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Enterprise Agile Transformation Model: barriers, enablers and best practices to implement Agile Methods

Frederico Cipriano Batista

PhD in Management, specialization of Strategy and Entrepreneurship

Supervisors:

PhD Leandro Pereira, Professor, Iscte - Instituto Universitário de Lisboa

PhD Renato Lopes da Costa, Professor, Iscte - Instituto Universitário de Lisboa

December, 2021



BUSINESS
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Jury:

PhD Ana Margarida Madureira Simaens, Assistant Professor, Iscte - Instituto Universitário de Lisboa (President of the Jury)

PhD Maria Teresa Barros, Adjunct Professor, ISCAP - Instituto Superior de Contabilidade e Administração do Porto - Instituto Politécnico do Porto

PhD Aldora Gabriela Gomes Fernandes, Assistant Professor, Universidade de Coimbra

PhD José Alberto de Jesus Borges, Assistant Researcher, Academia Militar

PhD Pedro Miguel Ribeiro de Almeida Fontes Falcão, Assistant Professor, Iscte - Instituto Universitário de Lisboa

PhD Leandro Luis Ferreira Pereira, Assistant Professor with Habilitation, Iscte - Instituto Universitário de Lisboa

December, 2021

Dedication

This research is completely dedicated to the people I most admire and love in my life – my parents, my brother and my wife.

“If I have seen further it is by standing on the shoulders of Giants.”

Isaac Newton

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The greatest achievements of our lives are never achieved individually. They are always the result of sacrifices, support and enthusiasm of the people who care and love us the most. In this sense, one of the most rewarding and joyful parts of having completed a PhD thesis is looking back at everyone who has helped me along the way.

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Resumo

Os Métodos Agile representam atualmente um dos temas mais discutidos nas organizações e equipas que trabalham com produtos tecnológicos. No entanto, ainda existe um conjunto reduzido de estudos científicos que expliquem, de uma forma clara, como uma organização pode adotar estes métodos.

Esta tese apresenta três objetivos principais, onde foi desenvolvido um estudo para cada um: (i) identificar na literatura as melhores práticas para implementar e gerir um portefólio de projetos agile, (ii) identificar as barreiras e facilitadores de uma Transformação Agile e (iii) expandir um modelo teórico que permita conduzir as organizações a realizar uma Transformação Agile. O primeiro estudo recorreu à abordagem qualitativa para realizar a revisão sistemática da literatura. O segundo estudo utilizou uma abordagem quantitativa para identificar as barreiras e facilitadores. O terceiro estudo utilizou uma abordagem qualitativa para desenvolver o modelo teórico Enterprise Agile Transformation Model.

Esta tese concluiu que, para a implementação e gestão de um portefólio de projetos agile, existem quatro dimensões relevantes a considerar. Foram também identificadas quatro barreiras e cinco facilitadores determinantes para o sucesso de uma Transformação Agile. Já o Enterprise Agile Transformation Model, considera ações para mitigar as barreiras e potenciar os facilitadores de uma Transformação Agile e apresenta recomendações para aumentar a maturidade ágil das organizações.

A contribuição académica consiste em colmatar a lacuna existente na literatura científica sobre Transformações Agile e gestão de portefólio de projetos agile.

Para a prática, a contribuição passa por dar ferramentas, estratégias e recomendações para a implementação de Métodos Agile nas organizações.

Palavras-chave: Métodos Agile, Gestão de Portefólio de Projetos Agile, Transformações Agile, Enterprise Agile Transformation Model

JEL Codes: M10, M15, O21

Abstract

Agile Methods currently represent one of the most discussed topics in organisations and teams working with technological products. However, there are still few scientific studies that clearly explain how an organisation can adopt these methods.

This thesis has three main objectives, where was developed a study for each: (i) identify in the literature the best practices to implement and manage an agile project portfolio, (ii) identify the barriers and enablers of an Agile Transformation and (iii) expand a theoretical model that allows organisations to carry out an Agile Transformation. The first study used a qualitative approach to carry out a systematic literature review. The second study used a quantitative approach to identify the barriers and enablers. The third study used a qualitative approach to develop the Enterprise Agile Transformation Model.

This thesis concluded that, for the implementation and management of an agile portfolio of projects, there are four relevant dimensions to consider. The key four barriers and five enablers for the success of an Agile Transformation were also identified. The Enterprise Agile Transformation Model considers actions to mitigate barriers and enhance the enablers of an Agile Transformation and provides recommendations to increase the agile maturity of organisations.

The academic contribution focuses on filling the gap in the scientific literature on Agile Transformations and Agile Project Portfolio Management.

For practice, the contribution involves providing a theoretical model with tools, strategies, and recommendations for the implementation of Agile Methods in organisations.

Keywords: Agile Methods, Agile Project Portfolio Management, Agile Transformations, Enterprise Agile Transformation Model

JEL Codes: M10, M15, O21

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Glossary

AAF - Agile Adoption Framework

AM - Agile Methods

APM - Agile Portfolio Management

DAD – Disciplined Agile Delivery

DSDM - Dynamic Systems Development Method

EAT - Enterprise Agile Transformation

EATM - Enterprise Agile Transformation Model

EFA - Exploratory Factor Analysis

FDD - Feature Driven Development

IBM - International Business Machines Corporation

IT - Information Technology

LeSS - Large Scaled Scrum

NASA - National Aeronautics and Space Administration

PDSA - Plan, Do, Study, Act

PMI – Project Management Institute

PMP – Project Manager Professional

PPM - Project Portfolio Management

SAFe - Scaled Agile Framework

XP - Extreme Programming

1. Introduction

This thesis shows the result of the studies that were carried out not only on the best practices found in the literature to implement and manage several projects using Agile Methods but also on the barriers and enablers of an Agile Transformation. The main output of this thesis is the theoretical model *Enterprise Agile Transformation Model* (EATM), that consolidate all the results obtained through these studies. The systematic literature review conducted in the first study contributed to bring more clarity about the best practices for managing agile portfolios and how to ensure the appropriate conditions to be succeeded in this implementation. The second study contributed to fill the gap in the scientific literature on Agile Transformations by identifying the Barriers and Enablers with higher importance referenced in the systematic literature review of Dikert et al (2016). The third study represents an advance in the theory of Agile maturity models topic since it represents an evolution of the current AAF to EATM to serve as a guide for organisations that intend to start adopting agile practices in their projects and teams. The EATM also brings clear management contributions. Through this theoretical model the organisations could assess agile maturity and implement agile principles in their projects and teams.

This section contains the structure of this research and the context about Agile Methods. It also presents the motivation to develop this research that is related with the current challenges of implementing this new way of working in organisations. The need to analyse these challenges and problems in greater detail served as the main motivation for the development of this thesis and the research approach is explained in the last subsection.

1.1.Thesis structure

This thesis is structured in five main sections: 1) introduction, 2) first study on the systematic literature review of agile project and portfolio management, 3) second study on barriers and enablers of Agile Transformations, 4) third study on Enterprise Agile Transformation Model and 5) conclusions.

The literature review of the main topics of this thesis was elaborated within each study, therefore, can be found in section two, three and four. In table 1 it is explained the main topics that were reviewed through the literature.

The methodology used in this thesis was mixed methods, where the first and the third study used a qualitative approach, and the second study used a quantitative approach. The detailed methodological approach is explained in each study and summarized in table 1.

The next subsections of introduction present the context, history of Agile Methods, research gap, objectives, and research summary. The first study of this thesis, presented in section 2 consisted in performing a systematic literature review about the best practices to implement and manage a portfolio of agile projects. The goal of this study was to review the state of the art of this topic and obtain the best practices that could be used in Agile Transformations and help organisations manage agile project portfolios. This literature review analysed 28 scientific papers published between 2005 and 2020, where were identified four groups of best practices that should be considered to implement and manage a portfolio of agile projects: i) *Coordination*, ii) *Prioritization of projects and resources*, iii) *Agility* and iv) *Change management*. The results of this study have significant importance to guide organisations in Agile Transformations and were applied as recommendations to follow in the Enterprise Agile Transformation Model, developed in the third study.

The second study, presented in section 3, focused on finding the barriers and enablers that best explain the failure and success of an Agile Transformation. Through a survey strategy, were collected 294 valid responses of Agile Transformations experts, where were identified four barriers: 1) *Using old and new approaches side by side*, 2) *Lack of coaching*, 3) *Gap between short and long term planning* and 4) *Reverting to the old way of working*, and five enablers: 1) *Concentrate on agile values*, 2) *Allow teams to self-organize*, 3) *Recognize the importance of the Product Owner role*, 4) *Communicate the change intensively* and 5) *Educate management on Agile*. During this study, the enablers had the designation of *success factors*. However, in this thesis the designation was changed to *enablers* to facilitate the understanding of what an enabler is and to create a better contrast with the word *barrier*.

The third study presented in section 4 developed the Enterprise Agile Transformation Model (EATM) which is an evolution of Agile Adoption Framework (AAF) (Sidky, Arthur, & Bohner, 2007). Based on the results achieved through the first and second study, were added to this model new agile practices associated with barriers and enablers of an agile transformation and a set of recommendations, actions and tools found in the literature, that organisations should consider.

Section 5 presents the main conclusions and contributions of this thesis, with a detailed analysis for each of the three studies that, being related to each other, collectively contribute to the final conclusions of this thesis. This section also contains future lines of research, the limitations of each study, and consequently, of this thesis.

1.2.Context

Business challenges as managing changing requirements, pressure to release new products in the market and the need to improve quality of products and services have pushed organisations to embrace new ways of working in projects and products (Korhonen, 2013). To stay competitive in those markets, organisations must boost responsiveness not only in product development and commercial teams but also in other several areas (Sommer, 2019). These new challenges have been reshaping the project management and software development fields over the last twenty years, where the focus is to shorten delivery cycles as a response to rapid market changes (Bäcklander, 2019), which represents one of the core values of Agile Methods (Beck, Cockburn, Jeffries, & Highsmith, 2001). Agile mindset can be used not only on the projects but also on the organisations, to provide the ability to be more effective in managing customer expectations (Putnik & Putnik, 2012) and to adapt fast (Gligor, Esmark, & Holcomb, 2015). These changes in the way of working are shaking the foundations of many traditional management rules (Meyer & Meijers, 2018), where the hierarchy, processes and functional silos need to be adapted to the increasing uncertainty of the markets (Itō & Howe, 2016) and are replaced by incremental and iterative product architectures, adaptative planning and continuous feedback to the teams (Sommer, 2019). In terms of project portfolio management, organisations need to change the long-term planning and budget to iterative cycles that allow adaptative planning and ability to change direction quickly (Horlach, Schirmer, Böhm, & Drews, 2018).

1.3.The history of Agile Methods

Agile methods were created as a reaction to traditional software development approaches, which were process oriented and bureaucratic (Sommer, 2019). These methods, formally created in 2001 through the Agile Manifesto, represent a new way of managing projects and developing products, that has been proving to be effective for the teams that use them (Beck et al, 2001). The Manifesto was written by a group of renowned software development experts who joined together to build an unified software development mindset (Sommer, 2019). Customer interaction, adaptability, collaboration, and the speedy delivery of working products are characteristics emphasized in the 12 principles of the Manifesto that expresses itself through a group of methods that allow unforeseen changes in requirements and solutions throughout the project, using an incremental and iterative approach (Boehm, 2002). According to Wang, Conboy, and Pikkarainen (2012), these methods are a group of frameworks that acquired traction among the practitioners due to the benefits they provide, where are included Dynamic

Systems Development Method (DSDM) (Stapleton, 1997), eXtreme Programming (XP) (Beck, 2000), Crystal (Cockburn, 2001), Lean Software Development (LSD) (Poppendieck, 2001) and Scrum (Schwaber & Beedle, 2002). Although the benefits of Agile Methods are widely recognized by the project management community, their implementation in organisations represents a complex transformation, with several changes not only at the project level but also at the project portfolio level, mostly because the Agile Methods were initially created to be implemented in small teams rather than entire project portfolio (Hossain, Babar, & Paik, 2009). With this transformation new needs such as new roles, team coordination and dependencies emerged. This type of organisational change gained the designation of Agile Transformations (van Oosterhout, Waarts, & Hillegersberg, 2006).

1.4.Motivation to develop this research

Agile methodologies have grown in favor among software development practitioners and academics over the last years. However, a reliable and in-depth scientific studies on this new way of working and how to implement and manage agile project are still scarce (Chow & Cao, 2008; Dikert, Paasivaara, & Lassenius, 2016; Paasivaara, Behm, Lassenius, & Hallikainen, 2018; Schwaber, Laganza, & D'Silva, 2007; Sillitti, Ceschi, Russo & Succi, 2005; Wang, Conboy, & Pikkarainen, 2012). At the same time, and even though the Agile Methods initial assumptions suggested that it is best suited to small projects and small teams (Jørgensen, 2018), large organisations are implementing agile methodologies on a large scale knowing that there are still a lot of questions about this subject that should be considered (Hobbs & Petit, 2017). In this era of rapid change and high unpredictability, organisations need to be aware that this change require not only giving autonomy and accountability to people and teams but also impacting the traditional leadership practices and the way the performance is measured (Meyer & Meijers, 2018).

The focus of this research is entirely dedicated to close this gap and bring more clarity about the steps and the skills that needed the be considered to move forward with an organisational transformation of this nature, not only in terms of change the way of working to Agile Methods but also on how to manage a portfolio of agile projects efficiently daily.

1.5.Research gap and objectives

According to the systematic literature review conducted by Dikert et al (2016), the authors argue that there is a significant lack of scientific studies on the adoption of Agile Methods at an organisational level, citing only six relevant scientific studies on the subject with reliable data.

Most of the available literature on this topic is made up of reports with no reliability in scientific method used published by Agile Methods practitioners (Hodgkins & Hohmann, 2007; Kalliney, 2009; Rautiainen, Schantz, & Vähäniitty, 2011; Stettina & Horz, 2015) and there is a significant gap between Agile Methods and scientific research (Barroca, Sharp, Salah, Taylor, & Gregory, 2018).

The first study had the objective to identify, assess and synthesize best practices and conditions found in the literature that could help the organisations to implement and manage a portfolio of agile projects efficiently.

The second study had the objective to contribute to the increase of scientific studies on Agile Transformations that can provide reliable data (Chow & Cao, 2008; Dikert et al, 2016; Paasivaara et al, 2018; Schwaber et al, 2007; Sillitti, Ceschi, Russo & Succi, 2005) and can identify which barriers and enablers best explain the failure and success of an Agile Transformation.

The aim of the third study was to develop a theoretical model that supports organisations in adopting agile methods, highlighting the most essential agile practices and include an improvement plan to increase agile maturity. The research summary could be found in table 1.

Table 1. Research summary

General research problem		
Despite the complexity associated to Agile Methods, Agile Transformations and Agile Portfolio Management, there is a lack of scientific studies related with these topics (Barroca et al, 2018; Dikert et al, 2016; Hodgkins & Hohmann, 2007; Kalliney, 2009; Rautiainen, Schantz & Vähäniitty, 2011; Stettina & Horz, 2015);		
Studie's title		
Study 1	Study 2	Study 3
Agile Project and Portfolio Management: A Systematic Literature Review	Success and Barrier Factors in Agile Transformations	Enterprise Agile Transformation
Research problem		
Lack of understanding about which practices are the most appropriate to manage the challenges associated with agile portfolio management and which is the most appropriate context	Lack of understanding about the characteristics of Agile Transformations, their Barriers and Enablers	Lack of theories to identify and mitigate barriers and identify and accelerate enablers of agile transformations
Literature review		
Agility and Agile Organisations		
Agile Methods Project Portfolio Management	From Traditional Project Management Methods to Agile Methods Agile Transformations	Agile Transformations Models to measure agile maturity
Definitions for the main constructs		

Table 2. Research summary (continue)

<p>Agile Methods: Incremental and iterative way of working to develop software in a highly collaborative, cost-effective, and timely manner, with teams self-organized and with the focus to meet the changing stakeholders needs, using a lightweight process (Ambler, 2007)</p> <p>Agile Portfolio Management: Group of techniques to 1) setup business areas investments, products, and goals, 2) develop portfolio resourcing, 3) manage iterations priorities and 4) manage time at a portfolio level (Vähäniitty, 2011)</p>		
	<p>Agile Transformation: move from traditional project management methods to Agile Methods by applying agile practices in an organisation and their projects (Denning, 2018; Dikert et al, 2016)</p>	<p>Model to measure agile maturity: maturity models can assess an organisation's agility and determine what needs to be done to go to the next level. Furthermore, the specific maturity levels must be specified in depth and should provide support for implementing agile practices to reach an appropriate maturity level (Schmitt, Theobald, & Diebold, 2019)</p>
Research questions		
<p>Question 1: What is reported in literature between 2005 and 2020, as best practices and techniques that allow to successfully implement and manage an agile portfolio?</p> <p>Question 2: Under what appropriate circumstances and in what organisational configuration have best practices been successfully applied, reported in literature between 2005 and 2020?</p>	<p>Question 1: What Barriers better explain the success of an Agile Transformation in organisations operating in Portugal?</p> <p>Question 2: What Enablers better explain the success of an Agile Transformation in organisations operating in Portugal?</p>	<p>Question 1: How to assess agile practices associated with barriers and enablers of an agile transformation?</p> <p>Question 2: What is the action plan that has the goal to improve the maturity level of agile practices associated with barriers and enablers of an agile transformation?</p>
Research design		
<p>A systematic literature review using 28 articles published between 2005 and 2020, related to Agile, APM and Scaled Agile</p>	<p>Quantitative methods and a survey approach were used to analyse the relation between Barriers and Success Factors and the importance of each one in explaining the success of an Agile Transformation</p>	<p>Qualitative approach and a focus group approach were used to create and validate the Enterprise Agile Transformation Model that serve as a guide for organisations that want to adopt and improve agile practices</p>
Research objectives		
<p>Identify which practices are the most appropriate to manage the challenges associated with agile portfolio management (APM) and which is the most appropriate context</p>	<p>Identify the frequency of occurrence of Barriers and Success Factors and how can they explain the success of Agile Transformations in organisations operating in Portugal</p>	<p>Research objective 1: Evolution of a theoretical model that allows assessing the maturity level of agile practices associated with barriers and enablers of an agile transformation</p> <p>Research objective 2: Definition of a plan to help organisations to improve the maturity level of agile practices associated with barriers and enablers of an agile transformation</p>
Publication Status* and Presentations		

Table 3. Research summary (continue)

	i) Accepted in the International Journal of Agile Systems and Management on 2021, May 2 nd	
i) Accepted in the International Journal of Process and Benchmarking on 2020, Jun 6 th	ii) Presented at an International Business School: Coventry Business School on 25 th of June, 2020	i) Accepted in the International Journal of Agile Systems and Management on 2021, Sep 26 th
ii) Presented at a Postgraduate Conference of Management, Hospitality and Tourism on 2 nd of October, 2020	iii) Chapter written in the book “Voices of Project Management in Portugal”, (Vozes da Gestão de Projeto em Portugal, 2021)	
	iv) Presented in Agile Connect event, (Agile Connect, 2020)	

*Publication status at 31st of November, 2021

2. First study: Agile Project and Portfolio Management: A Systematic Literature Review

2.1. Abstract

The application of agile methods (AM) in project management has shown great efficiency and remarkable results. However, these methods were born to be applied at team level and not at project portfolio level, where the complexity of managing multiple agile projects and teams leads to several challenges of resource management, priorities, and governance model of the project portfolio. The systematic literature review performed in this research aims to identify which practices are the most appropriate to manage the challenges associated with agile portfolio management (APM) and which is the most appropriate context. In this literature review 28 articles published between 2005 and 2020, related to Agile, APM and Scaled Agile were analysed. The existing scientific literature on APM is still very limited and this research aims to establish the baseline and encourage additional empirical studies in this area. For APM practitioners, it is intended to get an understanding of the most efficient practices and techniques for managing Agile Project Portfolios and how to ensure proper conditions for their implementation.

Keywords: Agile, Agile Portfolio Management, Scaled Agile

JEL Classification: M10, M15, O21

2.2. Introduction

Although the AM were originally created to be implemented in small and independent teams, they have been increasingly used by large organisations and in multiple teams (Passivaara, Behm, Lassenius, & Hallikainen, 2018).

As large organisations seek to use AM, several attempts had been made to extend these practices to the project portfolio level by creating new practices and techniques developed by AM practitioners (McMahon, 2005). However, in the context of managing several agile projects from the same portfolio, other features and organisational conditions emerge that should be considered to achieve all the benefits of AM (Kettunen & Laanti, 2008). Kalliney (2009) and Stettina & Hoërz (2015) also indicate that the success of the AM applied at the project level has not led to increased efficiency at the Project Portfolio Management (PPM) level. For Billows (2001), Conboy (2009) and Kalliney (2009), the success of individual projects does not guarantee by itself the success of the project portfolio, as they are complex structures and have additional management needs. Stettina & Hoërz (2015) state that PPM highlights relevant problems when the portfolio is made of agile projects.

Despite the references mentioned above, there are still few empirical studies researching the problem of manage a portfolio of agile projects. Dikert et al (2016) state in their systematic literature review, that there is a large deficit of scientific studies on the adoption of AM on an organisational large-scale, identifying only six scientific articles on the subject. Most of the existing literature on this subject consists of articles or reports written by practitioners of AM, where new methodologies are suggested without scientific ground (Hodgkins & Hohmann, 2007; Kalliney, 2009; Rautiainen, Schantz & Vähäniitty, 2011; Stettina & Hoërz, 2015). Barroca et al (2018), also state that there is still a large gap between AM and scientific research. However, many organisations continue to implement AM on a large scale (Hossain, Babar, & Paik, 2009) despite the efficiency of these transformations still to be proven (Dikert et al, 2016).

Regarding the relevance of this study, it is intended to contribute to increase the efficiency of APM by identifying the most appropriate practices and conditions to implement and manage multiple projects of this nature. As an answer to the changing environment and market conditions (Bäcklander, 2019; Greening, 2013), the reduction of time to market presents itself as one of the main implications by which an organisation can benefit from an agile transformation (Goos & Melisse, 2008; McDowell & Dourambeis, 2007; Prokhorenko, 2012; Silva & Doss, 2007). Challenges related to project management tools (Long & Starr, 2008), people management and schedule management are other aspects related to APM that organisations want to see resolved (Chung & Drummond, 2009). O'Connor (2011) and Denning (2017), state that another motivation is the need to change old ways of working, with heavy and bureaucratic processes that lead to internal bottlenecks. There are many authors who refer this need to rethink the project management processes, like Chung & Drummond (2009), who

highlight the existing process-gates, Hansen & Baggesen (2009) and Murphy & Donnellan (2009) refer the excessive documentation that is produced and Beavers (2007) and Ranganath (2011) refer the delay of processes with long cycles that leads to feedback being transmitted very slowly. We must not forget that the mission of the APM is to ensure the correct implementation of business strategy. There is evidence that the ability to understand and implement AM at the project portfolio level has a positive influence on the identification of emerging strategies and project portfolio success (Kaufmann, Kock, & Gemünden, 2020).

This systematic literature review aims to identify, evaluate, and synthesize best practices and conditions to efficiently implement and manage an agile portfolio and thus gain a common understanding of how organisations can manage these challenges. It is also intended to contribute to the increase of scientific studies on APM.

Chapter 2 of this paper consists in reviewing the theoretical background of the main concepts investigated. Chapter 3 will describe the methodology that was used to perform the systematic literature review. Chapter 4 presents the results and analysis of the data collected and chapter 5 aims to present the discussion and conclusion of this systematic literature review.

2.3.Theoretical background

This section consists of reviewing the theoretical background of the main concepts of this research. Agile Methods were the first topic reviewed and Project Portfolio Management was the second topic considered.

2.3.1. Agile Methods

If we consider that for the Project Management Institute (2017), project management consists of the "application of techniques, tools, knowledge and skills in project activities with the aim of responding successfully to project requirements", we realize that, from an early age, man had to deal with challenging and complex projects. Projects such as the Coliseum in Rome, the Great Wall of China, the Hanging Gardens of Babylon, Stonehenge and the Pyramid of Giza are some of these examples. Although there is physical evidence of these great achievements, there is little information about the methods and techniques that have been used in conducting these projects. It was during the 19th century that the application of project management methodologies began to cover several sectors in a standardized way (Seymour & Hussein, 2014), as demonstrated in table 2. In the 1950's several traditional project management concepts related to project planning and monitoring were created and prescribed to be used across all types of projects, from the simplest to the most complex. This set of techniques contributed to

traditional project management (Collyer, Warren, Hemsley, & Stevens, 2010). The concept of traditional project management arises from the premise that projects are predictable, with well-defined scope boundaries, which allow planning in a detailed way and with few changes in scope (Boehm, 2002; Collyer et al, 2010). The main goal of traditional project management is the optimization of the initial project plan to achieve the scope, schedule and cost initially planned (Shenhar & Dvir, 2007). Although traditional project management methodologies give an image of consistency and predictability, the prescription of these techniques and methods in a generalized way is increasingly being referred to as a disadvantage in some types of projects, since "one size does not fit all" (Shenhar & Dvir, 2007). The focus on exhaustive planning before the execution that traditional project management uses is not the most efficient way to work in environments with high levels of unpredictability, uncertainty of requirements and technical solutions (Dybå & Dingsøyr, 2008). With the advent of the internet, organisations have increased their focus on quickly develop products and services to be available in every part of the world. Due to technological disruption, organisations had to reinvent themselves and become even more efficient and customer oriented through technological products and services (Turban, Outland, King, Lee, Liang, & Turban, 2008). The importance of innovation and technology projects grew up in organisations strategy, which encourage the need to have more agility as an answer to the constant transformation of the external environment (Azanha, Argoud, Junior, & Antoniolli, 2017; Conforto, Amaral, Silva, Ariani, & Kamikawachi, 2016; Denning, 2018; Version One, 2016) and to decrease the failure rates of technological projects that remained high throughout the early years of 2000 (The Standish Group, 2011). With projects not going well, practitioners and researchers began to study and seek alternative ways to implement projects (Dybå & Dingsøyr, 2008) and solutions to manage complexity, volatility and scope changes in projects (Angioni, Carboni, Pinna, Sanna, Serra, & Soro, 2006). Conforto et al. (2016), indicate that the main features of agility in project management are the ability to change project planning in a simplified way and active involvement of the client. Angioni et al (2006), Chin (2004), Cockburn (2002), Cohn (2005), Conforto & Amaral (2009), Cooper (2008), Highsmith, (2004) & Ludwig (2003), state that Agile Methods are the best way to manage projects involving a high level of uncertainty and is defined as a set of techniques that allow a team to make fast changes in the dimensions of people, technology and business (Cockburn, 2005). Cockburn (2005) clarifies that despite AM ideas are based on Theory of Constraints and Lean Thinking, the way of working is independent and was created separately.

Table 4. AM Chronology

1920-1940	1941-1960	1961-1980	1981-2000	2001-2020
1930, PDSA, Shewhart	1950, X-15 hypersonic jet e Mercury Projects with iterative approach, NASA	1961, IBM, US Navy, Canon, Honda and Fujitsu started using iterative and incremental methods	1984, Theory of Constraints, Goldratt	2001, The Agile Manifesto, Agile Alliance
1940, Kanban, Ohno			1986, The new new product development game, Takeuchi & Nonaka	2004, Agile Project Management, Highsmith
			1992, Crystal, Alistair Cockburn	2005, LeSS, Larman & Bas Vodde
			1994, DSDM, The DSMD Consortium	2007, SAFe, Leffingwell
			1995, SCRUM, Schawber & Sutherland	2008, Agile Portfolio Management, Krebs
			1996, XP, Beck	
			1997, FDD, Coad & De Luca	

Conboy & Fitzgerald (2004), proposed an AM conceptual framework, explaining agility as "the ability of an organisation to proactively and reactively adopt changes in a timely manner, through its internal components and its relationships with its environment". These AM features are more suitable to be applied in technological projects, where volatility and complexity of the project environment is frequent (Lindvall et al., 2002). From an internal perspective, AM promotes the sharing of knowledge and learning, improve the levels of satisfaction and trust of project team members.

2.3.2. Project Portfolio Management

According to Martinsuo & Lehtonen (2007), the objectives of PPM are: 1) maximize the financial value of the portfolio, 2) ensure the correct connection of the business strategy with projects, and 3) balance the execution of portfolio projects according to the internal capacity of the organisation. The relevant literature also describes how to implement PPM processes in a traditional way, where Cooper, Edgett, & Kleinschmidt (1992) and Project Management Institute (PMI, 2017) highlight the processes of allocating resources and identifying, prioritizing, and evaluating portfolio projects. According to Lycett, Rassau, Danson & John (2004), the current context of managing a project portfolio assumes the application of prescriptive and highly structured methods for different contexts. Cicmil, Williams, Thomas,

& Hodgson (2006), refer that managing multiple projects cannot be seen in the same way as managing a single project and Aritua, Smith, & Bower (2009), propose to use the theory of complexity to understand how the context of multiple projects have the look of complex adaptive systems.

Another point of view identified by Edgett (2013), is that one of the classic challenges of PPM is the unreliability of reported data. Unreliable data leads to poor decisions and contributes to project pipeline overload since they are not efficient in eliminate low-performance projects (Cooper, Edgett, & Kleinschmidt, 1992). SAFe, one of the most noted frameworks in APM environments (Figure 3), was developed to implement agile practices at the corporate level and includes Lean, Agile and Continuous Delivery practices (Duncan, 2018). However, Schwaber (2015), one of the pioneers of Agile approaches, criticized this structure for being too rigid and hierarchical. Conboy et al (2017), further indicate that focusing on executing programs according to prioritization at the portfolio level can undermine a company's ability to respond to change or learn from it. Denning (2015) also states that the SAFe method tries to fit the Agile ideology into a vertical management structure with excessive bureaucracy.

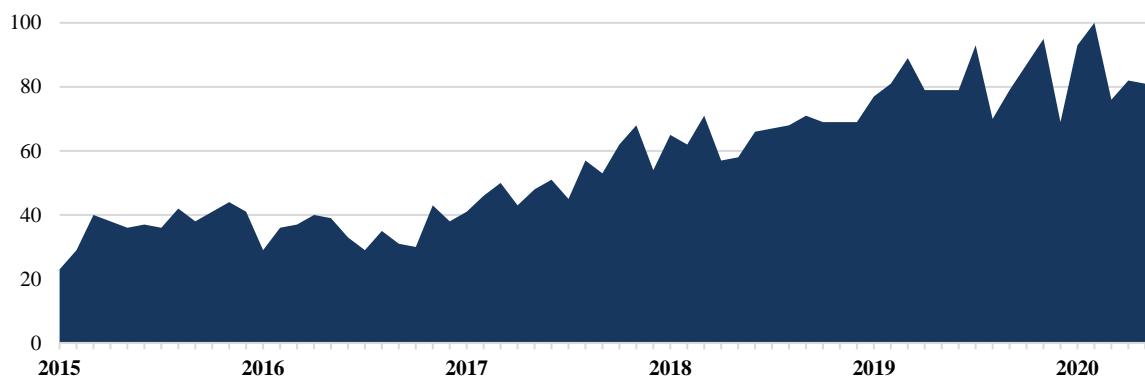


Figure 1. Interest and search for the term "Scaled Agile" on Google over the past 5 years in Google Web Browser

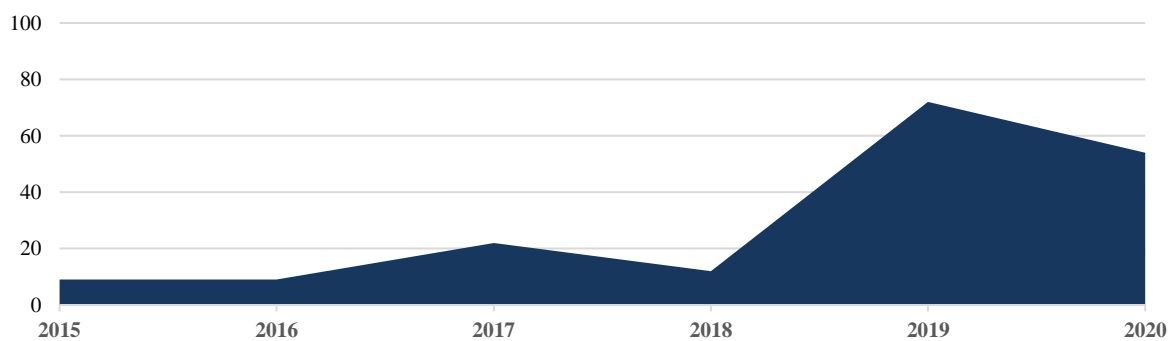


Figure 2. Interest and search for the term "Agile Transformation" over the past 5 years in Google Web Browser

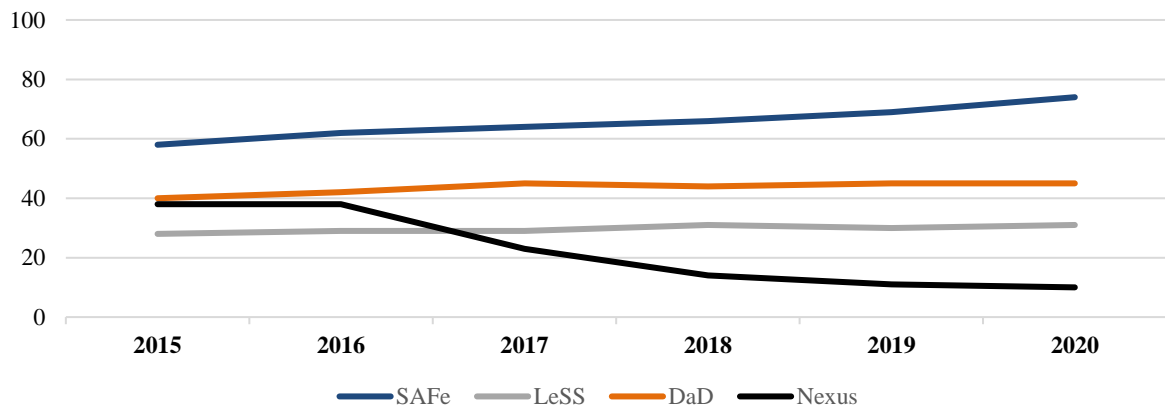


Figure 3. Comparison and search on terms "SAFe", "LeSS", "DaD" and "Nexus" over the last 5 years in the Google Web Browser

Although there are several frameworks to help to implement AM, there is still a great lack of evidence and studies where these experiences have been documented, under which circumstances they should be implemented, what are the main challenges and what are the success factors for their implementation (Paasivaara et al, 2018). Dikert et al. (2016) also reveals that in the systematic review of the literature on large-scale agile transformations they conducted, they do not found scientific papers directly addressing the effects of an agile transformation and additional empirical evidence on the transformations that have occurred is needed.

2.4. Research Methodology

The purpose of this research is to conduct an exploratory study (Saunders, Lewis, & Thornhill, 2009) in the APM literature to identify the best practices and the most proper conditions for this structure. Regarding the protocol used in the literature review, it was followed the protocol recommended by Kitchenham & Charters (2007) to conduct a literature review:

1. Planning the literature review:

- a. Identification of the need for literature review (section 1);
- b. Identification of research issues (section 3.1);
- c. Developing the research protocol (section 3);
- d. Evaluate the literature review protocol (performed by the second author);

2. Conduct the literature review:

- a. Identification of studies (section 3.3);
- b. Selection of studies (section 3.4);

c. Conducting a quality assessment (section 3.5);

d. Data extraction and synthesis (section 3.6);

3. Conclusions of the literature review (this study).

The first author was the study's principal investigator. Through the evaluation of the protocol through a random extraction of a sample of the collected data, the second author supported this investigation and ensured the consistency of the data and the bias in the collection and analysis of the data was mitigated.

2.4.1. Research questions

This research aims to collect insights in the literature about the complex challenge of managing an agile portfolio. The research questions of this study are:

Q1: What is reported in literature between 2005 and 2020, as best practices and techniques that allow to successfully implement and manage an agile portfolio?

Q2: Under what appropriate circumstances and in what organisational configuration have best practices been successfully applied, reported in literature between 2005 and 2020?

2.4.2. Research process

A manual search was performed on B-On, Research Gate, Science Direct and Scopus databases. The research focused on the search and combination of terms and keywords such as "Agile AND Project Portfolio Management", "Scaled-Agile AND Project Portfolio Management", "Agile AND Agile Project Portfolio Management".

Following the recommendations of Vom Brocke, Simons, Niehaves, Reimer, Plattfaut, & Cleven (2009), in a first phase the research focused on reading the abstract and title to minimize the identification of irrelevant studies. To assess the relevance of the articles, the second phase consisted in a complete reading of most of the articles, especially those that were not enlightening in the analysis of the title or abstract.

2.4.3. Inclusion and exclusion criteria

Empirical papers published in English language between 2005 and 2020 were included in the B-On, Research Gate, Science Direct and Scopus databases, which are directly related to research issues. The empirical research studies selected were case study, experience report, and systematic review according to the definitions proposed by Tonella, Torchiano, & Du Bois (2007). References from books, theses and workshops, articles written in other language than English and all articles outside the selected timeframe were excluded.

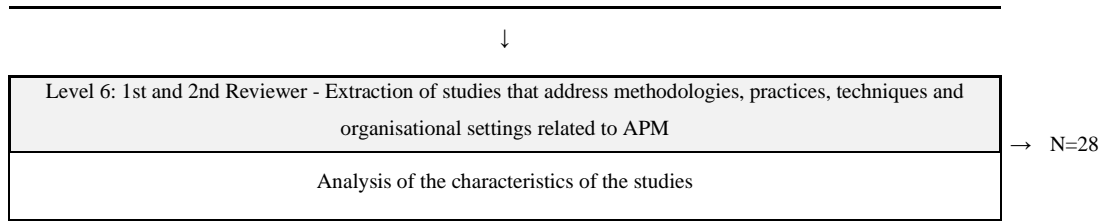
2.4.4. Study selection

The study selection process was inspired by the structure used by Vallon, Estácio, Prikladnicki, & Grechenig (2017), with 6 selection levels (table 3). The purpose of this method is to ensure the highest quality of studies through a phased selection based on strict criteria. At level 1 all studies that appeared in the search for titles, abstract and keywords in English language articles published between 2005 and 2020 were identified. At level 2, through the reading of the abstract, a segmentation in terms of relevance of the article was performed, where relevant, maybe relevant, and non-relevant studies were identified. At level 3, a second opinion was obtained about the studies considered maybe relevant and irrelevant by the second reviewer. At level 4, the two reviewers agreed on the studies to be included. It was analysed the maybe relevant studies and it were excluded all those which one reviewer considered as irrelevant but keeping all those which one reviewer regarded as relevant, or both regarded as maybe relevant. Nyes/Nmb/Nno, indicate the number of relevant studies considered at the respective level.

Table 5. The 6-level process of inclusion of articles

Table 5: The 6-level process of inclusion of articles

Level 1: 1st Reviewer - Final search		→ N= 542
Papers in english and published between 2005 and 2020	Search through title, abstract and keywords	
↓		
Level 2: 1st Reviewer - Reading abstracts		Nyes= 132
Classified as <i>relevant</i> (Nyes), <i>maybe relevant</i> (Nmb) and <i>irrelevant</i> (Nno)		→ Nmb= 24 Nno= 386
↓		
Level 3: 2nd Reviewer - Reading abstracts		Nyes= 134
Get a second opinion on <i>maybe relevant</i> and <i>irrelevant</i> studies		→ Nmb= 12 Nno= 396
↓		
Level 4: 1st and 2nd Reviewer – Agreement		Nyes=131
Full text available	Agreement on the studies to be included	→ Nmb=0 Nno= 411
↓		
Level 5: 1st– Full-text analysis		→ N=53
Sorting based on the quality checklist		



After downloading all studies through the university library services and achieving an agreement at the end of step 4, the two reviewers agreed on the studies to be included in this research. In level 5 the selection of articles was based on the quality checklist (table 4). The last level, level 6, consisted of making the final selection of the articles that proved to be successful empirical studies.

2.4.5. Quality criteria

The criteria used to ensure the quality of the selected articles are described in table 4 and were inspired on the quality criteria used by Vallon et al, (2017).

Table 6. Checklist for quality assessment of the studies

Criteria	Question
1	The essence of the study focuses on the use of agile methods at agile portfolio management level?
2	Does the study refer to concrete agile techniques, best practices and methodologies and not just the agile context?
3	Does the study refer to the application of concrete agile techniques, best practices and methodologies applied in large organisations or multiple agile teams?
4	Is the purpose of the study clear?
5	Does the study report original results that were not reported in previous studies?

The criteria chosen were adapted to the APM dimensions and has been eliminated the step 5 that asked "Is the methodology appropriate to achieve the study objectives?" since this study analysis many experience reports that do not have a defined research methodology.

2.4.6. Data extraction and synthesis

Data extraction was done by qualitative reading of the selected studies by the first author. The first author has read all 28 selected articles to identify relevant best practices and techniques of APM to answer the research questions. To analyse the most referred words in the selected articles and to identify patterns, were collected the most frequent words, bigrams and trigrams of the selected studies. To make this analysis more efficient, was done the merge of the 28 selected articles into a single digital document in order to upload a single file. For the analysis

of the most frequent words (figure 4), was used the Word Cloud website, where the digital document containing the 28 articles was uploaded. A cleanup of the stopwords and repeated words was performed. Regarding the identification of the bigrams and trigrams (figure 5 and 6), all the text of the 28 articles was selected and uploaded to the N-gram generator website. The results were clustered by analyzing the key terms of the studies and according to the APM dimensions referred in section 2.5.2. The entire process was audited and mentored by the second author.

2.5.Results

This section will present the main results obtained. Firstly, a first analysis of the identified studies was conducted. Secondly, a critical analysis of the main findings was conducted to answer the research questions.

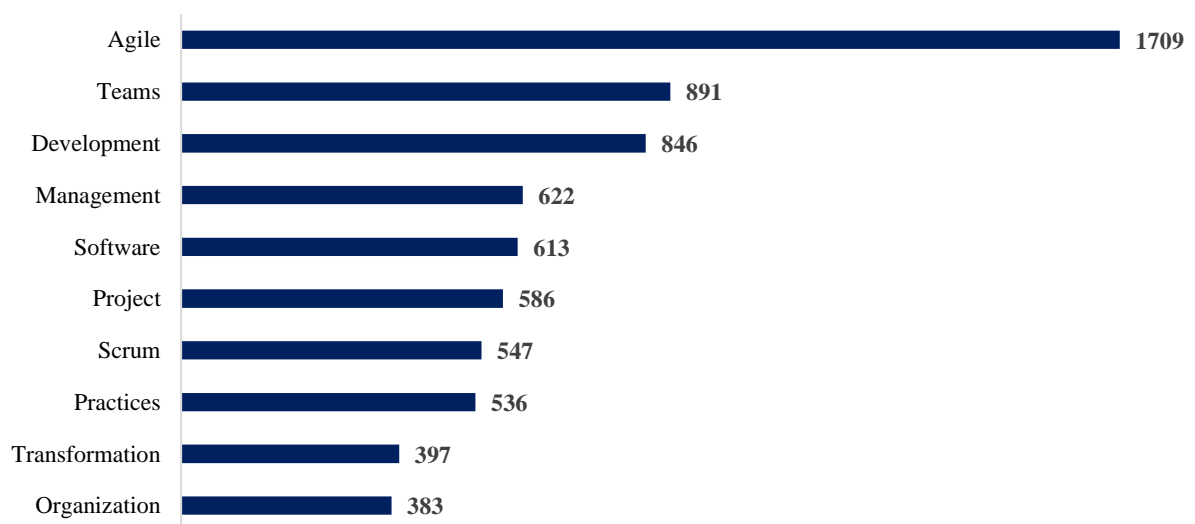


Figure 4. Top 10 of the most frequent words in the selected studies

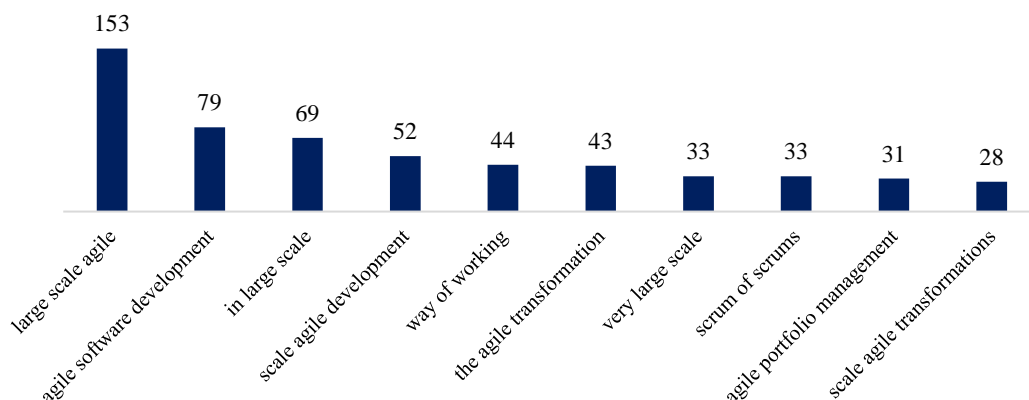
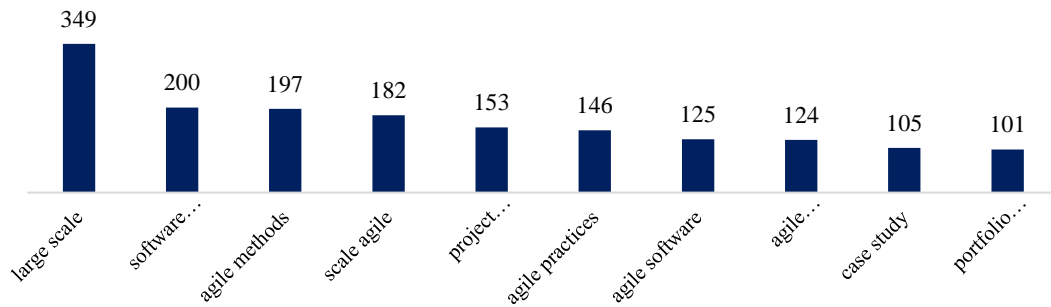


Figure 5. Top 10 of the most frequent trigrams in the selected studies



2.5.1. Data collection overview

Figure 6. Top 10 of the most frequent bigrams in the selected studies

The results include findings from 28 empirical studies, in which, according to the types of empirical studies suggested by Tonella et al (2007), 9 studies are experience reports, 5 studies are systematic literature reviews and 14 case studies (table 5). The number of citations for each article in the B-ON and Research Gate databases was also assessed, and the studies with the highest number of citations accumulated in these databases are Dikert et al. (2016), Paasivaara et al (2012), Stettina, C. & Hörz, J. (2015) with 264, 112 and 145 citations accumulated, respectively, at the date of May 26, 2020.

Table 7. Characterization of the analysed studies

Study ID	Author(s)	Source	Publication date	Empirical study types	B-ON & Research Gate Citations
S13	Dikert, K., Paasivaara, M. & Lassenius, C.	The Journal of Systems and Software	2016	Systematic review	264
S29	Stettina, C. & Hörz, J.	International Journal of Project Management	2015	Case study	145
S39	Paasivaara, M., Behm, B., Lassenius, C. & Mallikainen, M.	Empirical Software Engineering	2018	Case study	39
S60	Korhonen, K.	Software Quality Journal	2013	Case study	48
S62	Fry, C. & Greene, S.	Conference: Agile 2007	2007	Experience report	45
S73	Tengshe, A. & Noble, S.	Conference: Agile 2007	2007	Experience report	30
S78	Hodgkins, P. & Hohmann, L.	Conference: Agile 2007	2007	Experience report	25
S86	Berkani, A. & Causse, D.	Conference: Euram 2019	2019	Case study	5
S91	Kalliney, M.	Conference: 2009 Agile Conference	2009	Experience report	15
S94	Goos, J. & Melisse, A.	Conference: Agile 2008	2008	Experience report	12
S122	Paasivaara, M., Lassenius, C. & Heikkilä, V.T.	Proceedings of the 2012 ACM-IEEE International Symposium on Empirical Software Engineering and Measurement	2012	Case study	112

		Empirical Software Engineering and Measurement			
S124	Laanti, M.	32nd Annual IEEE International Computer Software and Applications Conference	2008	Experience report	53
S133	Pinto, J & Ribeiro, P.	Procedia Computer Science	2018	Systematic review	0
S138	Abrantes, R. & Figueiredo, J.	International Journal of Project Management	2015	Case study	18
S139	Vlietland, J. & Van Vliet, H.	Information and Software Technology	2015	Case study	45
S140	Vlietland, J., Van Solingen, R. & Van Vliet, H.	The Journal of Systems and Software	2015	Case study	31
S141	Ponsteen, A. & Kusters, R.	Procedia - Social and Behavioral Sciences	2015	Systematic review	20
S142	Mucambe, B., Tereso, A., Pereira, F., Peixoto, J. & Mateus, T.	Proceedings of the 33rd International Business Information Management Association Conference	2019	Systematic review	0
Table 8. Characterization of the analysed studies (continue)					
S144	Bjørnson, F.O., Wijnmaalen, J., Stettina, C.J. & Dingsøyr, T.	19th International Conference on Agile Software Development, XP	2018	Case study	7
S145	Karvonen, T., Sharp, H. & Barroca, L.	19th International Conference on Agile Software Development, XP	2018	Case study	11
S150	Dingsøyr, T., Rølland, K., Moe, N. & Seim, E.	Procedia Computer Science	2017	Case study	15
S151	Stojanov, I., Tureken, O. & Trienekens, J.J.M.	Conference: Software Engineering and Advanced Applications, SEAA	2015	Experience report	21
S152	Laanti, M., Sirkkiä, R. & Kangas, M	ACM International Conference Proceeding Series	2015	Experience report	6
S153	Brenner, R. & Wunder, S.	2015 IEEE 8th International Conference on Software Testing	2015	Case study	16
S154	Dingsøyr, T., Moe, B., Faegri, E. & Seim, A.	Empirical Software Engineering	2018	Case study	109
S158	Conboy, K. & Carroll, N.	IEEE Software	2019	Experience report	22
S159	Uludag, O., Proper, H. & Matthes, F.	23rd International Enterprise Distributed Object Computing Conference (EDOC)	2019	Case study	0
S164	Sweetman, R. & Conboy, K.	Project Management Journal	2018	Systematic review	4

The conference with the highest representation in the number of empirical studies is the Agile Conference that took place in Washington, DC, USA in 2007, with 3 studies identified. The Research Journals with the highest representation are the International Journal of Project Management with 2 studies, The Journal of Systems and Software with 2 studies and Procedia Computer Science with 2 studies. The authors with the highest representation in the identified studies, Dingsøyr, T. and Passivaara, M., stand out with 3 studies each, followed by Laanti, M., Vlietland, J., Van Vliet, H., Conboy, K. and Stettina, C., with 2 studies (table 5). The year with

the highest number of articles represented in this study is 2015, with 8 studies, followed by 2018 and 2019 with 5 studies each.

2.5.2. APM dimensions

The previous research led by Dikert et al (2016), where the success factors and challenges for large-scale transformations were identified, served as inspiration to create the different dimensions of the techniques that were identified. In the research conducted by Dikert et al (2016), the main success factors identified of large-scale agile transformations were: Top Management support, Customization of the agile model, Training and coaching, Alignment and Mindset agile. Still in this research, it was identified the main challenges of large-scale agile transformations: Agile difficult to implement, Requirements engineering challenges, Change resistance and Integrating non-development functions. It was also considered the domains of practice that enable agility outside individual projects, identified in the research conducted by Stettina & Hörz (2015): Strategize & roadmap, Identify & funnel, review, prioritize & balance e Allocate & delegate. Based on the challenges mentioned in the theoretical background section of this research, the dimensions of the two studies mentioned above were considered and techniques and best practices collected in this literature review were classified into 4 APM dimensions: Coordination, Project and resource prioritization, Agility and Change Management (table 6).

Table 9. Description of the identified best practices and techniques

APM Dimension	Type	Studies
Coordination		S29, S39, S73, S79, S86, S133, S138, S139, S140, S141, S152,
Business Unit Roadmap	Artifact	
Roadmap of roadmaps	Artifact	
Kanban Metrics	Artifact	
Scrum of Scrums	Event	
Epic Planning	Event	
Monthly Business Unit Backlog Revision	Event	
Portfolio Revision	Event	
Agile Coordination Office	Structure	
Escalation Group	Structure	
IT Steering	Structure	
Product team	Structure	
Project Management Office	Structure	
Program Management Office	Structure	
Portfolio Work Control System	Process	
Portfolio Manager	Role	
Project and resources prioritization		S29, S39, S60, S62, S73, S78, S86, S94, S105, S124, S133, S138, S139, S140, S151, S152, S154

Product Owner Group	Structure
Portfolio Backlog	Artifact
Strategic Product Backlog	Artifact
Feature Product Owner	Role
Business Project Manager	Role
Epic Owner	Role
Epics Prioritization	Event
Agility	S29, S39, S49, S60, S62, S78, S86, S94, S140, S144, S145, S151, S154, S159
Daily Meetings	Event
Refactoring	Event
Continuous Integration	Event
Scrum Master	Role
Agile Coach	Role
Internal Agile Coaches	Role
Cross Functional Teams	Principle
Dedicated Teams	Principle
Table 6. Description of the identified best practices and techniques (continue)	
Self-organized Teams	Principle
Change management	S13, S49, S62, S73, S78, S94, S105, S145, S152, S158
Customized Agile framework	Artifact
Management Support	Event
Stakeholders Engagement	Event
Assessment of Organisational Needs	Event
Agile Pilots	Event
Incremental Agile Adoption	Event
Agile Concepts Alignment	Event
Evaluate Stakeholders Satisfaction	Event
Engage Change Leaders	Event
Scaled Agile Training	Event
Change Driver Team	Structure
Communication & Transparency	Principle
Mindset & Autonomy	Principle

In the first dimension Coordination, are considered the techniques and actions that aim to ensure Top Management support, Alignment, Strategize & roadmap, Identify & funnel. The second dimension Project and resources prioritization is composed by the key actions needed to ensure coherence and focus on the multiple projects through Review, prioritize & balance and Allocate & delegate. The third dimension Agility have the key actions needed to ensure the success factors Customization of the agile model and Agile mindset. The fourth dimension Change Management aims to meet the challenges related to Agile difficult to implement, Requirements engineering challenges, Change resistance and Integrating non-development functions and

contribute to Agility. A typification of each technique and best practice was also created where we can typify by: Artifact, Event, Structure, Process, Roles and Principles.

2.5.2.1.Coordination

Although AM have specific events to manage the coordination at the team level, at the portfolio level such support is scarcer regarding resource dependencies, tasks, technology or knowledge (Dingsøyr, Moe, Faegri, & Seim, 2018). Alignment between projects, production and business practices represents one of the greatest challenges identified in Agile project portfolio management when teams need to interact with each other (Stettina & Hörz, 2015). Therefore, the application of practices that allow coordination at project portfolio level has a positive impact on the alignment between teams working with AM (Vlietland & Van Vliet, 2015). Paasivaara, Lassenius, & Heikkila, (2012) states that close communication between teams is essential to increase alignment and efficiency in coordination. The main practices and techniques identified to ensure the common purpose shared between project managers and portfolio managers (Sweetman & Conboy, 2018) are related to the coordination between all projects in the portfolio. The main artifacts that have been identified were Business Unit Roadmaps, Roadmap of Roadmaps and Kanban Portfolio Metrics. These artifacts are helpful to communicate strategic intent of each product roadmap and provide guide about the priorities of the Portfolio through Roadmap of Roadmaps (Hodgkins & Hohmann, 2007). Regarding the specific and periodic events, were identified Scrum of Scrums, Epic Planning, Monthly Business Unit Backlog Revision and Portfolio Revision. These events have the specific mission to improve transparency about resources and to ensure the commitment of senior management (Stettina,& Hörz, 2015). The structures oriented to ensure inter-project coordination that were identified were Agile Coordination Office, Escalation Group, IT Steering, Product Team, Project Management Office and Program Management Office. Most of these terms are synonyms and have the common mission to support and empower the agile development teams, promote and collect distinct agile metrics and disseminate best practices (Pinto & Ribeiro, 2018). Portfolio Work Control System is the process proposed by Tengshe & Noble (2007) to control the affluence of new requests and the Portfolio Manager role, suggest by Stettina & Hörz (2015) and Abrantes & Figueiredo (2015) has the mission to quickly respond to the frequent changes in a coordinated manner.

2.5.2.2. Projects and resources prioritization

One way to increase transparency and alignment among AM teams is to prioritize projects and work (Stettina & Hörz, 2015). Visibility into the portfolio priorities and the ability to understand what is happening in each team is essential for the implementation of agile at a large-scale (Laanti, 2008). In this type of organisation, transparency is everything and can even be taken to a more radical level, through visual communication, frequent strategic vision communication and frequent planning meetings that allow everyone to be on the same page regarding projects priorities (Fry & Greene, 2007). The practices identified aim to ensure that the agile project portfolio is seen as a unique system in resource allocation and is made of simple rules that allows quick decision making on resource sharing (Sweetman & Conboy, 2018). The identified practices that most contribute to this dimension were the creation of a Product Owner Group team, where is discussed and decided the priorities of each feature on the backlog (Vlietland et al, 2015). The Strategic Backlog and Portfolio Backlog artifacts identified by Laanti et al (2015) aims to establish a clear vision and communication about what needs to be implemented, what are the strategic focus (prioritization) and resource allocation (backlog). The Feature Product Owner role, Business Project Manager, Epic Owner are roles that help to plan project resources and budget control and coordinates internal development teams to ensure the correct execution of the projects (Berkani, & Causse, 2019; Vlietland et al, 2015) in the prioritization events like Epic Prioritization (Dingsøyr et al, 2018; Laanti et al, 2015).

2.5.2.3. Agility

One of the criticisms the AM pioneers made about the current APM solutions was that they are too rigid and too bureaucratic (Schwaber, 2015). On the other hand, overly hierarchical levels can block the adoption of agile principles. To prevent this, it is necessary to empower the management team to be more involved in planning and scope reviews sessions and to get frequent feedback from the team to help it overtake obstacles and increase efficiency (Tengshe & Noble, 2007). Self-organised teams, one of the core principles of AM, need to be included in a flexible structure that allows projects to cooperate with each other in response to new challenges (Sweetman & Conboy, 2018). Some of the techniques identified are the Daily Meetings, Refactoring, and Continuous Integration. These events are defined by Korhonen, (2013) as a “basic” set of agile practices to consider in Agile Transformations. Scrum Master roles were mentioned to promote the agile principles and the Internal Agile Coaches, trained by Agile Coaches, are crucial roles to set up of a network of retrospective facilitators and later on a network of agile experts (Goos & Melisse, 2008). The Cross Functional Teams, Self-

Organized Teams, and Dedicated Teams are considered non-negotiable items to ensure the focus on Agile principles over the processes. Additionally, the implementation of this principles provided accessibility, transparency and shared ownership in an agile transformation (Dikert et al, 2016; Fry & Greene, 2007).

2.5.2.4.Change management

Adherence to the AM represents a challenge for any organisation wishing to change the way of working on projects. To move from a highly predictable and planning oriented environment to a dynamic one represents a challenge that to be successfully executed must have: 1)top management support, 2)dedicated teams and change facilitators, 3) focus on agile principles, 4) focus on automation and continuous improvement and 5) training of experienced agile professionals (Fry & Greene, 2007). The best practices founded in this study answers to the challenges identified in the literature (Dikert et al, 2016). The creation of a customized Agile Methodology represents the artifact that was identified. Management Support, Engagement of Stakeholders, Initial Needs Assessment, Realization of Agile Pilots, Customization of Agile Concepts, Measurement of Stakeholder Satisfaction, Involvement of Change Agents and Agile Training are the events that were identified (Conboy & Carroll, 2019). Communication, Transparency, Agile Mindset and Autonomy are the principles that were mentioned (Dikert et al, 2016). The creation of a Change Driver Teams was also identified as a critical structure to manage change and involve stakeholders in the new agile mindset (Goos & Melisse, 2008). These initiatives indicate the clear need to perform a customized approach to the organisation, in order to get all the benefits associated to Agile and ensure the active support of top management, as it is considered as success factor in establish and manage an Agile Portfolio (Dikert et al, 2016).

2.6.Discussion and findings

The following sections aim to present the discussion of this systematic literature review by answering the research questions, presenting the main limitations and conclusions of the research.

2.6.1. Answers to research questions

In the last 15 years the implementation of the AM has grown considerably. Despite being a successful methodology at team level, there is still a lack of empirical evidence about how to manage agile projects at a portfolio level. This research analysed 28 studies that had identified

techniques and best practices to address these challenges. The research question Q1: “What is reported in literature between 2005 and 2020, as best practices and techniques that allow to successfully implement and manage an Agile Portfolio?” was answered with the identification of techniques and best practices in the APM dimensions of Coordination, Project and Resources Prioritization and Agility. Regarding the research question Q2: “Under what appropriate circumstances and in what organisational configuration have best practices been successfully applied, reported in literature between 2005 and 2020?”, the best practices of Change Management dimension were considered as appropriate organisational conditions and circumstances to ensure the correct implementation of the AM at the Portfolio level.

2.6.2. Limitations

The data collection was based in a manual search in each study except for the bigrams and trigrams identification that used the N-gram Generator tool. The analysis carried out, although it includes the full reading of each article, may present flaws in the identification of techniques, tools, and organisational conditions of each study. Additionally, one third of the analysed articles are experience reports, which lack scientific validation despite being rich in empirical data.

2.7. Conclusions

The application of AM in project management has shown great efficiency and remarkable results. In recent years, the complexity of managing several agile projects and teams has raised big challenges in resource management, priorities, and governance model of the project portfolio. The systematic review of the literature conducted in this research, identified 4 dimensions of action to consider in APM. The Coordination, Prioritization of Projects and Resources and Agility dimensions are the most relevant best practices to implement while the Change Management dimension gives the appropriate circumstances and conditions that should exist to manage an agile portfolio effectively. In this systematic literature review, 28 studies published between 2005 and 2020, regarding agile, APM and scaled-agile were analysed. The existing scientific literature on APM is still very limited and this literature review aims to establish the basis and guide additional empirical studies and contribute to increase scientific studies on APM. For APM practitioners, it intends to give an understanding of the most efficient best practices for managing agile portfolios and how to ensure the appropriate conditions for these implementations. For future investigations it is recommended that each technique and best practice identified in this study be described in greater depth and detail.

3. Second study: Success and Barrier Factors in Agile Transformations

3.1. Abstract

Agile Methods have become an efficient way of working for organisations 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 analyse 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

3.2. 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 organisations (Hossain, Babar, & Paik, 2009) with emphasis on organisations from 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 organisations were already using Agile Methods, while more than half of the organisations 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 organisations 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 organisation (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 organisational change represents a challenging transformation (Svensson & Höst, 2005) and organisations 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 organisations have teams in different countries working on the same project. Despite these challenges, more and more organisations 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 analysed, 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 organisations 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.

3.3.Theoretical framework

In this section we presented an overview about previous research 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 organisations are interested Agile Transformations in Large-Scale and what are its Barriers and Success Factors identified in previous studies.

3.3.1. Distinction between Agility and Agile Organisations

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, Lyytinen, & Siau (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, Ganesh, & Raman (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 organisations, Kettunen and Laanti (2007) suggested that an organisation 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 organisations could prioritize these goals in different ways and there are many different approaches to achieve them. These organisations 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 organisations are entities that learn fast and are effective and this mindset could be helpful for organisations focused on

developing products and platforms (Raudberget, Elgh, Stolt, Johansson, & Lennartsson, 2019). Gligor et al (2015) looked to Agile organisations as the ability to quickly adjust and Putnik and Putnik (2012) mentioned that these entities are more focused and oriented to respond to specific customer expectations, which makes them more efficient. Agile organisations 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, Raduan, Abdullahy, & Masrom, 2005). For this research was considered the Agile Organisations definition indicated by Filipe et al (2016): “Organisations 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 organisation's potential of action in anticipating and seizing opportunities, in particular through innovation and learning.”.

3.3.2. 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, Ferreira, & Santos, 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, Sabido, & Santos, 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 organisations 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 organisations reducing costs, reducing waste, and increasing employee satisfaction through quality processes (Costa, Resende, Dias, Pereira, & Santos, 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).

3.3.3. 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 organisations 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 organisational 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 organisations (Kaufmann, Kock, & Gemünden, 2020).

Although many practitioners promote the success of Agile Transformations, these cases represent complex, long-term and stepwise organisational 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 organisation does not need to apply a specific framework and the process should be tailored to the organisation needs while keeping the alignment with Agile principles (Kalenda, Hyna & Rossi, 2018). To apply a specific framework in an organisation 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 organisations: 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 organisation, which often leads to inertia responsible for slowing down organisational 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 organisational culture has been identified as one of the Success Factors (Kettunen & Laanti, 2007) and is also important to clearly identify the main objectives each organisation intend to implement Kettunen & Laanti (2007). Paasivaara 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 takeaways. 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 advice that Fry & Greene (2007) gave for practitioners, based on their experience, was to not be afraid to change the entire organisation 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.

3.4.Methodology

The following section aim to present the objectives of the research, the population and sample characterization and the research strategy. It is also presented the main quantitative techniques that were used to data analysis.

3.4.1. 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 are presented in table 7. The research questions are:

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

Table 10. Identification of the research problem, general and specific research questions, research objectives and discussion of the results

Research problem	General question	Specific research questions	Research objectives	Discussion of results with authors of literature
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Lack of understanding about the characteristics of Agile Transformations, their Barriers and Success Factors	What variables better explain the success of an Agile Transformation?	<i>Question 1:</i> What Barriers better explain the success of an Agile Transformation in organisations operating in Portugal?	Identify the frequency of occurrence of Barriers and Success Factors and how can they explain the success of Agile Transformations in organisations 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
		<i>Question 2:</i> What Success Factors better explain the success of an Agile Transformation in organisations operating in Portugal?		

3.4.2. 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.

3.4.3. 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.

3.4.4. 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.

3.4.5. Variable types

The survey was made up of 9 questions with mandatory answers, in Portuguese or English language (table 8). Each respondent was asked to answer, anonymously, the same set of ordered and sequential questions (de Vaus, 2002).

Table 11. Identification and description of survey questions

ID	Description of survey questions
P1	What is your role in the Organisation 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 Organisation has used Agile Methods?
P4	How many employees do you have, approximately, in the Organisation where you used Agile Methods?
P5	Since when has the Organisation implemented Agile Methods in its teams and projects?

Table 12. Identification and description of survey questions (continue)

P6	What is the predominant Agile Method in the Organisation?
P7	In the transformation to Agile Methods that the Organisation is performing (or has performed), how often do you observe (or have
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 Organisation 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 organisation
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 organisation
P8.18	Allow teams to self-organize
P8.19	Recognize the importance of the Product Owner role

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 Organisation, 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 organisation 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.

3.4.6. 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 Organisation 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.

Table 13. Classification of response options for each question

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:

Table 14. Classification of response options for each question (continue)

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 15. Relationship between research questions and survey questions

Research questions	Question 1: What Barriers better explain the success of an Agile Transformation in organisations operating in Portugal? Question 2: What Success Factors better explain the success of an Agile Transformation in organisations 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 organisations operating in Portugal.	
	Investigative questions	Variables required Detail in which the data is measured
	In the transformation to Agile methods that the Organisation 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 Organisation 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

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 9, 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 10 aims to characterize the investigative questions in the survey and summarize the relationship between them.

3.4.7. 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 n°2, 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 n°5, the Organisation 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.

3.4.8. 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 analysed 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.

Table 16. Cronbach's Alpha

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

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 11) presented a coefficient of 0.844 based on standardized items, thus presenting a high level of internal consistency.

3.4.9. 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 analysed to assess distribution asymmetry and Kurtosis to assess the sharpness or flatness of the distribution compared to the normal distribution of each variable. Table 12, presents the Skewness and Kurtosis measures, ordered from highest to lowest Skewness value.

Table 17. Skewness and Kurtosis measures

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 organisation	-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

Table 18. Skewness and Kurtosis measures (continue)

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 Organisation?	-0,485	0,142	0,391	0,283
F11. Engage everyone in the organisation	-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

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).

3.4.10. Correlation analysis

The correlation analysis between the independent variables was carried out to analyse whether there are redundant variables and what is the strength of the relationship between the Barriers

and Success Factors (table 13). 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.

Table 19. Correlations

	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**	-.0103	-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**	-.0088	-0.042	-0.114	-0.066	-.137**	-.208**	-.198**	-.152**	-.052**	-.165**	0.039	-0.043	-0.065	.592**																					
F3	0.017	-0.051	-.137**	-0.085	-0.098	-.196**	-.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**	-.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	-.204**	-.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**	-.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**	-.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**	-.144**	-.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**	-.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

According to Dancey & Reidy (2006), relations between variables with Pearson's correlation coefficient ($r \geq 0.4$ and < 0.7) represent moderate correlations and relations with $r \geq 0.7$ 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 ($p < 0.05$).

3.4.11. Factor analysis

To comprehensively analyse 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.

3.4.11.1. 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 $\geq 0,5$ 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 14), which represent superb values, according to Hutcheson & Sofroniou (1999) and confirms that EFA is appropriate for the sample data.

Table 20. KMO and Bartlett's Test of Sphericity indicators

		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

Bartlett's sphericity test (table 14), 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 $\alpha=5\%$ ($\alpha=0.001$), we admit that the analysis is adequate and that there are significant correlations between some variables. (Bartlett, 1951).

3.4.11.2. Factor extraction

The adequacy of each variable was also analysed 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 15), the percentage of the variance of each variable explained in the extracted factors should be $\geq 0,5$ for each variable, so that it significantly represents some factor of the model. Values <0.5 indicate that there may be a weak relationship with the extracted factors.

Through table 15, 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 21. Communalities

	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 organisation	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 organisation	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 16).

Table 22. Total variance explained

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

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.

3.4.11.3. Results interpretation

The interpretation of the factors was made through the Rotated Component Matrix (table 17), obtained after the Varimax rotation. In each line of the table, were selected for each factor loadings $\geq 0,4$ 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 23. Rotated Component Matrix

	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 organisation	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	
Table 24. Rotated Component Matrix (continue)		
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 organisation	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 18).

Table 25. Cronbach's Alpha of the factors extracted for the Barriers and Success Factors

	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

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.

3.4.12. 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:

$$y = \beta_0 + \beta_1\chi_1 + \beta_2\chi_2 + \dots + \beta_k\chi_k + \varepsilon \quad (1)$$

where y is the dependent variable and $\chi_1, \chi_2, \dots, \chi_k$ are the independent variables and β_i is the regression coefficient and ε is the random error component. The value of the coefficient β_i determines the contribution of the independent variable χ_i , 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:

$$y = \beta_0 + \beta_1B_1 + \beta_2B_2 + \dots + \beta_kB_{19} \quad (2)$$

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:

$$y = \beta_0 + \beta_1F_1 + \beta_2F_2 + \dots + \beta_kF_{19} \quad (3)$$

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 19, 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 26. Regression coefficients, level of significance and collinearity

	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 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 organisation	0,129	0,099	0,085	1,297	0,196	0,438	2,283

F17. Align the organisation	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. Communicate positive experiences in the beginning	0,040	0,126	0,024	0,320	0,749	0,322	3,102

Table 27. Regression coefficients, level of significance and collinearity (continue)

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 Organisation?

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 20), 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 28. Optimization of regression coefficients, level of significance and collinearity

	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 organisation?

The p-value of F-test was then analysed 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 21).

Table 29. F-test

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 organisation?

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

R2 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 R2 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 22).

R2 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 R2 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 22).

Table 30. Summary of models

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 Organisation?

To summarize the results achieved through multiple linear regression analysis for each model, Table 23 identifies the key statistics of each one.

Table 31. Reproduction of final models

	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			

3.5.Discussion

The following sections aim to present the discussion of this research by answering the research questions and comment the main findings on the barriers and enablers. It is also presented the main limitations, conclusions and future lines of research.

3.5.1. 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.

3.5.1.1. Answer to research question 1

The research question 1 was "What Barriers better explain the success of an Agile Transformation in organisations 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.

3.5.1.2. Answer to research question 2

The research question 2 was "What Success Factors better explain the success of an Agile Transformation in organisations 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.

3.5.2. Comments on barriers

The factor analysis conducted in this research grouped the Barriers into five factors (table 17). 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 organisation why the way of working is changing and what are the benefits of

transformation in the long term. A top-down implementation should be avoided 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 immediately 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 avoided preserving 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 organisation (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.

3.5.3. Comments on success factors

The factor analysis conducted in this research grouped the Success Factors into 4 Factors (table 17). 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 organisation, 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 we are 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 organisation must be prepared for change and should communicate the change intensively to ensure that the purpose is well known across all organisation (Naslund & Kale, 2020). To facilitate change management processes, organisations should identify the Change Leaders with a positive attitude and previous experience in Agile Methods who are able to facilitate coaching sessions across the organisation (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.

3.6.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 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.

3.6.1. 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 analyse 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 analysed after data collection. The focus of this study was to analyse 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.

3.6.2. 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 organisations 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.

4. Third study: Enterprise Agile Transformation

4.1. Abstract

Implementing agile methods is currently one of the central topics for many organisations and teams focused on developing technological products. Although the benefits of these methods are widely recognized by the product and project management community, their implementation in organisations means going through a complex transformation with several changes in the way of working. There are few scientific studies that explain how an organisation can carry out this transformation, what are the barriers, the enablers and the recommendations that should be followed to increase agility level and drive an agile transformation successfully. Knowing that the adoption of agile methods generates several changes in roles, processes and organisational culture, this research aims to create the Enterprise Agile Transformation Model to serve as a guide for organisations to adopt and improve agile practices.

Keywords: Agile Transformations, Agile Maturity Models, Enterprise Agile Transformation Model

JEL Classification: M10, M15, O21

4.2. Introduction

Over the last few years organisations have questioned themselves why they should adopt agile methods (Highsmith, 2006). This new way of working, officially introduced through values and principles of Agile Manifesto in 2001 (Beck, Cockburn, Jeffries, & Highsmith, 2001), has been showing many success cases, where the value added for teams and organisations are unquestionable (Korhonen, 2013). Scrum, Extreme Programming (XP), Crystal and Dynamic Systems Development Method (DSDM) were the main agile methods included in this new way of working mindset (Anand & Dinakaran, 2016; Hamed & Abushama, 2013). These success cases had encouraged the adoption of these methods across all sectors, particularly in the IT sector (Dybå & Dingsøyr, 2008), where more than half of projects fail to deliver functional software and the main obstacles are related to communication problems with stakeholders, who

play critical roles in the execution and development phases of IT products (The Standish Group, 2015). Digital and mobile platforms are having a key role in transforming the way organisations run their businesses (Bondar, Hsu, Pfouga, & Stjepandić, 2017) although product-oriented struggle to introduce the correct product components and modules to quickly respond to customer needs and the introduction of new technologies (Raudberget, Elgh, Stolt, Johansson, & Lennartsson, 2019). Challenges such as the pressure to reduce the time to market, the need to improve product quality and increase the ability to adapt to customer needs changes, contributed to the decision to adopt agile methods (VersionOne, 2016) to deliver products quickly and adapted to the customer needs (Korhonen, 2013; Petersen & Wohlin, 2010). Many authors in the IT scientific literature designate this process of adopting agile methods as an agile transformation (Dikert et al, 2016). As a result of the growing success and popularity of adopting agile methods, many organisations are now seeking to understand how they can holistically implement these practices in their teams (Highsmith, 2006). However, scientific literature on these transformations is still scarce (Dikert et al, 2016) and is difficult to find a clear direction to follow (Schwaber, Laganza. & D'Silva, 2007; Sillitti, Ceschi, Russo, & Succi, 2005).

Through this research, it is intended to define a theoretical model that guides organisations in adopting agile methods, highlighting the most important agile practices, and adding an improvement plan to drive the organisations to achieve the maximum agility potential they can reach. Thus, this research had as starting point the barriers and enablers of agile transformations studied by Batista et al (in press)^b and the theoretical model Agile Adoption Framework (AAF) developed by Sidky, Arthur & Bohner (2007), which was used as a structural piece in Enterprise Agile Transformation Model (EATM) created through this research. The EATM has the mission to guide organisations in adopting agile methods, highlighting the most important agile practices, and adding an improvement plan to increase the agility that is intended to be achieved. Section 2 of this research consists of a literature review of the main concepts. Section 3 contains the methodology used to identify the research problem as well as carry out data collection and data analysis. Section 4 presents the results collected via interviews and surveys from project management and agile methods experts, to evaluate the EAT. Chapter 5 contains the discussion and answers to the research questions. Chapter 6 brings together the conclusions, limitations of the research as well as the recommendations for future lines of research.

4.3.Theoretical background

This section consists of reviewing the theoretical background of the main concepts of this research. Agile Transformations were the first topic reviewed and the Models to measure agile maturity was the second topic reviewed.

4.3.1. Agile transformations

An agile transformation goes far beyond the simple adoption of agile practices (Paasivaara, Behm, Lassenius, & Hallikainen, 2018). In fact, this transformation promotes the change of several traditional management practices (Dosquet, Conticello, Dosquet, Dour, & Van Bennekum, 2017) and requires fundamental changes at the individual and organisational level (Laloux, 2014). Agile transformation as a process of transition from traditional project management methods to agile methods is a complex and evolutionary process and requires a high level of coordination between the organisation and its projects (Dikert et al, 2016) and it has several obstacles that should be considered (Gandomani, Zulzalil, Ghani, Sultan, & Nafchi, 2013).

Agile methods are often criticized for being applicable primarily to small teams and small organisations rather than large organisations with several development teams (Reifer, 2003). There are a limited number of comprehensive scientific studies dedicated to agile transformations at the organisational level in IT sector (Petersen & Wohlin, 2010). These processes are impacted by a large number of issues, barriers and enablers (Dikert et al, 2016) requiring a lot of long-term investment and collaboration across all the organisation levels (Dikert et al, 2016; Gandomani & Nafchi, 2015). There are studies that explain the most important issues that organisations are facing during an agile transformation. People-related issues represent the majority of the problems associated with this type of transformation (Nerur, Mahapatra & Mangalaraj, 2005). Other study has addressed several success factors that can facilitate the adoption of agile practices, most of which are also related to people (Misra, Kumar, & Kumar, 2009; Vijayasarathy & Turk, 2012). Moe & Dingsoyr (2009), report that the main issues to be addressed in an agile transformation are: 1) coordination between teams, 2) business agility, 3) knowledge sharing and 4) knowledge networks. Paasivara et al (2018), analysed an agile transformation in an organisation oriented to product development and presented four lessons learned: 1) use experimental transformation approach, 2) gradual and phased transformation, 3) common agile method and 4) team skills development. These characteristics, barriers and enablers should be considered for all organisations that intend to implement agile methods.

4.3.2. Models to measure agile maturity

An agile maturity model could be defined by a group of agile best practices that have the purpose to help organisations improve their processes (SEI, 2010) through a step by step and iterative approach (Yin, Figueiredo, & Mira da Silva, 2011). The shift from traditional project management methods to agile methods represents the main goal of every agile transformation (Dikert et al, 2016) and should consider the agility potential of the organisation, to choose the right agile practices and to get a competitive advantage as a result (Gandomani & Ziaei, 2016). Organisations have many difficulties in implementing this type of transformations in short term (Qumer & Henderson-Sellers, 2008) and the maturity models should work as an action plan that organisations can implement with a step-by-step approach (Norton, 2008). Typically, these models have different maturity levels with several agile practices that should be achieved to reach each level (Becker, Knackstedt, & Pöppelbuß, 2009). In a recent literature review carried out by Schweigert, Vohwinkel, Korsaa, Nevalainen, and Biro (2013), it was possible to identify about 40 agile maturity models. Nevertheless, none of these models are consensual either by professionals or academics (Schweigert et al, 2013). On the other hand, the systematic literature review conducted by Ozcan (2013) assessed the strengths and weaknesses of five agile maturity models where AAF obtained the best result. The other four agile maturity models considered in this literature review were Agile Maturity Model, Scrum Maturity Model, Benfields' Model and Agile Scaling Model (Ozcan, 2013).

4.4. Methodology

The following section aim to present the approach and research questions of the research. It is also presented the main techniques that were used to data collection and analysis.

4.4.1. Research approach

To conduct this research was used a qualitative approach with secondary data to expand a theoretical model identified through the scientific literature. To validate the model was used a focus group with a sample of 10 experts using a defined and clear topic to be discussed where the main purpose was to promote an interactive discussion with all the participants (Saunders, 2009).

4.4.2. Research questions

This research intends to expand a theoretical model that allows the assessment of the barriers and enablers of agile transformations and provide a plan to improve the weaknesses identified

through the assessment. The relationship between the problem, the questions, the research objectives and the discussion of results with authors in the literature is shown in table 24. The following are the questions of research:

- Question of research 1: How to assess agile practices associated with barriers and enablers of an agile transformation?
- Question of research 2: What is the action plan that has the goal to improve the maturity level of agile practices associated with barriers and enablers of an agile transformation?

Table 32. Identification of the research problem, general and specific research questions, research objectives and discussion of the results

Research problem	General question	Specific questions of research	Research objectives	Discussion of results with authors of literature
Lack of theories to identify and mitigate barriers and identify and accelerate enablers of agile transformations	What should the theory consider to mitigate the barriers and accelerate the enablers of an agile transformation?	<p><i>Question of research 1:</i> How to assess agile practices associated with barriers and enablers of an agile transformation?</p> <p><i>Question of research 2:</i> What is the action plan that has the goal to improve the maturity level of agile practices associated with barriers and enablers of an agile transformation?</p>	<p><i>Research objective 1:</i> Evolution of a theoretical model that allows assessing the maturity level of agile practices associated with barriers and enablers of an agile transformation</p> <p><i>Research objective 2:</i> Definition of a plan to help organisations to improve the maturity level of agile practices associated with barriers and enablers of an agile transformation</p>	It is intended to expand the theoretical model Agile Adoption Framework, developed by Sidky et al (2007)

4.4.3. Data collection

This section aims to present the main changes that were suggested to expand the AAF model as well as the method that was followed to select the right model to expand from the scientific literature.

4.4.3.1. Selecting the theoretical model to expand

The data collection was based on secondary data, largely collected from the studies of Ozcan (2013), Sidky et al (2007), Batista et al (in press)^a and Batista et al (in press)^b. The validation of this data was obtained through a focus group with 10 experts from agile methods and project management community. To get different point of views during the focus group session, were

selected academics, project and program managers, product owners, scrum masters and agile consultants, where 75% have more than 10 years of professional experience. The first step consisted in identifying the most appropriate agile transformation theoretical model expand with the agile practices associated with barriers and enablers. Through the systematic literature review and multiple case study analysis carried out by Ozcan (2013), it was possible to verify that the AAF obtained the best result, considering the criteria Fitness for Purpose, Completeness, Definition of Agile Levels, Objectivity, Correctness, Consistency. The inclusion criteria of theoretical models in this systematic literature review considered i) a detailed process for each model that could be analysed and ii) a publication in a conference or academic journal. After an exhaustive literature review of agile theoretical and maturity models, the AAF model was selected as the starting point of this research, mainly due to its comprehensive structure, which is also confirmed by the scientific literature.

4.4.3.2. Analysis of AAF model

According to Sidky et al (2007), AAF has an agile measurement index and a 4-step process that act together to assess and guide agile practices adoption (appendix K). While the agile measurement index has the mission to assess the agile potential of projects and organisations, the 4-step process has the goal to determine the organisation readiness and which agile practices could be applied. Despite being a robust and complete model, AAF authors indicated that the model also has some limitations, namely, it does not present recommendations neither a plan on how to overcome the identified weaknesses in the assessment, which is an essential piece to organisations improve their processes and agile maturity (Sidky et al, 2007). Additionally, the authors also mentioned that, according to the feedback collected in agile community, exist some discussion around the right agile level for each agile practice presented in the model (Sidky et al, 2007).

4.4.3.3. The barriers and enablers of agile transformations

Considering the limitations identified in the AAF model, the next step of this research was to improve it through the results obtained by Batista et al (in press)^b, where was identified the barriers and enablers that best explain the success of an agile transformation. The enablers had the designation of success factors in Batista et al (in press)^b research but the name was change to harmonize the nomenclatures. Barriers of agile transformations are considered factors that have a negative impact, block, and delay the successful implementation of agile methods and practices. On the opposite side, enablers are considered factors that have positive impact and

accelerate the successful implementation of agile methods and practices. To reach these results, the authors conducted a multiple linear regression analysis to analyse the relation between the independent variables - barriers and enablers - and the dependent variable - agile transformation success - where the relative predictive importance of the independent variables was defined (Williams & Monge, 2001). Through this analysis two models were established. The barriers and enablers models indicate which factors best explain the success and failure of an agile transformation (table 25).

Table 33. Barriers and enablers that better explain agile transformations success and failure

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

The results of Batista et al (in press)^b showed that the barriers Using traditional methods and agile methods in parallel, Lack of coaching for teams, Gap between short and long term planning and Revert to the old way of working are the factors that best explain the failure of an agile transformation. The enablers Concentrate on Agile values, Allow teams to self-organize, Recognize the importance of the Product Owner role, Communicate the change intensively and Educate Management on Agile represent the enablers that best explain the success of an agile transformation. Considering the importance of these factors, the agile practices associated to each were highlighted in the theoretical model developed.

4.4.4. Data analysis

As the objective of this research is to expand a theoretical model that allows to assess and improve the maturity level of agile practices associated with barriers and enablers of an agile transformation, the following sub sections focus on suggested evolutions for the AAF model through the data collected. These evolutions resulted in the creation of the EAT model (table 26).

4.4.4.1.A new agile level 1 - essentials

The agile measurement index of AAF consists of 5 agile levels where each one represents an agile maturity level of a given project or organisation. Level 1 represents the first level of agility and level 5 represents the maximum level of agility that can be achieved. There are agile practices from the AAF model that represent barriers or enablers identified in this research but there are new agile practices associated with barriers and enablers that have been added to the EAT model. A new Agile Level 1 – Essentials was developed (table 26), where the new agile practices associated with barriers and enablers identified by Batista et al (in press)^b were considered.

Table 34. Enterprise Agile Transformation Model

Table 3.7: Enterprise Agile Transformation Model

Measurement Index		Artifacts	Objective														
Stage 1 - Factors of Discontinuation	↔	Discontinuing Factors	Go/ NO Go decision to continue with agile transformation														
↓																	
Stage 2 – Project evaluation	↔	<table><tr><th colspan="2">Measurement Index</th></tr><tr><td>6</td><td></td></tr><tr><td>5</td><td></td></tr><tr><td>4</td><td></td></tr><tr><td>3</td><td></td></tr><tr><td>2</td><td></td></tr><tr><td>Level 1: Essentials</td><td>New agile practices</td></tr></table>	Measurement Index		6		5		4		3		2		Level 1: Essentials	New agile practices	Assess project agility potential
Measurement Index																	
6																	
5																	
4																	
3																	
2																	
Level 1: Essentials	New agile practices																
↓																	
Stage 3 – Organisational evaluation	↔		Assess organisational agility potential														
↓																	
Stage 4 – Improvement Plan	↔	Agile Practices recommendations	Recommendations for agile practices associated with barriers and enablers														
↓																	
Stage 5 – Agile Practices Leveling	↔	Agile Practices to be considered	Agile Practices to be considered														

The agile practices associated to this new Agile Level 1 have a critical role since has the purpose to create a solid ground for successful agile adoption. The Level 1 only contemplates the new agile practices not considered yet in AAF and works as a pre-agility level to guarantee a successful adoption of the practices of next levels. All the practices associated with agile levels already identified in AAF kept the same level.

4.4.4.2. New indicators to assess Agile level 1 practices

To assess the maturity level of each new agile practice, the assessment method developed by Sidky et al (2007) was considered (table 27), where was used the same categories, areas and characteristics to be assessed.

Table 35. Assessment tables for Level 1 agile practices

Level 1 Agile practice	Category of Assessment	Area to be assessed	Characteristics to be assessed	To determine	Assessment method	Sample indicators
Agile Training for Leaders	People	Management	Learning	Whether or not managers are willing to learn agile principles	Interviewing	OE1_M1, OE1_M2
			Buy-in	Whether or not managers are committed to apply agile principles	Interviewing	OE1_M3, OE1_M4
			Experience	Whether or not the managers have experience in work with agile methods	Interviewing	OE1_M5
	Process	Table 36. Assessment tables for Level 1 agile practices (continue)				
		Management	Learning	Whether or not the managers have already attended agile training	Interviewing	OE1_M6
			Existence	Whether or not the organisation can provide agile training	Interviewing	OE1_M7
			Active Change Management Communication	People	Management	Buy-in
Whether or not the managers are committed to constantly share the goals and outcomes of agile transformation with all the stakeholders	Interviewing	OE1_M9				
Competence	Whether or not organisation has a culture of communicate the goals and outcomes of the projects in a regular and transparent way	Observation				OE1_A1
Developers	Existence	Whether or not organisation has a culture of communicate the goals and outcomes of the projects in a regular and transparent way			Interviewing	OE1_D1
	Teams Coaching for Agile Users	People			Coaching	Competence
Experience			Whether or not the organisation has people with experience in agile transformations	Interviewing		OE1_M13, OE1_M14
Project		Resources	Existence	Whether or not the project has an allocated resource, responsible to	Interviewing	OE1_M15

Using this method, were developed new indicators to assess Agile Level 1 practices (table 28). These indicators allow the assessment of several organisational characteristics through questions made to managers, developers and through the evaluator's observation, where was used a five-level likert scale: strongly disagree, tend to disagree, neither agree nor disagree, tend to agree, strongly agree. After the data collection, the maturity of each agile practice was assessed using a four-level scale: not achieved, partially achieved, largely achieved, and fully achieved. If any organisational characteristic evaluated in an agile practice was considered "not achieved" or only "partially achieved", that means that the organisation needed to improve that characteristic to adopt that agile practice (Sidky et al, 2007). If the organisational characteristics obtained the classification of "largely achieved" or "fully achieved" it means that had the required maturity level to move forward to the next level (Sidky et al, 2007).

Table 37. Indicators for Level 1 agile practices

Agile Practice	ID	Statement
Agile Training for Leaders	OE1_M1	You are willing to dedicate time to agile training to learn agile values
	OE1_M2	You are interested in learning agile values and principles
	OE1_M3	You recognize that learning agile values and principles before the adoption of agile practices is critical
	OE1_M4	You are willing to apply agile principles and values in agile transformation
	OE1_M5	You already applied agile methods in previous projects and organisations
	OE1_M6	You already attended agile training sessions
	OE1_M7	Organisation has the necessary resources to provide agile training for leaders
Active Change Management Communication	OE1_M8	You believe that it is important to create a change management plan to communicate the new way of working effectively to the stakeholders involved
	OE1_M9	You are willing to dedicate time in communicate the vision, objectives and accomplishments of the transition to agile methods to the team
	OE1_M10	You believe that including others in the planning of a project is critical.
	OE1_A1	After looking to previous project's change management or communication plans, you know that the organisation is prepared to communicate the transition to agile methods properly
	OE1_D1	You recognize that the organisation use to share the vision, objectives and accomplishments of every organisational initiative and changes in the way of working
Teams Coaching for Agile Users	OE1_M11	The organisation already identified the resources responsible to lead agile coaching
	OE1_M12	The Agile Coach holds agile certifications
	OE1_M13	The Agile Coach has a proven record of leading agile transformations
	OE1_M14	The Agile Coach has a proven record of leading agile teams
	OE1_M15	The Agile Coach has an allocation of 100% on the agile transformation

The OE1_M1, OE1_M2,..., acronyms used in table 27 and table 28 stand for: OE - Organisational Evaluation, 1 - Agility Level, (M)anager / (D)eveloper / (O)bservation by the

Assessor, 1 - Question number. This classification was selected to assess each agile practice of Level 1.

4.4.4.3.AAF agile practices associated with barriers and enablers and new agile practices

All the practices associated with barriers and enablers that were identified in EAT are described in table 29 and below. Teams that self-organize is a practice that was used to assess the enabler with the same name. Concentrate on Agile values is an enabler that aggregates four AAF agile practices embedded in Agile Manifesto values (Beck et al, 2001): Customer dedication to collaborate with a team, Cooperative Teams, Frequent Delivery and Changing Requirements. Was created the practice Agile Training for Leaders to respond to the enabler Educate Management on Agile. The practice Teams Coaching for Agile Users was created to respond to the barrier Agile Coaching is insufficient and the practice Active change management communication was created to respond to the enabler Communicate the change intensively. The Customer availability practice is associated with the Recognize the importance of Product Owner role enabler. Different layers of planning is associated with the Gap between short and long term planning barrier. The Teams with a sense of purpose practice is associated with the Reverting to the old way of working barrier. Finally, the Continuous improvement process practice is associated with the Using old and new approaches side by side barrier.

Table 38. New Agile Practices in EAT and AAF Agile Practices associated to barriers and enablers

	Adapted AAF Agile Practices	New Agile Practices
Barriers		
Using old and new approaches side by side	Continuous improvement process	-
Gap between short and long term planning	Different layers of planning	-
Reverting to the old way of working	Teams with a sense of purpose	
Agile coaching is insufficient	-	Teams coaching for agile users
Enablers		
Concentrate on agile values	Customer dedication to collaborate with a team, Cooperative teams, Frequent delivery, Changing requirements	-
Allow teams to self-organize	Teams that self-organize	-
Recognize the importance of product owner	Customer availability	-
Communicate the change intensively	-	Active change management communication
Educate management on agile	-	Agile training for leaders

The new agile practices that were created for EAT model are all in Level 1 – Essentials (table 30).

Table 39. The 6 Levels of Agility of EAT populated with Agile Practices and Concepts associated to barriers and enablers

Agile Principles				
<i>Accept Change in Order to Provide Customer Value</i>	<i>Frequently plan and deliver software</i>	<i>Human-centered design</i>	<i>Technical quality</i>	<i>Collaboration with Customers</i>

Level 6				
Table 40. The 6 Levels of Agility of EAT populated with Agile Practices and Concepts associated to barriers and enablers (continue)				
Level 5				Customer availability
Level 4			Teams that self-organize	
Level 3	Changing Requirements	Frequent Delivery		
		Different layers of planning		
Level 2	Continuous improvement process		Cooperative Teams	Customer dedication to collaborate with a team
			Teams with a sense of purpose	
Level 1			Agile training for leaders	
			Active change management communication	
			Teams coaching for agile users	
Bold: Agile practices associated with barriers and enablers				

Since the AAF agile practices already have indicators suggested to measure the maturity level of each practice, were not defined new indicators for these practices. Level 6 has no barriers or enablers associated and was left without any agile practice in table 30. Nonetheless this level has 7 agile practices identified in AAF not mentioned in this research since it is not the focus of this research.

4.4.4.4. New stage with improvement plan for agile practices associated with barriers and enablers

To respond to the lack of an action plan of AAF to overcome the weaknesses identified, a literature review was also carried out to find the best practices and recommendations that aims to improve the maturity level of agile practices assessed with a low maturity level in EAT.

Table 41. Improvement plan for each agile practice associated with barriers and enablers

Barriers	EAT Agile Practice	Best practices and tools	Actions description
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Agile Coaching is insufficient	<i>Teams coaching for agile users</i>	Agile Coordination Office (Batista et al, in press)a Agile Coach (Batista et al, in press)a	Honest, objective feedback from an outside source (Schatz & Abdelshafi, 2005) Frequent retrospective moments where the group share their experiences (Martin et al, 2005) Define individuals and groups within the organisation with a positive attitude toward agile methods and previous experience with agile (Dikert et al, 2016) Identify who can provide coaching for less experienced employees (Paasivaara, 2018) Agile networks for Scrum masters and product owners, called guilds; and biweekly Agile meetings with specific topics or guest speakers (Sommer, 2019) A group of Agile advocates and coaches responsible to persuade other staff to adopt the same elements of interpretation and practice to frame agile adoption as their own (Abdelnour-Nocera et al, 2007)
Using old and new approaches side by side	<i>Continuous improvement process</i>	Customized Agile framework (Batista et al, in press)a Assessment of Organisational Needs (Batista et al, in press)a Sprint Retrospective (Henriksen & Pedersen, 2017).	Develop an agile software development process model building on feedback continuously gained from iterative improvement workshops at the project level (Pikkarainen et al, 2012). Define the use of agile development methods in specific situations (Pikkarainen et al, 2012). Continuously adapt the agile-based process model at the organisational level (Pikkarainen et al, 2012).
Gap between short and long term planning	<i>Different layers of planning</i>	Business Unit Roadmap (Batista et al, in press)a Epic Planning (Batista et al, in press)a Scrum of Scrums (Vallon et al, 2017) Sprint Planning (Vallon et al, 2017) Estimation Meeting (Vallon et al, 2017) Requirements workshop (Vallon et al, 2017) Sprint Backlog (Henriksen & Pedersen, 2017)	Co-operation between customer and team for initial and flexible requirements and team-level goals, (Lappi et al, 2018). Product backlog and vision guide prioritization and iteration process (Lappi et al, 2018) Flexible budgeting (short-term) and contracting (time & material) support agile projects (Lappi et al, 2018) Iterative project planning using product vision and backlogs (Lappi et al, 2018) Backlogs and priorities analysed in each sprint in order to assess possible changes resulted from deliverables tests or product vision update (Bjarnason et al, 2016)
Reverting to the old way of working	<i>Teams with a sense of purpose</i>	Agile Pilots (Batista et al, in press)a Incremental Agile Adoption (Batista et al, in press)a Improve collaboratively (Henriksen & Pedersen, 2017) Team based estimation (Henriksen & Pedersen, 2017)	Include motivated developers on each team (Conboy et al, 2011). Gather and share success tales and good experiences about adoption. (Conboy et al, 2011). Provide psychological motivators since they play a significant role, together with abilities to cope with and manage change, in adopting new technologies and methods (Murphy & Cormican, 2015) Locally experiment, test, learn and protect before repeating and adapting at the scale (Calnan & Rozen, 2019). Let the experiment guide your learning, not the expected (desired) result (Calnan & Rozen, 2019).
Enablers			

Concentrate on agile values	<i>Customer dedication to collaborate with a team, Cooperative teams, Frequent delivery, Changing requirements</i>	Agile Mindset & Autonomy (Batista et al, in press)a Incremental design (Henriksen & Pedersen, 2017) Iterative development (Henriksen & Pedersen, 2017) Continuous integration (Vallon et al, 2017)	Make sure the team, management and all stakeholders have a clear vision, understanding and awareness of agile methods (Pikkarainen et al, 2012). Ensure multiple members get agile training or attend agile conferences (Conboy et al, 2011) Encourage agile coaching and championing (Conboy et al, 2011) Ensure cross-team observation and validation of agile practices (Conboy et al, 2011) Assess agility in terms of agile values not practice adherence (Conboy et al, 2011) Focus on behaviour and mindsets to foster culture (Calnan & Rozen, 2019) Agile principles can work as a shared compass to align the efforts of all actors (Calnan & Rozen, 2019).
Allow teams to self-organize	<i>Teams that self-organize</i>	Cross Functional Teams (Batista et al, in press)a Dedicated Teams (Batista et al, in press)a Whole Team (Henriksen & Pedersen, 2017) Daily Stand-up (Henriksen & Pedersen, 2017) Task Board (Henriksen & Pedersen, 2017) Visualize workflow (Henriksen & Pedersen, 2017)	People should be eager to share information with one other, continuously learn (Misra et al, 2009) Teamwork and team building are critical to establishing self-managing teams. (Schatz & Abdelshafi, 2005) Team colocation is a real boost to productivity (Schatz & Abdelshafi, 2005) Managers learn to properly delegate to teams, they should shift their focus from tasks and assignments to team dynamics (Schatz & Abdelshafi, 2005) Small teams are better suited for implementing Agile methods (Boehm, 2002) The number of 10 elements of the development team is the ideal number, although it is not mandatory (Rising & Janoff, 2000) A successful implementation requires a certain level of freedom among the development team to decide which agile practices they intend to adopt once they have received training in Agile methods (Pikkarainen et al, 2012) Encourage self-assignment task to let developers work in different areas and learn new skills (Morgan, 1986) Senior management defining only the critical factors that are needed to direct the team and placing a few restrictions on the team as possible (Morgan, 1986) Promote an environment of “bounded” or “responsible autonomy” (Morgan, 1986) Introduction of more decentralized decision-making processes (Paasivaara et al, 2018)
Recognize the importance of the product owner role	<i>Customer availability</i>	Product Owner Group (Batista et al, in press)a Feature Product Owner (Batista et al, in press)a Onsite/proxy customer (Vallon et al, 2017) Sprint review/demo (Vallon et al, 2017)	Ensure that they are responsive, collaborative, authorized, committed and knowledgeable (Conboy et al, 2011) Clear roles are identified to be essential for successful agile implementation (Boehm & Turner, 2005) Ensure the Product Owner is dedicated to this role and/or if there is only one (single) PO in the team (Alliance, 2015)
Communicate the change intensively	<i>Communicate the change intensively</i>	Management Support (Batista et al, in press)a Stakeholders Engagement (Batista et al, in press)a	Identify a Sponsor who’s willing to put everything on the line and is committed to moving to agile (Schatz & Abdelshafi, 2005)

Educate management on agile	<i>Agile training for leaders</i>	Evaluate Stakeholders Satisfaction (Batista et al, in press)a Engage Change Leaders (Batista et al, in press)a Change Driver Team (Batista et al, in press)a Promote Communication & Transparency (Batista et al, in press)a	Sponsor should be able to stand up to the critics, encourage the leaders and communicate the team's vision (Schatz & Abdelshafi, 2005) Pick good people and reward the results of pilot projects (Boehm & Turner, 2005) Show your appreciation for the team's work, regardless of the outcome (Boehm & Turner, 2005) The team members put their reputations on the line for the organisation, leaving themselves vulnerable to the organisational antibodies. Don't minimize that effort (Boehm & Turner, 2005) Small local and personal initiatives can have a big impact (Calnan & Rozen, 2019) Small successes are contagious and help foster emulation (Calnan & Rozen, 2019)
		Agile Concepts Alignment (Batista et al, in press)a Scaled Agile Training (Batista et al, in press)a	Make sure the team, management and all stakeholders have a clear vision, understanding and awareness of agile methods (Pikkarainen et al, 2012) People should understand and learn agile values and principles in addition to practices to be motivated and committed. (Conboy et al, 2011) To transforming from traditional to agile methods, management style should be changed from "command and control" to "leadership and collaboration" (Yang et al, 2009) The role of project manager should be altered from planner and controller to director and coordinator (Moe et al, 2009; Monteiro et al, 2011) Project manager should have an adaptive leadership style (Lappi et al, 2018)

Considering the importance of the barriers and enablers in agile transformation, it is crucial not only to identify their maturity but also what are the best practices that allow overcoming the weaknesses of each factor. A new stage in the EAT process was developed – Stage 4: Improvement Plan – which contain a set of actions, best practices and tools found in the scientific literature that aim to improve the degree of maturity of each barrier and enabler. Thus, organisations that are involved in a transformation of this scale have a direction they can take to successfully move to the next agile level (table 31).

4.5.Results

The next step consisted of the presentation and validation of the EAT with a focus group of 10 experts from agile methods and project management community, during August 2021. To get different point of views, the experts had a heterogeneous background as academics, project and program managers, product owners, scrum masters and agile consultants. The presentation was carried out in one-hour session, where at the second part of the session there was a moment of discussion to collect qualitative feedback about the importance, clarity, completeness,

practicality, necessity, and effectiveness of EAT. It was also possible to collect data from experts about their professional experience and role. The following section presents the analysis of the data obtained related with the 6 levels of agility and the 5-stage process.

4.5.1. Feedback on the 6 levels of agility

The questions discussed during the focus group related with the 6 agility levels aimed to collect feedback on its completeness, practicality, necessity, as well as whether the practices represent the correct agility levels. The majority of the experts agreed that the EAT has a high level of completeness and partially agreed that the 6 levels are defined in a valid and logical order. As for the practicality of the EAT, all participants fully agreed the 6 Agile levels can be used to rate and support an agile transformation and could be beneficial to the software development industry. About agile practices at the respective levels, the majority agreed that they are correctly assigned, and a small group disagree with the attribution of practices by level. This disagreement may be associated with the different experiences and previous projects of each participant, which influences the way in which they attribute the degree of agility to each technique.

After collecting feedback from the experts, the existent AAF agile practices associated with barriers and enablers were not moved to the new Level 1 and remained at the levels initially assigned in the model. According to the feedback collected, these practices require some level of agility to be implemented and should stay in their original level. Additionally, their shift to Level 1 could represent a roadblock to the change as it may be too disruptive to require this practice as a Level 1 practice, which can lead to team frustration and abandonment of agile adoption.

Some of the statements of participants were:

- E2: *“The basic practices must exist”*;
- E3: *“If there is no context, it's harder to be faithful to Agile”*;
- E5: *“It has to be simple and easy to understand.”*;
- E8: *“If level 1 included all barriers and enablers it could represent a big barrier to agile transformation”*.

4.5.2. Feedback on the 5-stage process

Regarding the 5-step process, the discussion was designed to assess the criteria of understanding, need, completeness and clarity. All participants understood the objective of the model and the majority indicated that they agree that the process is appropriate to be used by

the IT organisations. In terms of clarity, most of the experts mentioned that all activities are organized in a logical sequence. Regarding completeness, a small number of experts indicated that they partially disagree that the model contains all the necessary elements.

Some of the statements of participants were:

- E3: *“The improvement plan could have some suggestions for possible paths of implementation”*;
- E4: *“Agile training should not only focus on top management but also on middle management as these positions are often the ones leading the real change”*;
- E7: *“Active communication is a necessary and fundamental skill for change and must be implemented from day 1”*;
- E8: *“The creation of organisational awareness is essential, so the practice related to active communication makes perfect sense”*;
- E10: *“The process is clear and simple to follow”*.

4.6.Discussion

The following sections aim to present the discussion of this research by answering the research questions and comment the main findings of the research.

4.6.1. General comments

The evolution of AAF to the EAT model allows organisations to initiate agile transformation with the practices that ensure the success of the transition and adoption. Level 1 – Essentials contains the practices associated with mitigating the barriers and accelerate the enablers of an agile transformation, which means that the successful adoption of practices at this level allows organisations to look to the future with confidence that they are building solid foundations. Level 1 ensures that there is an alignment of the agile principles with the organisation needs while implementing agile methods in an organisation (Kalenda, Hyna, & Rossi, 2018) through the application of agile essentials concepts that allows flexibility to accommodate expected or unexpected changes rapidly (Qumer & Henderson-Sellers, 2006). This flexibility could be gained by applying knowledge management techniques to overcome ambiguity (Tooranloo & Saghafi, 2018) which can be complemented with training and coaching practices. Additionally, all these Level 1 agile practices are related with people, culture and communications which are factors that influence agile transformations success (Lindvall et al, 2004). On the other hand, the new Level 4 - Improvement Plan, aims to respond to one of the weaknesses pointed out to the AAF and suggested a set of actions, best practices and tools that organisations could try if they

intend or need to increase the maturity level of a specific Level 1 agile practice. EAT also allows to understand the causes of failure and success of an agile transformation before applying a specific tool or technique which represents a clear benefit according to Pereira & Santos (2020). On the other hand, the improvement plan for agile practices aims to mitigate the limitation identified in the AAF model of Sidky et al (2007) related with the lack of guidance about how organisations can overcome their weaknesses and improve agile maturity.

4.6.2. Findings

Considering the development of the EAT theoretical model developed during data analysis and based on the results collected through a focus group of experts, it was possible to answer the research questions, identified in the following sub-sections.

4.6.2.1. Findings of question of research 1

Research question 1 was “How to assess agile practices associated with barriers and enablers of an agile transformation?”. Agile practices of the AAF and new practices associated with barriers and enablers were identified in EAT. The agile practices already identified in AAF should use the indicators already suggested in AAF to measure the maturity level of each practice. For the new practices identified in Level 1 - Essentials, they should be assessed through the assessment table and indicators suggested in table 27 and table 28, respectively.

4.6.2.2. Findings of question of research 2

Research question 2 was “What is the action plan that has the goal to improve the maturity level of agile practices associated with barriers and enablers of an agile transformation?”. Through the creation of step 4 – Improvement Plan, it was possible to create a plan that mitigates barriers and accelerate the enablers. The plan consists of a set of actions, best practices and tools that can be tried out by the teams to understand which are the most efficient (table 31).

4.7. Conclusions

EAT aims to define a theoretical model that guides organisations in adopting agile methods, highlighting the most important agile practices, and adding an improvement plan to help increase the maturity of the agility level that is intended to be achieved in each organisation. The structure was based on the AAF theoretical model that evolved in this research through the creation of a new Agile Level 1– Essentials, where new agile practices associated with barriers and enablers of an agile transformation were added. Was also considered a new stage in the process – Stage 4: Improvement Plan – where was defined a set of recommendations, actions

and tools found in the scientific literature that aimed to improve the degree of maturity of each barrier and enabler. With EAT theoretical model, organisations involved in an agile transformation have a better direction they can take to successfully move to the next agile level, with clear instructions about how they can holistically implement these practices in their teams (Highsmith, 2006). This research represents a considerable contribution to the theory and literature review due to the clear direction that provide to the organisations, and which is currently missing (Schwaber, Laganza & D'Silva, 2007; Sillitti, Ceschi, Russo & Succi, 2005). In conclusion, EAT represents a theoretical model that serves as a guide for organisations that intend to start adopting agile practices in their projects and teams.

4.7.1. Limitations

It is important to recognize that this research has some limitations. In first place, the data of this study was collected via secondary data. In second place, the data validation was obtained through a focus group of 10 experts which could represent a small sample. In third place, Step 4 – Improvement Plan only suggests recommendations and actions for agile practices of Level 1 – Essentials. In fourth place, the assessment indicators of the new practices of Level 1 – Essentials are already defined but need to be validated and will be tested in further research.

4.7.2. Future lines of research

It is recommended the development of an improvement plan for all levels and agile practices contained in EAT. It is also recommended that the EAT be tested and validated through qualitative studies, namely through case studies carried out in organisations from several sectors. Other approaches are also recommended that allow the validation and consolidation of agile practices at each level.

5. Conclusions

The purpose of this thesis is to investigate how organisations can lead an Agile Transformation and manage their portfolio of agile projects. Through the first and second studies developed was possible to found in the literature the best practices to implement and manage a portfolio of agile projects and how to manage the barriers and enablers of Agile Transformations. The third and last study intended to expand a theoretical model considering the results found in the first two studies. Although the three studies are complementary and linked to each other, each presents different conclusions as they address different research questions and different gaps in the literature.

5.1.First study

The challenges associated with managing agile projects that organisations are facing over the last years are mostly related with 1) having too many active projects running in parallel without the right prioritization criteria and 2) lack of vision to select the right resources (Krebs, 2008). These challenges can also be summarized as issues associated with the complexity of managing multiple resources and agile project priorities (Oosterhout et al, 2006). The systematic literature review conducted in the first study intends to contribute to the lack of scientific studies by identifying the best practices to manage a portfolio of agile projects. This study analysed and reviewed 28 scientific studies on agile portfolio management, published between 2005 and 2020. The first research question was focused in identify the best practices that allow a successful implementation and management of an agile project portfolio. The best practices found were grouped in three different dimensions: *Coordination*, *Prioritization of Projects and Resources* and *Agility*. The best practices grouped in *Coordination* have the mission to align the strategy and vision for each product roadmap or project as well as improve coordination and communication at a portfolio level. *Projects and resources prioritization* best practices are focused in providing clarity about the priorities of each project and resources allocation needs. *Coordination* and *Projects and resources prioritization* dimensions are complementary of each other. The third dimension *Agility* contain the critical best practices to enable agility within an agile project portfolio.

The second research question was focused in identify the baseline conditions that enable the implementation of *Coordination*, *Prioritization of Projects and Resources* and *Agility* dimensions' best practices. The *Change Management* dimension was created to this end.

The goal of this study is to provide insights about the most efficient best practices for managing an agile project portfolio, as well as how to confirm that the right conditions are in place.

5.2.Second study

As a starting point for this study was used a preliminary list of the barriers and enablers of an Agile Transformation identified by Dikert et al (2016). Was used a quantitative approach where was collected 294 valid responses from Agile Experts via questionnaire about the selected barriers and enablers. The first research question of this study was focused on identify which barriers better explain the success of an Agile Transformation. It was expected to see a relationship with negative direction between the barriers and the success of an Agile Transformation. Using factor analysis, it was possible to group the selected barriers in five

factors: *1 – Resistance to Change; 2- Ambiguity in the way of working; 3 – Lack of technical consistency; 4 - Difficulty in planning and estimating and 5 - Lack of coaching to teams.* The factors prove that most of the obstacles found at the organisational level are typically related with change resistance, lack of motivation and lack of investment in the transformation. The answer to the first research question was obtained through multiple linear regression analysis, where were identified the following barriers: *1) Using old and new approaches side by side; 2 - Lack of coaching; 3 - Gap between short and long term planning and 4 - Reverting to the old way of working.* These are the barriers that have the greatest negative impact on the success of an Agile Transformation which means that these are the barriers that best explain and are closely related to the failure of an Agile Transformation.

The second research question was focused on identify which enablers – previously named as Success Factors during this study - better explain the success of an Agile Transformation. In this case it was expected to see a relationship with positive direction between the enablers and the success of an Agile Transformation. Through factor analysis it was found four factors. *1 - Communication and involvement; 2 - Training and commitment; 3 - Gradual approach and 4 - Adaptation of the way of working.* The answer to the second research question was also obtained through multiple linear regression analysis, where were identified the following enablers: *1 - Concentrate on agile values, 2 - Allow teams to self-organize, 3 - Recognize the importance of the Product Owner role, 4 - Communicate the change intensively and 5 - Educate management on Agile.* These are the enablers that have the greatest positive impact on the success of an Agile Transformation. Looking to the literature it's common to find activities related with training, engaging and informing people as well as activities related to organisational culture as critical enablers. This means that these are the enablers that best explain and are closely related to the success of an Agile Transformation.

The Barriers and Enablers highlighted in this study should be considered by Agile Practitioners and Agile Experts involved in Agile Transformations, as they have a crucial role in the outcome.

5.3.Third study

This study used a qualitative approach with secondary data that aimed to evolve a theoretical model found in the literature. Using the AAF as a starting point, was created the EATM model that enables organisations to begin an Agile Transformation with strategies that increase the probability of success of the implementation. The first question of research was: “*How to assess agile practices associated with barriers and enablers of an agile transformation?*”. The agile

practices associated with mitigating the barriers and accelerating the enablers of an Agile Transformation were identified in EATM. Some of the practices already have indicators that allow to measure agile maturity but all the new practices that were created in *Level 1 – Essentials* could be assessed through the new indicators that were created for each one. The Level 1 only contemplates the new agile practices not considered yet in AAF and works as a pre-agility level to guarantee a successful adoption of the practices of next levels. All the practices associated with agile levels already identified in AAF kept the same level.

The second question of research was: “*What is the action plan that has the goal to improve the maturity level of agile practices associated with barriers and enablers of an agile transformation?*”. The *Level 4 - Improvement Plan* developed in EATM, address one of the weaknesses of the previous model by recommending a set of activities, best practices, and tools that organisations could use to improve the degree of maturity of each barrier and enabler. The EATM was presented and validated with a focus group of 10 Agile Experts and project management community, during August 2021 to get feedback on the 6 levels of agility and the 5-stage process. The majority of the experts agreed that the EATM has a high level of completeness and partially agreed that the 6 levels are defined in a valid and logical order. As for the practicality of the EAT, all participants fully agreed the 6 Agile levels can be used to rate and support an agile transformation and could be beneficial to the software development industry. Regarding the 5-step process, all participants understood the objective of the model and the majority indicated that they agree that the process is appropriate to be used by the IT organisations. In terms of clarity, most of the experts mentioned that all activities are organized in a logical sequence. Regarding completeness, a small number of experts indicated that they partially disagree that the model contains all the necessary elements.

Through the EATM is possible to have a better understanding of the causes of agile transformation failure and success and what can be done to improve. The improvement plan for agile practices tries to address the issue related with the lack of direction on how organisations can overcome their fragilities and enhance agile maturity.

5.4.Theoretical contributions

The scientific literature on Agile Portfolio Management is currently scarce despite its recent growing. The systematic literature review conducted in the first study contributed to bring more clarity about the best practices for managing agile portfolios and how to ensure the appropriate conditions to be succeeded in this implementation. The study created a viewpoint of four

important dimensions to take into account and a overall understanding of the journals and authors more active publishing papers on this topic.

The second study contributed to fill the gap in the scientific literature on Agile Transformations by identifying the Barriers and Enablers with higher importance referenced in the systematic literature review of Dikert et al (2016).

The third study represents an advance in the theory of Agile maturity models topic since it represents an evolution of the current AAF to EATM to serve as a guide for organisations that intend to start adopting agile practices in their projects and teams.

5.5.Management contributions

The first study contributes to support the Agile practitioners by providing an awareness about the most efficient best practices for managing agile project portfolios, as well as how to ensure that the right conditions are in place for these transformations. These best practices were identified and explained via the four dimensions that were identified: *Coordination, Project and Resources prioritization, Agility and Change Management*:

- *Coordination*: Were identified artifacts as *Business Unit Roadmaps, Roadmap of Roadmaps and Kanban Portfolio Metrics* which have the mission to communicate strategic intent of each product roadmap and provide guidance on the priorities of the project portfolio. To improve transparency on resources and buy-in of senior management, were identified the events *Scrum of Scrums, Epic Planning, Monthly Business Unit Backlog Revision and Portfolio Revision*. The structures oriented to ensure inter-project coordination that were identified were *Agile Coordination Office, Escalation Group, IT Steering, Product Team, Project Management Office and Program Management Office*. Most of these structures have the same role but have different names. The common mission is to support and empower the agile teams, promote and collect distinct agile metrics and disseminate best practices. *Portfolio Work Control System* is the process found to control the affluence of new requests and the *Portfolio Manager* role has the mission to quickly respond to the frequent changes in a coordinated manner.
- *Projects and Resources prioritization*: The identified practices that most contribute to this dimension were the creation of a *Product Owner Group team*, where is discussed and decided the priorities of each feature on the backlog. The *Strategic Backlog* and *Portfolio Backlog* artifacts aims to establish a clear vision about what needs to be done

and resource allocation needed to deliver the backlog. The *Feature Product Owner*, *Business Project Manager* and *Epic Owner* are roles that help to plan project resources and budget control to ensure the correct execution of the projects in the prioritization events like *Epic Prioritization*.

- *Agility*: The techniques identified to ensure agility principles were the *Daily Meetings*, *Refactoring*, and *Continuous Integration*. *Scrum Master* role was mentioned to promote the agile principles and *Agile Coaches* are crucial to create a network of agile experts. *Cross Functional Teams*, *Self-Organized Teams*, and *Dedicated Teams* are considered non-negotiable principles to ensure agility.
- *Change Management*: To move from a highly predictable and planning oriented environment to a dynamic one represents a challenge that needs to use specific management techniques and best practices to be successfully executed. The development of a *Customized Agile Methodology* represents the artifact that was identified. *Management Support*, *Engagement of Stakeholders*, *Initial Needs Assessment*, *Realization of Agile Pilots*, *Customization of Agile Concepts*, *Measurement of Stakeholder Satisfaction*, *Involvement of Change Agents* and *Agile Training* are the events that were identified. *Communication*, *Transparency*, *Agile Mindset* and *Autonomy* are the principles that were mentioned. The creation of a *Change Driver Team* was also identified as a critical structure to manage change and involve stakeholders in the new agile mindset.

The second study provided advice about the most important barriers and enablers of Agile Transformations discovered through this research. 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* are the barriers that have the greatest negative impact on the success of an Agile Transformation. A correct understanding of each barrier is essential to apply the best practices in a consistent way:

- *Using old and new approaches side by side*: Implementing Agile Methods in a continuous and evolving manner is critical. The customization to the individual and project context is needed to avoid disruption and to ensure consistency and the existing waterfall processes should be linked with the new agile way of working to find the right balance. The continuous improvement and customization of agile practices need time and effort to fit in the organisation culture and priorities and should start in peoples'

mindset (Denning, 2016; Ebert & Paasivaara, 2017; Gandomani & Nafchi, 2015; Pries-Heje & Krohn, 2017).

- *Lack of coaching:* It's important to ensure the role of Change Leaders. These people should have positive attitude on agile way of working and are experienced in previous agile implementations, which allows less experienced people to be properly taught and trained to use new agile techniques and concepts. The teams should be coached as they learn by doing. The creation of an Agile Centre of Excellence is important to guide and coach people on agile practices and to define the initial setup and alignment (Dikert et al, 2016; Naslund & Kale, 2020; Poth, Kottke, & Riel, 2019).
- *Gap between short and long term planning:* A flexible planning and budgeting are considered key ingredients of Agile Transformations as a core Agile principle. Shifting to a frame-based planning and funding where a minimum viable product is developed to show future investments is essential to enable the speed and get customer feedback much earlier than using the traditional approach (Sommer, 2019).
- *Reverting to the old way of working:* Without training, teams struggled to use agile methods correctly, and the difficulty posed by adopting the new practices could cause people return to their old way of working. The Change Team should share agile success stories to promote the involvement and encouragement to use agile practices and to avoid setbacks in the transformation. The leaders need to lead by example the principles that they want to implement in their teams and the change leaders should be responsible to push the agile transformation forward (Conboy et al, 2011; Ebert & Paasivaara, 2017; Poth, Kottke, & Riel, 2019).

The enablers *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* were identified as the enablers that have the greatest positive impact on the success of an Agile Transformation. It was also developed the following detailed analysis for each enabler to clarify the meaning of each:

- *Concentrate on agile values:* Before explaining which agile techniques should be implemented, people need to understand the agile mindset and values. This requires a change not only in the mindset of individuals but also in the organisational culture. It is considered that methodologies, tools and management theories are less important than principles when facing an organisational transformation (Calnan & Rozen, 2019; Laloux, 2014; Pikkarainen et al, 2012).

- *Allow teams to self-organize:* Increase teams autonomy is a central piece in the agile mindset as well as giving the freedom to organize as they see appropriate to achieve the desired outcomes. Should be encouraged a development of t-shaped teams, where each team member expand the field of expertise to adjacent topics (Calnan & Rozen, 2019; Dikert et al, 2016; Paterek, 2018).
- *Recognize the importance of the Product Owner role:* The conversion of roles and responsibilities in the team often bring the need to assess and adjust existing roles. Delivering requirements through incremental cycles could be difficult a concept difficult to understand and should be managed closely. Since the Product Owner role is one of the most important in Agile Methods, it should be filled by someone dedicated to this role who has good understanding on how the business and technology teams can work together (Calnan & Rozen, 2019; Dikert et al, 2016; Nuottila et al, 2016; Pikkarainen et al, 2012).
- *Communicate the change intensively:* It is essential to ensure since the beginning that people understand the justification of the change and its benefits. The transformation should be communicated in a transparent way and the top management support should be visible. During the transformation should be implement tools and processes to increase knowledge sharing in a transparent way, to promote collaboration and engagement of all the people involved and to create agile communities (Ebert & Paasivaara, 2017; Gupta et al, 2019).
- *Educate management on Agile:* The top management buy-in is critical to keep high levels of motivation between the stakeholders, not only at the beginning of the transformation but during the entire transforming process. They should be aware of the changes needed to implement a new way of working and support the impacts on the organisational structure. The change from a command and control to a coaching and servant leadership style require training and workshops on agile mindset as well as the implementation of decentralized decision-making processes. These new concepts should be well explained and understood by the management team. (Birkinshaw, 2018, Campanelli et al, 2017, Javdani et al, 2015; Johnston & Gill, 2017; Pikkarainen et al, 2012).

The EATM developed in the third study also brings clear management contributions. Through this theoretical model organisations could assess agile maturity and implement agile

principles in their projects and teams. Using an existing model, it was expanded the following components:

- *Agile Level 1 – Essentials:* The agile measurement index of AAF consists of 5 agile levels where each one represent an agile maturity level of a given project or organisation. A new Agile Level 1 – Essentials was developed to include the new agile practices associated with barriers and enablers identified in the second study of this thesis. The Level 1 only contemplates the new agile practices not considered yet in AAF and works as a pre-agility level to guarantee a successful adoption of the practices included in the next maturity levels.
- *New indicators to assess Agile Level 1 practices:* To assess the maturity level of each new agile practice were developed new indicators to assess Agile Level 1 practices through questions made to managers, developers and through the evaluator's observation. The maturity level of each agile practice could be assessed and evaluate which characteristics needs to improve and which ones already have good maturity level.
- *New stage with improvement plan for agile practices associated with blockers and enablers:* A literature review was also carried out to find the best practices and recommendations that aims to improve the agile practices with a low maturity level in EATM. The *Stage 4: Improvement Plan* contains a set of actions, best practices and tools found in the scientific literature that aim to improve the degree of maturity of each barrier and enabler. Thus, organisations that are involved in a transformation of this scale have a direction they can take to successfully move to the next agile level.

5.6. Research limitations

The first limitation is related with the type of search used in the first study. Except for the bigrams and trigrams identification, which used the N-gram Generator tool, the data collection in the first study was based on a manual search in each study. Even though the analysis comprises a thorough reading of each article, there may be gaps in the identification of techniques, tools, and organisational conditions of each study. Furthermore, one third of the publications examined are experience reports, which, despite their abundance of empirical data, lack scientific confirmation.

As a second limitation, it's important to mention that could exist some overlapping between the concepts Agile Projects Portfolio and Agile Transformations. Despite of the Change

Management dimension found in study one had some topics considered in Agile Transformations, the ultimate goal of the first study, oriented to Agile Projects Portfolio, was to find in the literature the best practices to manage a portfolio of agile projects while the ultimate goal of the second study was to identify the barriers and enablers that best explain the success and failure of agile transformations.

The third limitation has to do with the sample that was used in second study. It was used a non-probabilistic sample for convenience, so it needs some caution in terms of generalizing conclusions with statistical accuracy.

The fourth limitation has to do with how Agile Transformations were considered in the second study. Although it was stated in the communication to each respondent and reiterated in the survey header that the purpose of the study was to examine Agile Transformations that occurred in Portugal, it is impossible to guarantee that all of the cases collected are related to Agile Transformations that occurred in Portugal. The fact that the study focuses solely on the Portuguese situation is also a geographical constraint worth noting.

The sample classification variables were not directly assessed after data collection in second study, which is the fifth limitation. The goal of this study was to look at data on Barriers and Success Factors, as well as Agile Transformation Success, rather than attribute type data from each case. Complementary research focused on these characteristics is advised.

In the third study, it is critical to acknowledge that the data was gathered from secondary sources which represents the sixth limitation.

In the seventh limitation is highlighted that the data validation of the third study was collected in focus group of ten agile experts, which may represent a small sample.

The Step 4 – Improvement Plan only offers recommendations for Level 1 – Essentials agile practices and should be considered as the eighth limitation.

As the ninth limitation is highlighted the fact that the assessment indicators for the Level 1 – Essentials practices have already been identified but they need to be validated and tested in further study.

5.7.Future lines of research

Each technique and best practice identified in the first study should be detailed in greater depth and detail.

In the second study, we discovered several factors and difficulties that influence the success of an Agile transformation. To get a full understanding of each barrier and enabler, as well as relevant models and strategies to manage an Agile Transformation and an Agile Project

Portfolio, more in-depth research in collaboration with Portuguese organisations is required. Each factor of barriers and enablers discovered in the second study could be studied in depth using the factorial analysis results. To confirm cause-and-effect links between barriers and enablers, it is recommended the execution of further studies.

The formulation of an improvement plan for all levels and agile techniques contained in EATM are recommended in the third study. It is also suggested that the EATM be verified and validated through qualitative investigations, such as case studies conducted in a variety of businesses industries. Other ways that allow for the validation and consolidation of agile processes at each level are also encouraged as well as prove that Agile Transformations leads to greater success for organizations.

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Attachments

Attachment A – Acceptance for publication of the first study in International Journal of Process Management and Benchmarking

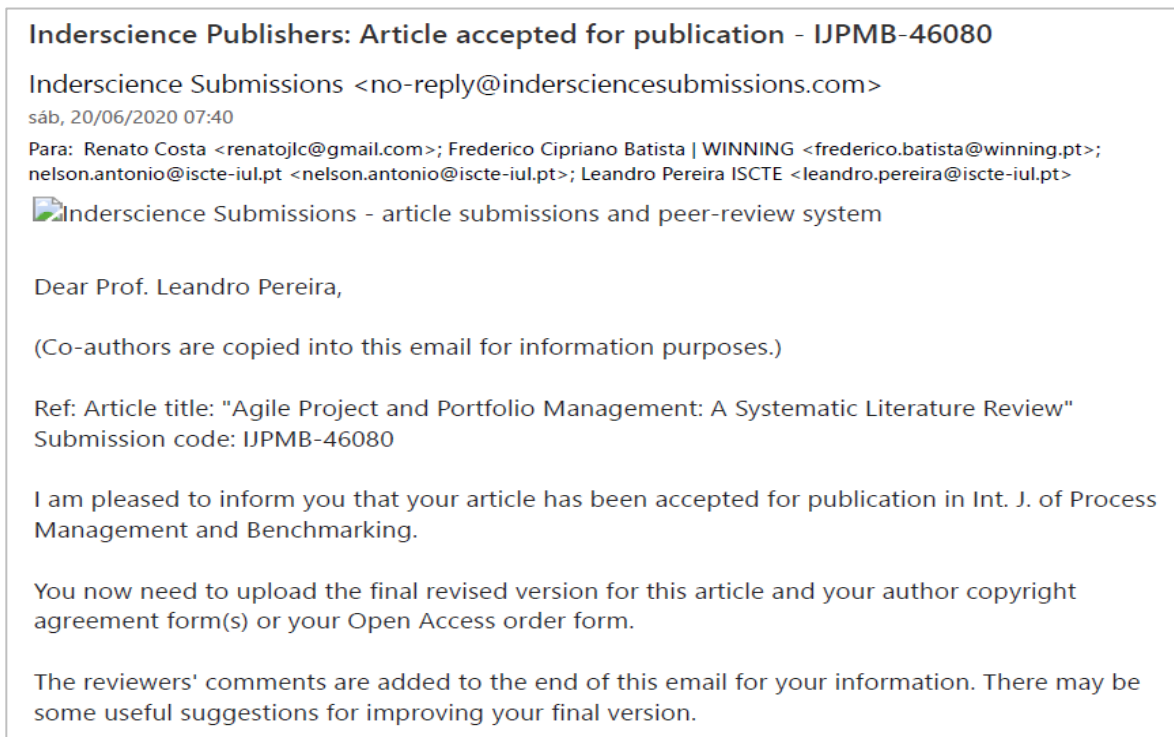


Figure 7. Acceptance for publication of the first study in International Journal of Process Management and Benchmarking

Attachment B – Acceptance for publication of the second study in International Journal of Agile Systems and Management

Final Refereeing Decision IJASM_316901

Inderscience Publishers <noreply@indersciencemail.com>

dom, 02/05/2021 16:59

Para: Frederico Cipriano Batista | WINNING <frederico.batista@winning.pt>; llfpa@iscite-iul.pt <llfpa@iscite-iul.pt>; Renato_Jorge_Costa@iscite-iul.pt <Renato_Jorge_Costa@iscite-iul.pt>; Editor <josip.stjepandic@prostep.com>

Dear Frederico Batista, Leandro Pereira, Renato Costa,

Ref: Submission "Success and Barrier Factors in Agile Transformation"

Congratulations, your above mentioned submitted article has been refereed and accepted for publication in the International Journal of Agile Systems and Management. The acceptance of your article for publication in the journal reflects the high status of your work by your fellow professionals in the field.

You need now to login at <http://www.inderscience.com/login.php> and go to <http://www.inderscience.com/ospeers/admin/author/articlelist.php> to find your submission and complete the following tasks:

1. Save the "Editor's post-review version" on your local disk so you can edit it. If the file is in PDF format and you cannot edit it, use instead your last MS Word revised version, making sure to include there all the review recommendations made during the review process. Rename the new file to "authorFinalVersion."
2. Open the "authorFinalVersion" file and remove your reply or any response to reviewers that you might have in the front of your article.
3. Restore the author's identification, such as names, email addresses, mailing addresses and biographical statements in the first page of your local file "authorFinalVersion."
4. IMPORTANT: The paper is accepted providing that you, the author, check, edit and correct the English language in the paper. Please proofread all the text and make sure to correct any grammar and spelling mistakes.

Figure 8. Acceptance for publication of the second study in International Journal of Agile Systems and Management

Attachment C – Acceptance for publication of the third study in International Journal of Agile Systems and Management

Inderscience Publishers: Article accepted for publication - IJASM-95227

Inderscience Submissions <no-reply@indersciencesubmissions.com>

dom, 26/09/2021 09:18

Para: Leandro Ferreira Pereira <Leandro.Pereira@iscte-iul.pt>; renatojlc@gmail.com <renatojlc@gmail.com>; Frederico Cipriano Batista <Frederico_Cipriano_Batista@iscte-iul.pt>



Dear Prof. Frederico Batista,

(Co-authors are copied into this email for information purposes.)

Ref: Article title: "Enterprise Agile Transformation"
Submission code: IJASM-95227

I am pleased to inform you that your article has been accepted for publication in Int. J. of Agile Systems and Management.

You now need to upload the final revised version for this article and your author copyright agreement form(s) or your Open Access order form.

The reviewers' comments are added to the end of this email for your information. There may be some useful suggestions for improving your final version.

Figure 9. Acceptance for publication of the third study in International Journal of Agile Systems and Management

Attachment D – Conference book of abstracts where the first paper was presented

AGILE PROJECT AND PORTFOLIO MANAGEMENT: A SYSTEMATIC LITERATURE REVIEW

Frederico Cipriano BATISTA

ISCTE – Instituto Universitário de Lisboa | Portugal

frederico.batista@winning.pt

Leandro Ferreira PEREIRA

Renato Lopes da COSTA

15

Aims: The application of Agile Methods (AM) in project management has shown great efficiency and remarkable results. However, these methods were born to be applied at team level and not at project portfolio level, where the complexity of managing multiple agile projects and teams leads to several challenges of resource management, priorities and governance model of the project portfolio. The systematic literature review performed in this research aims to identify which practices are the most appropriate to manage the challenges associated with Agile Portfolio Management (APM) and which is the most appropriate context.

Methodology / Approach:

Research Process

A manual search was performed on B-On, Research Gate, Science Direct and Scopus databases. The research focused on the search and combination of terms and keywords such as "Agile AND Project Portfolio Management", "Scaled-Agile AND Project Portfolio Management", "Agile AND Agile Project Portfolio Management".

Inclusion and exclusion criteria

Empirical papers published in English language between 2005 and 2020 were included in the B-On, Research Gate, Science Direct and Scopus databases, which are directly related to research issues. The empirical research studies selected were case study, experience report, and systematic review according to the definitions proposed by Tonella, Torchiano & Du Bois (2007). References from books, theses and workshops, articles written in other language than English and all articles outside the selected timeframe were excluded.

Study selection

The study selection process was inspired by the structure used by Vallon, Estácio, Prikladnicki & Grechenig (2017), with 6 selection levels.

Data extraction and synthesis

Data extraction was done by qualitative reading of the selected studies by the first author. To analyse the most referred words in the selected articles and to identify patterns, were collected the most frequent words, bigrams and trigrams of the studies.

Conclusions / Results: The previous research led by Dikert et al. (2016), where the success factors and challenges for large-scale transformations were identified, served as inspiration to create the different dimensions of the techniques that were identified. It was also considered the domains of practice that enable agility outside individual projects, identified in the research conducted by Stettina & Hörz (2015). The dimensions of the two studies mentioned above were considered and techniques and best practices collected in this literature review were classified into 4 APM dimensions: Coordination, Project and resource prioritization, Agility and Change Management. A typification of each technique and best practice was also created where we can typify by: Artifact, Event, Structure, Process, Roles and Principles.

Research implications: This research analysed 28 studies that had identified techniques and best practices to address APM challenges. For APM practitioners, it intends to give an understanding of the most efficient best practices for managing agile portfolios and how to ensure the appropriate conditions for these implementations.

Originality: The existing scientific literature on APM is still very limited and this literature review aims to establish the basis and guide additional empirical studies and contribute to increase scientific studies on APM. The 4 APM dimensions identified in this study represents a new point of view regarding managing multiple agile projects and teams.

KEYWORDS: Agile; Agile Portfolio Management; Scaled Agile.

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Figure 10. Conference book of abstracts where the first paper was presented

Attachment E – Excerpt of the presentation of the second study that was made in Coventry Business School

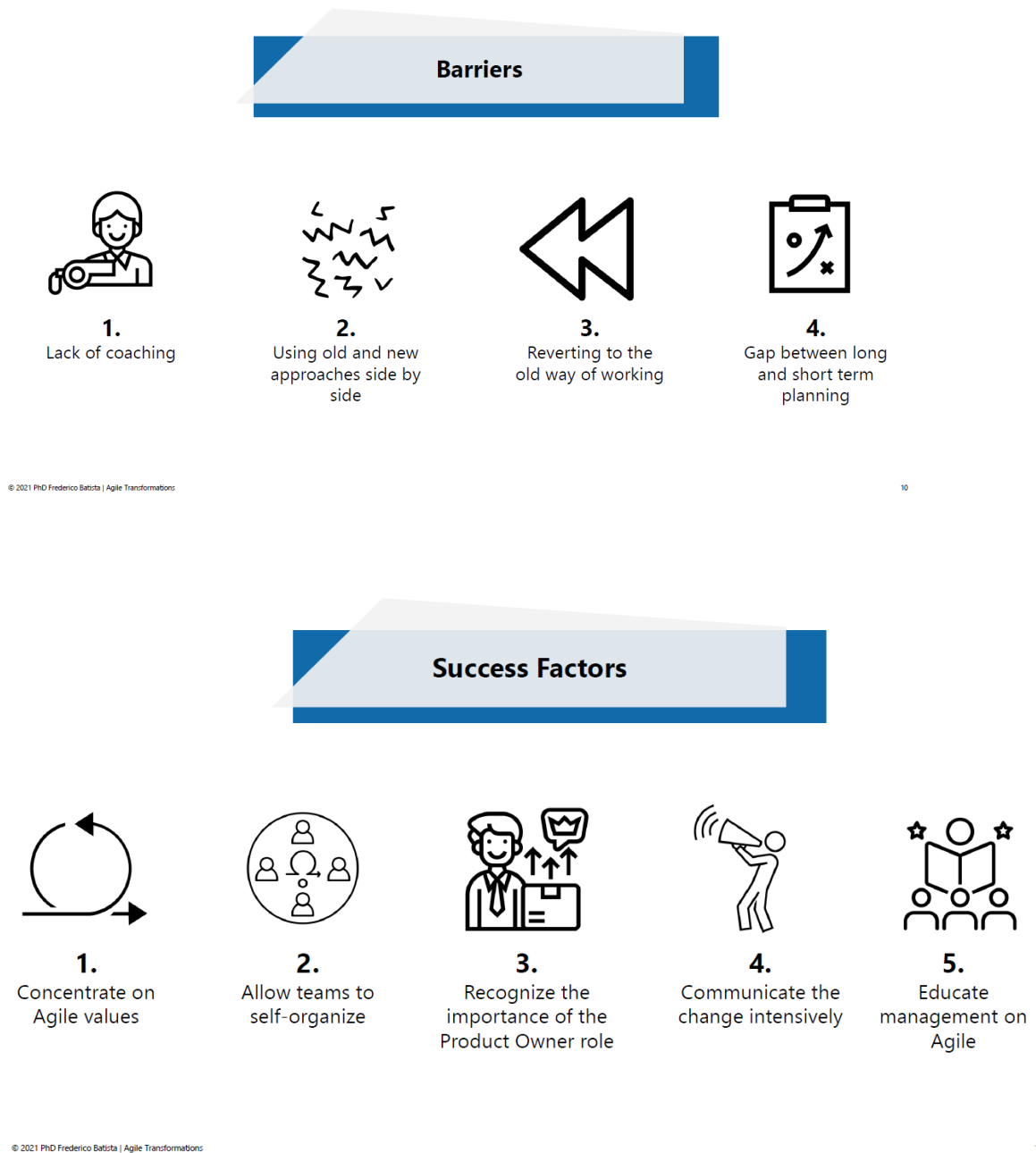


Figure 11. Excerpt of the presentation of the second study that was made in Coventry Business School

Attachment H - Abstract of the chapter written for the book *Voices of Project Management in Portugal* (Vozes da Gestão de Projeto, 2021).

**BARRIERS AND ENABLERS OF AGILE TRANSFORMATIONS
IN PORTUGAL**

WHAT ARE THE GREATEST PREDICTORS OF SUCCESS?

Frederico Cipriano Batista, Leandro Ferreira Pereira, Renato Lopes da Costa
ISCTE Business School

Abstract. Agile Methods increasingly represent an effective solution for organizations focused on delivering technological projects and products. However, these methods were originally conceived to be used by small and independent teams, which creates challenges in terms of resource management, priorities and governance model when they are implemented in different teams and projects of the same organization. Based on the scientific studies of Batista et al (in press) b and Batista et al (2021), this chapter aims to identify the factors associated with Barriers and Enablers with greater preponderance in the success of an Agile Transformation in Portugal. The results revealed four barriers and five enablers that stand out from the rest. Considering these results, the authors propose a new Agile Transformation model that aims to eliminate these barriers and enhance the enabling elements. For practitioners, it is recommended that they consider the Barriers, Enablers and Transformation Model suggested in this chapter as they can be decisive factors for the successful adoption of Agile Methods in the organization.

Figure 12. Abstract of the chapter written for the book *Voices of Project Management in Portugal*

Attachment J - Excerpt from the presentation given in the Agile Community Forum Agile Connect (Agile Connect, 2020)

BARRIERS AND ENABLERS OF AGILE TRANSFORMATIONS

1. Barriers and enablers associated with transformations from traditional project portfolio management methods to Agile methods in Portugal.

Literature review

Challenges and Success Factors for large-scale agile transformations: systematic literature review

- Journal of Systems and Software
- Q1 Ranking
- Published in 2016
- 52 primary studies:
 - 46 experience report
 - 6 case studies
- 35 identified barriers/ 9 categories
- 29 enablers/ 7 categories

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journal homepage: www.elsevier.com/locate/jss

Challenges and success factors for large-scale agile transformations: A systematic literature review

Kim Dikert^a, Maria Paasivaara^{a,b}, Casper Lassenius^{a,b,*}

^a School of Science, Department of Computer Science and Engineering, Aalto University, Finland

^b Helsinki University of Technology, School of Management, United States

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Success factors
Systematic literature review

ABSTRACT

Agile methods have become an appealing alternative for companies wishing to improve their product market, but the practices were originally designed for small and individual teams. This creates unique challenges when introducing agile at scale, while organizations require more systematic ERP activities, and there might be a need to interact with other organizational units. In this paper we present a system and literature review of large-scale agile transformations and their outcomes. We have adopted a state-of-the-art reporting challenges and success factors in the transformation. We conducted a systematic literature review of empirical large-scale agile transformations. Our keyword search resulted in 10,174 papers. We included 51 publications describing 42 individual cases presenting the process of taking large-scale agile development into an Agile ERP. Of the included papers, we identified 35 barriers, indicating a lack of sound academic research on the topic. We identified 10 reported challenges grouped into nine categories, and 29 success factors, grouped into seven categories. The most useful success factors categorized with management support, coaching and mentoring, the agile model, training and coaching, and mindset and alignment.

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1. Introduction

Agile methods were originally designed for use in small, single-team projects (Dikert and Turner, 2010). However, their proven and potential benefits have made them attractive also outside this context, particularly both for larger projects and in larger companies. This despite the fact that they are more difficult to implement in larger projects (Dikert and Lassenius, 2016). Compared to small projects, which are ideal for agile development, larger ones are characterized by the need for additional coordination. A particular problem in applying agile in larger projects is how to handle inter-team coordination. Large-scale agile involves additional concerns in interacting with other organizational units, such as human resources, marketing and sales, and product management. In addition, large scale may cause users and other stakeholders to become distant from the development team. Despite these known problems related to large-scale agile, there is an industry trend towards adopting agile methodologies in the large (Verschuere, Inc., 2016; Paasivaara et al., 2011, 2014; Dikert and Moe, 2014).

The State of Agile Survey that Version One has been conducting annually since 2007, has recently asked a few questions related to large scale as well, e.g. on scaling methods used and tips for success with scaling agile. According to the latest survey (Verschuere, Inc., 2016), 62% of the almost 4000 respondents had more than a hundred people in their software organization and 43% of all the respondents worked in development organizations where more than half of the teams were agile. Of course, the sample of this study is limited to a selected subset of companies and countries (of the almost 4000 respondents to the latest survey 55% were from North America and 26% from Europe). However, this indicates that there seems to exist a large number of companies that have taken or are taking agile into use in large-scale settings (Verschuere, Inc., 2016).

While the research literature contains several experience reports and some case studies on large-scale agile adoption, a systematic overview and synthesis of this growing body of research is still missing. (Furuberg and Shary, 2010) asked the industrial practitioners at the SP2010 conference to create a backlog of topics they think should be studied. The practitioners voted "Agile and large projects" as the top burning research question. Moreover, among the top ten topics, three focused on distributed agile development, which is relevant especially for larger organizations as

* Corresponding author.
E-mail addresses: kim.dikert@aalto.fi (K. Dikert), maria.paasivaara@aalto.fi (M. Paasivaara), casper@cs.aalto.fi (C. Lassenius).

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Figure 13. Excerpt from the presentation given in the Agile Community Forum Agile Connect

Appendixes

Appendix A – Detail of table 13 - Correlations

Table 13. Correlations

	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**	-.434**	-.395**	-.330**	-.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**	--			

Appendix B- Pre-test of the survey used in the second study

Pre-test feedback

Research survey – Barriers and success factors of Agile Transformations

Introduction:

Dear participant,

This investigation, taking place at ISCTE Business School, aims to study the challenges and success factors associated with organisational transformations from traditional project management methods to Agile methods.

This questionnaire is aimed at people who are or have been involved in organisational changes to Agile methods and intends to validate elements from the literature. For these reasons, your experience and contribution is very important to the academic and business community.

Time needed: approximately 4 to 7 minutes.

This data collection is covered by the utmost confidentiality and required complete anonymity. The processing of collected data, as well as their eventual communication in the form of scientific publication, will be carried out in an aggregated and never individualized manner.

In case of doubts or difficulty in filling it out, please contact fcbaio@iscte-iul.pt.

Thank you!

Frederico Cipriano Batista

Question 1: Indicate your role in the current Organisation

Question 2: What is your experience in working directly with Agile methods in various teams and projects?

- **Tiago Vieira:** The first time I read this question I confess that only after carefully looking at the answer options, I realize what was intended. I would inverted part of the sentence and left it like this: "In your teams and projects, what is your experience in working directly with Agile methods?";
- **Renato Paiva:** I would eliminate the word "several".

Question 3: What industry is your organisation in?

- **André Salgado:** Is this what interests you, or is it more which sector you work for? (This is because consulting firms are in services sector but they may have vertical specialization. E.g. my organisation's sector is services, but I work for the health sector in my client). Just to confirm the meaning of the question.
- **Ricardo Santos:** There are broader ways to define them. If you want, I can share with you a more holistic and understandable way by the market.

Question 4: How many employees does your organisation have, approximately?

- **Hélio Antunes:** Just a small detail: Identify if it is "your organisation and/or customer".

Question 5: Since when does your organisation use Agile methods in different teams and projects?

- **Ricardo Santos:** agile methods is in the context of project management right?
- **Renato Paiva:** I would eliminate the word "several".
- **Bráulio Rocha:** It may be difficult for some people to answer this question within your company (e.g., they may have been recently hired). In this case, it might be worth adding an option like "don't know/can't answer". Otherwise, there is a risk of choosing an option that does not properly reflect reality and end up introducing a bias in the results.
- **Hélio Antunes:** Do you need to repeat "(...) several teams and projects?"
- **Carlos Veneno:** This question may not be exactly known to the respondent and may lead to an inaccurate answer. There is a monthly time span that requires accuracy in answering. Do these options need to have a short initial time span?
- **Carlos Jerónimo:** the organisation may not use it but have already tried. "If you don't use it but already tried, please indicate what didn't go".

Question 6: What is the rate of adherence to agile methods in the teams involved in projects/development of your Organisation's products?

- **Ricardo Santos:** if someone has it in trial mode in all departments isn't it difficult to answer the question?
- **Carlos Veneno:** The "residual" hypothesis is not concrete. Initially you speak in teams, the answers take you to departments. There can be more than one team in departments. Will it be possible to draw conclusions with some of these options?

Question 7: What is the predominant Agile method in your organisation?

- **Ricardo Santos:** Wouldn't multiple choice be better here?
- **Bráulio Rocha:** Although the question is singular, it might be interesting to allow multiple answers (max. 2-3 options). I can give the example of the department where I

work at Siemens, where Scrum and Kanban are the main methods without an evident predominance.

- **Carlos Veneno:** Does it make sense in a previous question to group these methods? The most common types. The most similar. Or else multiple answer. I don't know if it makes sense but the opinion remains.
- **Tiago Vieira:** For example, if in question 6) I choose the option with more than one department, and if you are thinking of a very large organisation, could I not have the need to indicate more than one method? It may not be the best of both worlds but it may even happen that an organisation uses more than one method. At this point in question 7), and if I saw correctly, it is only possible to choose one method, I don't know if you should not allow the choice of more than one option;

Question 8: How often do you see the following BARRIERS in your Organisation in organisational transformation to Agile methods? – barriers identified in the literature

- **Renato Paiva:** I felt some discomfort in the transition from the original question to the others. But it's a good understanding, but I had this perception. Maybe it was just an idea to contextualize in the first part, and after "8 a." onwards expose the question.
- **Tiago Vieira:** In this question, I think an answer related to the adaptation to new functions would make sense, for example: "Difficulty in adapting to new functions". I don't know if this type of question for you is in the one you have and that says the following "Functions not willing to change". But I don't think so, there you were thinking of something different. I don't know if I didn't rephrase something about this;
- **Bráulio Rocha:** This comment is one more detail about the experience of the respondent. It might be interesting to summarize the title in order to show what is being evaluated at all times, as shown in the example below. As this is a sequence of several questions, this change may help to reinforce/remember what is being evaluated over time.

Question 8a, b e c

- **Bráulio Rocha:** "Skepticism about the new way of working" and "Jobs not willing to change" seem to me to be particular examples of "Resistance to change". Perhaps question 8a can be dropped and questions 8b and 8i combined within the "Resistance to change" category at a later stage of the results analysis.

Question 8g

- **Ricardo Santos:** I don't know if this is a barrier. It's another phenomenon. The broader question refers to barriers.

Question 8n

- **Ricardo Santos:** Would write high-level requirements and not high-level requirements.

Question 8i

- **Bráulio Rocha:** Was I in doubt as to what technical consistency would be? I assumed it was the correct application of the methodology in several different projects/initiatives.

Question 9: How often do you see in your Organisation the following SUCCESS FACTORS in organisational transformation to Agile methods? – success factors identified in the literature

- **Ricardo Santos:** I don't know if you would reach the goal more easily if the question was: identify the top 3 success factors... And the guys in that whole list could only select 3. Or 5. Do you understand? Imagine that they do it very often in all of them. We stay the same.
- **Renato Paiva:** Same as question 8.

Question 9a:

- **Renato Paiva:** I would substitute "Ensure...." by "Support Assurance"

Question 9e:

- **Bráulio Rocha:** Depending on the company, converging on a single approach can actually be beneficial in terms of results or corporate culture/strategy. However, for other companies it may be beneficial to keep both traditional and agile methods (I think of Siemens as an example). So I was a little dubious about considering this a success factor, but maybe it's my ignorance of the literature.
- **Hélio:** I confess that at some point I got lost in the chapter and the objective of the derived questions. In other words, I think it would be useful to keep the initial topic.

Question 9r:

- **Hélio Antunes:** When I got to this one I lost it.
- **Tiago Vieira:** Questions 8 and 9 appear with the text cut off whenever you are looking at the respective items (see the image below). I tried more than one different browser and was trying to see if it was because of the zoom but I couldn't really make the text all visible.

Question 10: How would you rate the success of your organisation's transformation to Agile methods?

- **Carlos Veneno:** With this question you are inducing that the respondent's company is in a transition phase.

Suggestions for new questions:

- **Bráulio Rocha:**
 - Maybe what I'm going to propose next is related to one of the existing questions and I just didn't understand, but I missed a question that assesses how much “difficulty in deciding if agile methods are the best approach to managing the project” is a barrier to transformation. This doubt motivated some effort and discussion within Siemens so that it did not become a factor against the adoption of agile methods.
 - Another possible point to reflect on would be the resistance that “managing teams in a completely virtual mode” offers to transformation. In large companies, the development team, Scrum Master and Product Owner may be in different countries. It is an extreme example, but it could be the reality among some interviewees. Furthermore, the pandemic may have made this factor significant.

Suggestions for improvements:

- **Margarida Peres:** It would just give you the opportunity to put "don't know/doesn't apply" to every question in the quiz.
- **Hélio Antunes:** You could add the challenge and/or ease of using Agile methods in telecommuting
- **Hélio Antunes:** In the introduction you have "traditional methods" and in the questions you have "old way of working", "old approach", "traditional way". Perhaps it would be better to stick with the introduction.
- **Luis Costa:** The entry into the 2 modules of what can be improved and what there is to keep, is a bit exhausting with more questions. Maybe you have to ask all that, but I felt that the questions were repeated and instead of one scale for the positive and another for the negative, why not use the same scale for everything?
- **Carlos Veneno:** Do you think it makes sense to know how long each respondent has been with the company? There are questions that need more knowledge about the company, it might be interesting to use this note.
- **Lanna Oliveira:** For me the questionnaire is great, it covers topics that are essential I just found it a little long. The only item I thought wouldn't fit d. Difficulty in

reorganizing new physical spaces. Because even if the person has difficulty, there is nothing he can do.

- **Ricardo Santos:**

- It would suggest having either PT and EN version or only EN version;
- In the intro, it is always good to say that the results of the study will be shared by those who have this intention,
- Suggests adapting the timing of the survey. It would probably take between 5 to 10 minutes. Note: in your email you refer 4 to 6. In the survey refer 4 to 7. Make sure that the email you are going to send to Malta is identical. You can put one last non optional question to say: "If you want to receive this study as soon as it is finished, please provide your email"

- **Carlos Jerónimo:**

- Won't it be important to know why they are changing or agile?
- You have "Provide training in Agile methods". is this a success factor for organisational transformation?
- I can't understand what you really want to understand because of the questions. So I suggest you send me all the questions listed, one by one it's hard to get a feel and we make a 30 minute call and I'll help you with my perspective.
- Add the field "Other" to the questions on barriers and success factors

- **Gonçalo Cunha:**

- I think that an initial explanation of what it is like to work with "Agile" methods would not be inappropriate,
- Some people work in Agile and don't know and others think they work because they have a different sense of what it is to work in Agile.
- "Since when does your organisation use Agile methods in different teams and projects?". I don't really like essays with "since when", I would just put "Since when has your organisation...", I removed the "is that".
- The scale should have the two opposites at each end, that is, in my view it should be between "Never" and "Always", it becomes easier for respondents to mark the answers.
- The "difficulty in achieving technical consistency" I'm not sure if it's very explicit. Technical consistency in the use of the methodology?

Appendix C – Overview of the Agile Adoption Framework

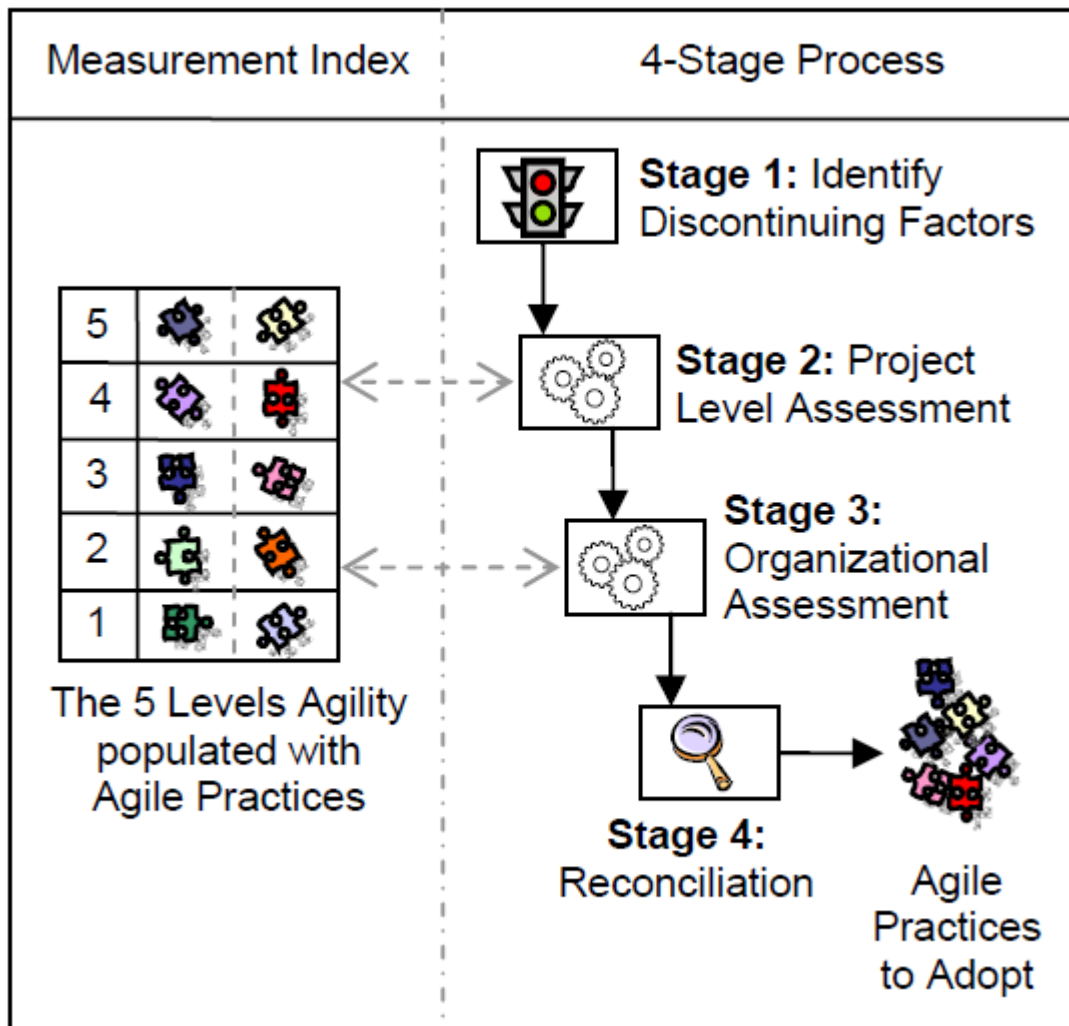


Figure 15. Overview of AAF

	Agile Principles				
	<i>Embrace Change to Deliver Customer Value</i>	<i>Plan and Deliver Software Frequently</i>	<i>Human Centric</i>	<i>Technical Excellence</i>	<i>Customer Collaboration</i>
Level 5 Ambient <i>Establishing a vibrant environment to sustain agility</i>	Low process ceremony [33, 38]	Agile project estimation [20]	<u>Ideal agile physical setup [33]</u>	Test driven development [11] Paired programming [48] No/minimal number of level -1 or 1b people on team [17, 15]	<u>Frequent face-to-face interaction between developers & users (collocated) [12]</u>
Level 4 Adaptive <i>Responding to change through multiple levels of feedback</i>	Client driven iterations [33] Continuous customer satisfaction feedback [35, 42]	Smaller and more frequent releases (4-8 weeks) [35] Adaptive planning [33] [20]		Daily progress tracking meetings [6] Agile documentation [39, 31] User stories [21]	<u>Customer immediately accessible [15]</u> <u>Customer contract revolves around commitment of collaboration [26, 35]</u>
Level 3: Effective <i>Developing high quality, working software in an efficient an effective manner</i>		Risk driven iterations [33] Plan features not tasks. [20] Maintain a list of all features and their status (backlog) [31]	Self organizing teams [33, 38, 31, 18] <u>Frequent face-to-face communication [38, 18, 13]</u>	Continuous integration [33] Continuous improvement (refactoring) [31, 12, 24, 5]. Unit tests [28] <u>30% of level 2 and level 3 people [17, 15]</u>	
Level 2: Evolutionary <i>Delivering software early and continuously</i>	Evolutionary requirements [33]	Continuous delivery [33, 31, 26, 12] Planning at different levels [20]		Software configuration management [31] Tracking iteration progress [33] No big design up front (BDUF) [4, 12]	<u>Customer contract reflective of evolutionary development [26, 35]</u>
Level 1: Collaborative <i>Enhancing communication and collaboration</i>	Reflect and tune process [35, 42]	Collaborative planning [38, 18, 33]	Collaborative teams [45] Empowered and motivated teams [13]	Coding standards [29, 47, 36] Knowledge sharing tools [33] Task volunteering [33]	<u>Customer commitment to work with developing team [13]</u>

Figure 16 - The 5 levels of Agility of AAF