. Gap between long and short term planning, B11. Using old and new approaches side by side, B3. Lack of coaching, B7. Reverting to the old way of working
c. Predictors: (Constant), F18. Allow teams to self-organize, F2. Educate management on Agile, F19. Recognize the importance of the Product Owner role, F12. Communicate the change intensively, F15. Concentrate on Agile values

R^2 of Model 1 is 0.274, meaning that approximately 27% of the variability of Agile Transformation Success is explained by the Barriers identified in the model. In this case, adjusted R^2 indicates that about 26% of the variability of Agile Transformation Success is explained by the Barriers identified in the model, even after considering the number of independent variables (Table 16).

R^2 of Model 2 is 0.455, meaning that about 46% of the variability of Agile Transformation Success is explained by the Success Factors identified in the model. In this case, adjusted R^2 indicates that about 45% of the variability in Agile Transformation Success is explained by the Success Factors identified in the model, even after considering the number of independent variables (Table 16).

Table 16

Summary of models
Source: Authors elaboration with SPSS output

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	,523a	0,274	0,264	1,465	0,274	27,233	4	289	0,000
2	,674b	0,455	0,445	1,272	0,455	48,074	5	288	0,000

a. Predictors: (Constant), B16. Gap between short and long term planning, B11. Using old and new approaches side by side, B3. Lack of coaching, B7. Reverting to the old way of working

b. Predictors: (Constant), F18. Allow teams to self-organize, F2. Educate management on Agile, F19. Recognize the importance of the Product Owner role, F12. Communicate the change intensively, F15. Concentrate on Agile values

Variable Dependent: S1. How do you rate the success of the transformation to Agile Methods of the Organization?

To summarize the results achieved through multiple linear regression analysis for each model, Table 17 identifies the key statistics of each one.

Table 17

Reproduction of final models
Source: Authors elaboration with SPSS output

	b	SE b	β
Model 1 - Barriers			
(Constant)	11,003	0,441	
B11. Using old and new approaches side by side	-0,485	0,093	-0,306***
B3. Lack of coaching	-0,284	0,100	-0,158**
B16. Gap between short and long term planning	-0,249	0,105	-0,126*
B7. Reverting to the old way of working	-0,239	0,101	-0,148*
Model 2 - Success Factors			
(Constant)	1,905	0,349	
F15. Concentrate on Agile values	0,421	0,102	0,249***
F18. Allow teams to self-organize	0,280	0,091	0,179**
F19. Recognize the importance of the Product Owner role	0,280	0,091	0,173**
F12. Communicate the change intensively	0,244	0,102	0,140*
F2. Educate management on Agile	0,216	0,092	0,125*

R^2 Model 1: 0.274 R^2 Model 2: 0.455 *p<0.5 **p< 0.1 ***p<0.001

5. Discussion

5.1. Answers to research questions

Considering all the assumptions used in data analysis and based on the results obtained in the multiple linear regression analysis, it was possible to answer the research questions of this research. Each of the research questions is answered in the following sub-questions.

5.1.1. Answer to research question 1

The research question 1 was *"What Barriers better explain the success of an Agile Transformation in organizations operating in Portugal?".* Of the 19 Barriers identified, 4 of them have a statistically significant impact on the Agile Transformation Success. The Barriers that better explain Agile Transformation Success are:

- B11. *Using old and new approaches side by side;*
- B3. *Lack of coaching;*
- B16. *Gap between short and long term planning;*
- B7. *Reverting to the old way of working.*

5.1.2. Answer to research question 2

The research question 2 was *"What Success Factors better explain the success of an Agile Transformation in organizations operating in Portugal?"*. Through multiple linear regression analysis, it was possible to identify that of the 19 Success Factors identified, 5 of them have a statistically significant impact on the success of an Agile transformation. The Success Factors that better explain Agile Transformation Success are:

- F15. *Concentrate on agile values;*
- F18. *Allow teams to self-organize;*
- F19. *Recognize the importance of the Product Owner role;*
- F12. *Communicate the change intensively;*
- F2. *Educate management on Agile.*

5.2. Comments on Barriers

The factor analysis conducted in this research grouped the Barriers into five factors (Table 11). Considering the Barriers in each factor, the following designation is suggested for each: Factor 1 – *Resistance to Change*; Factor 2- *Ambiguity in the way of working*; Factor 3 – *Lack of technical consistency*; Factor 4 - *Difficulty in planning and estimating* and Factor 5 - *Lack of coaching to teams.*

One of the biggest barriers to transformation is the process model change, from a detailed design to one that supports evolutionary and iterative progress.In this way, *Using old and new approaches side by side* could be problematic since they are two process models that have different forms of collaboration and planning (Dikert et al, 2016). A clear communication and training about how to use the new processes and an utilization of a pilot project and gradual changes should be used to avoid employee frustration (Kalenda et al, 2018). Teams without adequate training could struggle in using Agile Methods properly, which could lead to people abandon them and *revert to the old way of working* (Dikert et al, 2016). Should be clear to the entire organization why the way of working is changing and what are the benefits of transformation in the long term. A top-down implementation

should be avoid otherwise the people could have the skills but could not be convinced that Agile will work (Conboy et al, 2017). As mentioned by Conboy & Carol (2019), it's important to build metrics to support the success of the transformation, to identify issues and establish next steps. To mitigate this barrier, we also recommend strong people involvement and training to aware people that some benefits could not be immediate achieved and take some time until get there. Both these Barriers are part of Factor 1 – *Resistance to Change*. To avoid the *gap between short and long term planning* teams should be focused in give short term visibility of the backlog and just a high level view for long term sprints. As mentioned by Dikert et al (2016), long term planning is a schedule-driven practice that should be avoid to preserve agility. This Barrier is part of the factor related with *Difficulty in planning and estimating. Lack of coaching* could prevent pilot teams to repeat what they learned when agile is scaling in the organization (Dikert et al, 2016). It is recommended the assignment of an Agile Champion to lead these transformations to teach Agile values and principles correctly (Conboy et al, 2017). The change to short and medium term planning instead of long term planning could represent an issue in the transition and this Barrier is part of Factor 5 – *Lack of coaching to teams*

5.3. Comments on Success Factors

The factor analysis conducted in this research grouped the Success Factors into 4 Factors (Table 11). Considering the Success Factors in each factor, the following designation is suggested for each: Factor 1 - *Communication and involvement*; Factor 2 - *Training and commitment*; Factor 3 - *Gradual approach* and FActor 4 - *Adaptation of the way of working*;

According to our findings, the commitment to *focus on Agile values*, rather than tools, appears to be a key Success Factor to create a new culture to support an Agile Transformation at all levels of the organization, as mentioned by Calnan & Rozen (2019) and Kalenda et al (2018) Focusing on the principles and values of Agile methods rather than the processes and tools also help stakeholders understand why are we implementing Agile Methods (Fry & Greene, 2007). The openness to *allow teams to self-organize* is seen as an Agile Principle related with employee autonomy that must be in place to establish Agile Methods properly and to create commitment to the change (Dikert et al, 2016). Self-organized teams could mean anything to anyone. It's important to define the rules of the game and help the team understand what kind of flexibility they have to reach their goals (Fry & Greene, 2007). This type of transformation requires a revision and adaptation of existing and new roles to align Agile ideas and new way of working (Noutilla et al, 2016). *Recognize the importance of the Product Owner role is* highlighted as a key success factor to increase the team performance. Product Owners should be properly engaged in Agile Transformations and should receive training in Agile Methods and Techniques to properly manage the backlog, user stories and establish the Agile Planning (Dikert et al, 2016). The organization must be prepared for change and should *communicate the change intensively* to ensure that the purpose is well known across all organization (Naslund & Kale, 2020). To facilitate change management processes, organizations should identify the Change Leaders with a positive attitude and previous experience in Agile Methods who are able to facilitate coaching sessions across the organization (Dikert et al, 2016) and share agile success stories to provide motivation and belief (Conboy et al, 2017). Over-communicate vision, plans and information with everyone could be a powerful tool to adapt daily (Fry & Greene, 2007). Additionally, our research shows that the active support and involvement from the management team is critical to keep people motivated and lead by example, as suggested by related earlier studies (Campanelli et al, 2017); Kalenda et al, 2018; Karvonen et al, 2018). While the success factor *Educate Management on Agile* was considered a critical factor to the success of an Agile

Transformation in our research, *Ensure Management Support* did not make the final list of the 5 success factors that most contribute to the success of a transformation. However, it was demonstrated in the correlation analysis carried out, that there is a moderate correlation between these factors, which means that management education, facilitated through Agile training sessions, is a factor that directly contributes to support management in the transformation. Naslund & Kale (2020) mentioned this factor as the most critical to the success of an Agile Transformation. Of these four Success Factors, only *Ensure Management Support* belongs to Factor 2 - *Training and commitment*, while the rest belong to Factor 1 - *Communication and involvement*

6. Conclusions

Despite the growing amount of evidence on the success of Agile Methods in several professional sectors, there are still few scientific studies researching Agile Transformations challenges in Large-Scale. This study aims to fill this gap through explanatory research, supported by existing literature and using quantitative analysis. A preliminary list of potential Barriers and Success Factors of Agile Transformations was created and compiled and through a questionnaire 294 valid responses were collected from respondents directly involved in Agile Transformations.

Correlation analysis, factor analysis and multiple linear regression analysis techniques were used to establish two different models – Barriers and Success Factors - that indicate which variables are really relevant to explain Agile Transformation Success. The results show that the Barriers *Using old and new approaches side by side*, *Lack of coaching*, *Gap between short and long term planning* and *Reverting to the old way of working* represent the Barriers that better explain Agile Transformation failure. The Success Factors *Concentrate on agile values*, *Allow teams to self-organize*, *Recognize the importance of the Product Owner role*, *Communicate the change intensively*, *Educate management on Agile* represent the Success Factors that better explain Agile Transformation success.

At the academic level, this research aims to contribute to fill the gap in the scientific literature on Agile Transformations by identifying the Barriers and Success Factors with higher representativeness referenced in the systematic literature review of Dikert et al (2016). For practitioners and professionals involved in Agile Transformations, it is recommended to consider the most relevant Barriers and Success Factors identified in this research as they will be critical for the success or failure of an Agile Transformation.

6.1. Limitations

Through the survey data, this research has three limitations that need to be recognized. The first limitation relates to the fact that the sample is a non-probabilistic sample for convenience. Although it is more accessible to perform in terms of time and cost, some caution is needed in generalizing with statistical accuracy about the population in this type of sample.

The second limitation is related to the origin of Agile Transformations. Although it was mentioned in the communication to each respondent and reinforced in the survey header that this research aims to analyze Agile Transformations that took place in Portugal, it is not possible to state with total certainty that all the cases collected concern Agile Transformations that took place in Portugal. The fact that the research focuses only on the Portuguese reality also represents a geographical limitation that should be noted.

The third limitation concerns the sample classification variables that were not directly analyzed after data collection. The focus of this study was to analyze the data that concern the Barriers and Success Factors and Agile

Transformation Success and not the attribute type data collected from each case. Complementary studies focusing on these variables are recommended.

6.2. Future lines of research

We identified several variables and challenges that influence an Agile Transformation success. These challenges need more in-depth research in cooperation with Portuguese organizations to identify a comprehensive understanding of each Barrier and Success Factor and to find appropriate models and techniques to manage an Agile Transformation and an Agile Project Portfolio. More research is needed to confirm cause-effect relationships between Barriers and Success Factors.

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