

# Agile Software Development and Project Portfolio in Dynamic Environments

## An Exploratory Case Study

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### Abstract

Integrated solutions providers have big challenges in dynamic, full of changes, unpredictable, and stressful environment that impact the project portfolio management (PPM), therefore it is necessary to understand what can be done to support these companies in such a way they can get appropriate returns from investments and achieve their organizational goals. To deal with a more turbulent, speedy, risky, uncertain, and unpredictable market, some authors suggest the adoption of values, principles, and practices of agile methodologies. This empirical research aims to understand how agile software development relates to PPM in dynamic environments. This study is classified as exploratory and qualitative; based on literature review on agile methodology, PPM, uncertainty and dynamic capabilities; conducted by a unique case study, which evidences were gathered by documental investigation, interviewees guided by a case study protocol, and participant-observation. This study is based on the organizational context of an information technology company focused on integrated solutions, integrations and customization of software, and that adopt the agile methodology Scrum to support the PPM in dynamic environments. The findings suggest that Scrum can contribute to PPM, particularly in i) resource reallocation, ii) dissemination of knowledge, iii) engagement of the development team, and iv) improvement of the organizational atmosphere. This research contributes to a better understanding of the relation of agile development software and PPM in an IS provider, since there are few studies that connect these subjects.

### Introduction

The information technology (IT) field has some organizations that are based on projects to support their business, for instance, software houses, consulting firms, and systems integrators. Integrated solutions (IS) providers combine products and systems with services in order to specify, design, deliver, finance, maintain, support, and operate a system throughout its life cycle to address customer's specific business problems [1].

These IS providers have to manage their portfolio of projects to achieve organizational strategies and objectives, where projects are evaluated, selected, removed, canceled, postponed, prioritized, authorized, assessed, and monitored. Limited internal resources are allocated and reallocated to the project activities. Some resources are allocated exclusively to a unique project, and others are shared across multiple projects [2, 3, 4, 5].

The project portfolio management (PPM) is specially challenging when changes in the environment combined with high complexity increase uncertainty. Petit and Hobbs [5] reviewed the literature on management of uncertainty, and proposed a novel framework to study PPM based on concepts derived from the dynamic capabilities and sensemaking. They found in some studies of dynamic capabilities that to achieve a strategic advantage is necessary to reallocate and reoptimize resources and capabilities to adapt to changing environment.

There are IS providers that develop software, changing their own product and integrating it with third-party software to meet the user requirements according to contractual conditions. To deal with a more turbulent, speedy, risky, uncertain, and unpredictable market, authors suggest the adoption of values, principles, and practices of agile methodologies [6, 7, 8, 9, 10].

In 2012, Brazil was among the top 10 growth in IT, occupying the 7th position in the global ranking of IT investments. The Brazilian IT market, which includes hardware, software and services, moved 60.2 billion dollars, representing 2.67% of the Brazilian gross domestic product (GDP). Of this, 9.5 billion came from software and 15.5 billion from services. Summing up these two segments they represent more than 40% of the total IT market [11].

Given this uncertain and unpredictable scenario but, at the same time, full of opportunities, it is fundamental that IT companies find ways to manage their project portfolios using practices that provide them with better results. In this way they will optimize the resource allocation and raise productivity, maximize profitability, protect their expertise and deliver quality products achieving their strategic objectives.

### **Research Problem, Research Question and Objectives**

There are few empirical studies of agile methodologies, and/or the impact of them on PPM or vice-versa [12, 13, 14, 15]. On the one hand, there are some benefits in the adoption of agile software development [12], but on the other hand, it is difficult to introduce agile methods into large and complex projects [12, 16]. At the same time, there are studies suggesting the scaling software agility for large companies [9] and how PPM can support it [15].

This study is based on the organizational context of an IT company focused on integrated solutions that customizes its own software and integrates it with third-party software to meet their customer needs. This company manages a portfolio of projects in a dynamic environment and is implementing the agile methodology Scrum to support the PPM.

Consequently, the motivation of this research is to identify how agile software development relates to PPM in this organizational context, considering that these subjects are relatively recent in social science research. The research question is formulated as "*How agile software development relates to project portfolio management in dynamic environments of an integrated solutions provider?*"

The company in this study has been suffering in a dynamic, unpredictable, and stressful environment that has impacted the results of the project portfolio, therefore it is necessary to understand what can be done to support the company in such a way that it can get appropriate returns from investments and achieve the organizational goals.

The main objective of this research is to understand how agile software development relates to PPM in dynamic environments of an integrated solutions provider. The specific objectives of this research can be summarized as: (1) to identify the common practices in the field of agile software development and PPM adopted by the company; (2) to identify the types of uncertainties found in the portfolio studied; (3) to identify how the company handles these

uncertainties; and (4) to make recommendations according to the results of the research and literature review.

## **Literature Review**

### **Agile Methodology**

According to Beck et al. [6], to deal with a more turbulent, speedy, risky, uncertain, unpredictable, and replete of competitive challenges market, seventeen specialists, experienced software developers and agile practitioners met in February 2001 and created a statement that was an alternative to rigorous methodology. They called it *The Manifesto for Agile Software Development*. Fernandez and Fernandez [10] concluded that “agile practices, including project management, grew out of a need to manage projects characterized by complexity and uncertainty with responsiveness and adaptability. When goals and solutions are unclear and there is high volatility, there is particular need for alternative approaches to managing projects”.

Processes and tools are important, but talented people and the interaction between them are by far more important, therefore processes and tools must be adapted to talented people, not the opposite. Comprehensive documentation is essential, but just the minimum necessary to deliver real, functional and working software that the customers can see working on screen. The working software is the only thing that shows what the development team has achieved, no matter what has been documented [7, 8].

Contract negotiation must have limits within which the parties can move, but only the customer collaboration with the development team during the project execution can deliver the suitable results for the customers’ real needs. Collaboration means close interactions of individuals, making decisions together. Planning is useful, important and necessary, but adapting to further changes to the plan and understanding the limits of planning is even more important and desirable. Each one of the agile methodologies contains planning activities and mechanisms for dealing with changing priorities [7, 8].

According to West et al. [17, 18], “in the past few years, agile processes have not only gained increasing adoption levels; they have also rapidly joined the mainstream of development approaches”. They showed that, in the research conducted in 2009 and 2010, 35.4% and 38.6%, respectively, of IT professionals stated that agile closely reflects their development processes. Scrum is the most popular and adopted agile methodology, according to Forrester Research (as cited in West et al. [18]). The research showed that 31.9% of the application developers adopting some agile methodology are using Scrum.

### **Project Portfolio Management (PPM)**

According to Cooper, Edgett and Kleinschmidt [2], the PPM is defined as a dynamic decision process in which projects of new products, and research and development (R&D) are constantly updated and reviewed. The projects are assessed, selected, and prioritized; current projects are advanced, canceled, or postponed; and resources are allocated and reallocated to the project activities. The PPM is all about the allocation of resources, the alignment between new projects and organizational strategy, and the balance between new projects, this is, dealing with risk versus return, maintenance versus growth, and short-term versus long-term.

For Reyck et al. [3], the PPM considers the entire project portfolio the company is engaged with, in order to make decisions about which projects will be prioritized, added, or removed from the portfolio. For PMI [4], the PPM “is the coordinated management of one or

more portfolios to achieve organizational strategies and objectives. It includes interrelated organizational processes by which an organization evaluates, selects, prioritizes, and allocates its limited internal resource to best accomplish organizational strategies consistent with its vision, mission, and values”.

The main issues faced by organizations in project selection and portfolio management are: disconnection between projects approved and strategic objectives; portfolios of low quality; inefficiency in the decision process Go/Kill, leading to non-effective projects; scarce resources allocated to wrong projects; and oversimplification of product development [2].

Vähäniitty, Rautiainen, and Lassenius [19] identified 34 research papers related to inadequate PPM and/or the typical problems that occur in conjunction with it. They found eight problem areas that are symptomatic of inadequate portfolio management: i) excessive multitasking; ii) firefighting; iii) overload; iv) ineffective decision making, v) missing strategic alignment; vi) slipping schedules; vii) project failures and poor profitability; and viii) perceived need to improve project management.

Castro and Carvalho [20] concluded that the main aspects that differentiate organizations that perform the PPM of those who do not do so are: i) clarity about the availability of resources for management and implementation of projects, ii) evaluation, selection and prioritization of projects by category, iii) comparison and competition for resources projects for the same project category, iv) information from the ongoing projects is considered when assessing, selecting, prioritizing projects and allocating resources, and v) projects running are reassessed periodically, and may be paralyzed so that resources can be directed to other projects when necessary.

### **Uncertainties and Dynamic Capabilities**

According to Petit and Hobbs [5], the PPM literature “does not provide an adequate framework for the study of changes to the project portfolio between periodic review cycles, a phenomenon that is common in dynamic environments”. So, they reviewed the literature on management of uncertainty, and proposed a novel framework based on concepts derived from the dynamic capabilities and sensemaking. The assumption for the research is that portfolio managers might also implement processes to manage and control uncertainties, besides monitor changes.

Eisenhardt and Martin [21] concluded that dynamics capabilities are “well-known organization and strategic process like alliancing and product development whose strategic value lies in their ability to manipulate resources into value-creating strategies... Their broad structural patterns vary with market dynamism, ranging from the robust, grooved routines in moderately dynamics markets to fragile semi-structured ones in high-velocity ones. They evolve via well-known learning mechanisms”.

Petit and Hobbs [5] found in some studies of dynamic capabilities that to achieve a strategic advantage it is necessary to reallocate and re-optimize resources and capabilities to adapt to a changing environment, instead of just developing unique resources or capabilities, as proposed in the resource-based view.

### **Methodology**

The research process was based on Martins & Theóphilo [22] and Yin [23]. The research strategy for this study has the following characteristics: 1) classified as a qualitative research, 2)

exploratory; 3) conducted over a single-case study; 4) bibliographical and documentary research, and 5) participant-observation.

### Propositions

The three pillars defined from the literature review (agile methodology, PPM, and uncertainty and dynamic capabilities) were used to identify the main references in the literature and the relevant concepts that supported the formulation of propositions and the construction of the construct. Table 1 illustrates the 10 propositions defined for this study.

**Table 1: Research Propositions**

Pillars	Propositions
Agile Methodology	Processes and tools are important, but talented, motivated, valued, skilled, self-organized people and the interaction between them are far more important, thus process and tools must be adapted to people [6,7,8].
	Working software delivered early and frequently allows for continued wins, early feedback from users, rapid response to changing marketing conditions, and customer can sense that deliverables are evolving, despite of what was documented [6, 7, 8, 9].
	Just the customer collaboration and close communication with the development team during the time of delivery can provide the customers with their real needs and prevent undesirable deliverables [6, 7, 8].
	Planning is useful, important and necessary, but adapting to changes to the plan is more important and useful for the customer's competitive advantage, especially in an environment characterized by change, speed, and turbulence [6, 7, 8, 9].
Project Portfolio Management	A portfolio is a collection of programs, projects, or operations managed as a group to achieve organizational strategies and objectives [4].
	The project portfolio management is defined as a dynamic decision process where projects are evaluated, selected, prioritized, authorized, assessed, and monitored [3, 4, 24].
	The effective allocation of resources, increasingly scarce, will make all the difference to achieve the objectives set by the organization [3, 4, 24].
Uncertainty and Dynamic Capabilities	Portfolio management might implement process to manage and control uncertainty, and not only monitor changes [5, 14].
	There are additional types and sources of change that the organizations managing the project portfolio were facing, beyond the commonly described in the literature [5].
	It is necessary to reallocate and re-optimize resources and capabilities to adapt to changing environments [5, 14].

### Case Selected and Unit of Analysis

The organization nicknamed *Company Brazil* is a subsidiary of a multinational company dedicated to the research, development, and integration of technological solutions, including software and hardware. It has three BUs, all focused on providing custom services. One of these BUs is focused on the financial sector – banking. This BU offers integrated solutions that include customization and integration of proprietary and third-party software, hardware, and consultants highly specialized in certain banking processes. There is intensive use of skilled labor to provide cutting edge solutions.

The BU has one product that has been evolving for more than 12 years. It is software to capture and process financial and non-financial documents, such as, checks, money orders, deposit slips, and payment coupons, supporting the banking’s back-office. There is intensive customization of this software to create, modify, remove, or enhance its functional and non-functional features according to customer’s business needs. It also includes integration between this software, customer back-end applications, and third-party software.

The unit of analysis of this research is the BU’s portfolio called *Portfolio Banking*. It has four ongoing projects, all focused on customizing the software of the company, according to the

customer's needs. Considering the amount of work done and yet to be done, we considered only three projects, since almost professionals of the development team were allocated to these projects in the last year, period when the BU adopted the Scrum methodology.

These projects were purchased by Brazilians public and private banks. The main objective of these projects were the acquisition of a solution for the capture and processing of financial, non-financial, and automated conference of formal aspects and signatures, through decentralized image capture and centralized processing. It includes licenses of software for thousands of users, software customization, hardware, software and hardware installation, technical support, technology updates, knowledge transfer, and hours for integration, customization, and training.

All projects have basically two phases to evaluate the software release: system integration testing (SIT) and user acceptance testing (UAT). In the SIT phase, professionals of the BU test all functional and non-functional features released into a development environment of the customer. In the UAT phase, only customer's professionals do it in an acceptance environment of the customer.

### **Data Collection**

This research used documents, interviews, and participant-observation for data collection. This study used a case study protocol to support the interview of the following employees: i) development manager; ii) project managers of each project in the portfolio; and iii) two key professionals of the software development team. Each interview was taped (a total of 8.42 hours) and transcribed verbally in a structure sheet composed of all propositions and respective questions. This model facilitated the writing of the findings once it was easy to compare the respondents' answers. Notes were also taken for some questions that rose after the interviews and the writing were incorporated to the findings.

### **Analysis and Conclusion**

This master's research was undertaken to investigate the area of agile software development and PPM in dynamic environments of an integrated solution provider. The strategy was to explore it through the qualitative study of one portfolio of three projects in one company – single case study. After the implementation of the agile methodology Scrum, it is possible to identify some benefits that are contributing to the BU's PPM, as follows:

- The resource reallocation between projects is better supported by the information provided from the Sprint reports;
- The Daily Scrum gives the opportunity to anticipate any resource reallocation to avoid or minimize the delay of delivers.
- Senior professionals have taken more responsibility and risk for their actions, getting more engaged to implement new initiatives and make decisions;
- The development team is being more responsible, dedicated, and aware of their duties and how this affects the project's goals.
- The dissemination of knowledge and the communication between team members improved greatly, keeping the whole development team aware of how things are going in all project portfolios.
- The adoption of a white board and sticky notes aided the communication of resources allocated in each project's activity;

- The organizational climate is much better now affecting positively all project portfolio; and
- The replication of knowledge for the development team helps to mitigate the impact of few experts knowing almost all the solution components, facilitating the resource reallocation.

### ***Common practices in the field of agile software development adopted by the company***

Considering the 12 principles defined in the Manifesto by Beck et al. [6] and the seven best practices identified in the literature by Leffingwell [9], it is possible to conclude that the BU tries to deliver early, frequently and continuously working software within a Sprint of two weeks, as recommend by Leffingwell [9] and Krebs [25]; embraces changing requirements, as stated by one project manager, “changes are in the DNA of the company”, and the development team is aware of the changing environment; the team has engaged people that talk with each other constantly, in different ways according to each project characteristic.

Although the organizational climate is much better now, the development team still lacks the full support of the company, as stated by the project managers. The development of a simple design and complex behavior is a challenge being faced every day by them. Cockburn [8] said that the architecture needs to be adjusted over the time and grow in steps, but to do it depends on availability and authority, and maturity of the team.

The direct interaction between customers and the development team during the project execution was not identified in the portfolio investigated. The alternative adopted by the BU was the use of intermediaries: business analysts and the project managers. Some contractual terms and the customers’ location contributed to this, but it was not possible to identify other reasons about if it is right or wrong for the context studied.

It was evidenced that there are people working long hours during overtime, affecting the productivity and probably introducing more errors into the code, which reflects, in part, on some reworks identified in the projects. Also, evidences were not found of formal processes to test the software too, but some initiatives are in progress to resolve this fundamental issue, nor of the development team reflecting on what they do after each regular interval, but just informal conversation during one Daily Scrum in the week.

It is also evidenced the engagement of the development team, especially senior professionals, to improve the continuous process of integration as described by Leffingwell [9], but in different levels of applicability for each project.

### ***Common practices in the field of PPM adopted by the company***

Although the company has a formal methodology to manage a portfolio of projects, it is not effectively used, and there is not a dedicated division to focus on evolution and innovation of current and new products, which is in part related to concepts studied by Cooper, Edgett and Kleinschmidt [2, 24], it was possible to identify how the BU handles some processes of PPM suggested by the literature review.

Almost all typical problems that occur in conjunction with inadequate portfolio management identified by Vähäniitty, Rautiainen, and Lassenius [19] were also found in this case, such as: excessive multitasking, firefighting, overload, and slipping schedules.

Considering the context of the projects, the processes of identification, classification, evaluation, selection, prioritization, authorization, and review, showed to be less relevant

compared with the interdependence among projects, and resource constraints shared between projects, two key elements identified in the literature review made by Reyck et al. [3].

### ***Types of uncertainties found in the portfolio studied***

According to the respondents, the main sources of uncertainties identified in their projects can be summarized, as follows:

- i. The detailed scope is not known before the contract signature;
- ii. Signing the contract after the project has started, which in practice implies assuming all changes as being part of the original scope at the time of the signature, without opportunities to manage the changes;
- iii. The political conflicts between the business and the customer's IT professionals, since it is very difficult to foresee these conflicts before the beginning of the project;
- iv. Last minute requests to meet customer's security and infrastructure policies; and
- v. Business partner without knowledge of customer's business processes and application.
- vi. The unavailability of the legacy of the customer for testing during the development phase.

Three of six types are related to unknown changes of scope. Petit and Hobbs [5], reported a similar finding in their results: the main source of uncertainty is related to scope changes. The main impacts of these changes to the projects and portfolio are:

- a) The development team works overtime, in a stressful environment and not motivated;
- b) The BU assumes risky deadlines in a specialized and short market;
- c) There is a much greater amount of time than planned, creating overtime bank, which is a labor liability for the company;
- d) High cost because of not expected extra hours, travel, and lodging;
- e) Much more parallelism of work in the project and with other projects, since there scope is larger than planned but with the same deadline;
- f) The deadlines assumed with the customer are not reached;
- g) The company's reputation is harmed with the customer;
- h) Delay in receiving and invoicing;
- i) Structural changes in the software to meet security and infrastructure policies; and
- j) The solution is partially tested during the development phase.

### ***How the company handles these uncertainties***

Despite the perception of the project managers that the BU does not manage uncertainties correctly following common practices in the market, they have been taking some actions to minimize the impacts of changes presented before, such as:

- a) Allocating a senior business analyst full time to understand the customer's business processes to minimize the impact of the business partner lack of knowledge;
- b) Delivering parts of the solution at the beginning of the SIT, allowing the team to perform the SIT on the planned date, and delivering the remaining parts during the

execution of the SIT, permitting the customer to see the evolving of deliveries, and;

- c) Running the Daily Scrum, it is possible to identify who is having difficulties or problems to perform their work, given the opportunity for the development team to support and/or reallocate resources, if necessary.

### **Contribution for Academia and Practice**

This master's research contributes for academia since there are few empirical studies of agile methodologies and the impact of them on PPM. This exploratory case study showed that Scrum can contribute to PPM, particularly in resource reallocation, and dissemination of knowledge.

This master's research is contributing to the company studied since it was able to make recommendations according to the results of the research and literature review, as follows:

- To re-implement the formal process to plan and prioritize the project's backlog, instead of keeping it under the responsibility of just one person;
- To make workshops to better explain the concepts of agile methodology and how to take best advantage of it;
- To keep evolving in the use of common practices of agile software development, especially those that there are evidences of lack of application, such as: formal processes of testing and regular reflection; and
- To reevaluate how commercial decision making is affecting the project portfolio, since the aggressive deadline of the projects assumed with the customer is not been met;

### **Limitations and Future Works**

This research is based on a single case study, so it is not possible to generalize the findings to all project portfolios, although it helps to understand and make comparisons with similar IT project portfolios. For future works is suggested the following topics: i) expand the research to a multiple case study of IS providers whose business is based on projects to identify common characteristics in the context of agile software development and PPM; and ii) explore how the organizations can better manage constraints related to contractual terms, such as fixed price contract with uncertainty scope, that affect project deadlines and communication between customer and development team.

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