# THE USE OF AGILE PRACTICES IN INNOVATION PROJECTS: A SYSTEMATIC REVIEW OF THE LITERATURE

# O USO DE PRÁTICAS ÁGEIS EM PROJETOS DE INOVAÇÃO: UMA REVISÃO SISTEMÁTICA DA LITERATURA

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Submetido: Julho 2021
Aceito: Junho 2022
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**Revista Brasileira de Gestão e Inovação – *Brazilian Journal of Management & Innovation***
v.9, n.3, Maio/Agosto – 2022
ISSN: 2319-0639
**http://www.ucs.br/etc/revistas/index.php/RBGI/index**
**DOI: 10.18226/23190639.v9n3.06**

## ABSTRACT

The preference for agile practices to manage projects comes from the software development field. Based on similarities between software and innovation projects, this article aims to present the academic approach of agile practices on innovation projects management. A systematic review of literature was adopted. The results were grouped into three topics according to the relationship between agile practice and innovation: (1) agile practices adopted in projects focused on innovation; (2) innovation as result of agile practices adopted to manage projects; and (3) innovative combinations of agile practices to manage software projects. The agile practices application in innovation projects not associated with software development were only 17% of the analyzed articles. The main contribution of this study is the evidence that the application of agile practices in projects provides similar benefits if its output is a software development or not. However, some adjustments are usually necessary, sized according to project´s output. They are bigger as the project´s delivery moves from digital concept to physical products such as hardware or manufacturing. The engagement and autonomy of project's team are essential components in the process of adaptation to project´s needs. When agile practices are adopted, the literature also recommends waiting for a maturation period before performing efficiency and effectiveness measurements. Contributions of this article include a better understanding of the different relationships between innovation and application of agile practices.

**Keywords:** Agile practices; Innovation projects; Systematic literature review; Software development; Hybrid approach.

## RESUMO

A preferência por práticas ágeis para gerenciar projetos vem do campo de desenvolvimento de software. Com base nas semelhanças entre software e projetos de inovação, este artigo tem como objetivo apresentar a abordagem da literatura sobre a aplicação das práticas ágeis na gestão de projetos de inovação. Foi adotada uma revisão sistemática da literatura para atingir esse objetivo. Os resultados foram agrupados em três tópicos de acordo com a relação entre prática ágil e inovação: (1) práticas ágeis adotadas em projetos focados em inovação; (2) inovação como resultado de práticas ágeis adotadas para gerir os projetos; e (3) combinações inovadoras de práticas ágeis para gestão de projetos. Não mais do que 17% dos artigos analisados mostram a aplicação de práticas ágeis em projetos de inovação não associados ao desenvolvimento de software. A principal contribuição deste estudo é a evidência de que a aplicação de práticas ágeis em projetos não exclusivamente relacionados ao desenvolvimento de software proporciona os mesmos benefícios obtidos em projetos de software, exigindo, no entanto, que alguns ajustes sejam feitos. Tais ajustes são maiores à medida que a entrega do projeto se afasta do conceito digital indo na direção de produtos físicos, como hardware ou manufatura. O engajamento e autonomia da equipe são componentes essenciais no processo de adaptação às necessidades do projeto. Além disso, recomenda-se, segundo a literatura, aguardar um período de maturação antes de realizar medições de eficiência e eficácia desse tipo de abordagem de gestão. As contribuições incluem uma melhor compreensão das diferentes relações entre inovação e aplicação de práticas ágeis.

**Palavras-chave:** Práticas ágeis; Projetos de inovação; Revisão sistemática da literatura; Desenvolvimento de software; Abordagem híbrida.

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**DOI: 10.18226/23190639.v9n3.06**

## 1. INTRODUCTION

Technological changes and processes are getting faster and less predictable. In this uncertain and nonlinear context, the organizations seek solutions to maintain or increase their strategic differential from competitors, and their better service to customers. The innovation of products and services becomes a fundamental activity for business success in such scenario. As Salmelin (2020) points out, innovation must be thought of in a context of co-creation in scalable markets where the different actors play more active roles. Notwithstanding the type of innovation involved, there is an intrinsic need to implement more appropriate management methods due to the speed and complexity of changes involved. Cooper (2019) points out practices such as agile development for physical products and design thinking for ideation. Open innovation, lean product development and lean startup, among other new practices, have been introduced in the development of new products to face the challenges of the current scenario.

Innovation projects are inherently subject to situations of uncertainty and ambiguities, and adequately managing this type of project has been a great challenge for organizations (Silva et al., 2020). The ability to effectively manage uncertainties has proved to be a key factor for the success of innovation-focused projects, as Dönmez and Grote (2018) points out. This challenge led organizations to adopt different approaches to project management and the agile practices gained space and became a good alternative. According to Tura, Hannola and Pynnönen (2014), agile practices represent a more effective solution to the challenges posed by innovation projects and Hannola, Friman and Niemimuukko (2013) present some guidelines to apply agile practices which can bring positive results in innovation processes.

Among the three main trends pointed out by the 14th Annual Agile State Survey™ (Digital.AI.TEAM,2020), organizational culture remains one of the greatest challenges to adopt and scale agile practices in companies. Scrum, plain or associated with another method, forming a hybrid method, is the solution adopted by at least 75% of respondents, indicating that Scrum remains the most widely practiced agile method. The survey also states that project visibility and improvement in the ability to manage priorities in changing processes are top consequences of implementing agile practices. Other enhancements provided using agile practices listed by the survey are Information Technology (IT) alignment with business; higher team morale; faster development speed; smaller launch time; and higher team productivity.

Issues like customer integration, efficient communication, self-organizing teams, and flexibility to adapt to frequent changes have been fundamental to expansion of agile practices to other fields. Although agile practices have emerged and spread through software

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development projects, their application in other types of projects has been recently disseminated. Although recently, research of agile practices application on management of different types of projects has advanced, there are still opportunities regarding the application of agile practices specifically in innovation projects. Based on this premise, a systematic review of literature was used to examine how the academic literature has been discussing this perspective with the aim to propose an agenda for new research in the future. In line with this objective, the following research question was adopted: **How the use of agile practices has been addressed in innovation projects?**

The aim of this research is to contribute with practitioners in understanding the benefits, challenges, and difficulties of agile practices application on innovation projects management. To academics, the understanding of how the subject has been covered will promote insights to new research, increasing the understanding of the application of agile practices in innovation projects. This article is structured in 5 sections. After this introduction, there is a brief conceptual approach on the two main themes discussed here: innovation projects and agile practices. The research method is then presented in section 3. Section 4 shows the findings and how they look toward the available literature. The article is finalized in section 5 with conclusions and proposals for future works.

## 2. LITERATURE REVIEW

This section presents the concepts of innovation projects and agile practices. It is not intended to exhaust the subject on the topics here addressed, but only to present the necessary to achieve the objectives defined in this article.

### 2.1. Innovation projects

An innovation occurs when a new product, service or technology is first put into commercial use (Hall, 1994), meeting new customer needs, or creating unknown markets. Schumpeter (1997), considers innovation emerging spontaneously and discontinuously, taking the system out of its current equilibrium, and generating differentiation which turns into new opportunities and competitive advantages. Innovation is related to change, a radical or incremental, resulting from adoption of new ideas or behaviors in an organization (Hage, 1999).

As customers are more and more prepared to pay for innovative products, the organizations are increasingly seeking innovations to stay competitive (Cordero,1991). The launching speed of new products has become competitive advantage, accelerating the rate of obsolescence of products. For Pavitt (1990) and Von Hippel (1986), the ability to get over their

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competitors in satisfying the needs of the customers can be considered a measure of an organization's success. Therefore, projects aimed at innovation become the means for organizations to launch new products and services to satisfy new requirements of their customers. For Brown and Eisenhardt (1995), R&D projects are considered the heart of the implementation of corporate strategies focused on innovation.

The innovation process underlies the development of new products and services and usually follows a model as Harkema (2003) points out. The innovation process underlies the development of new products and services and usually follows a model as Harkema (2003) points out. The most used models are based on the funnel´s concept, or stage-gate (Cooper, 1987). Innovation usually emerges from new ideas, which are developed through R&D projects and transformed into new products or services. From preliminary investigations of new ideas (inputs) to new products or services launches (output), a lot of activities are performed as indicated in Figure 1.

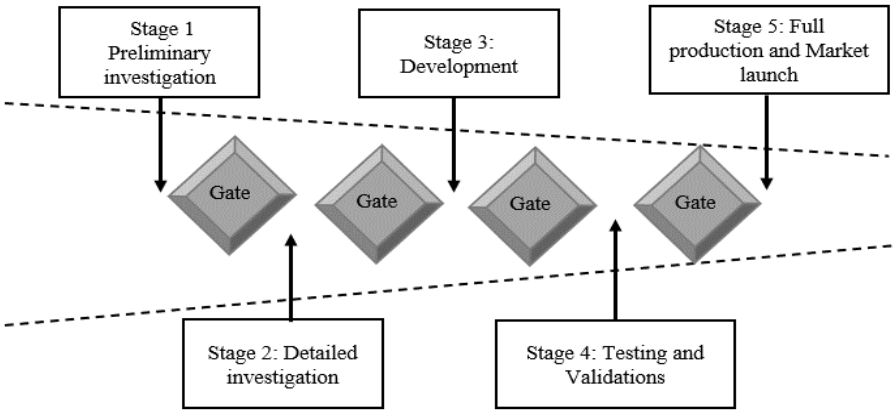


**Figure 1 - Funnel model for new product development**
Source: Adapted from Harkema, 2003

There are many tools to enhance effectiveness of innovation processes (Cooper, 1983; Koen et al., 2001), but in practice these methods are very inflexible and excessively formal (Cooper, 2019). To overcome this deficiency, organizations have adopted different adaptive and responsive methods. In this context of search for tools and more adaptive solutions, agile practices become a relevant option. Despite the difficulties to clearly define agile practices (Tura, Hannola and Pynnönen,2017), they can contribute to a mindset modification of the senior management level, giving flexibility to the organizational systems and raising the process effectiveness, notably when there are intellectual property issues involved (Cooper, 2019.

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## 2.2. Agile Practices

The digital transformation has brought new challenges and opportunities to project management practices (Denning,2016). This new scenario is leading organizations to promote changes in the way they manage projects to quickly adapt to the new characteristics of the market and customers (Gurd & Ifandoudas,2014; Cegarra-Navarro et al., 2016; Ravichandran, 2017). Many organizations with focus on software projects are using agile practices (Laanti et al., 2011; Dikert et al., 2016; Moe & Dingsøyr,2017).

Agile development practice is defined as a set of methods based on iterative and incremental development, which promotes adaptive, evolutionary, and timely delivery planning. The flexible response to changes is stimulated, transforming the product development process more customer-centric and promoting customer involvement since the early stages of the projects (Silva et al., 2020).

The term "agility" should be associated with a painless adaptation to changes, which could be an interesting advantage when associated with innovation projects. It represents a mindset transformation and is linked to the approach given to changes, which must be received in a proactive way, so that the value perceived by customers becomes higher (Conboy, 2009). The introduction of agile practices fosters changes in various aspects of the organization. The change in the way of thinking of the organization members is the main one since reflects directly in the business processes adequacy (Denning, 2016).

Livari and Livari (2011), however, recommend considering in studies a synthesis of the different agile practices due to the high diversity of methods and techniques available. This diversity can generate difficulties to connect and interpret them, if they are not based on a clearly defined central idea. Following this recommendation, Table 1 offers a summary of the agile practices addressed in this paper with the unique objective of helping their understanding.

**Table 1 - Characteristics of agile practices addressed in this work.**

| Agile Practice | Authors | Main features |
|---|---|---|
| Scrum | Takeuchi and Nonaka (1986); Schwaber and Beedle (2002); Schwaber (2004); Sliger (2011); Green (2016); Schwaber and Sutherland (2017) | Scrum is characterized by development cycles or stages, defined as sprints, and maximizing the development time of a software or business product. |
| XP (eXtreme Programming) | Beck (2000) | XP is considered an agile practice and is well suited for software projects with highly abstract and constantly changing requirements. For this, the practice adopts the strategy of constant monitoring and making minor adjustments. |

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| | | |
|---|---|---|
| Lean UX | Gothelf and Silks (2013) | Lean UX is an agile practice to work documents in the UX area so that the day-to-day of professionals is freer from excess deliverables. |
| Kanban | Ohno (1988); Anderson (2010); Ordysinski (2013) | Kanban is an agile practice aimed at continuous improvement and flexibility in task management and workflow. |
| Lean Startup | Ries (2011) | Lean startup is a set of processes used by entrepreneurs to develop products and markets, combining agile software development, customer development, and software development platforms. |
| Design Thinking | Lindberg et al. (2011) | Design Thinking is the set of ideas and insights to address the future acquisition of information, knowledge analysis, and proposed solutions. |
| Crystal | Cockburn (2001) | Crystal is based on people management, focusing on interaction, skills, talents, and communication. The Crystal practice is divided into colors, where the most appropriate color for each project must be selected, according to the level of criticality and size of the team. |
| Scrumban | Ladas (2009); Ahmad-Kahan (2014); Gamboa-Manzaba (2014) | Scrumban is an Agile development practice that is a hybrid of Scrum and Kanban. Scrumban is becoming extremely popular in the service industries where we have development and maintenance projects. |
| MDSIC | Kiron et al. (2012); Aldave et al. (2019) | The Collaborative Integrated Software Development Model is software designed to help people working on a standard task to achieve their goals. |
| Lean | Poppendieck and Poppendieck (2003) | Lean is a corporate philosophy composed of a set of techniques and tools that aim to value human beings and improve the performance of an organization to increase its competitiveness. |
| Mobile-D | Abrahamsson et al. (2004) | The Mobile-D approach is a practice applied in a team of fewer than ten developers working in a single space to deliver a fully functional mobile app in a short time (less than ten weeks). |
| FDD (Feature Driven Development) | Coad et al. (2000); Palmer and Felsing (2002) | The FDD practice is a lightweight, iterative method for software development. The practice combines project management with good software engineering practices. |

Source: authors

The scrum is composed of three basic principles: transparency, inspection, and adaptation (Green, 2016), executed through successive and iterative deliveries with frequent feedback and collaborative decision-making process (Sliger, 2011). The XP practices focus on programming techniques excellence through clear communication and teamwork to enable a sustainable pace in development (Aldave et al., 2019). Lean UX is applied in the defining phase of new applications or software. It is based on three principles: 1) prioritize development over documentation; 2) increase integration among team members, and 3) promote frequent iterations to quickly converge to the user's needs (Eric Ries, 2011). Kanban has an emphasis on continuous delivery without overloading the team by limiting work in progress (Ohno, 1988; Anderson, 2010), using three fundamental principles: 1) workflow visualization; 2) determination of the current work limit in each period; and 3) time control for each task (Ordysinski, 2013). Lean Startup drives the progress of a new product or process development

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through the test results of successive MVPs (Minimum Viable Product), enabling time and cost reduction (Ries, 2011). Design Thinking promotes constant communication between the development team, stakeholders, and end-users (Sohaib et al., 2019), and has five steps: 1) user requirements gathering (user experience); 2) problem definition; 3) ideation; 4) prototype design; and 5) prototype tests. In the same line, Crystal practice focus on people rather than on processes, reducing the number of artifacts or elements produced using: 1) intermediate tasks elimination; 2) team working close physically; 3) incremental development with cycles shorter than four months; 4) meetings before and after each increment; and 5) development of team's skills and competencies (Cockburn, 2001). The Scrumban practice enables the workflow visualization inside and outside each sprint, with bottlenecks identification, established priorities, and resource allocation. It uses the number of tasks to be performed in each sprint as limits. The Scrumban sponsors more autonomy to the team, shorter planning meetings, frequent queue updates, and effort estimation for each task (Ladas, 2009; Ahmad-Kahan, 2014). The MDISC practice applies the best-listed construction practices by small and medium-sized software companies to build web and mobile applications (APPs) (Kiron et al., 2012). The Lean practice uses the following principles: waste elimination; learning incentive; decisions as late as possible; deliver as soon as possible; team empowerment; integrity building and holistic vision, and it is customized to the software development peculiarities (Poppendieck & Poppendieck, 2003). The Mobile-D is the optimized approach for small teams, less than ten in the same physical working environment, and intends to deliver a mobile application within less than ten weeks (Abrahamsson et al., 2004). And finally, the FDD has no specific requirements. The practice has five sequential processes: 1) general model development; 2) list of features elaboration; 3) planning; 4) design; and 5) delivery. Sequential and iterative deliveries with cycles of up to two weeks prioritizing the quality aspects (Coad et al., 2000; Palmer & Felsing, 2002).

The theoretical framework presented in this research does not claim to exhaust the topics addressed, but simply provide a conceptual basis for the discussions held further ahead, considering the results obtained from the papers analyzed.

## 3. METHODOLOGICAL PROCEDURES

The Systematic Literature Review (SLR) is a study that aims to identify, evaluate, and interpret available literature to answer a specific research question (Kitchenham, 2004) including the critical evaluation and the synthesis of the findings (Pollock & Berge, 2018). Following this workflow, a theoretical corpus is constituted and allows researchers to detect the

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reality of a phenomenon through results and prescriptions already validated. There are different types and methods of SLR to answer different types of questions. Despite this variety, the essence of an SLR is to ensure the rigor in research and its replicability, which are obtained by applying a transparent research process. Therefore, the detailed description of the collection and analysis activities is fundamental.

A literature review combines qualitative and quantitative evaluation to investigate a specific topic and can be framed as a content analysis (Pollock & Berge, 2018). The SLR process, according to these authors, involves six consecutive stages: 1) formulation of the research question to clarify the goals and objectives of the literature review; 2) finding the relevant literature available about the topic to be studied; 3) data extraction; 4) assessment of the quality and alignment with the theme; 5) synthesis preparation; 6) interpretation of results.

Following the sequence proposed by Pollock and Berge (2018), a search was carried out in the Scopus and Web of Science databases using the terms "Innovation", "projects" and "Agile Methodology" to gather relevant available literature to answer the research question proposed in this study. After different combination trials, a final string was adopted in both databases, as presented in Figure 2.

| | |
|---|---|
| TERMS | Innovation AND Projects AND agile metho* |
| SCOPUS string | (TITLE-ABS-KEY ("innovation") AND TITLE-ABS-KEY ("projects") AND TITLE-ABS-KEY ("agile metho*")) AND (LIMIT-TO (DOCTYPE,"ar") OR LIMIT-TO (DOCTYPE, "re")) |
| WEB OF SCIENCE string | ALL FIELDS: ("innovation") AND ALL FIELDS: ("projects") AND TOPIC: ("agile metho*") Refined by: DOCUMENT TYPES: (ARTICLE OR REVIEW) Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years |

**Figure 2 - Terms and strings**
Source: authors

The sequence proposed by Pollock and Berge (2018) for elaborating the corpus of analysis presents four steps. The first step is selecting the string for the database search. The second step is the screening of results to define the articles corresponding to the research proposal. The next step is to apply the eligibility criteria, where the articles were evaluated according to the inclusion and exclusion criteria. And finally, at the fourth step, the corpus of analysis is constituted, resulting in the sample database of articles for the research. To compose the database at the initial research, filters such as, choose only articles in journals, excluding articles in congress and books, were applied. The areas delimited for this research were at Web of Science: "Computer Science Software Engineering"; "Computer Science Information

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Systems"; "Management" and "Computer Science Theory Methods", and at the Scopus base: "Business" and "Computer Science". The search resulted in 24 articles from Scopus and 28 from Web of Science. Disregarding 11 duplicated articles, the result from data extraction was 41 articles. In the subsequent step all the abstracts were read and assessed, leading to the exclusion of 24 articles which were not aligned with the scope of this research. The steps are illustrated in Figure 3.

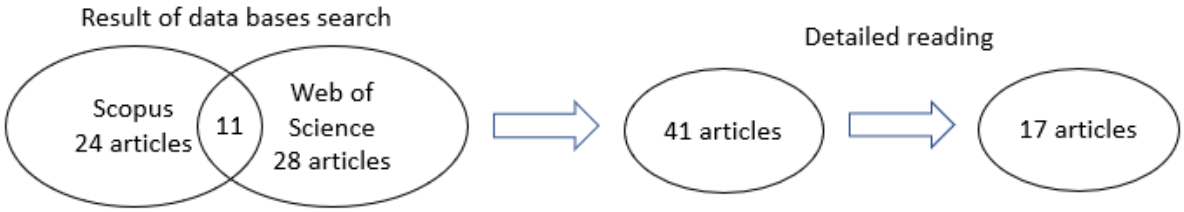


**Figure 3 - Sequence of analysis**
Source: authors

The 17 articles selected were fully read by the authors. Based on content analysis carried out, the articles were grouped into 3 different categories according to agile practices and innovation relationships identified. The detailed explanation of the analysis is described in section 4.

## 4. RESULTS

After the analysis process of the selected articles, evidence of some patterns was found. Only three of the 17 articles selected have as main subject agile practices in innovation projects that were not related to software development. Six articles discussed innovation as a result of the application of agile practices in project management, with the objective of leveraging the use of available resources and capabilities to explore new technologies and development modes. Performance enhancements of the organization's processes and of new product development were detected as outcomes of this approach.

The innovative combination of different agile practices in software development projects was addressed by eight of the articles analyzed. Although these articles deal specifically with software development projects, all of them presented some degree of innovation in the way agile practices were employed in project management activities. Considering the similarities described above in terms of innovation and agile practices combination, the findings were separated into 3 groups, as presented in Table 2.

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**Table 2 - Grouping of articles.**

| Group | Number of articles | Theoretical focus | Authors |
|---|---|---|---|
| Agile practices in innovation projects | 3 | Application of agile practices in projects focused on innovation not associated with software development | González *et al.* (2014); Konnolla *et al.* (2016); Coenem and Robijit (2017) |
| Innovation introduced through the application of agile practices | 6 | Innovation as a result of agile practices application in project management | Hannola *et al.* (2013); Gonzalez (2014); Tura *et al.* (2017); Cooper and Sommer (2018); Donmez and Grote (2018); Valero-Pastor *et al.*, (2019) |
| Innovative combination of different agile practices to manage software projects | 8 | Innovation in the way agile practices were applied in the management of software projects | Kane *et al.* (2006); Vidgen and Wang (2009); Concas *et al.* (2012) Konnola *et al.* (2016); Heikkila *et al.* (2017); Aldave *et al.*, (2019); Valdez *et al.* (2019); Sohaib *et al.* (2019) |

Source: authors

In the first group are the articles which applied agile practices in innovation projects. The articles in which any kind of innovation resulted from the application of agile practices in project management were clustered in a second group. Finally, in a third group, are the articles that combine different agile practices, in an innovative way, to manage projects. The following discussion is based on this grouping.

### 4.1. Agile practices in innovation projects

It is clear by the number of articles in this group that studies about the application of agile practices in innovation projects are still rare. Only three articles could be included in this group: González et al. (2014), Konnolla et al. (2016), and Coenen and Robijt (2017). Besides the application of agile practices in this type of project, other similarities could be noted in this group. Concerning the methodology used, all the articles adopted a qualitative approach, confirming a trend already identified by the literature in articles that address agile practices. Regarding agile practices application, Scrum was applied in all three studies, confirming the result pointed out by the 14th Annual Survey on the State of Agile ™ (Digital.AI.TEAM, 2020).

Table 3 presents a summary of the results identified in the application of agile practices in the studies of this group. Scrum was applied alone, in association with XP (eXtreme Programming) (Konnolla et al., 2016), and with Lean UX (User eXperience) (Coenen & Robijt, 2017).

Among the agile practices, the User eXperience (UX) is the one that shows how the user feels as a result of interaction with, and usage context of a system, device, or product, including the influence of usability, usefulness, and emotional impact during the interaction, and appreciating the memory after interaction (Hartson & Pyla, 2012).

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**Table 3 - Results identified in articles dealing with the application of agile practices in innovation projects.**

| Article | Agile practices | Identified results |
|---|---|---|
| Konollal *et al.* (2017) | XP and Scrum | Among the positive results identified in this study, some can be highlighted: improvement in communication through more efficient meetings; enhancement in teamwork through planning; and increased visibility of the project progress through frequent iterations among team members. On the other hand, according to the article, customer interface remained a point to be improved in the future, |
| Coenen and Robijt (2017) | Lean UX and Scrum | The framework proposed in this study, named FALL (Framework for Agile Living Lab), is based on Scrum and oriented to the management of innovation laboratories with the objective of boosting the participation of customers in open innovation projects. The application of Lean UX aims to prioritize the project assumptions testing and to assist in the user's graphical interface building. |
| González *et al.* (2014) | Scrum | The Scrum application in software acceptance testing aims to inspire user effective participation, getting quick responses, speeding up the error correction, and reducing the development time without generating additional costs. The article, however, only presents the proposal, not addressing the results achieved in acceptance tests. |

Source: authors

Coenen and Robijt (2017) reported an action research work which deals with creation of a framework based on the integration of Lean UX and Scrum in the processes of an innovation laboratory (living lab) to enhance the customers participation in open innovation projects. However, it is a theoretical proposition, not tested in a practical and real situation, thus there are no empirical results. González et al. (2014) proposed the application of Scrum in the validation testing phase in an innovation project called TOHO. The innovation, in this case, refers to the document management of records from contracting services and transport infrastructure projects. Scrum was applied in association with NDT (Navigation Development Techniques) methodology with the aim of enhancing the performance of software acceptance tests by boosting the user participation. The idea is that the intensive involvement of the users can result in more agility in the performance of acceptance tests, since the errors found can be corrected in the following sprints, reducing the total development time, and keeping the costs within the project´s budget. The article, however, boils down to the method description but does not present the results achieved in the acceptance tests.

Konnolla et al. (2016) developed a multiple case study to analyze the application of XP and Scrum in hardware and in embedded software projects in three different companies, all of them focused on electronic equipment manufacturing. The aim of the study was to explore the opportunities and challenges of applying agile practices in projects that normally apply traditional practices (waterfall) (Cao, 2004). Unlike Coenen and Robijt (2017) and González et al. (2014), Konnola et al. (2016) presented several practical results, generating important insights which can be considered in future works and applications. The significant enhancement

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**DOI: 10.18226/23190639.v9n3.06**

of communication in project teams was highlighted by the authors, among the benefits listed, because it also promoted other gains.

The conclusion, according to Konnola et al. (2016), is that the application of agile practices in this type of project brings benefits similar to those obtained in software development projects, even considering that some adjustments are needed, based on the characteristics of the product, and mainly regarding the slower pace of a hardware development project. However, no significant enhancements in the team efficiency and productivity were noticed, perhaps due to the short time available for analysis, as explained by the authors. Although projects of embedded software usually are not considered innovation projects, the R&D team was involved in one of the cases analyzed by Konnola et al. (2016), because it is a new product for a special customer rather than a mere customization of something already existing. According to Eklund and Bosch (2012), agile practices can be applied to mass-produced embedded systems, even considering that the complete R&D process cannot be agile.

### 4.2. Innovation introduced through the application of agile practices

In this group are the articles which presented some innovation because of the application of agile practices in project management, as summarized in Table 4. Despite the great evolution that has happened since the 1950s, when the theme emerged, the innovation processes have still many points which must be improved (Apilo et al., 2007). Inflexible specifications at the beginning of the project; changes in product characteristics to satisfy new customer needs; knowledge and know-how transfer between different stakeholders; communication problems; and the inflexibility of the traditional stage-gate model represent improvements that must occur in this type of project (Apilo et al., 2007).

Gonzalez (2014) explored the pre-development stages of innovation projects, known as fuzzy front end (FFE) or front end of innovation (FEI) by proposing a conceptual model, named by the author as Agile Project Management (APM). The application of the agile approach in this context proved flexible and dynamic, bringing benefits such as an increase of development speed and more flexibility to faster adaptation to changes, implying increased effectiveness in this initial phase of the innovation process.

As the application of agile practice brings benefits to projects which involve the creation and innovation of intellectual property, it also requires flexible organizational systems for their management. The agile practices implementation in this context still represents a challenge to organizations. There is a need for appropriate agile culture development in sync with a better alignment between teams and management levels (Gonzalez, 2014). Hannola, Friman, and

Niemimuukko (2013) analyzed the similarities, differences, and criticism of innovation and software development processes. The results obtained from a combination of agile practices are concerned with organizational practices, transference of know-how and knowledge (whether tacit or explicit), and the ability to understand customer needs. Moreover, the study provides several agile guidelines so that managers and members of project teams can improve the innovation process.

**Table 4 - Results in articles addressing the issue of innovation introduced through agile practices.**

| Article | Agile practices | Identified results |
|---|---|---|
| Dönmez and Grote (2018) | Scrum, Kanban, and XP | The application of different agile practices contributed to mitigate threats and showed opportunities, enhancing the creation of innovation. Additionally, the production of significant information supported the strategic decision-making process within the projects, resulting in advantages |
| Gonzalez (2014) | APM (Agile Project Management) | Agile Project Management (APM) is a conceptual model proposed to apply the concepts of the agile approach in the pre-development phases of the innovation process. The gains in development speed and in flexibility to adapt quickly to changes are some of the benefits achieved, giving more effectiveness at the front-end of the innovation process |
| Valero-Pastor *et al*. (2019) | Lean S, Design Thinking, Scrum, Crystal, Kanban, XP and Scrumban | An enhancement in the processes of new product ideation and creation emerged from the combination of these agile practices. It allowed the launching of new products with the potential to continuously evolve to meet the variable needs of users. Additionally, there was a boost in daily work coordination and in organizational communication |
| Cooper and Sommer (2018) | Scrum Hybrid and Stage Gate | The application of this hybrid practice resulted in several benefits: lead time reduction of a new product launching; productivity increase in the development phase; faster responses to market changes and customer needs; and increase of the development team satisfaction level. However, management skepticism and resources availability for a more fluid product definition is still challenged to this approach |
| Tura *et al.* (2017) | Selected tools from different agile practices | The transformation from a technology-oriented vision to a more market-oriented vision through agile practices application implied in the reduction of innovation processes lead time. Consequently, it was possible to identify different business opportunities and create more sustainable and valuable business models |
| Hannola *et al.* (2013) | XP, SCRUM, Mobile-D, LEAN, and feature driven development | Improvements were obtained through the application of some agile practice's combination: customers need understanding through a closer relationship and incremental development process; knowledge transfer through a more intense communication; team and organization development; openness for changes in the innovation front-end |

Source: authors

Successful commercialization plays a crucial role in the innovation process (Schumpeter, 1934). However, the assessment of the commercial opportunity of new technology is vital to minimize the risks before a new product development project is launched (Cho and Lee, 2013). The traditional new product developing methods are generally inflexible and excessively formal (Apilo et al., 2007), hampering quick decisions. Agile practices, however, support the transformation from a technology-oriented to a market-oriented approach (Tura, Hannola, and Pynnönen, 2017), providing a chance to overcome the sales weaknesses in

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**DOI: 10.18226/23190639.v9n3.06**

innovation projects. Consequently, it is possible to increase the effectiveness of commercialization processes aiming to convert a new technology into a successful innovation. According to Tura, Hannola, and Pynnönen (2017), agile practices include skills to readily respond to changes, provide a good balance between flexibility and structure, and encourage creativity and innovation. The agile approach can be considered a multi-method process combining fast group decision methods.

The concerns of innovation's development processes are not restricted to the launch and commercialization steps. According to Dönmez and Grote (2018), the inherent uncertainties of software development are fundamentally considered threats. However, there is always a potential to transform uncertainties in learning opportunities or to generate innovations that are often neglected by both academics and professionals. The innovative potential of uncertainties can be reduced when the difference between uncertainties that lead to threats versus uncertainties that lead to opportunities is ignored, creating a fixation on threats. The application of different agile practices allowed the mitigation of threats and, simultaneously, kept the team open to new opportunities, enhancing the innovation's creation (Dönmez and Grote, 2018). Agile teams have relevant qualities to generate important information for strategic decisions. The practices applied in this study promote uncertainty anticipation. This result achieved by Dönmez and Grote (2018) corroborates with the findings of Conforto and Amaral (2010), who observed that the use of an approach turned to agile project management provided flexibility to deal with the inherent uncertainties of innovation processes, reducing planning time and improving communications.

The application of agile practices to manage innovation projects results in several benefits: the learning environment leads to open communication, creativity, and collaboration among all stakeholders (Schwaber, 2004; Highsmith, 2004; Augustine, 2005); continuous feedback from stakeholders allows knowledge sharing and exchange (Augustine, 2005); a mindset modification on team focus results in easy adaptation to customer's changes, rather than trying to anticipate and plan activities on schedules (Highsmith, 2004); add value to the customer through innovations (Highsmith, 2004; Augustine, 2015; Meyer & Marion, 2010); and allows to deal with certain levels of uncertainty and a high frequency of variable requirements The application of agile practices in projects not focused on software development is becoming more and more frequent. Valero-Pastor, Prieto, and Aviles (2019), for example, achieved a more fluid and transversal organizational communication and, therefore, an enhancement of coordination between different teams and professionals, in a media newsroom. Through the conceptual model proposed, it was possible to identify two groups of agile

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practices: 1) methods aimed at assisting in the ideation and creation processes, enabling the launch of assets that continuously evolve to meet the changing needs of users; and 2) agile practices to manage the daily work. It is a combination of practices such as Scrum, Crystal, Kanban, and Scrumban focused on interpersonal communication, and techniques such as Design Thinking and Lean Startup, more focused on activities such as design and implementation of new products.

There are also good results from the application of agile practices in manufacturing industries. Cooper and Sommers (2016) present a hybrid combination of Agile and Stage-Gate resulting in the lead time reduction to launch new products, productivity enhancement in the development phase, faster responses to market changes and customer needs, and the satisfaction level increase of development teams. However, things like the management skepticism and the no availability of resources necessary to work with product definitions in a fluid way represent challenges to work with the hybrid methods. The degree of difficulty to overcome these problems depends on the board's support and the establishment of a clear plan to implement the methodology.

### 4.3. Innovative combinations of different agile practices to manage software projects

The articles of this group showed that agile practices applied in complex scenarios of software development projects have a positive influence and are considered a success factor. Table 5 presents the most relevant findings of this group of articles.

**Table 5 - Results that address innovative combinations of different agile practices.**

| Article | Agile practices | Identified results |
|---|---|---|
| Valdéz et al. (2019) | Collaborative and Integrated Software Development Model (MDSIC) | This article identifies the best practices to achieve agile development success in software engineering and process modeling. The application of agile principles in software developments is encouraged by this work. |
| Aldave et al. (2019) | Scrum, XP, Kanban | Agile practices such as Scrum, eXtreme Programming (XP), Kanban, or other methodologies based on rapid modeling are considered good choices to increase the creativity to grab requirements in software engineering. However, customization is needed according to the project's particularities. |
| Heikkila et al. (2017) | Scrum adapted to large organizations | The customization of the Scrum methodology in large organizations, which usually do not make use of an agile lifecycle model, enabled gains in effectiveness and efficiency in medium and long-term requirements planning. |
| Concas et al. (2012) | Pair Programming (PP), Test Driven Development (TDD) and restructuring | The assessment of initiatives to improve the quality of software development evidenced better results in project phases where agile practices were adopted. |
| Vidgen & Wang (2009) | XP | An organizational model was developed for agile software development teams and some enablers and inhibitors were identified. Some emerging capabilities of agile teams were recognized, like the coevolution for |

ISSN: 2319-0639
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| | | |
|---|---|---|
| | | business value, sustainable working with rhythm, creation of team learning, adaption and improvement of development, creation of product innovations, and collective mindfulness. |
| Kane et al. (2006) | XP e Scrum | Agile practices proved to be adequate and provided an appropriate structure to scientific results reproduction and to clinical support systems development. The agile development approach provided a model for collaboration between engineers and researchers in the field of biomedical software, including bioinformatics applications and clinical support. |
| Könnölä et al. (2016) | XP, Scrum, Lean | The agile practices application, adapted to the product's characteristics, in embedded software and hardware projects, provided benefits like those obtained in software development projects. Multidisciplinary teams improved the work and interdependencies understanding, and the activities prioritization. The focus moved from the documentation to the work done. On the other hand, there was no improvement in efficiency and productivity in the period of analysis, probably because the practices had not been yet well assimilated by the team. |
| Sohaib et al. (2019) | eXtreme Programming (XP) e Design Thinking (DT) | According to the authors, a DT to XP integration can help to provide continuous and stable deliveries to customers, faster than the traditional approach. However, the integrated structure proposed was not assessed in real software projects. |

Source: authors

The influence of innovation on agile practices happens through the interaction generated between the people involved in the project and an intensive collaboration among project teams and customers, presenting fast and effective responses to changing situations (Rahman et al., 2019). Scrum, XP, Lean, and Kanban were the main agile practices identified in this study for software development projects. XP and Scrum were the most mentioned and adopted ones, and are pointed out by Könnölä et al. (2017) as favorites among project managers. The agile practices, when adopted in projects of software development, enable planned and iterative development of the system or product, encompassing design, implementation, and testing in each iteration (Könnölä et al., 2017). New features are added incrementally, keeping the software always functional.

Kane et al. (2006) argue that many organizations implement Scrum followed by XP practices in their projects to enhance the value and the quality of the delivered products. The authors discussed the application of hybrid models, combining agile and traditional practices, especially Waterfall, in software projects of bioinformatics applications and clinical support. Among the benefits reached, the authors highlight a better integration between the team members in the field of biomedical software.

Hybrid models are often adopted and are the favorites of teams of agile projects due to their adaptability (Rahman et al., 2019). Agile teams are generally small, put more focus on people, and prioritize interactions rather than processes and tools, as determined by the Agile Manifesto (Sohaib et al., 2019). Therefore, according to the authors, agile teams usually do not follow a standard process, adapting engineering and software development practices according

ISSN: 2319-0639
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to the particularities of each project. The same agile practices can be adapted in different ways, always keeping the trend to produce significantly better results in the process (Sohaib et al., 2019). The combination of XP and DT has the potential to enhance the management of software projects, by ensuring quality and usability.

Aldave et al. (2019) identified, through a systematic literature review, different forms of agile practices adaptations in software engineering and concluded that the agile practices must be customized for each project. Despite the best criteria to be used in these adaptations is not clear to Aldave et al. (2019), Rahman et al. (2019) and Konnolla et al. (2017) recommend considering external environment characteristics, like the active participation of users and customers, as well as targets like continuous integration and development tests, to define the adaptations necessary to enhance the project´s processes.

Concas et al. (2012) conducted a case study on measurements and assessments of improvement initiatives directed to the software development process. The authors proposed the use of object-oriented metrics to indirectly evaluate the quality of development and identified the different types of software metrics used in improvement initiatives. They concluded that process metrics, such as productivity during the development phase and defect rate per development phase, are the most used. The phases of the project where agile practices were adopted showed better results than the ones where agile practices were not adopted.

Consequently, the relevance and importance of agile practices in the field of software engineering are clearly established, showing efficiency and effectiveness enhancements in projects of software development (Rahman et al., 2019; Konnolla et al., 2017). It is also clear that, although agile practices typically have significant advantages over the traditional approach, they need to be customized to existing conditions.

## 5. CONCLUSIONS

Although the application of agile practices in innovation projects provides similar benefits to those obtained in software projects, less than 20% of the articles located and analyzed in this research effectively deal with this subject. This result can be attributed to a lack of interest of researchers in the subject or because it is a new theme and, slightly explored by academic literature.

Agile practices emerged and spread out in the context of software development. However, its application has started to be disseminated to other contexts, and the innovation projects are included in this list of contexts. This research showed that the relationship between agile practices and innovation occurs in different ways: 1) Agile practices can be applied to

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manage projects focused on innovation; 2) Innovation can emerge as a result of the application of agile practices in project management, which are not necessarily focused on innovation; or 3) Agile practices have been innovatively combined and applied in the management of software development projects, in a hybrid way. The diversity encountered in the relationship between innovation and agile practices fulfills the objective of this research to analyze how the academic literature has discussed this perspective and answers the proposed question of this research: "How agile practices have been addressed in innovation projects?"

The distribution of the analyzed articles into the three groups enabled a more focused analysis of the relationship between agile practices and innovation. Some convergence points in the application of agile practices were identified, independently if the innovation was the focus (group 1), the result (group 2), or the way of doing things (group 3). The results of agile practices application are positive and comparable to those obtained in software projects.

Among the benefits achieved are the enhancements in communication and team working, achieved through more efficient meetings and the effective participation of the teams in the planning of each step of the projects. Another positive result is the increased transparency of the project status and progress, coming from the most frequent iterations and interactions with the customer.In a more strategic approach, the uncertainties can be more flexibly managed, allowing a simultaneous approach from the perspectives of threats or opportunities, and stimulating innovation emergence. Moreover, the flexibility of agile practices allows different forms of combination and adaptation, in a hybrid way, enhancing the understanding of customer needs, and keeping the trends of positive results in terms of know-how, and knowledge transfer, contributions to team development and organizational learning.

Some of the analyzed studies failed to identify gains in terms of efficiency and effectiveness of the processes. This limitation is attributed to the lack of time for processes to achieve a sufficient maturity level, needed to show robust results, whether positive or negative. This probably happens because a mindset modification normally is not fast, demanding some time to become perceptible. This is an important finding for practitioners, who need to be aware that results provided by the implementation of agile practices are not immediate, demanding, some time for maturation. This lead time must be considered before performing measurements of efficiency and effectiveness enhancements.

A better understanding of the challenges and difficulties that can be encountered for the implementation of agile practices constitutes another important contribution for practitioners. As evidenced by this study, there are still barriers to the application of the agile practices that shall be overcome. A third contribution to the practice is the understanding that it is necessary

to adjust the development pace when agile practices are applied in project management. The depth of these adjustments depends on the digital level of the project output. Physical outputs such as hardware or manufacturing should need deeper modifications on the project's rhythm.

Contributions to academia include a better understanding of the different possible relationships between innovation and agile practices. This finding opens the way to encourage new insights so that other works can be conducted in the future. Despite all the benefits pointed out by the literature, many studies are still theoretical, without practical evidence or validation of the expected results. This opens an agenda for future works that can address the application of agile practices in innovation projects, with the objective of enhancing and validating the models and frameworks already proposed by the literature, as well as encouraging the proposition of new ones. This gap identification can be considered another contribution to academia.

This work has similar limitations to any qualitative assessment, usual in systematic literature reviews. Despite the fact that the articles were read by all the authors of this paper, the interpretation is always subject to bias, thus the classification of the articles into three groups here proposed can be discussed and argued by others. It is expected that this study will contribute to the deepening of the discussion on the topics of agile practices in innovation projects and that the relevance of providing a database that informs the work carried out, periodicals, authors, and sub-theme categories is a facilitating tool for researchers and a possible source of gaps for further research.

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ISSN: 2319-0639
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