POLITECNICO DI TORINO

Department of Management and Production Engineering

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in ENGINEERING AND MANAGEMENT
(Ingegneria Gestionale)

Final Thesis

Design of implementation method for blended Agile Project Management methodology in a manufacturing company

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0. Abstract

Since its appearance at the beginning of the century, Agile Project Management methodologies have been spreading from the software development environment where they were originated to almost all type of business and working activities, including manufacturing companies. One of the challenges of implementing this methodology is the design of the implementation process.

Agile implicate a way of performing project management that breaks the traditional waterfall approach. This is why it is relevant to have a proper exposure to the concepts and an organised design process.

Based on a case study of a metalworking manufacturing company of operating machines, a survey to students from master's degree, and academic literature, the design of implementation has been divided in three steps:

1. Exposure and comprehension of Agile methodologies.
2. Analysis of current Project Management process and best fit for implementation.
3. Design of blended Agile Project Management method.

The outcomes of this work support the view that first exposure to Agile methodologies needs to be interactive including "on the job" activities, and the design of the implementation should be tailor made to the company and its processes, performed by an internal team, which is suggested to be cross-functional.

Acknowledgments

I will like to thank all the people who were involved in the development of this work.

First, professor DeMarco, who's experience, and innovative ideas inspire this work. For including me on this project, deliver the necessary material and help for surveying Project Management students. To the 40 colleagues' students who get committed on the development of one section of this thesis. To the Merlo team, who was always able to welcome me on their facilities and reach necessary information for this work.

To my professors from Universidad Adolfo Ibanez and Politecnico di Torino, whose ideas and knowledge are embodied on this work.

Finally, to the people who stayed close to me and support me on moving to Italy for following this academic path, I will be always in debt.

Objective

The objective of this work is to explore an approach to the design of the implementation of Agile Project Management methodologies, performed by a cross-functional team in a manufacturing company. The thesis topic came out when Italian company, Merlo S.p.A., decided to introduce changes in the way they perform project management, moving from traditional to a mixed method that includes Agile tools. This case study will be used to deepen and complement a literature review in the way to give the first step on moving from traditional to Agile approach. Following the procedure on the case study, the approach for designing of implementation method includes the following three key steps:

1. Exposure and comprehension of Agile methodologies.
2. Analysis of current Project Management process and best fit for implementation.
3. Design of blended Agile Project Management method.

For the development of current work, these three points will be covered trough conclusions from the case study and academic literature, finally complementing it with a survey to Project Management course master's students, gathering insights that will conclude on an analysis of this three steps for the design of the implementation, that will complement the existing literature.

Methodology

The outcome of the thesis is based on a literature review, which includes manuals, books, publications and previous Agile implementations case studies, the results of a case study, and a survey performed to Politecnico di Torino master's students. It is focus on explaining Agile methodologies, including relevant frameworks and tools, for addressing the three steps.

Merlo case study is used to complement the information gather from literature.

The relationship with the company was limited to the follow:

- Set up of cross-functional core team
- Workshops that will explain Agile Project Management methodologies to the team and gather information about current Project Management methods.
- Analysis of the information and discussion with core team for establishing roles and milestones.
- Co-working for designing of the first approach.

For complement the information on the three steps, a survey was be conducted on a group of 40 Project Management master's students, before and after going through a learning process of Agile Project management methodologies. This will help to understand the effectiveness of traditional learning methods, on the job learning method, and practical examples for first exposure to Agile methodologies.

1. Theoretical background

1.1. Agile Project Management

1.1.1. Definitions and contrast with traditional waterfall approach

Agile can be defined as a set of values that is based on the Agile manifesto, which states:

"[…] Through this work we have come to value:

Individuals and interactions over processes and tools
Working software over comprehensive documentation
Customer collaboration over contract negotiation
Responding to change over following a plan […]" (17 signatories, 2001)

The first strategies for Agile methodologies were define in a software development environment. Even though, they have been modified in order to be applied to any type of industry, without losing its core values. Agile methodologies are people centred approaches (Whitworth & Biddle, 2007), and according to Robert Wysocki, Agile corresponds to an "Industrial model designed for adaptive projects in order to deliver maximum business value to clients from every iteration cycle within limits of client imposed time and cost constraints" (Rico, The History, Evolution and Emergence of Agile Project Management Frameworks, 2012).

Agile Project Management (Agile PM) refer to the application of different frameworks for the planning, execution, control and closing of teamwork in an organization, in order to meet project requirements (Project Management Institute, 2019). It is important to notice that this concept differs from Agile manufacturing, which corresponds to the application of technological advances in production and manufacturing methodologies, that allows an organization to better respond to its environment requirements, supplemented by Lean manufacturing techniques in order to reduce cost and dead time (Ingram, 2019).

Agile PM and traditional approach are always contrasted when treating Project Management, this allows to have a better general understanding of the implication of

implementing Agile over a waterfall approach. Nerur, Mahapatra & Mangalaraj (2005) summarize it accurately, as it shown on Table 1.1.

	TRADITIONAL	**AGILE**
Fundamental Assumptions	Systems are fully specifiable, predictable, and can be built through meticulous and extensive planning	High-quality, adaptive product can be developed by small teams using the principles of continuous design improvement and testing based on rapid feedback and change.
Control	Process centric	People centric
Management Style	Command-and-control	Leadership-and-collaboration
Knowledge Management	Explicit	Tacit
Role Assignment	Individual-favours specialization	Self-organizing teams-encourage role. Interchangeability
Communication	Formal	Informal
Customer's Role	Important	Critical
Project Cycle	Guided by tasks or activities	Guided by product features
Development Model	Life cycle model (Waterfall, Spiral, or some variation)	The evolutionary-delivery model
Desired Organizational Form/Structure	Mechanistic (bureaucratic with high formalization)	Organic (flexible and participative encouraging cooperative social action)

Table 1.1. *Traditional vs Agile approach to Project Management. Adapted from Nerur, Mahapatra & Mangalaraj (2005)*

Among the differences previously presented, it can be state that Agile methodologies confronts unpredictability trough people's creativity, in contrast with traditional approach, that relies on process and planning. Notice that, despite having different ways

to approach project management, both methodologies are in fact not exclusive, but could be complementary depending on industry and project.

In 2003, Barry Boehm and Richard Turn observed that rather than supporting each other, Agile and traditional approach have become opposites and "zero-sum games" (Bohem & Turner, 2003). The truth is both agile and traditional approach to project management contributes to develop a proper strategy. Agile is not just fully implemented or not implemented, there are several approaches between the spectrum of pure Agile and traditional approach, as it can be seen in Figure 1.1., and different ways to apply agile principles to traditional approach and vice versa, to add more control to agile methodologies (Cobb, 2011).

For a combined approach, Virani & Stolzar (2014) recommends considering at the beginning of the project the level of flexibility needed on the system, and when will be necessary to change project management approach.

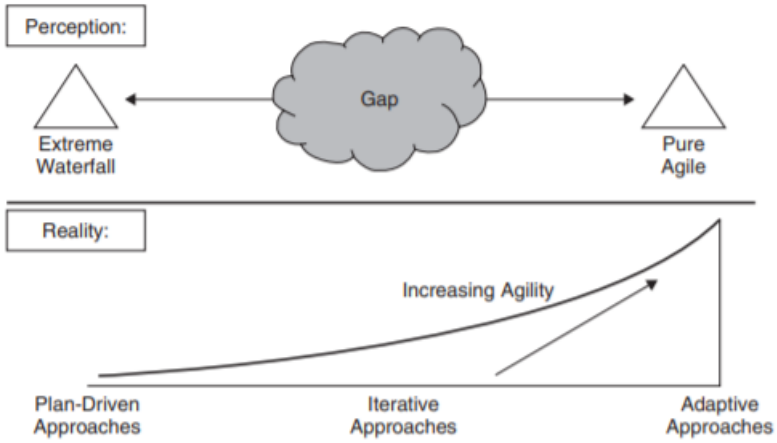


Figure 1.1. *All-or-nothing misconception about Agile methodologies* (Cobb, 2011)

Another common misconception about Agile is the belief that it has no structure. Agile is carried out as an extremely discipline approach, otherwise it becomes unencumbered enthusiasm (Bohem & Turner, 2003). Agile by itself is not a framework, neither a methodology. From the Agile values it has been derive several methodologies depending on the industry and the teams. These frameworks are not fix but can be adapted to different organizations and teams.

The application of Agile methodology requires discipline, from individuals and teams, in order to succeed. Several experiments in the application of Extreme Programming, a broadly extended Agile methodology, have shown that fails in the implementation occurs

due to “reluctance or incapability to apply the practices in a disciplined and professional manner” (Ilieva, Ivanov, & Stefanova, 2004).

Agile by itself is not a framework, neither a methodology. Aside from its practices, Agile values had allowed to derive several methodologies that can be adapted to different industries and teams. These methodologies are translated into frameworks, which have specific requirements, procedures, roles, etc. and are not fix, but can be adapted depending on organizations and teams’ needs. For the purpose of this work, two frameworks will be analysed: DSDM and Scrum, which betters adapt to the business case company’s reality.

1.1.2. Practices

Agile PM methodologies, born in XXI century, differ from traditional waterfall approach, which domains the previous years, on several points. The differences are noticed on the practices that Agile methodologies promote, in order to change the approach to project management.

- Cross-functional teams: Teams includes people with different capabilities/professions.
- Iterative and incremental development: Deliver of constant, small, pieces of work that adds value to the customer.
- Daily meetings: Short and efficient moderated meetings that includes team members.
- Feature-Driven Development: Adding constant features to the product, as requirements and demands changes.
- Planning Game: Planning is made by the team and not by one individual.
- Co-location: Different teams work in nearby environments that boosts ideas and information sharing.
- Visual Management: Usage of tools that everyone in the team can see, that are visually attractive, and simple.
- Agile coach: A member that teach Agile practices and guide the team members.

(Medinilla, 2012)

1.1.2.1. Agile competence pyramid

The pyramid of agile competences separates the skills required for Agile methodologies performance in three main levels, at it can be appreciated in Figure 1.2.

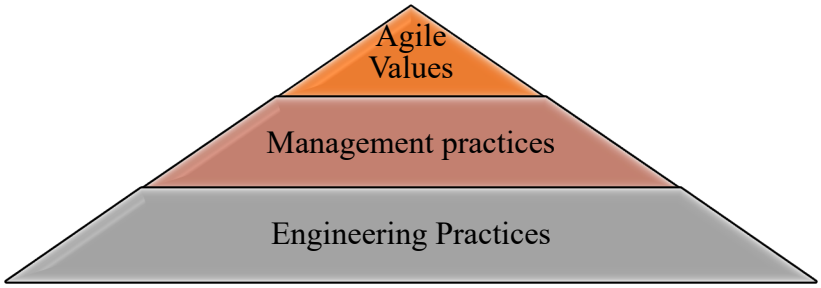


Figure 1.2. *Pyramid of Agile competences*

With respect to the levels of the pyramid, Engineering Practices refers to any type of best practice to perform work on an Agile way, such as constant report value delivery each two weeks, for example. The second level, Management practices, defined how teams and project are organized under Agile methodologies. Finally, in the top level, is the interiorization of the Agile values expressed on the manifesto by members of the organization

It also reflects the difficulty of obtaining these skills, Engineering skills are the easiest ones to obtain, they can be tough trough lectures or practical examples. Management practices needs to include some "on the job" experience to polish them. Agile Values take time, and a constant try and error journey, in order for a team to interiorize them (Kropp & Meier, 2013).

1.1.3. Benefits

Azanha, Batista, Domingos and Terra (2016) found that the use of Agile frameworks increases motivation and staff satisfaction, it allows a better control of client requirements, and generates added value to the organization through a high-quality delivery system. Quantitative analysis carried out on 1386 projects by Serrador & Pinto (2015) find out that the greater Agile approach reported, the higher is the success of the project for two assessments: efficiency and stakeholders' satisfaction. Another important point highlighted by Kaur, Jajoo & Manisha (2015) is that constant client involvement allows to reduce the failures of the product, due to constant feedback. Companies that have applied Agile methodology have reported an increase in job's satisfaction of employees and products' satisfaction from customers.

1.1.4. Frameworks

1.1.4.1.Dynamic System Development Method (DSDM)

Due to its complexity, there are currently different varieties of DSDM framework. In this case, the presented one is defined by Agile Business Consortium (Agile Business Consortium Limited, 2014).

DSDM is a methodology created in 1994 with the objective of finding a methodology in between the traditional Waterfall Approach and the Rapid Application Development (RAD), that can address both methodologies' problems: slow and big, and lack of quality, respectively.

DSDM requires basic foundations of the project to be agreed on an early stage, and its expected outcome is the right solution, at the right time for the right cost (Agile Business Consortium Limited, 2014). The change in paradigm is important, which it can be notice in the change of variables of the project, as is presented in Figure 1.3.

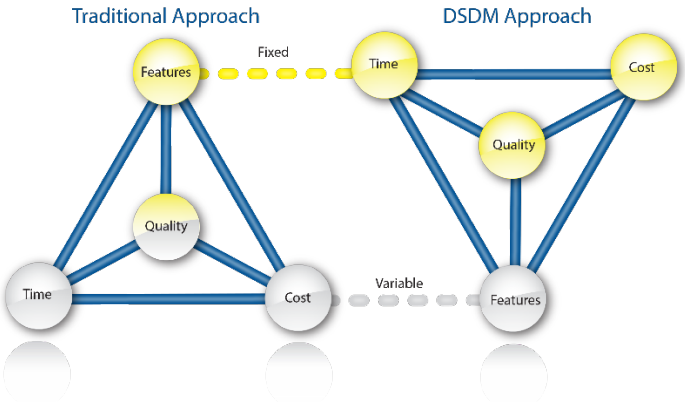


Figure 1.3. *Variables in Traditional approach vs DSDM* (Agile Business Consortium Limited, 2014)

Instead of having fixed features, and constantly change deliverable times and costs, sometimes affecting quality, DSDM expected the outcome of the project to be the best with a fixed amount of time and cost, without affecting a pre-established basic level of quality desired. For the selection of the Features, prioritization techniques, such as MoSCoW, are used. This perception on the variables of project management is also applied to the rest of Agile methodologies.

The methodology is based on a constant Project Increments of fixed durations which add value for customer, supported by the following eight principles:

1. Focus on Business Needs: Project should deliver what business needs
2. Deliver on time: Respect the times previously agreed
3. Collaborate: Teams that work with active cooperation
4. Never Compromise Quality: Works should aim the expected level of quality.
5. Build incrementally from Firm Foundations: Incremental delivery of the solution.
6. Develop Iteratively: Constant reviews and feedback
7. Communicate Continuously and Clearly: Using face-to-face and other tools
8. Demonstrate Control: Stick to the Project Plan agreed at the begging.

(Agile Business Consortium Limited, 2014)

1.1.4.1.1. Process

The DSDM process is iterative, as it can be expressed in diagram in Figure 1.4., where all the phases can be appreciated.

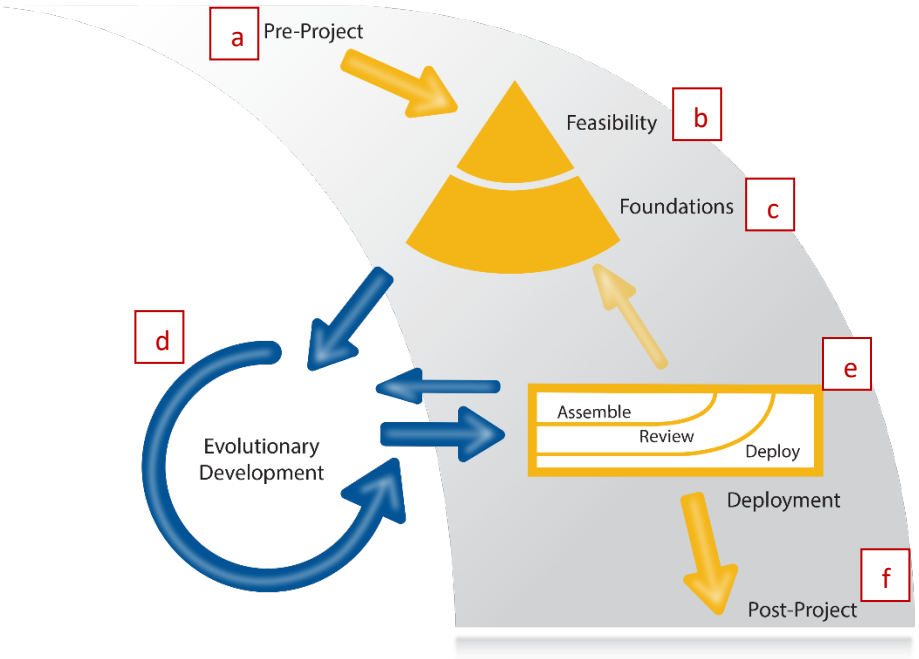


Figure 1.4. *Diagram of phases in DSDM Process* (Agile Business Consortium Limited, 2014)

a) Pre-Project

This phase is a filter for projects, only the ones who aligns to business needs (following principle 1) continues the process of development. The scope is to define clearly what would be used to perform financial requirements and understand the business domain (Anwer, Aftab, Waheed, & Muhammad, 2017).

Outcome: Possible business-oriented projects ideas.

b) Feasibility

Allows to understand the viability of the project, in financial and technical terms. After analysis, is decided if is justified to continue with the research for project.

Outcome: Feasible project idea.

c) Foundations

This phase is focus on understanding what would be the solution created from the project and how it would be manage. It is supposed to last for not more than four weeks therefore, this phase lack high level of detail. It is possible to come back to this process and make changes or re-affirm what t was established previously.

Outcome: How, whom when and where the work will be carried out and Project Lifecycle

d) Evolutionary Development Phase

Characterized by iterative development, this is the process in which solution is created, through the release of small pieces of value, that are added together after, to deploy the final product. The use of Timeboxes is highly relevant to create the solution, and MoSCoW prioritization technique is used to manage the variable of features, keeping in mind that time and cost are constant.

Outcome: Deliverables that add value to the project

e) Deployment Phase

The main objective of this phase is to bring together the baseline of evolutionary development. It is divided in three sub-phases:

- Assemble: It brings together all the value created previously, in order to make sure what is going to be deliver is coherent.
- Review: This is an approval process before deployment. It could be a formal or informal process.
- Deploy: Put the solution into use. May include technical and managerial work.

Outcome: Deployment of final solution, or a subset of final solution.

f) Post-Project

Keep track of how the business benefit have been meet after the deployment of the project.

The format and number of deliverables, the time, process standards and characteristics, and materials needed are out of the framework explanation, because they are set-up depending on the company and the project that would be release.

(Agile Business Consortium Limited, 2014)

1.1.4.1.2. Roles

As it is for Agile approaches to Project Management, DSDM's team is an empowered and self-organized group of people. Team members must take personal responsibility, respect the knowledge of the rest of the members and be willing to challenge the processes' status quo.

For a DSDM approach to project management, some roles are defined, which the DSDM handbook presents organized as in Figure 1.5., where the colours represent the different perspectives that the role should have from the Project: Orange is a business interest role, Green is a solution/technical perspective, Blue have a management perspective, and Grey roles focus on process's aspects.

The roles are divided into three main groups: Project Level, Solution Development Team and Support roles. The first one is organized by Team Management, the second one by Team Leader, and both are connected through the Business Analyst, who's role is to communicate the Business and the Technical side of the project. Technical and Business Advisors are the nexus with Support roles, that are not necessary part of the project.

For DSDM project management, communication is vital, as is state in principles 3 and 7. One of the reasons for it is the importance of communication between roles for everyone to perform properly. It needs to be a clear and effective communication, group distributed, with everybody freely sharing information.

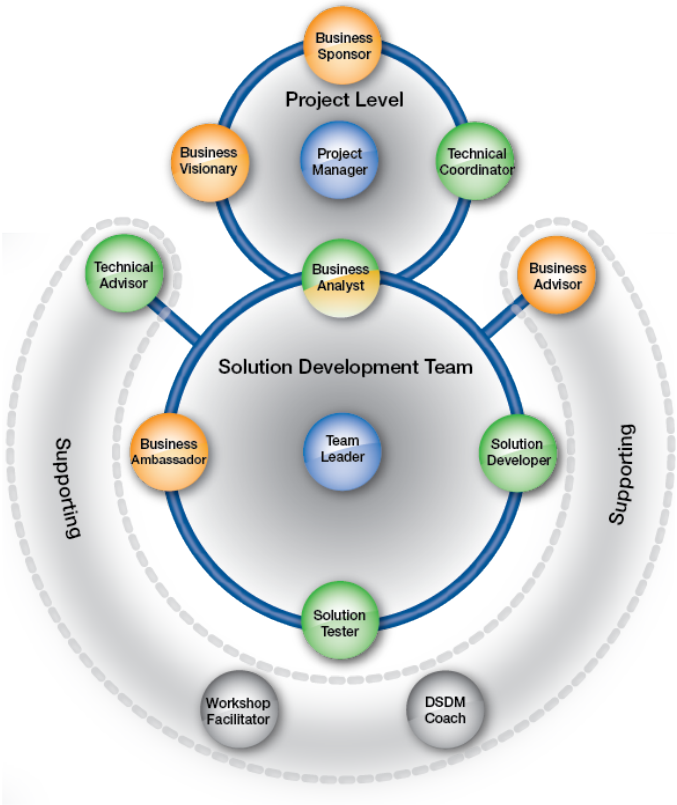


Figure 1.5. *Roles in DSDM Framework* (Agile Business Consortium Limited, 2014)

- Business sponsor: Senior Role. Owner of the project. In charge of resolve business issues through financial decisions. Empower the people and make sure to eliminate the limitations that the team members have while performing their roles.
- Business Visionary: Senior role that defines the business vision for the project, ensuring collaboration between stakeholders.
- Technical Coordinator: Ensures the coherent and consistency of the solution on technical terms. Approves the solution from a technical perspective. Manage technical differences. Ensure and promote technical standards.
- Business Analyst: Connection between Business and Technical parts of the project.
- Project Manager (PM): High-level project planning. Manage the working environment where solution is developed. For some projects there should be two PM, one from the supplier side and one from the customer side.
- Technical Advisor: Provides technical inputs about the project, verifying is evolving properly.

- Business Advisor: Representant of the intended user. Provide advice to Business Ambassador.
- Solution Tester: Perform tests during the development of the project.
- Solution Developer: Understand the business requirements and translate them into solution increments.
- Business Ambassador: Provide daily business perspective to the developing team.
- Workshop Facilitator: In charge of managing the proper development of the workshops
- DSDM Coach: Ensure team members follow properly the DSDM approach to project management.

(Agile Business Consortium Limited, 2014)

1.1.4.2. Scrum

Scrum is an Agile framework based on collaborative effort. This methodology encourages teams to learn trough experiences while working in a problem, improving through reflections about successes and failures during the development process (Atlassian®, 2019).

Originally thought to carry out Software development projects, Scrum can be modified and applied to any industry in what is referred to Project Management organization, in order to make the working process highly dynamic and communicative.

There are five relevant values that must be follow when applying the methodology:

- Courage: Team do the right thing and work on problems.
- Focus: Team member focus on the work and goals proposed.
- Commitment: Personal commitment from each one of the team.
- Respect: See team members as capable and independent.
- Openness: Agree to be open about work and challenges.

(Atlassian®, 2019)

1.1.4.2.1.Roles

There are three main important roles for applying this methodology, which are independent from job titles' responsibilities.

- Product Owner: It is the connection between the team and the customer, it has the vision of what is the value that Scrum team is delivering and understand the requirements. It is the one who prepares the product backlog and constantly communicates with customer and manage the stakeholders.
- Scrum Master: Its main role is to ensure that Scrum its being properly applied. It is work as a servant leader, supporting the team and helping to put together the value that is constantly deliver by the team. The person with this role needs to ensure that teams work transparently, learn from their failures and successes, and work according to Scrum values.
- Development Team: Multi-disciplinary and self-organized group that aims to deliver value in each of the Sprints. It characterises by its capacity to improve and learn from experience. Needs to be a clear and honest communication between

teams., which is ensure on the daily meetings. The roles of each member of the team are define according to the task and goal wanted to be achieved.

1.4.2.2. Process

The key strength of Scrum lies on the self-organized and cross-functional teams that divides the work in work cycles call *Sprints* (SCRUMstudy, 2017). Sprints are the heart of Scrum and consist in time-boxed period where the team works to complete a certain amount of labour, previously defined. It allows the team to be more flexible, to respond easily to new requirements and helps to follow the Agile principle of regular delivery of value. Figure 1.6. shows the flow of Scrum framework.

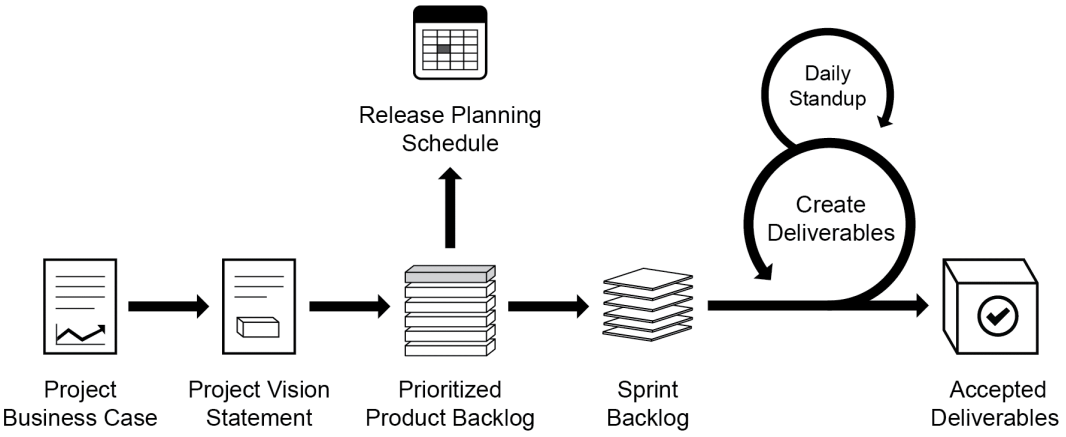


Figure 1.6. *Scrum Flow* (SCRUMstudy, 2017)

The Sprint process starts by a stakeholder meeting with the Product Owner, where the Project Vision is created after reviewing the Business Case. The Product Owners create a Prioritized Product Backlog, establishing the *Don*e criteria and ranking what is more relevant for the product.

- Business Case: It shows the reason for initiate the project, and the business needs behinds it.
- Project Vision: It shows what is expected to be achieve with the project.
- Prioritized Product Backlog: List of the functionalities of product and needs of the client. Done by Product Owner.

Before start working, the team have a Sprint Planning Meeting, in which it plans what would be done during the Sprint and release the Sprint Backlog. This is carried out by the three roles and includes the usage of User Stories (SCRUMstudy, 2017).

- User Stories: High level definition of requirement, expressed as: *"As a <user>, I want <goal> so that <reason>"* (Ambler, 2018), that allows team to estimate the effort to implement the solution.
    - Example: As student, I want more activities at university so that I could meet new people"
- Sprint Backlog: It expressed the times for Sprints, the expected value that would be deliver, and which labour would be done and what is the amount of work that would be deliver. This is

The team begins creating deliverables, which gives value to the customer, divided in functional increments. The time for a Sprint must be between one and four weeks. While the team works on the project, the Scrum Master have the role to moderate and support the team with the achievement of the objectives.

The Daily Stand-ups allows the team and Scrum Master to monitor what is have been doing during the development phase. During the reunion, that should not last more than 15 minutes, three main points are address: "*what has been done since the last meeting?"*, "*what would be shown in the next meeting?",* and "*what are the issues you encounter when performing the job?"*

A Sprint Review is carried out in order to verify the achievement of the objectives and guarantee a deliverable for the client.

A Sprint Retrospective reunion is carried out to analyse the main results of the Sprint and address problems or improvements for the next one.

After finishing the Sprint, a new one needs to begin from the Print Planning Meeting. This process will continue until it would be possible to exhibit a final product, which would be deliver to the client for him to interact and have feedback for improvements (Henao, 2018).

1.1.5. Tools

1.1.5.1. TimeBoxing

One of the main differences between Agile methodologies and traditional approach is the idea of Timeboxing. For Agile projects, a time is defined beforehand and needs to be respected, which means after the previously accorded period ends, some value must be delivered, even though is not exactly what it was planned. The objective of Timebox is to complete one or more deliverables, this assure that teams work for an objective and not only for "being busy" (Agile Business Consortium Limited, 2014).

Different options for Timeboxing are propose by different Agile Frameworks, such as DSDM or Scrum, but Agile teams are free to design their own type, depending on business needs, objectives and capacity. The only requirement is that Timebox's time must be fix for all iterations and have to be respected by all team members. An example of Timebox, took from DSDM methodology, can be seen on Figure 1.7.

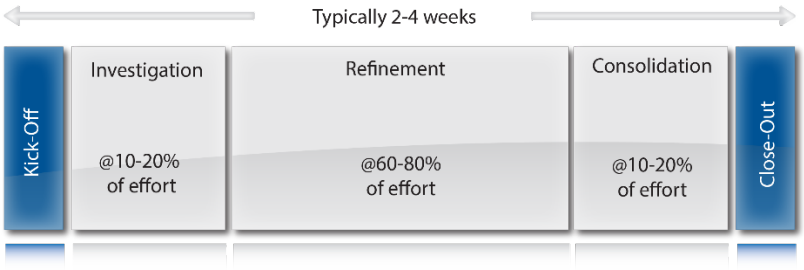


Figure 1.7. DSDM Timebox format

1.1.5.2.Story Points

Story points are a practical way to measure effort that a requirement would take to be completed. Based on workload, Story Points can be assigned to each task to be perform, this helps to distribute them on different timeboxes. It rates the relative effort of work and, even though any type of numbers and scale can be use, it is suggested to use a Fibonacci-like format: 0,0.5,1,2,3,5,8… , because "push the team to make tougher decisions around the difficulty of work" (Atlassian®, 2019) . These values do not represent the amount of time, but the relative effort required to complete a task.

Team should define a story points' maximum for each Timebox, depending on the performing capacity of the team. This performing capacity can be measure after a couple of iterations have been done, and it improves with time, while people get use to work on an Agile framework.

1.1.5.3. Product Backlog

The product backlog is a decomposition of everything that is needed on a product. It represents what are the features that the product needs to properly the task that it was designed for and could always be under changes (Scrum.org, 2020).

Later on, it is useful to define priorities and activities that will be performed in each of the Sprints when implementing Agile methodologies.

1.1.5.3. MoSCoW Prioritisation Method

As it was explained previously, Agile approach requires the use of prioritization to confront the variability of Features. MoSCoW is a technique that allows Agile teams to understand and manage priorities.

The names stand for: "*Must have*", "*Should Have*", "*Could Have*" and "*Won't have this time*".

- *Must have*: A requirement that, if is not meet, the project fails or cannot be carried out.
- *Should Have*: Important requirements that may be painful to leave out but there is a way to carried out the project
- *Could Have*: Requirement that is desirable but not important
- *Won't Have this time*: Requirement that project team decide not to include this time.

For effort distribution we will out of scope the *Won't Have*. Within the scope, it is recommended to classify not more than 60% of requirements (in terms of effort) as Must Have, this allows the team to create a contingency, that makes them highly flexible for responding to change.

When the team classify the requirements, *Must have* are usually object, while the difference between *Should have* and *Could have* tends to be more objective, and depends on team vision an experience.

1.1.5.4. Agile Kanban Board

Kanban is a broad technique, originally develop by Toyota, that allows manufacturing teams to have a scheduling process focus on consumer, on a Lean way that allows to reduce inventory. According to Gross & Mcinnis (2003), for a scheduling process to be

consider a true Kanban, the production process it controls must only produce to replace the consumed product and needs to be based on signals sent by the customer.

The core idea of Kanban are cards with information that moves from one process to another in order to control the Work in Process, as it can be seen in Figure 1.8., where I_{it} represents a resource/machine, with their respective buffer represented by letters (F,P,A) and KP_{it} represents Kanban cards moving from ones stage to another, in order to communicate all the stages in the manufacturing process. This method allows to decrease cycle time and wasted time and increase throughput (Villa, 2013).

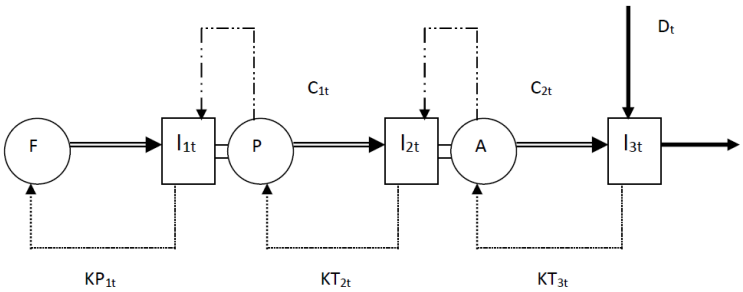


Figure 1.8. *Production Process with Kanban* (Villa, 2013)

Agile software development teams modify the idea of Kanban cards used in production systems, and replace machines by process needed to fulfil before delivering a project. What is called Agile Kanban Board could be seen on Figure 1.9.

Figure 1.9. *Kanban Board on Software Trello* (Atlassian®, 2019)

Kanban work with a set of rules:

1. Start by doing what is currently being doing
2. Mapping the value stream
3. Use Kanban cards to visualize work

4. Introduce a limit of work-in-progress

(Medinilla, 2012)

1.1.5.5. Minimum Viable Product (MVP)

A minimum viable product is version of the product complete enough that delivers the expected basic value for the user (Rancic, 2012). It has the minimum amounts of features required to fulfill its design purpose.

This is widely use as outcomes from Agile processes, because facilitate the process of constant adding value, and variables features present in this type of methodologies.

1.1.5.6. Responsibility assigned matrix (RACI)

This is not an Agile tool itself, but it would be useful when first performing implementation to clarify what is the scheme of roles of the team.

The RACI matrix maps each of the task, as it is shown in Figure 1.10., and the four types of responsibilities that team member has over it, which are:

- Responsible: Person assigned to get the work done, only one person is responsible.
- Accountable: The person who will decide over the end of the task.
- Consult: People who provide information or work under the direction of the responsible person.
- Informed: People that do not contribute but needs to be informed.

(Khan & Quraishi, 2014)

#	Activities	Steering Committee	SMEG	RAMG	Project Team
1	Governance, guidance and sponsorship	A, R	R	R	I
2	Define criteria, search and extract potential assets	I	A, R	C	C
3	Analysis and re-work on assets with potential for re-use	I	C	A, R	C, I
4	Submit the Assets to a repository, publish and spread awareness	I	C	A, R	I
5	Initiate project, plan for re-use from the repository	I	C	R	A, R
6	Measure re-use effectiveness at project milestones and elicit feedback	I	C	R	A, R

Figure 1. 10. *Example of RACI matrix* (Khan & Quraishi, 2014)

2. Case Study: Merlo Spa Industria Metalmeccanica

2.1. About the company

Merlo Spa is a metalworking manufacturing company of operating machines located in Cuneo, Italy. As it is shown in Figure 2.1., the company offers a variety of products, which they adapt according to requirements from each customer. To achieve this, it is important for the company to have a flexible and standard process of manufacturing.

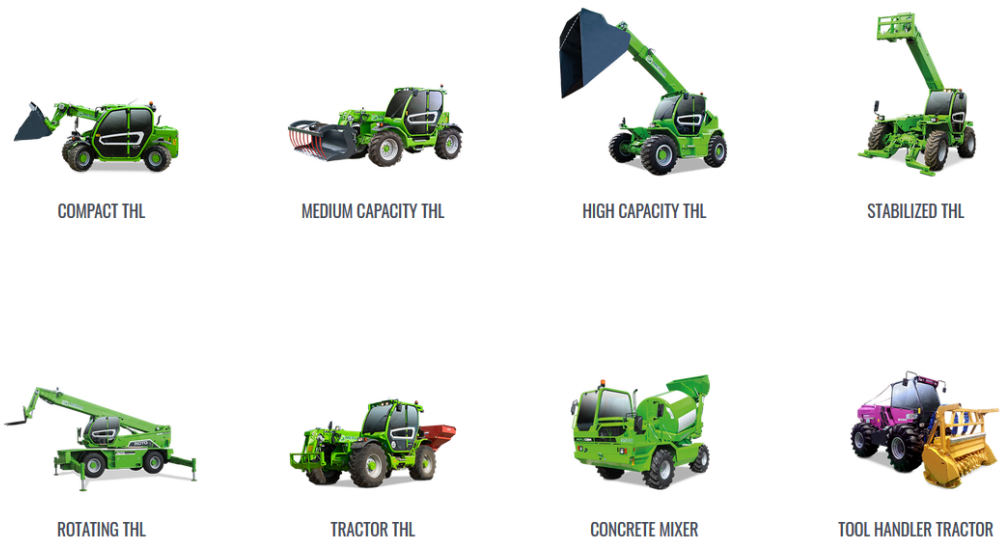


Figure 2.1. *Merlo Products* (MERLO S.p.A. Industria Metalmeccanica, 2019)

For the machines, different attachments are available such as forks, buckets and hooks. 90% of the production is exported out of Italy, and its international business is guaranteed by 6 branches and approximately 600 dealers, with presence in more than 80 countries. Merlo keeps a Global Customer Support that complements its standards of quality and reliability (MERLO S.p.A. Industria Metalmeccanica, 2019). As manufacturing company, Merlo's products are widely recognized for its quality and adaptiveness.

Merlo is a structured, team-based company, with a matrix organization, and a business model based on stakeholders, which could be consider in line with Agile methodologies practices. Merlo responds to its clients' demand producing personalized orders that fits each client's specifications. It has a base products range, that is adapted to client needs

by changing some characteristics of the machine; therefore, each of the orders has different requirements.

The main authority is hold by members of Merlo's family, highlighting the power of the main shareholder, Mr. Merlo, who stills implement a centralized, figure-based powered role, according to the employees that were involved on the implementation workshops.

The company is looking forward to improve their project management practices inside their business processes on project development.

2.1.1. Company's Project flow

The company business model is based on projects, that comprise from an initial feasibility study to manufacturing of the production and its launch. The machine is tailor made for the client according to his specifications. From a general perspective, Merlo process for a project have the structure shown in Figure 2.2., which includes the following processes that need to be accomplished, and the following teams to be involved.

		DEPARTMENT				
PHASE	**PHASE NAME**	**TECHNICAL OFFICE**	**PROTOTYPE**	**PRODUCTION/ QUALITY/ TMD/ ACQUISITIONS**	**R&D**	**SALES/ MARKETING**
1	**Feasibility study**	3D Model. Logical layout/ conceptual. space layout. Project presentation. Preliminary study review.		Production evaluation.		Market analysis. Technology and customer demand.
2	**Initial project**	Projection requirements. Technical specification. ↔ 2D Model. Prototype review.	Prototype α.	Industrial evaluation.	Structural test Stability test Motor	Fair.
3	**Definitive project**	Registration. Non-official design. Non-official spare parts book. ↔ Accessories projection. Prototype part list.	Prototype β. Accessories.	Cost analysis.		Fair. Orderability, versioning.
4	**Project approval**	Official design. Book of spare parts. Official part list (MA). List of accessories. Non-official technical name. Operation manual. Ratification.	Installation of the predisposition inside the vehicle on the Prototype β.		Final validation	
5	**Avan-series**	Diagnosis tool.	**6 weeks** →	Masks and industrial equipment Prototype γ.		Fair. Demo. Garage manual.
6	**End of the project**	MA validated. Modifications of project. Technical file. Official technical name. Predisposition of the interior space of the vehicle.	**3 weeks** ↓			Bulletin. Technical course.
7	**Pre-series**	Pre-series review. Project changes.	**5 weeks** →	Pre-serie.		
8	**Production in series**			**6 weeks** ↓ Serie.		
9	**Variants and Derogations**	Markets. Variable rafts. Special platforms.				

Figure 2.2. *Merlo Project development process*

The different teams and its roles are the following:

- Technical office: Development of technical activities related to product development.

- Prototype: Physical development of the product.
- Production: Logistics and coordination for manufacturing of new product.
- Quality: Standard assurance.
- TMD: Time and Methods department, dedicated to organizing industrial assembly of the components.
- Acquisition: Selection and purchase of material.
- R&D: Test and validation of product
- Sales.
- Marketing.

To be consider for the implementation, important milestone described by Merlo team are the development of prototypes α, β, and γ.

2.2. Scope of Case Study

The scope of the case study is analysing a real example on how the initial contact and implementation design of Agile Project management is carried out on a manufacturing company.

The initiative presented in this section corresponds to the first time Merlo as organization, deal with Agile project management methodologies. The design of the implementation process will be follow up, until before the implementation is applied.

From it, conclusions and suggestion on how the implementation process should be performed will be presented. The outcomes of the case study will also help to analyse some points that may be taken into consideration when performing the implementation.

2.3. Methodology

Employees of Merlo decide to launch the initiative of implementing Agile practices on Merlo's Project Management processes, expecting an improvement on the current traditional waterfall approach.

As different clients have different requirements that may change during a Merlo's project, Agile PM could be useful to improve the capability of Merlo's team to respond to change, be more flexible, adaptable, and use better communication tools, in order to have a healthier and more productive working environment. The company contact Politecnico

di Torino to help with the implementation of a blended Agile Project Management approach.

The initiative is carried out by a cross-functional core team of six employees with different roles and from different business units, and a professor that will perform a consultant role as Agile coach.

The student joined the core team and coach on the design face of the implementation process. The design phase was composed of 4 workshops (1 Kick-off, 2 sessions, and 1 design session), in which the student was not involved in the discussion but gathering information of the activities and capturing the perception of the team for post workshops debriefs.

From each of the sessions, conclusions were collected. They are used to achieve the objective of the thesis of define steps, tools and considerations for performing the design of a blended Agile Project Management implementation.

2.4. Objective

The objective of the implementation is to increase responsiveness to new requirements from client, improve communication with the client and within the team, and increase value perceived by client. The team believes applying Agile practices will allow them to have a grateful and more productive working environment.

The implementation is based on two main Agile methodologies: SCRUM and DSDM. Both methodologies are presented to the core team. The original idea is to take Agile tools from both, and gradually insert them into the project management process the company have currently in place.

The proposal is to start from a complete traditional approach with some Agile tools in place, and then start to escalate the number of Agile tools for different processes or projects depending on the performance after the first implementation. In this way, the risk of impact product quality due to possible failures that may happen during the learning and adoption of blended Agile methodology is mitigated.

2.5. Development of the project

The work with the company was divided in workshops and post monitoring work for helping the implementation of the first Agile PM methodologies that adapts to Merlo's processes. The implementation workshops were carried out in four sessions of four hours and a half each, to a core team of six employees, that have an influential role on the company. All of them were carried out by Politecnico di Torino's professor in charge of the implementation project. The first session was focus on teaching Agile methodologies with a Practical/theoretical approach. Second and third session were focus on involve the team in applied activities, in which they should bring a real case and apply Agile Project Management tools. Fourth session was dedicated to present a success case example from other company, draft the first design for implementation, and agree on the next steps for beginning the implementation.

After the design, it is expected from the company to continue independently with the implementation, with intermittent monitoring from the coach.

2.5.1. Kick-off Workshop: First session

Date: 24/09/2019

2.5.1.1. Objectives

Give a brief introduction to Agile and gather first perception from the core team.

2.5.1.2. Meeting

During this session, the core team experienced a brief introduction to Agile Management and traditional waterfall perspective on PM, and a two hours lecture on two Agile Frameworks: DSDM and Scrum.

It was necessary to understand why core team have the initiative to move from traditional, to Agile approach on project management: they want the process to be more flexible, easier to cope with and more efficient.

A practical example knows as the *Penny Game*, was used to show the difference between traditional and Agile approach to value delivery: The six participants were put in a line (simulating a production line) and were given the task to flip 10 coins, one time each participant. The following parameters would be measure: Time that first coin took to reach the end of the flipping process (i.e. first time the client perceive value), whole

processing time, and individual working time. For the first round, each participant flips the ten coins, and then move to them to next participant, until it reach the end of the line, as it shown in Figure 2,3. This represents waterfall approach.

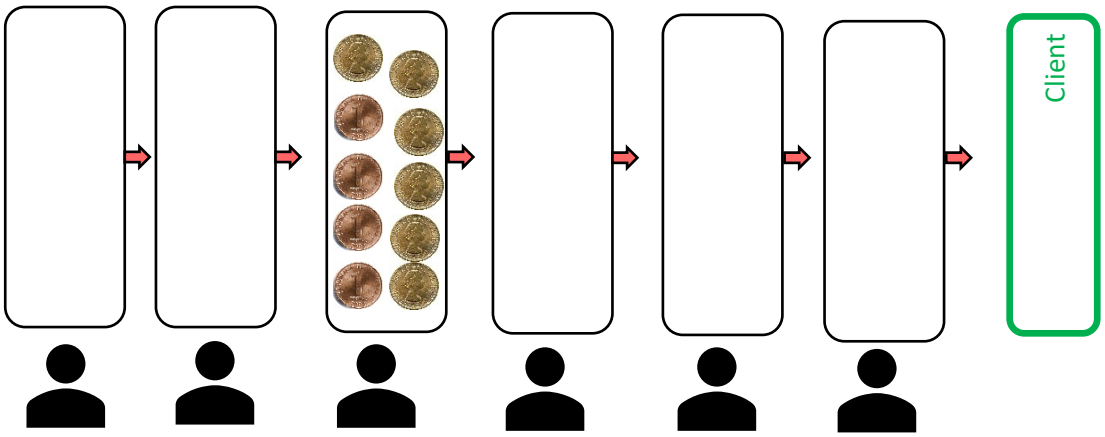


Figure 2.3. *Waterfall approach to PM: Coins example*

On the second round, each participant begins by flipping two coins, and then passing them to the next one, and so on, as it shown in Figure 2.4. This represents Agile approach. After the two processes were completed, the three parameters were compared.

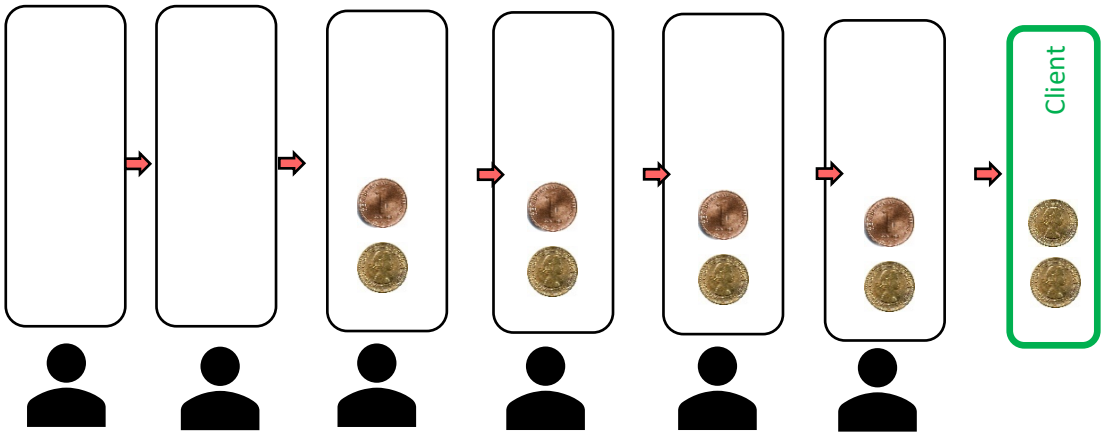


Figure 2.4. *Agile approach to PM: Coins example*

The measures of the time are shown in Table 2.1.

	Waterfall approach (first round)	***Agile approach (second round)***
First time client receive value	54’	**10’**
Average time of work per participant	**9’**	27’
Total time of the process	56’	**47’**

Table 2.1. *Results (times) from Penny Game Workshop 1*

After measuring the times, the practical example made clear that, even though each participant was working more time using an Agile approach to the problem (which can be translated as more time dedicated to the project by each participant), the client receive value sooner, and the total time to finish the work was shorter, using this methodology. With this practical example, participants had the chance to see the value of applying an Agile methodology.

Following the interactive lecture, the team expressed their concern about applicability of the methodologies on the current process of the company. They were worried about three points:

- Timeboxing: Some process of the company for achieving the first addition of value on the product are longer than the maximum duration time of an Agile Timebox: 4 weeks.
- Decrease in quality due to use of a Minimum Viable Product.
- The capacity of the team of being empowered, due to the high decision power that the CEO have.

2.5.1.3. Conclusions

Teams agreed on the value of Agile methodologies; the Penny Game helps them to interiorize and better perceive the idea behind the methodologies that would be implemented in the future.

According to the general first perception, the methodology is attractive, but core team believes it would be difficult to implement it on the company process, mainly because the timing, risks on product quality, and difficulties in terms of leadership it may represent.

2.5.2. Workshop 1: Second session

Date: 03/10/2019

This session was aimed to teach different software that work as project management tools, and allow core team to perform two applied activities, including company's information, applying Agile methodologies on a past project.

2.5.2.1.Objectives

Introduce Project Management Software for waterfall and Agile approach and perform an applied activity of Agile approach on a real product case.

2.5.2.2.Meeting

During the first part of the session, after a quick recap, the coach shows how to use three software for Project Management, one for waterfall approach, and two for Agile approach.

Software's perception

- *Microsoft Project*: It is a waterfall approach software. Results comfortable for the team, even though they see issues while allocating activities and resources. According to them, masterplan needs to be available for all team members and it centralize the planification, which is not possible with this tool.
- *Trello*: Agile software. It was perceived as too simple and difficult to administrate if you want to include 1000 employees into the platform. According to core team, the tool may not allow to organize time and schedules.
- *FreedCamp*: Agile software. Better reception from core team members, due to its allowance to monitor other teams and performance. Issues that appear is how to manage people who work in different teams and to do a cross functional implementation of the software.

2.5.2.3. Applied activity. Determine the requisites

Expected output: Taking as an example a project related to Merlo's Crane model, core team will develop the following documents:

- Product Backlog.
- MoSCoW prioritization.

Procedure

The core team was split into two teams of three people each and were asked to determine what would be the main features that a development project for a Merlo's Crane Model should have.

After approximated 20 minutes of brainstorming, each of the teams came out with several main features, based on team members' experiences. Then they were asked to prioritize them according to MoSCoW prioritization rule, as it is appreciated in Figure 2.5.

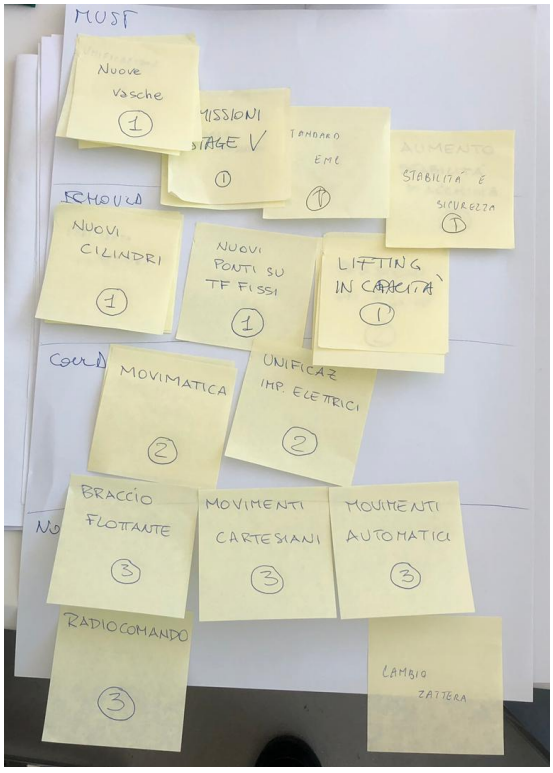


Figure 2.5. *MoSCoW prioritization of Workshop activity*

After the activity, a discussion was performed to understand the general perception of the activity and important points for discussion.

2.5.2.4. Important points for discussion (challenges)

- Proper understanding of Must and Could is blurry. It is important to consider stakeholders' points of view when making the prioritization decision.
- Company do not have a specific budget allocated for R&D.
- Some activities are impossible to split in Sprints smaller than 4 weeks.
- Apply this technique is not possible in some case because we do not know the exact duration of the tasks.
- Use a similar tool after the launch of prototype α.

2.5.2.5. Conclusions

The core team seems comfortable with Microsoft Project, unlike with Trello and FreedCamp. This is due to their routines are based on working with a waterfall approach, rather than performing Agile PM.

With respect to the activity, even though there was a positive feedback from the team, important points of discussion were highlighted, that translate into challenges, when performing the implementation.

2.5.3. Workshop 2: Third session

Date: 10/10/2019

2.5.3.1. Objectives

Core team self-drive the development of ideas on how Agile could be apply on company processes and define next steps as proposals of Agile activities to be implemented in the next months.

2.5.3.2. Meeting

The first hour of the workshop was dedicated to explaining to the team the concept of Portfolio Management and Program Management, on a traditional waterfall approach. It was highlighted the importance of Risk-value in order to the Portfolio planning and later explaining to investors.

This approach sees the company as a joint of projects over a centralize management in order to achieve a corporative objective, this is not particularly what Agile is looking for.

The first idea to approach a self-driven development of new ideas is to begin developing a project using the traditional Waterfall approach and then transform this approach into Agile.

2.5.3.3. Applied Activity 1: Microsoft Project

Using Microsoft Project, it was defined how the development of a new project could be arranged. Trough out the discussion, two options appears:

- Separate the project in terms of program (product)
- Organize the project in terms of parts included on product

The first approach, the team will be committed to one type product, the different parts and process it has on it. In the second approach, the teams are committed to the part that are included in different products.

The main difference between these two approaches that, while the first one is more specific in terms of activities to be performed by the team (following the project flow), the second approach see the development as modules that can be implemented in different products, supressing possible reengineering.

The second option was most likely to be used, due to is easier to implement Agile and less need of reengineering. There are two main issues that appears when selecting this approach:

- How to organize the people who work on a same product and must check out the implementation of different modules. This breaks the actual matrix organization.
- How to manage the development times to arrive with a final solution, it is needed to consider that what is deliver to the client is not a module but a product which, in this case, would correspond to the integration of different modules.

Whit respect to the cost of development, it could be allocated on R&D cost or being distributed among the products which use the feature.

2.5.3.4. Applied Activity 2: Post-it brainstorming

Procedure

Core team were given yellow post-it were they wrote what could be implemented of Agile in the current project management process, and purple ones, where they wrote what could be change on the current project management process (not necessarily related to Agile).

This was a self-driven activity carried out by the team. The outcome can be appreciated in Figure 2.6.

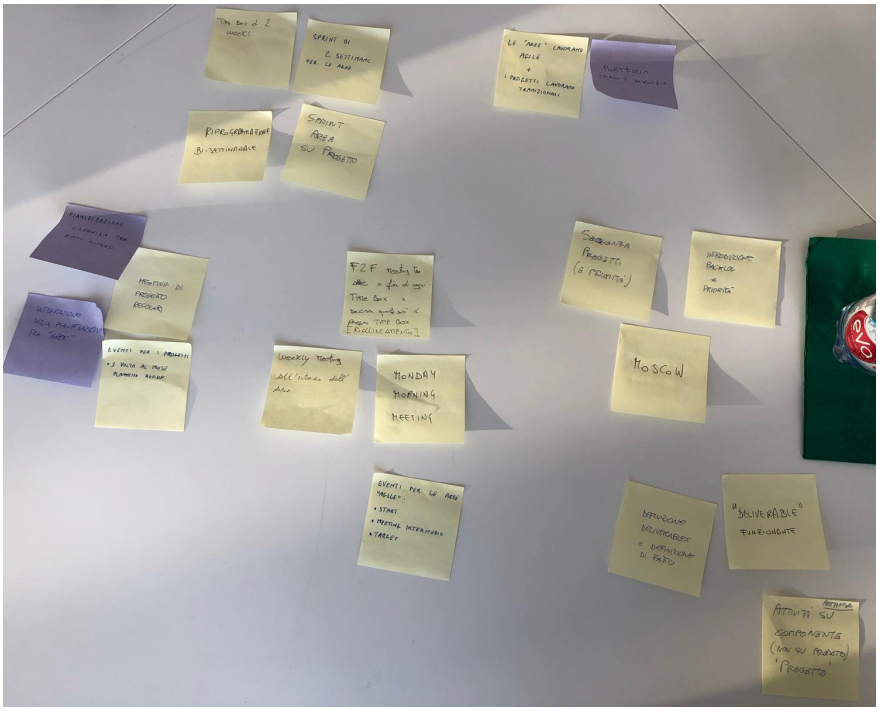


Figure 2.6. *Brainstorming of possible implementations*

After open discussion of the ideas with the coach, proposition for begging the implementation on the next month were established, and can be summarize in the following points:

- Usage of prioritization methods, such as MoSCoW.
- More often and flexible meetings:
    - Face to face daily meetings
    - Weekly meetings
- Planning reviews
- Define what Merlo consider as a "deliverable" and keep this idea in mind for using it on Agile implementation
- Think how to work with an Agile project portfolio

From this ideas, pragmatic proposals for implementation were develop.

2.5.3.5. Proposals for next month

The core team decided that, after the implementation, the following objectives should be achieved:

1. The project would be manage using traditional waterfall approach, with scheduling revisions each month.
    a. Important to define a SCRUM master.
2. In the functional area, such as test, hydraulics, electric, mechanical, design and prototype, program SPRINTs of two weeks.
    a. Include formal meetings between different areas to analyse the SPRINTs
    b. Formalize the SPRINT meetings. It should have initial, intermediate and final reunions.
    c. Us of Kanban board. Software may be useful
3. Use objective technique of prioritization, such as MoSCoW.
4. Define what is understand by "done".
5. Define who do, who approves, who is consulted and who is informed. Insert a RACI Matrix.
6. Define an appropriate WBS for correct management of modularity and incremental development on R&D.
    a. Project with traditional method, and areas with Agile
    b. Portfolio available

The following activities should be carried out by the core team on their business units in order to have a first approach to implementation of Agile Framework.

2.5.4. General conclusion from the three Workshops

The expectations of the members of the core team as is appreciated in Figure 2.7. are in general, optimistic.

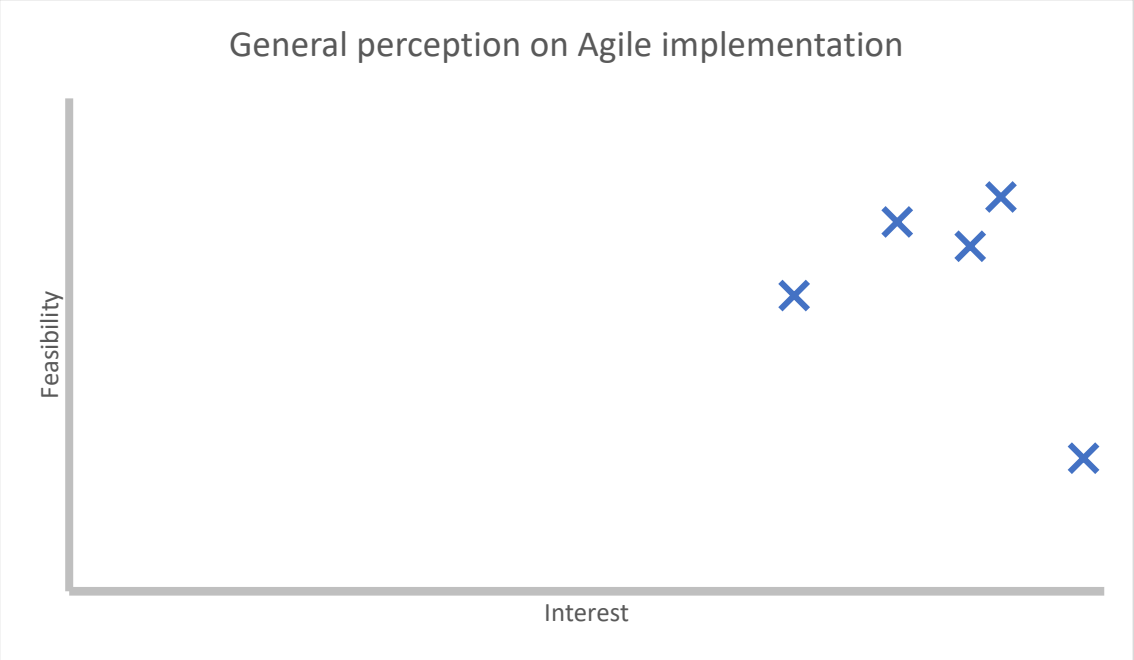


Figure 2.7. *General perception for future implementation by 5 of 6 members of the core team*

Despite the initial general perception after the first workshop, that Agile cannot be implemented, following the third, the ideas of using Agile Project management methodologies seems set down and more feasible than before. According to what was concluded from the workshops, the idea is to include gradually Agile PM.

Also, the core team was asked to evaluate the workshops sessions. The average grade of the Workshops was 9, which means core team value the way in which it has been carried out. Next step would be monitoring the process of implementation.

Practical example of the Penny Game was helpful on the teaching of Agile methodology. Activities based on real information helped the team to bring the theory into company's reality and realize how feasible is to approach a real project.

As it was discussed, the first Agile PM methodologies will be applied on the project development activities of the company, specifically after the development of prototype α. This is more feasible for Timebox reasons, due to the types of deliverable and the time and human effort they took can fit in 2-weeks Sprints according to the core team.

Depending on the results, the methodology could be gradually extrapolated to other areas of the company if the first implementation gives relevant results.

It is important to clarify that Agile and Lean methods are different strategies for approaching a change in a company. In this case, even though Merlo is a manufacturing company, the idea is to implement a change in Project Management, not in Production system, therefore Agile methodologies were chosen instead of Lean process, because company is not looking forward changing their production process.

2.5.5. Workshop 3: Recap and Design session

Date: 17/02/2020

The design of Agile methodology adapting the standard Agile PM framework of Scrum and DSDM was supposed to be done by team members during the month of November. At the end of November, a review and design session was planned, to establish how the beginning of the implementation would be performed.

The meeting was originally set-up to be Nov 29th 2019, but during the period between the last workshop and the meeting until January, the company had a priority project that required the allocation of members of the core team. Therefore, the designed workshop was moved for February 2020.

2.5.5.1. Objectives

Present a success case of Agile implementation in other company and decide the next steps for begin the implementation.

2.5.5.2. Meeting

A guest speaker was invited from *Sumitomo Riko*, a company that manufactures polymer materials for automotive industry. He was part of a past Agile implementation project and expose his experience as a success case on how they move from a silos organisation not committed to cost management, to an organization base on project platform.

His team applied Agile tools over a waterfall approach framework, with interesting results. It took his team approximately three years to finish the implementation project.

After it, a discussion was held between core team members and coach in order to define the next steps for the implementation based on current advance of the project and Merlo's processes.

2.5.5.3. Proposals for implementation

- Define who would be part of the team and roles for each of them.
- Cross-functional formal reviews within 2 weeks.
- Define RACI matrix.
- Define date for next meeting.

To be decided:

- Which project could be used for first approach?
- Which tools should be used for organising the process?

During the discussion, two possibilities were exhibited to launch the first implementation pilot:

- Perform the first implementation on a software development project, including Agile tools and measure the results.
- Include Agile Project management tools in all the current active projects, see how and in which it fits better, and gradually escalate them.

Even though this is a decision that core team should be taken, it is recommended to start with one project, learn from the experience and leverage it after as success case. If it is applied in small scale to all the project, it could be difficult to monitor and keep track of the results, risking to not obtain any outcomes at all.

It is important to highlight that after 3 months, the team's level of engagement was not as high as when the project started, it would be necessary to continue following up the implementation process. For improving this situation, the team should obtain a quick, fast win, on the implementation. It is recommended to apply a simple tool, such as the daily stand-up meeting and 2 weeks reviews, that will show the team quick results base of improvement of communication.

2.5.5.4. Conclusion

The expected advance of the team was belated with respect to what was expected from the planning and the coach. The proposals presented were supposed to be ready before Workshop 3, but due to prioritization of other task, the design is on a late phase. A constant monitoring of the activities performed on the implementation is required in order to make sure that the proposals for the implementation are carried out.

The success case highlights the importance to consider that Agile Project Management on manufacturing companies tend to be slower due to the process in which the company creates value. The case allows the core team to see that it is possible through a gradual implementation with a blended method outcome.

To boost core team's engagement with the implementation, quick wins should be obtain, implementing simple tools in one or more projects.

2.6. Discussion

The case study evidence a significant consideration when implementing Agile project management tools on a manufacturing company. The processes that add value to the product on this type of industries tends to be rigid, therefore is relevant to develop a blended Agile Project Management approach that includes waterfall approach and Agile tools. Perform the implementation over the current waterfall project management process is helpful, it allows the team to better fit Agile and then escalated it through gradual evolution, rather than force a new method from scratch that will break the previous methodologies currently in place.

Due to the rigidity on the process of a manufacturing company, required to deliver value according to the quality that client expect, the suggestion is to begin using simple Agile practices and gradually escalate them. This entail that the implementation of Agile methodologies results slower on manufacturing company.

The activities to introduce Agile are useful, but the proper advance and design considerable depends on the momentum of the core team. Daily responsibilities may deviate the attention from the implementation project; therefore, it is recommended to assign a resource focus on constant monitoring and making sure the times are respected. The engagement level of the team was lower after the one-month gap between third and fourth workshop, coach or other agent should have the responsibility to keep team's momentum high and not let other projects anchylose the implementation.

One of the key value points of the design of the implementation lies on the fact that is internally developed; core team knows the process better than any external agent. Furthermore, designing own method should generate more engagement during the implementation process than try to apply a pre-design external procedure (Lacey, 2007). Even though the design could be moderated from outside, it should be designed by the team internally.

Use a core team had proven to be useful in order to have the perspectives from different business units at the moment of the design. It is relevant to use a tool that allows to share information when implementing Agile Project Management. An Agile software will help be helpful, but it is needed to take into consideration that there may be resistance to use it because of natural routine of the team to work on a waterfall approach.

Finally, an important point to be discuss is the importance of communication between core team members. One of the shortcomings that can be appreciated on this case is that the core team did not discuss on the project on a regular basis. Boost discussion helps to keep the momentum and powered new ideas.

3. Student Survey: Project Management Course at Politecnico di Torino

A key element on Agile project Management implementation on a company is the learning process of the methodologies. Despite Chow & Cao survey study on critical success factors do not consider the learning process as a relevant element for being studied (2008), another statistical study, performed by Chandra, Kumar, & Kumar on an Agile methodologies showed that one of the factors that leads to success on an Agile implementation is teaching and learning (2009). Furthermore, a systematic mapping on available literature on Agile framework implementation performed by Jovanovič, Mesquida, Mas, & Colomo-Palacios, presents the situational factors ranked according to their impact on implementation process, in which Training appear on place 4, Domain knowledge, 8, and Previous knowledge, 11 (2020); in total they represent 17,6% weight on the total value of rate factor used to measure importance.

Considering the relevance of the learning process on Agile implementation, it is of interest to understand which could be a reliable approach to deliver the first knowledge on Agile methodologies to employees when performing a framework implementation. As it was discussed, a useful track is to begin with a core team with colleagues from different units, that can later on spread the methodology on the organization by application of small pilot projects, than can later on be escalated.

For getting deepen knowledge on this topic, an anonymous survey will be conducted on 40 students of the second year of Master of Science in Engineering and Management at Politecnico di Torino. These students come from different nationalities, and are following the course of Project Management, where one of the topics included in the syllabus is Agile Project Management. The selected group have never worked using Agile methodologies, and 50% have heard or read about Agile before the beginning of the course. During the progress of it, students will be exposed to six hours of lectures related to Agile Project Management and a practical example (*Penny Game* used in Merlo).

The syllabus also brings in a project management simulation on planning the building of a breach, using waterfall approach. This activity included weekly feedback sessions with the assistant of the course, similar to weekly agile stand-up sessions of 15 minutes approximately. The selected students for the survey are not in the same groups for this

project, they will be working with peers that will not be part of the study, and they are expected to experience the concept of SPRINTS during the feedback sessions.

The survey will be of longitudinal character. General concepts about Agile methodologies and the manifesto behind it, will be asked before and after they go through the agile part of the Project Management course, measuring also their interest on the topic.

3.1. Methodology

For reaching out the students aleatorily, the survey was first released on the third week of October to the whole population of the Project Management class through Politecnico di Torino students' portal, including a brief explanation on what was the objective of the activity. It was develop using Google's tool for surveys and was voluntary. The first 40 students that replied it were selected as participants; their student's codes were obtained to keep track of them, but it is not included in the answers and analysis. A first analysis of the data was then performed.

On late December of the same year, after they went through the learning process, the second survey was delivered to the population of 40 students.

Both surveys included two type of questions: first, the ones focus on understanding the current situation of the student and his/her opinion on the learning process; second, questions with expected answers taken from literature, related to Agile definitions.

The first survey, available in Appendix A, was designed based on Agile manifesto and basic concept on Agile methodologies, aiming to measure acknowledgment and perception of Agile PM. They were asked to determine what would be more relevant for a business based on the Agile manifesto statement, states which factors are variable on planning of a project, and finally evaluate some assumptions about Agile. The expected outcome was a first picture of the current situation of students on Agile.

The second survey, available on Appendix B, was delivered to the selected 40 students after they went to the learning process of Agile methodologies. It includes the same question on Agile manifesto and methodologies presented on the first survey, plus questions related to the perception of the learning process. The expected outcome is an image of the impact that this learning methodology have had on students' understanding of Agile methodology, and their perception of the learning process.

3.2. Questions and Expected answers according to literature

What do you think is more relevant for a Business? (Left blocks mean you think left option is highly more relevant than right one; Right blocks means you think right option is highly more relevant than left one).

In this question, participants were asked to decide what should be consider as more relevant for a Business regarding their performance of activities. The followings are the answers that are in line with Agile manifesto, shown inf Figure 3.1.

Process and Tools						Individuals and Interactions
Working product						Comprehensive documentation
Customer collaboration						Negotiation of a proper contract
Follow a plan						Respond to change

Figure 3.1. *Question relevance for business Agile Questionary expected answers*

From Agile Project Management perspective, which of the following elements could be variable when planning a project?

Students were given a multiple-choice question with the four possible general variables defined for Project Management: Time, Cost, Quality of the product, and Features of the product (Agile Business Consortium Limited, 2014), then it was analyze which mixture of elements were more chosen by students.

According to literature, Feature of the product should be variable when planning a project using Agile framework, the rest of the elements (Cost, Time and Quality) should be agreed beforehand (Atlassian®, 2019).

Evaluate the following assumptions about Agile Project Management

Basic characteristics of Agile approach took from literature (Project Management Institute, 2019) were embodied in the assumptions shown in Figure 3.2. in order to be evaluated by the students that will be part of the survey.

	Assumption	Answer	Explanation
I	Is a software	Incorrect	It is an approach to Project Management.
II	Is only use for software development	Incorrect	Is adapted for other industries.
III	Is a methodology	Incorrect	It is an approach to PM that have different methodologies.
IV	Uses evolutionary, incremental, and iterative delivery	Correct	
V	Helps organisations to be more adaptive, creative and resilient	Correct	
VI	Is normally use by big companies	Incorrect	Use in companies from different sizes.
VII	Have a strong and authoritarian sense of leadership	Incorrect	Empowering leadership.
VIII	Cost and Time are fixed on an Agile project	Correct	
IX	Helps organizations to respond to change	Correct	
X	Needs to carry out extensive documentation	Incorrect	Reduce the amount of documentation.

Figure 3.2. *Question evaluating following assumptions Agile Questionary expected answers*

After the realize of the first survey, it was determined that Point V was not specific enough for a clear comprehension from students. Point VI is not relevant for the scope of the study, as is focus on company's behavior rather than Agile Project Management itself. Therefore, for the second survey, they were not included. In the second survey there were also included questions about the learning journey, that are address further ahead on this section.

3.3. Results

According to literature, the shortest period of effective learning transformation from traditional waterfall approach to Agile on Project Management, take at least 12 months (Gandomani, Zulzalil, Ghani, Sultan, & Parizi, 2015) on teams of employees. Despite the study was carried out on teams of workers that have tried to apply Agile methodologies over a previous working background, and not on students, it was expected that the surveyed population do not gain many acknowledgments about Agile PM when going through this learning process. It is also expected, according to literature, that university students perceive agile methods improves team productivity (Dyba & Dingsoyr, 2009).

3.3.1. Survey I & II: Comparative results

The results from Survey I and Survey II is presented together, as the aim of the study is to have a clear view of the change experienced in the knowledge of the students.

With respect to Agile manifesto,

Survey I: Initial Questionnaire

- 33% give more importance to Individual and Interactions than process and tools, while 35% consider the two points they are equally relevant from a business perspective.
- 60% believes that working product is more relevant than comprehensive documentation for a business.
- 60% believes that customers collaboration is more relevant that negotiation of a proper contract.
- 68% responding to change is more important than following a plan.

Survey II: Progress Questionnaire

- 45% give more importance to Individual and Interactions than process and tools and, while 40% consider they are equally relevant.
- 68% believes that working product is more relevant than comprehensive documentation for a business.
- 65% believes that customers collaboration is more relevant that negotiation of a proper contract
- 75% responding to change is more important than following a plan, the rest believe they are equally important.

After the learning process, 9 students were able to prioritize the four points on the first question according to the Agile manifesto (22.5%), from which 8 classify their learning as *Good Enough*, and the other classify himself as *I was not able to properly learn them*.

In Figure 3.3. and 3.4 it is portrayed the elements that students perceived as variable when performing Project Management from an Agile perspective on Survey I and Survey II, respectively.

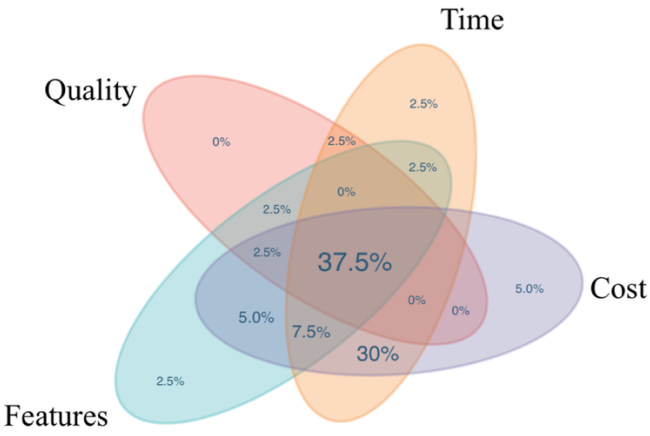


Figure 3.3. *S.I: From an Agile perspective "Which of the following elements could be variable when planning a project?"*

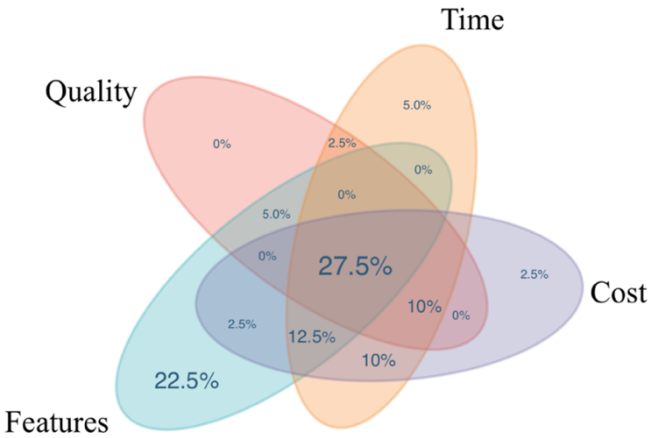


Figure 3.4 *S.II: From an Agile perspective "Which of the following elements could be variable when planning a project?"*

Survey I

- 37.5% of the students believes that all this Project Management elements could be variable.
- A considerable 30%, believes time and cost could be variable, the other mixes of variables have lower percentage and in total corresponds to 32.5% of the population. 2,5% considers only Features should be variable.
- 57,5% include Features as a variable element. 88% believes Cost should be a variable element and 68% consider Time as a variable element.

Survey II

- 27.5% of the students believes that all of the elements could be variable when performing Project Management.
- A considerable 22.5%, believes only features could be variable (this is what Agile methodologies states). 12.5% believes time, cost and features could be variable, and 10% believes Quality, Cost and Time could be variable.
- 68% of the population consider Features of the product as a variable element, also 68% believes time is a variable element, and 65% consider Cost as a variable element.
- From the 22.5% that answered to what Agile methodologies states (pointing that the variable should be just Features), 7 classify their learning as *Good Enough*, and 2 classify it as *Not enough.* The 68% that consider feature as variable, 11 classify their learning as *Good Enough*, and 7 as *Not Enough.*

It can be appreciated that there was an improvement in Agile basic concepts understanding, with students choosing Features as variable when performing project management.

From the 9 students that replied Features was the only variable when performing Agile Project Management, 7 selected *Practical examples* as the most useful learning method, one the *Group Project*, and one the *Lectures.*

The answers for evaluating the assumptions from Survey I and II are presented in Figure 3.5 and 3.6, respectively. In Table 3.1. the legend for both graphs is presented.

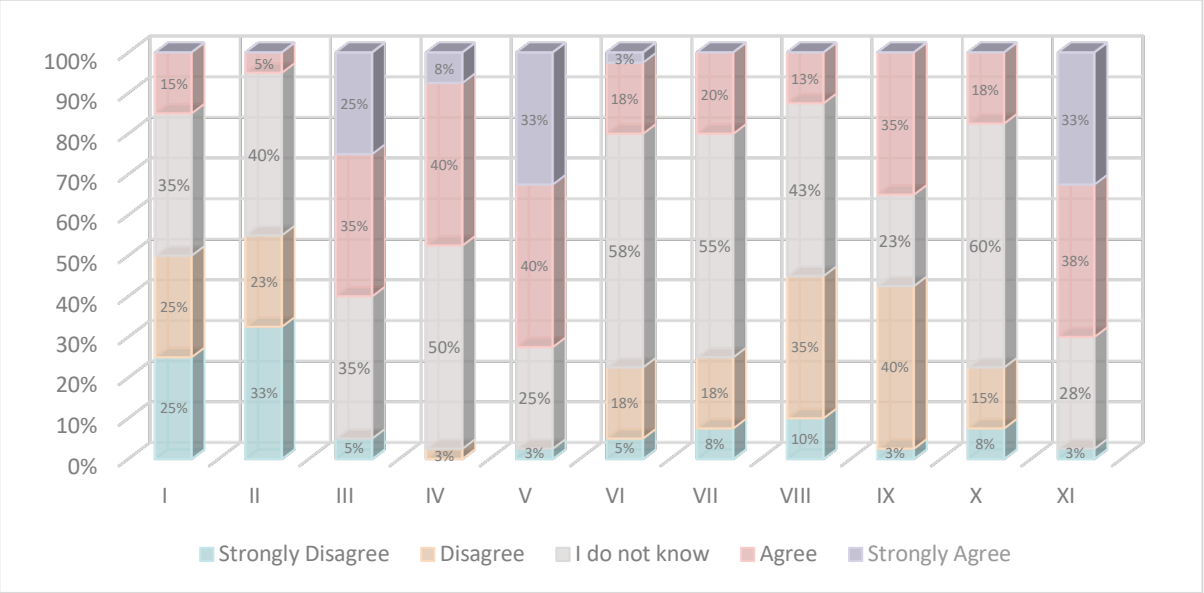


Figure 3.5. *S.I: "Evaluate the following assumptions about Agile Project Management"*

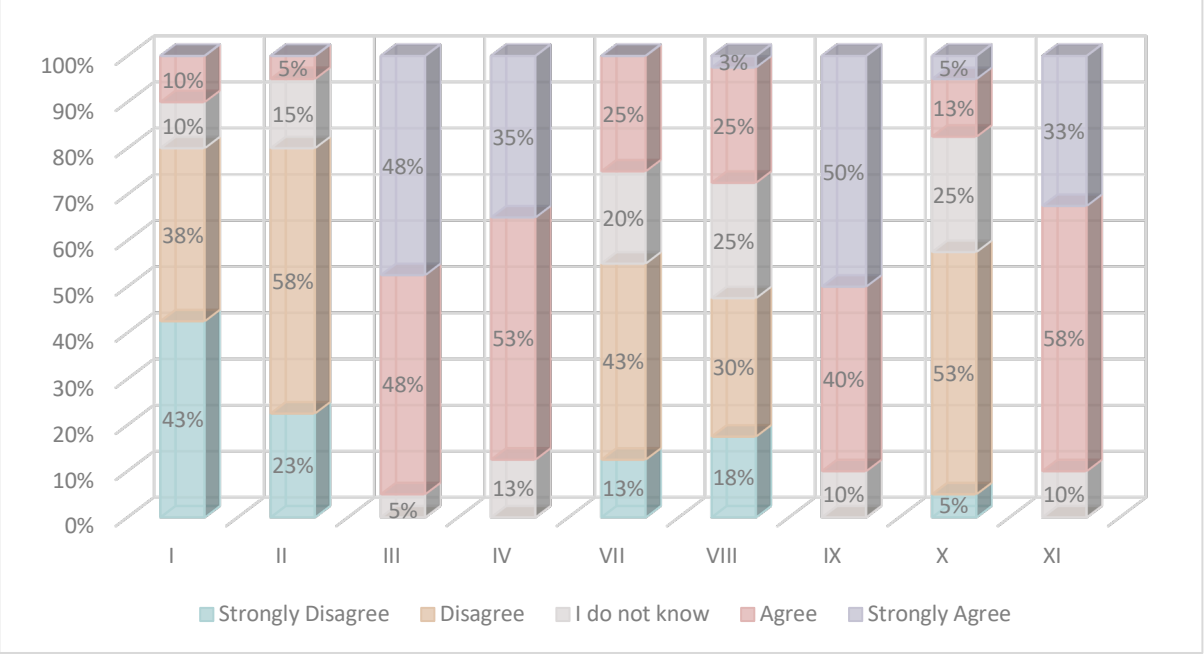


Figure 3.6. *S.II: "Evaluate the following assumptions about Agile Project Management"*

ID	*Assumptions*
I	Is a software
II	Is only use for software development
III	Is a methodology
IV	Uses evolutionary, incremental, and iterative delivery
V	Helps organisations to be more adaptive, creative and resilient
VI	Is normally use by big companies
VII	Have a strong and authoritarian sense of leadership
VIII	Cost and Time are fixed on an Agile project
IX	Helps organizations to respond to change
X	Needs to carry out extensive documentation
XI	I think is useful

Table 3.1.*: Legend for S.I and S.II: "Evaluate the following assumptions about Agile Project Management"*

Survey I

From first sight, high percentage of the population do not have knowledge about Agile Project Management assumptions.

50% have a no clear concept if Agile corresponds to a Software (I). 60% agrees that corresponds to a methodology (III).

56% Strongly disagree or disagree that Agile can only be use on software development (II).

48% Agree or strongly agree with the idea that Agile is base on incremental deliverables. (IV)

Despite 73% understand that helps organization to be more adaptive, creative and resilient (V), only 35% think it helps the organization to respond to change (IX). Majority of the population do not have a clear idea of which type of leadership is required (VII) by Agile and that it could be use by any type of company (VI), neither if this methodology requires an extensive documentation (X).

71% think beforehand that is something useful. High percentage of the population have not a solid comprehension of Agile methodologies (XI), the ideas behind the manifesto and some basic assumptions.

It is necessary to highlight that in all the aspect asked, a considerable number of respondents do not have clue of the answer.

Survey II

High percentage of the population understand that Agile is not a software (I), and it is not only use in software development (III).

Students consider it corresponds to a methodology (which is not the proper definition of Agile) that uses evolutionary, incremental and iterative delivery (V), and helps organization to respond to change (IX).

Less than 40% thinks Cost and Time are fixed on Agile PM (VIII). More than 50% disagree that Agile have a strong authoritarian leadership (VII). The majority of the students think is useful (XI).

There is evidently more clarity on basic concepts on Agile.

Survey II also includes questions related to the perception of the learning methodology used, which results are presented below.

3.3.2. Survey II: Progress Questionnaire specific questions

After the students have gone through the learning process, it was relevant to understand their perceptions on it. Figure 3.7 presents the questions and respective results shown graphically.

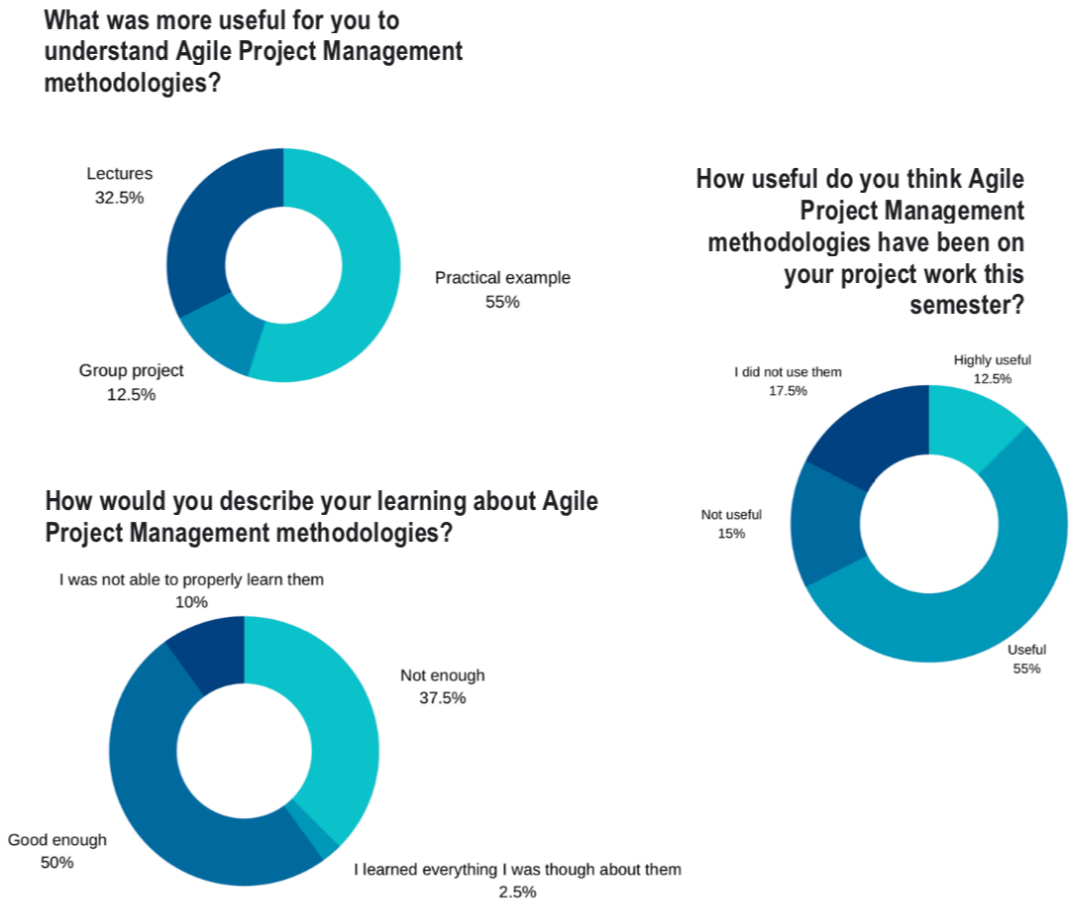


Figure 3.7. *S.II*: *Students perception on the learning approach*

It is appreciated that the *Practical example* presented during the lecture on Agile Project Management was considered to be more helpful than the other two learning methods when introducing the methodologies, then the lectures and finally the group project. For this one, 68% consider it *Useful* or *Highly useful*, even though there is a considerable percentage of students that do not used the methodologies for the development of the project.

68% considers that the methodologies were, at some level, useful for the project this semester. Meanwhile, 48% of the population consider their learning on Agile as insufficient.

It is of considerable interest to cross some of the answers of the second questionnaire, in order to have a clearer understanding of the outcome of the learning process.

On Figure 3.8. it can be appreciated that the 12.5% considering *Project Group* as the most useful between the tools to understand the methodologies, were only students that also consider Agile *Useful* or *Highly useful* on the course project work.

Practical example appears as the favourite learning tool for understanding the methodology, specially between people that find Agile *Useful* during the Project Management project.

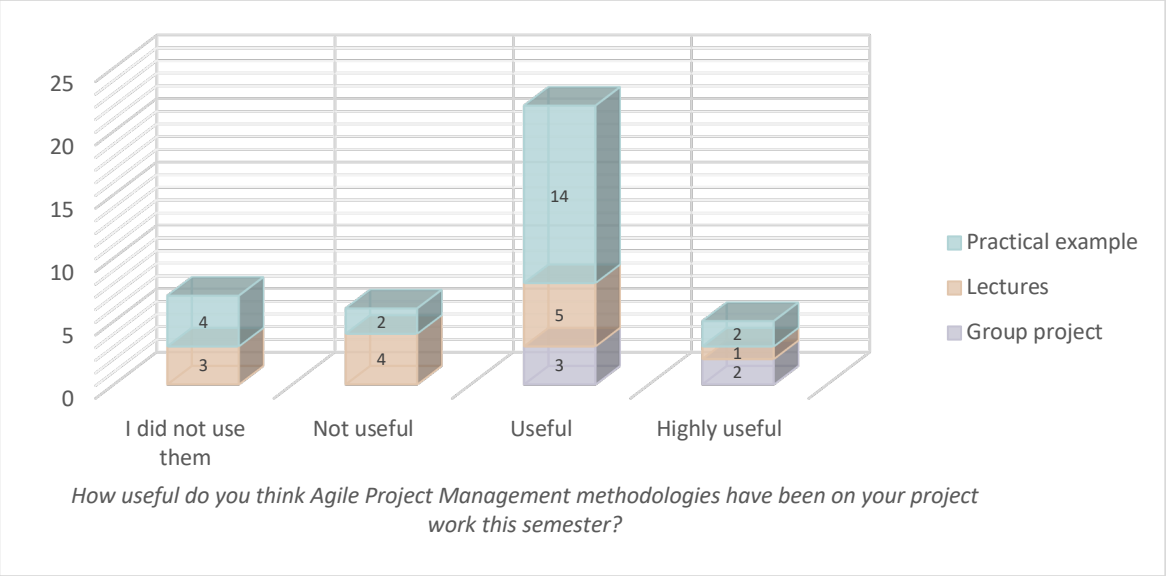


Figure 3.8. *S.II: How useful was Agile on the simulation project? Clustered by: What was more useful for you to understand Agile Project Management methodologies?*

As it is shown in graph Figure 3.9., half of the students that describe the use of Agile on the project as *Usefu*l or *Highly useful* on the simulation project, consider they have enough understanding of the Agile methodologies. Students that consider Agile PM methodologies as *Highly usefu*l on their project work, had a proper leaning process of the methodology (*Good enough* or *I learned everything I was tough about them*).

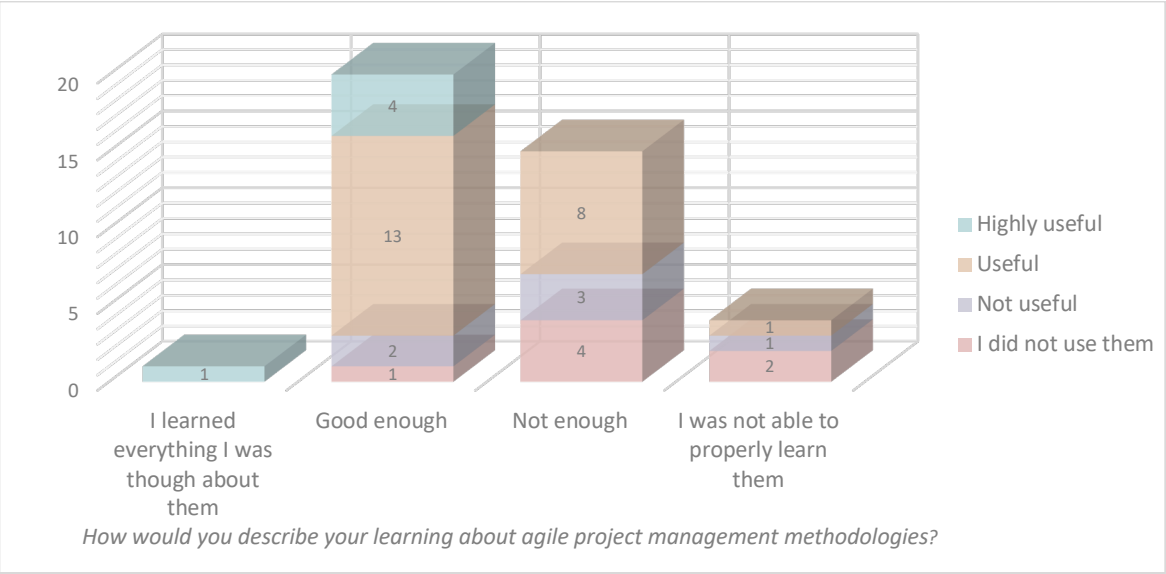


Figure 3.9. *S.II: How would you describe your learning about Agile Project Management methodologies? Clustered by: How useful was Agile on the simulation project?*

Practical example has been proved as the preferred way for interviewed students to get introduce to the methodology, it is the main method across the three perceptions on the learning journey as it can be appreciated on the Figure 3.10.

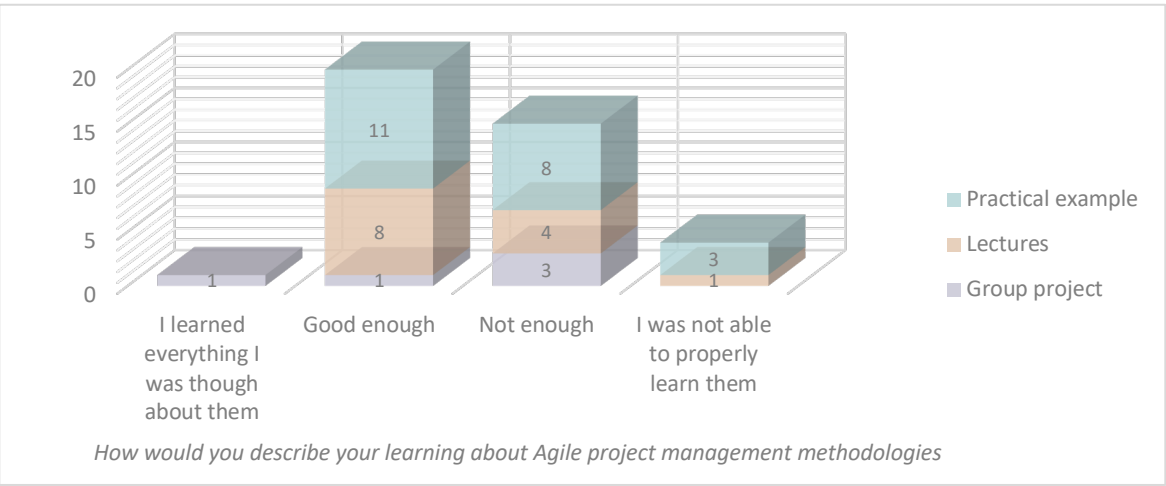


Figure 3.10.. *S.II: How would you describe your learning about Agile Project Management methodologies? Clustered by: How useful was Agile on the simulation project?*

Finally, 90% of the students are interested in deepening knowledge about Agile PM.

3.4. Discussion

In general terms, it can be concluded that the learning methodology of six-hour lectures, a practical example and a simulation of a traditional project planning activity with feedback sessions was effective within its limits. It allows the students to have a proper first understanding on Agile methodologies, with some misconceptions and a divided perception on the effectiveness of the learning process.

A considerable improvement in the understanding of the Agile manifesto is exhibit, as well as what are the elements that should be variable when performing Agile project management. A misconception that shows to get stronger with the learning process is the idea that Agile is a methodology, and not a set of values that derives in different frameworks; this is a point that should be re-clarified when performing Agile implementations.

It is also appreciated that understand of Agile is superficial, only getting a broad vision of the concepts, but lacking some specific knowledge. In particular, it should be clarified in the group the expected behaviour of an Agile leader and that there is not a mandatory need to carry out extensive documentation.

Only one student consider he/she was able to learn everything was though about Agile, even though he replies the assumption question properly (mistaken only in Q.III) and reply correctly 3 out of 4 of the prioritization questions related to Agile Manifesto (he/she decides that Time and Cost should be variable).

The technique that seems more useful to understand the Agile PM methodologies is the practical example. After the positive perception from students and from the core team of the workshops carried out in Merlo, it can be concluded that the *Penny Game* is highly useful for giving a first insight on Agile, as allows a group to experience and contrast traditional and agile approach. It is relevant to include a practical example that allows people to experience on a simpler and shorter way the benefits of Agile Project Management.

Further improvement is needed on making students aware of basic concept on the methodologies. The inclusion of a more practical example will be good. The Agile usage on the project shows to not be relevant for learning. Improve its usage and focus the project on Agile methodologies instead of waterfall will present a further improvement.

An improvement in the follow up of the application of the Agile framework on the group project could increase the awareness of the methodology, such as using an Agile software and document the processes that the project is carrying on.

The confidence on the learning of Agile is divided. Approximately half of the interviewed students feel that they learned enough about agile, the other half don't. Even though the results are not perfect, it is shown a relevant improvement of the understanding of students on the methodology, it is in line to the expectations based on literature. Therefore, it is concluded that this technique could be useful to give a first approach on show people how Agile project management should be perform.

4.Design of implementation of Agile Project Management methods for a manufacturing company

The design of implementation method could vary depending on the company, its situation, and the resources it has available. There is not a perfect recipe for properly implementing an Agile Project Management methodology. What is proposed in this work is based on the case study, literature review and the survey delivered to students.

The implementation project, as it was the case on the Case Study example, is performed by a cross-functional core team that is expected to take the developed framework to their respective business units. The cross-team should be formed by employees who in some way performed project management activities and have a clear understanding of the internal processes of the company. As the implementation is design for a manufacturing company, they need to have a clear view of what is their units' role in the value chain, and the rest of the steps that occurs from the raw material arrival to the finished product arrive to the customer. It would ideal if some of the core team member is in direct contact with client and can bring some insights from a customer perspective. The team should be selected by the people who start the initiative, ideally from own initiative. This approach does not necessarily ensure success of the implementation (Najafi & Toyoshiba, 2008).

An important figure to be included in the implementation is the coach. His role is to deliver the first exposure to Agile Project Management methodologies, help the core team to develop their own practices and monitor the implementation process trough constant feedback.

Another important consideration that needs to be address is that, in contrast with software development related companies, in manufacturing companies the processes used to create the product and constantly add value for the customer are mostly performed on a structured working flow, usually composed by machines. Making reference to the Agile Competence Pyramid, this implies that engineering practices are assumed as a base, that may not be challenge during the implementation. Despite this makes the implementation design process "less complex", it does not give much flexibility to perform changes, and limits them to aspects related to the management of the process, rather than the way in which manufacturing process is perform.

Despite the design is based on the Case Study in Merlo, this not necessarily implies that for all manufacturing companies there is a current need of bringing an external coach figure to drive the implementation, it could be a company employee with the adequate preparation on Agile Project Management. Even though, it is important to make an appropriate selection of a coach that have enough knowledge and experience to assets the team on Agile methodologies (Fraser, et al., 2009). The coach role is not part the Agile framework (like it is Scrum master, Team Leader, etc.), but is rather teaching the team, and helping them to understand what the steps are to be follow

Based on the study case and literature research (van Solingen, 2020), the design of the implementation process was divided in three steps:

1. Exposure and comprehension of Agile methodologies: It comprises from the first contact that the core team will have with Agile Project Management methodologies to the initiation for discussions on the design.
2. Analysis of current Project Management process and best fit for implementation: It comprises the study of the company project processes.
3. Design of blended Agile Project Management method: It comprises from the first decisions on the design, to the start of the implementation.

4.1. Exposure and comprehension of Agile methodologies.

The first step to implement Agile methodologies is having all the people in the "same page" (Bohem & Turner, 2003) in terms of understanding of what Agile is, what are the frameworks and tools that could be use. This is especially relevant considering that the methodology will be internally developed, tailor made for the company. Team needs to have a clear view of, at least, the basics of Agile, so they can have a better understanding from where the implementation could be started and have and adequate performance on the design face.

The coach is in charge of instruct the team and keep track of their learning, plus make sure the implementation is done on the right track, properly following Agile principles.

Training is an essential catalyst in moving from traditional to Agile approach on Project Management (Gandomani, Zulzalil, Ghani, Sultan, & Parizi, 2015). This should be performed in meeting or workshops, which may include Interactive lectures and Agile simulation activities.

There are some Agile skills related to the day-to-day tool usage of the process that can be thought trough lectures and can be learn by individuals at their own pace. Meanwhile, to teach management competences related to Agile, employees also needs to go through team experiences. Agile values require a change in attitude from the learner, therefore it took time and "try and error" experiences to fully assimilate them (Kropp & Meier, 2013).

Teaching students is not the same as teaching graduates with professional experience. For addressing this, Devedezić and Milenković (2011) recommends including real-life examples from work (e.g. processes in which it could be applied, situation in which often meetings are associated with success). It is also useful to bring real data from projects for performing simulation activities with it. Any students of Agile should learn the methodologies before applying them to a simulation activity, otherwise the activity may cause confusion (Rico & Sayani, 2009), following this logic, it is relevant to first explain trough lectures and then perform simulation activities.

4.1.1. Interactive lectures

Interactive lectures are a good tool for expose the team to Agile methodologies. It shows to have a positive impact in knowledge acquisition, both in the Case Study and the Project Management lectures, of people first encountering Agile methodologies.

Considering that the objective is to give exposure to the core team on Agile, the topics that need to be address on the interactive lectures are:

- Explanation of Agile core values and principles.
- Contrast traditional waterfall approach with Agile approach.
- Present Agile frameworks that the coach believes may fits company's situation.
- Present Project Management Agile tools that could be helpful for the implementation.

In this case, interactive lectures are the ones in which students are actively involve on the learning process, trough storytelling, share of own experiences, dynamics, simulation activities, discussion, or any other tool that the lecturer may find useful, and goes beyond traditional way, in which the lecturer limits itself to explain a topic on a one way communication.

The lectures should be interactive, as it is widely documented that it increase the engagement, which have a higher impact on students' learning process (Rambocas & Sastry, 2017), this have shift the learning process form a teacher, to a learner centre approach.

When teaching management skills particularly to a team, it is relevant to consider the educational background of it. A study carried out in 2017 by Rambocas & Sastry have shown that when engineers encounter management lectures it not necessarily appreciated, being interactive lectures a proper way for keeping engineers' attention. It also highlighted by the same study that some of the issues that may appear with interactive lecturing are "personal intimidation, boredom, fear of public speaking and isolation" (Rambocas & Sastry, 2017).

As it was clarified previously, before performing simulation activities the basic concepts needs to be clear, therefore the design of the lecture for giving the first contact to the core team with Agile methodologies should be organized with a structure similar to the following:

1. Presentation on Agile core values and principles
2. Discussion/shared experience activity and clarification of concepts
3. Presentation on contrast between traditional and agile approach
4. Discussion and clarification
5. Presentation of one or more Agile frameworks
6. Simulation activity
7. Discussion on simulation activity
8. Presentation of Agile software tools
9. Jointly usage of the tools
10. Debrief and measure of general perception

This is process is based on the followed on the study case, which gives effective results. Based also on the results of the survey to the students, it was highlighted the need of include some simulation activities to complement the lectures.

4.1.2. Agile simulation activities

The best way to teach Agile methodologies is trough practical work (Berbegal-Mirabent & Gil-Doménech, 2017). From the survey performed to students, and as it was shown on the case study, it is concluded the relevance that practical example has on giving a first approach to Agile PM techniques, and comparing them with the traditional approach. Any practical example (such as the coin activity) can be performed, and it helps the team to have a clear and fast appreciation of the contrast between both approaches, and what Agile is aiming to achieve. There are several serious games that Agile coaches use, that have been proven to be effective in the acquisition of capabilities (Johann, Offerman, de Mooij, & Sidhu, 2018).

4.1.2.1. The Penny Game

- Objective: Contrast waterfall and Agile approach
- Time: 10 mins
- Participants: 4+, coach and assistant.

The Penny Game is a well-spread Agile teaching tool used by coaches, with some variations available. The presented example is a short variation from the original version proposed by Geoff Watts. This activity was experience during the development of the Case Study at Merlo. The application of this activity can be found in section 3 of this work.

The main objective of this activity is to show the contrast between waterfall approach to Project Management and Agile. A group of six people (could be a different number) are align in one line, each of them flip 10 coins with one two hands as fast as they can, and then move to next participant, simulating a working flow process. A coach and another person are in charge of taking the following times during the performance: time that each person take to flip the ten coins, time when the first coin arrive at the end of the chain, and time of the whole process.

On the first round, each participant is asked to split the ten coins, and then move the ten coins to the next participant, and so on, until they reach the end of the line, as it is shown on Figure 4.1. This is equivalent to waterfall approach to project

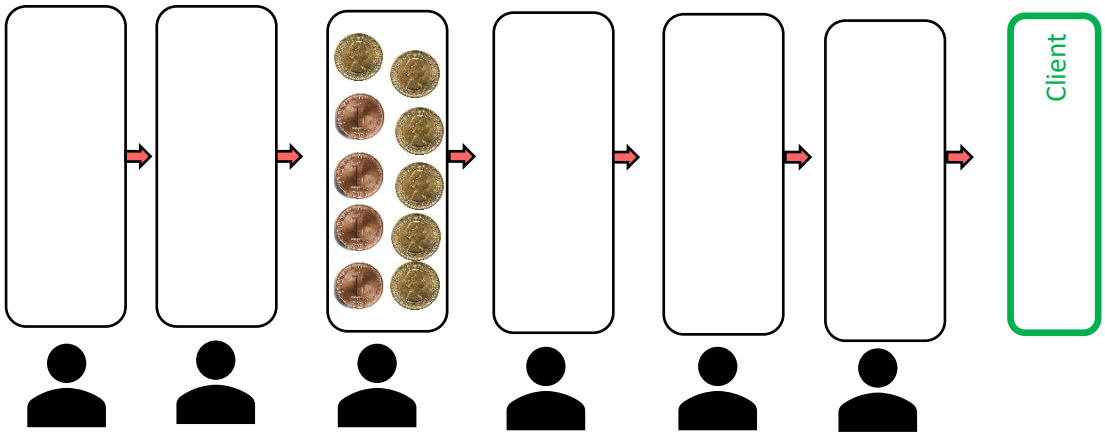


Figure 4.1. *Waterfall approach to PM: Coins example*

On the second round, each participant begins by flipping two coins, and then passing them to the next one, and so on, as it can be appreciated in Figure 4.2. this represents Agile approach.

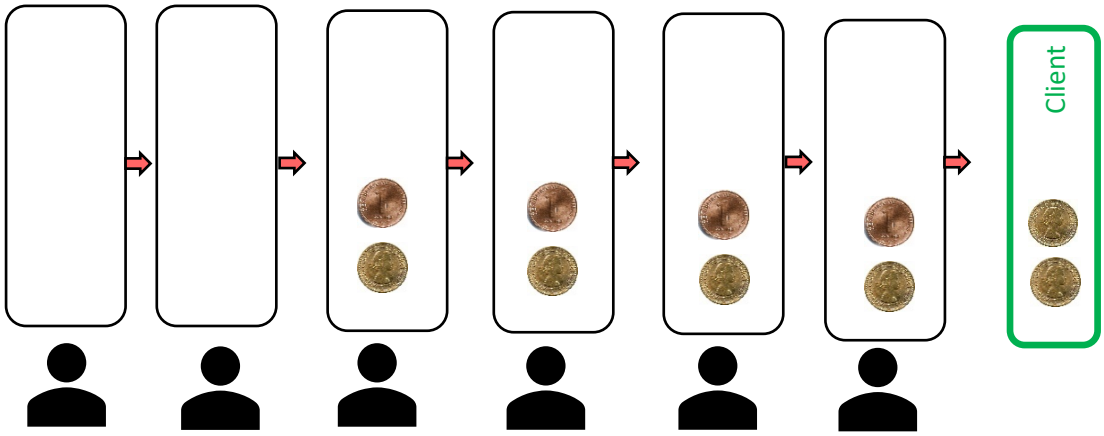


Figure 4.2. *Agile approach to PM: Coins example*

After the two processes were completed, the three parameters times are compared. The expected outcome is that, even though the time that each participant takes to finish to flips his coins (the task he is assign) the total time of the process each shorter, and the amount of time that the first coin takes to arrive to the end of the process(which represents the client), is shorter.

The activity will take up to 10 minutes and it is a fast way to contrast both approaches, that have been shown to be effective both in study case, and in the survey to Politecnico di Torino students.

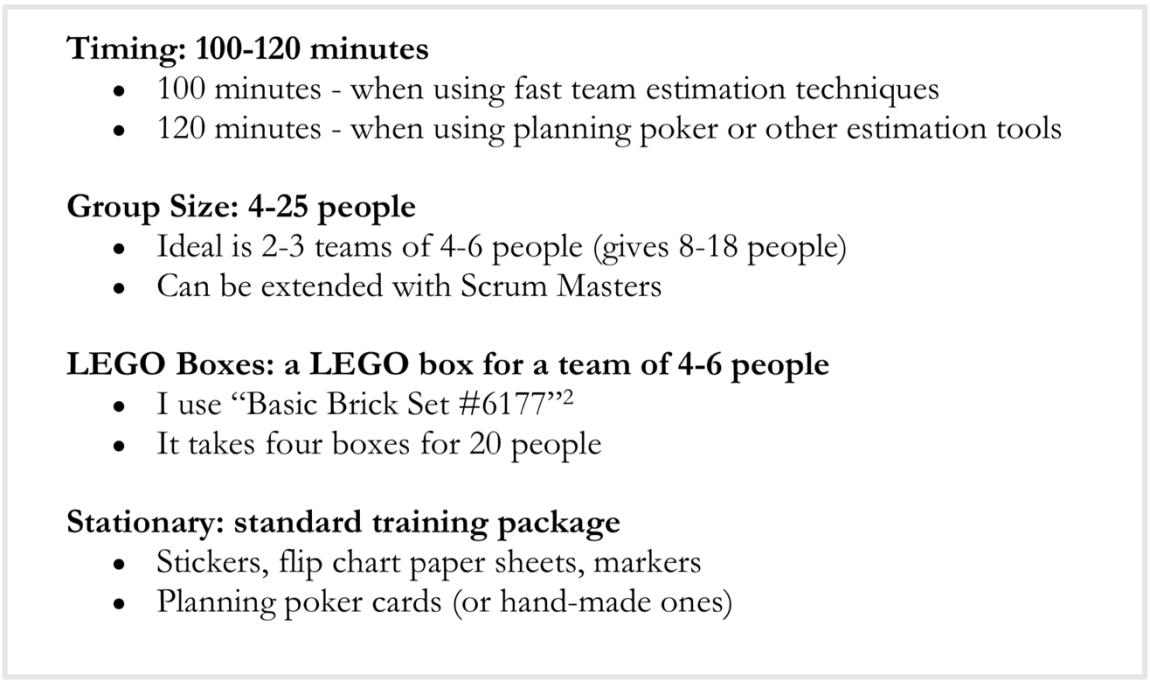
4.1.2.2. LEGO for teaching Scrum

- Objective: Understanding of agile process and SCRUM Agile framework
- Time: 100-120 mins
- Participants: 4-25 people, coach.

The LEGO activity developed by Alex Krivitsky have proven to be an effective way to explain Agile concepts, particularly Scrum methodology, and it is consider as a rigours game methods published in research literature (Paasivaara, Heikkilä, Lasseius, & Toivola, 2014) .

The explanation of the game given by Alexey Krivitsky on the guide states as follows.

The game can be adapted to different needs, in Figure 4.3. the standard duration, group size and materials can be appreciated.



Timing: 100-120 minutes

- 100 minutes - when using fast team estimation techniques
- 120 minutes - when using planning poker or other estimation tools

Group Size: 4-25 people

- Ideal is 2-3 teams of 4-6 people (gives 8-18 people)
- Can be extended with Scrum Masters

LEGO Boxes: a LEGO box for a team of 4-6 people

- I use "Basic Brick Set #6177"[2]
- It takes four boxes for 20 people

Stationary: standard training package

- Stickers, flip chart paper sheets, markers
- Planning poker cards (or hand-made ones)

Figure 4.3. *Standard duration, group size, and materials for LEGO teaching gaming* (Krivitsky, 2011)

Considering the previous information, the roles that need to be included in the SCRUM simulation are: Product Owner played by the trainer/coach, Scrum Master that could be a member of the team or another coach, and team members.

The point of the activity is for the team to experience SCRUM on a practical activity, that consist in teams working collaboratively to build a single product: a city, which

main buildings. Product owner is the owner of the city, he has the vision and is the one who gives may give changes to it.

Preparation

- Building the Backlog

After the teams are self-formed, they must build a product backlog that includes the buildings the city should have, then present it to the product owner and discuss it.

- Estimating StoryPoints

The team should perform an estimation of Story Points (based on time) that may take to build each of the buildings using Planning poker or other technique.

Game

- Sprint Planning

Using a planning wall, the first Sprint planning is performed, in which each team decide which activity (building) is going to be done by whom, as it is shown on Figure 4.4.

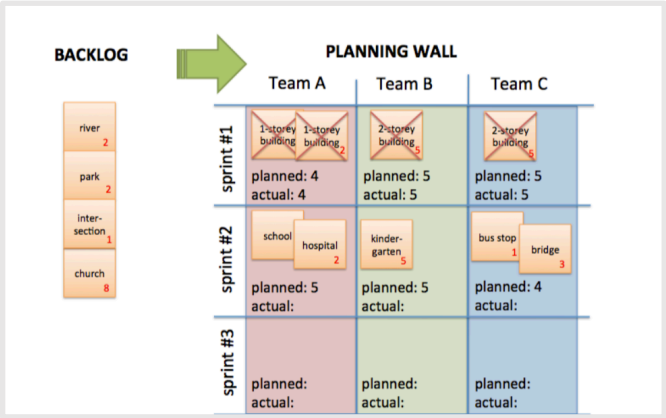


Figure 4.4.: *Planning wall on LEGO game* (Krivitsky, 2011)

- Sprint

Over a paper map of an empty city, teams start building with LEGO the houses. Each Sprint will last for 7 minutes, and to put more pressure on it, they should be able to see the time projected somewhere.

- Sprint review

Five minutes review in which the Product Owner will start asking questions and giving his feedback on the job currently performed. He will accept or reject some of the buildings, he will ask for some changes, creating *User Stories*.

Unfinished items are brought back to the Planning Wall.

A clear announcement that the release is planned after the 3 Sprint (this is the first time this information is communicated to participants), which increase the stress level on the team.

"The Sprint cycle, which is repeated three times, is as follows:

a. Sprint Planning 3 min.)
b. Sprint (7 min.)
c. Sprint Review (5 min)"

(Krivitsky, 2011)

After the game is done, a post-game process of debriefing is done over the outcomes of the process, that should look similar to Figure 4.5., aiming to understand what was observed on the process, the roles that everyone has on the process and how they feel with them, and learning achievements.

Figure 4.5. *Outcome of Lego activity after the 3rd Sprint.* (Krivitsky, 2011)

Krivitsky states that this game is designed to be stressful (2011), therefore it may expose bad working habits from the participants that could harm real Agile implementation performance. The coach should point them out and turn them into learning points.

4.1.2.3. Product development activity

- Objective: Understanding of Agile process and SCRUM Agile framework without reviewing without new requirements.
- Time: 60 mins
- Participants: 4+, coach and assistant

This activity, proposed by Berbegal-Mirabet & Gil-Domenéch in the 3rd International Conference on Higher Education Advances, is aimed to teach Scrum methodology to participant of a WS (Berbegal-Mirabent & Gil-Doménech, 2017). The main objective of this activity is to prepare a flowerpot with a plant made of cardboard materials.

On the activity, a group of people will be separated into teams composed by 1 Product Owner and 3 team members, the Scrum master will be performed by the coach.

After the teams are organized, the project is set-up beginning with *User Stories*, that are described on post-its and paste it on a wall. Then, the team define the condition of acceptance for User Stories, then moves to be requirements.

Story Points are assigned, being each of them equivalent to one minute, then Sprints of 10 minutes are organized, and the requirements allocated to each of them.

The Sprints are formed by 10 minutes of working and a sprint review before the beginning of the new Sprint. There is not a Sprint planning at the beginning, because new requirements are not included before each Sprint.

After the activity is finished, there is a debrief and discussion of the experience over the outcome, similar to what is shown on Figure 4.6.

Figure 4.6. *Outcome of the product development activity* (Berbegal-Mirabent & Gil-Doménech, 2017)

The total amount of time considering 3 Sprints, debrief, organization and explanation of the activity is the approximately 60 minutes.

Different from other teaching techniques, this one does not consider the variation of requirements in between the Sprints, which may do not add the stress to activity, and also made it less similar to the reality.

In contrast with the LEGO activity, this one is simpler in terms of material, and faster to perform, but less accurate with respect to reality.

4.1.2.4. Product Backlog and MoSCoW prioritization based on real project

- Objective: Understand on how to do Product Backglog, perform MoSCoW prioritization, and define what is understood as Minimum Valuable Product.
- Time: 40 mins
- Participants: 4+, coach

The activity consists in applied Agile tools: Product Backlog and MoSCoW prioritization, to a real-life case scenario.

One or more members of the core team should bring an example of the product the company manufactures (e.g. Telescopic Handler). The team with coach support brainstorm using Post-it, on a wall or piece of paper, a product Backlog with the requirements of a product. The coach must clarify that the requirements should be keep simple and not going into too much details.

The outcome should be 15-20 general requirements for a product. Some of the requirements may be similar enough so they can be merge in one, the coach is responsible of identified them and place them together, in order not to have doubled requirements.

When all the requirements are set-up, a discussion lead by the coach should be done on each of the requirement to determine if it is a *Must*, *Should*, C*ould* or *Won't have* type of requirement (performing MoSCoW prioritization). This process results to be insightful for cross-functional team members, because they are able to see what the perception from different parts of the process/ value chain is.

Finally, the requirements are sort and place so all team members can see them and have a clear view on how a Minimum Valuable Product should look like.

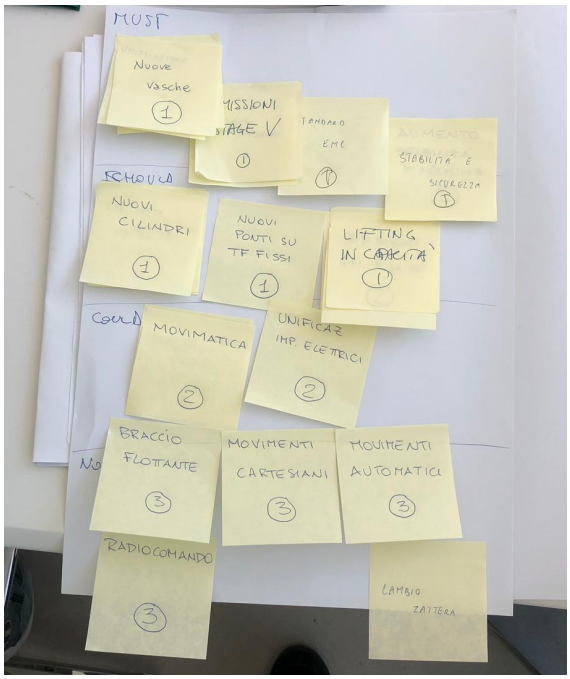


Figure 4.7. *Requirements from Product Backlog organized using MoSCoW, after the discussion from case study.*

This activity would talk roughly 40 mins. Even though it could be performed on the first encounter with the core team, it is recommended to reserved it for second or third encounter, because one or more participants should bring information, and it is better if they have a proper idea of which product would be more insightful to bring to the activity.

The general outcome is to help the team to understand how to do a Product Backlog, perform MoSCoW prioritization, and define what is understood as Minimum Valuable Product.

4.1.2.5. Discussion

The Simulation activities previously presented were selected because they are diverse in terms of time, the shortest 10 min, the longest 2 hours, which gives the coach that is the designing the exposure to Agile session flexibility, have different materials, and different objectives. All of them are applied activities works for different size teams.

Like this there are at least other 20 similar activities reviewed on available literature, some of them with application examples, that coach are able to select from (Johann, Offerman, de Mooij, & Sidhu, 2018). Is up to the coach to decide which ones to use, balancing the time available, the amount of people, and the objective that he wants to meet.

The number of workshops and activities on them is up to the coach, depending on the level of knowledge the core team already have on Agile methodologies. In the Case study, three of the four workshops were performed focus on increase the understanding of the core team on Agile Project Management methodologies on the core team, having a positive result.

In the available literature there is not a serious game focus on teaching DSDM method as it is for Scrum, it would be interesting to go further, develop and try an interactive way to teach this framework.

4.2. Analysis of current Project Management process and best fit for implementation.

Agile Project management implementation is considering a complex activity. Each transformation is unique per company and for the best fit, the core team must be fully involved on the Analysis process.

Clearly, people who works in the company have a sharper notion than the coach on how process are structure, and how *de-facto* the process are being carried out during the day-to-day operations. This is why the analysis should be performed by the team with coach guidance.

It is not the role of the coach to detailed analyse the process of the company, but rather have a clear overview of it, and listen what the core team discuss, giving informed suggestions that mix his superficial knowledge of the company's processes, and deep knowledge of Agile. The core team should deliver the necessary information to the coach.

Analysis have to be focus on one particular step of the process, for a future escalation of the Agile methodologies, otherwise, it would be unorganised, having a higher risk for the implementation not to work or having high cost impact (van Solingen, 2019). For cope with the traditional flow of manufacturing process, the best fit for the implementation is focus on gradually include Agile Project Management tools to the existing process, as it was done in the study case.

The result should be a clear notion on where the implementation should start, including:

- The method to address the implementation (e.g. Pilot project, small cross-project implementation).
- The project or product.
- Agile tools that could be implemented.
- The phase of the project in which the implementation would be perform.
- The obstacles that may be presented on the process.

It is important to consider the qualitative feelings of the team, what have been discussed during the case study is that implementation of Agile on a manufacturing company should be done gradually in order to respect the processes and keep the current quality level.

It is necessary to highlight that the outcome of the analysis should not be an action plan, but an initial assessment that allows to identify where Agile methodologies can have a better fit.

4.2.1. Activity for performing process analysis

For performing the analysis of the current situation, a workshop could be schedule including the core team and the coach.

As preparation, the core team should send beforehand to the coach and bring into the workshop the current project flow of the company. Core team should bring past, current and future projects/products that they may have in mind for include Agile Project management Tools. If there is no Project in mind, just a variety of projects as examples would be enough

On the workshop, there would be a discussion to select one of the projects, this would not be necessary the final decision for the implementation, so the discussion should be superficial and do not last longer than 20 minutes.

The map of the process will be printed and place on a meta plan board. The team together with the coach will work on it using Post-its and designing which and where would be the place.

After selecting one or more steps in which Agile tools could potentially be used, the team will go deeper in those processes and brainstorm which particular agile tools will be useful.

Out of this process, one or more ideas for implementation could come out. At the end of the workshop there should be a quick debrief in order to expose ideas and have a common agreement for the beginning the next step, the design of the implementation process.

4.3. Design of blended Agile Project Management method

Once the best fit for the implementation is selected, the design should be done by the team and coach in order to begin with the Agile Project Management implementation.

For a manufacturing company, as it was shown on the case study, a relevant point that needs to be consider is that usually a natural waterfall process is followed to reach the expected quality of the final product. Blended means that it could add tools from different Agile methodologies and mix it with traditional waterfall project management. Therefore, it necessary to keep in mind that this section is based on design over traditional approach, rather than change waterfall for a new Agile Project Management method.

4.3.1. Literature review

Jovanovič, Mesquida, Mas, & Colomo-Palacios analyse 1564 studies, mapping and offering a classification on 28 screening primary studies on Agile framework implementation (2020). It was concluded that Organizational Culture is the situational factor that have a strongest impact on the implementation. This is another factor that support the importance of internally design method.

Move from theoretical to practical implementation of Agile methodologies is not an easy task, what is called traditional approach is naturally embodied in non-agile organizations and it is difficult to make a change, especially considering Foss's idea that in firms "knowledge stocks are accumulated in a path-dependent way" (Foss, 2005). In other terms, knowledge about the methodologies is not enough, but a proper implementation also requires the development of the proper routines inside the organization, for the knowledge to be applied by the people. Begin from small and gradually increase Agile tools is a proper way to start.

Furthermore, Agile frameworks do not specifies exactly how to implement the methodology inside an organization, it is up to employees that are implementing it to interpreted and adapt the values to the context of the business and project (Cobb, 2011). Implementing Agile PM is not always successful, there are some cases in which teams that tries fails or develop less efficient processes (Dyba & Dingsoyr, 2009).

Implementing Agile in smaller projects/organizations is easier that doing it on larger ones. The bigger the business/project, the harder is to do the implementation. Larger

organizations have more dependencies between projects and teams, which increase the need for more formal documentation (Dyba & Dingsoyr, 2009). Smaller companies tend to be more flexible and have a better transversal communication between teams than traditional unit-base companies.

Leaders must be realistic when implementing an Agile methodology: not all functions could be organized under an Agile framework, this are not necessarily suited for all activities.

Companies usually struggle to understand which processes should be reorganize as Agile and which should not. Usually, routine operations are not proper processes for an Agile framework implementation. Conditions are proper for Agile teams where:

“

- Problems are complex.
- Solutions are at first unclear.
- Project requirements are likely to change.
- Close collaboration with end user is feasible.
- Creative teams will outperform command-and control groups.”

(Rigby, Sutherland, & Noble, 2018).

Even though authors such as Rigby, Sutherland, & Nobel (2018), believes there are some particular tracks that could be following in order to increase probability of success, Cobb insist that Agile methodologies still in a process of maturation, and mechanical implementation carried *by the book,* is not the proper approach (2011). This idea is also supported by the literature review done by Dikert, Paasivaara and Lassenius , which on an analysis of 42 organizations concludes that is not possible to identify a clear success factor and common general challenges perceived by teams when implementing Agile tools (2016). Despite of this, literature agrees that for a proper Agile framework implementation, the main points for success are learning, discussing and improving *on the field*, rather than on the planning table; it is important to remember that Agile is “heavily based on continuous improvement” (Cobb, 2011).

For measuring the implementation effectivity, metrics relevant for the company and the business must be defined; the metrics may vary depending on the business (Ilieva, Ivanov, & Stefanova, 2004). Focus, good interpersonal skills and trust are important for

successful of an Extreme Programming team. “Focusing on human and social factors is necessary to succeed” (Dyba & Dingsoyr, 2009).

Agile project management implementation affects company transversally, including management and business functions. A big challenge is to “move from a life-cycle model towards iterative and feature centric model” (Dikert, Paasivaara, & Lassenius, 2016).

Management and Leadership

On implementation of Agile Project Management methodologies in software development, Nerur, Mahapatra & Mangalaraj (2005) describes some general issues that appears on the process, on the following four areas: *Management and organization, People, Process and Technology*. These issues, which this work is not aimed to study, can be generalized to non-software related projects. They can be address in general terms by giving a mixture of autonomy, flexibility and responsiveness capability, trough relinquish autonomy from leaders, on a culture of respect and trust. It is recommended to invest time, effort, and capital on technologies to make the change and facilitate the implementation (Nerur, Mahapatra, & Mangalaraj, 2005).

When leaders haven’t properly understood and adopted the methodology, they think implementation should be done on a traditional way: through a top-down plan, this is not the best approach. Case studies have shown that the usage of an executive team is a better strategy, the members of the team should work as an “initiative owner”, responsible to facilitate, supress bureaucracy, and coach teams As it is not possible to know precisely how many Agile teams will be needed, in which period of time and how to address bureaucracy without producing chaos, it is propose to launch initial wave of Agile teams, gather data, and understand value created and constrain faced on the process to proceed with further implementation (Rigby, Sutherland, & Noble, 2018).

As it is state on the theory, managers need to look carefully on not just thinking new methodologies are just tools to improve the profit and efficiency of work procedures, but embrace the ideas and values of the new methodology in order to make a vertical change, and not an uncomplete implementation (Laloux, 2016).

4.3.2. Process for design

This Process design is aimed to work as first step that could be escalated to other process depending on the results. Should be included on the traditional waterfall approach leveraging improvement.

As was the case of in the Case Study, it is recommended to perform one or two workshops fully dedicated to the design of the implementation. Based on the literature and experience of the case study, the follow steps are recommended to be address:

4.3.2.1. Precisely define in which type of project and process the Agile tools are implemented.

From previous step the core team should have clear options in which the implementation can be performed. Before starting the design is important to define where the implementation will be first performed.

It is useful to physically bring the steps of the process for different projects, highlight the possible selected steps in which agile methodologies could be applied, and make comments on it in order to select the best fit, as it can be seen in Figure 4.8.

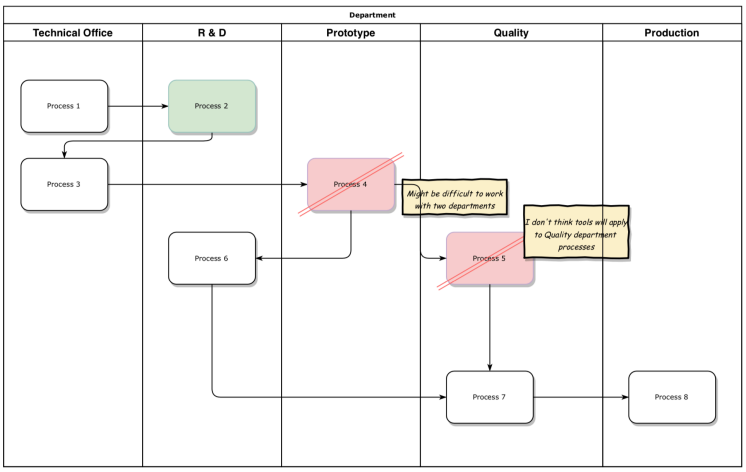


Figure 4.8. Example of process and selection of process

Out of the option one particular project must be selected in order to define specific objectives and monitor the results of the first implementation.

The project should be related to one product that can be define as outcome from the process.

4.3.2.2.Create a Product Backlog and perform MoSCoW prioritization

The product selected should be decompose into the requirements that make it perform the tasks for what it was designed, from there the product Backlog is defined. After, MoSCoW prioritisation should be performed over those requirements in order to define the Minimum Viable Product (MVP).

MVP should properly define before starting the implementation, since it establish a clear view of the final expected outcome of the process and keep it in mind when organizing the Agile iterations.

4.3.2.3.Define activities involved in the process selected

On manufacturing companies, different from software environment, usually the activities have pre-requisites and follows a stablish process.

It is important to have a map of the activities and the order in which they have to be perform, because if one of the *Must* requirements have strong dependence on another that is not that relevant, the last one becomes automatically equally relevant.

4.3.2.4.Define Story Points

For each of the activities is necessary to define story points according to the estimated load for later on organize the Sprints to be performed.

This are not exact numbers, just approximations established by the team based on their experience. It is always useful to use a common scale easy to understand and translate into workload.

Set-up the Story Points through discussion for accomplish team's agreement, each activity one by one.

4.3.2.5.Agree on next steps

- Plan the cross-functional Sprints

Set-up a workload for each of the Sprints, and assign task based on Story Points. This could be modified after.

- Implement an Agile Software

Start using free Agile software such as Trello or Freedcamp for performing the plan of some activities and keep track of what is done and what is yet pending. This is a good collaborative way to start keeping track of activities and progress.

- Define Agile roles

Depending on the Agile methodology selected, assign roles to the core teams and let the core team assign roles to the people who will work on the pilot launch of the project. The definition of the tasks needs to be clear.

It is recommended to consider including a Business Analyst role from DSDM framework, who is able to connect the business and technical part of the project and could be assign the role of monitoring the initiative and keep the momentum of the team. This role may have a considerable importance especially in manufacturing companies, where the technological complexity tends to be higher than in other industries.

- Define a RACI matrix

Together with the roles, it is needed to define what would be the responsibilities of each of the participants in the first implementation. For this purpose, RACI is an adecuate way to put in paper a map of the people accessible for all team members, to clarify responsibilities and in case there is some type of confusion.

4.4. Considerations for designing of the implementation

An implementation of Scrum on the IT area of a pharmaceutical company identifies the following main difficulties on sprint implementation:

- Lack of knowledge of Scrum
- Lack of involvement of other areas
- Tendency to return to the traditional approach on work
- Communication problems with Product Owner

(Azanha, Batista, Domingos, & Terra, 2016)

Based on the discussions of this work, these four points may be generalized for implementation in a manufacturing company of a blended Agile methodology.

It is important to give the team the right knowledge about the particular Agile methodology that will be implemented, before starting the design and implementation. With respect to the teaching of the methodology, from the survey performed to Politecnico students, it can be concluded the importance of dynamic lectures using a practical example when teaching the methodology, a frontal lecture may not be enough to properly give a first understanding of the methodology.

In the cross-functional team in charge of the implementation, there should be representants, or at least the responsibility of connect all the areas involved in it.

The tendency to return to traditional approach is a natural behaviour among employees. As it was appreciated on the Case Study, implementation initiative tends to get dissolve into the daily routine, if they are not monitored. It is highlighted by Goldstein that one of the key factors that makes an Agile project unsuccessful is when team members are drag from one project to work on a "more urgent" task (2014), so there is a need to assign a team member to have this responsibility.

Communication between the team members with different roles must be clear. The design should consider the use of a software or any communication network to share information, plus the face to face daily and weekly meetings.

5. Conclusions

5.1. Outcomes of the study

Manufacturing companies usually have rigid process flow performed by machines, for which a waterfall approach to project management is adequate. Even though, include Agile practices have shown to increase level of responsiveness to client requirement and improve employees working atmosphere. Therefore, it is proper to consider the implementation of Agile methodologies over traditional approach in the industry.

For implementing Agile project management methodologies in a manufacturing company, it is recommended to use a blended approach between different Agile frameworks and the waterfall approach.

From the Case study, it was confirmed that there is not a need to replace waterfall methodology, but rather implement Agile activities, tools and behaviours over some of the processes currently in place. A proper way to approach the first implementation is trough workshops dedicated to delivered knowledge and design the implementation and assigning a cross-functional core team and a coach that should carry out the design and the further implementation. To keep the engagement of the team, it is necessary to assign a role with the responsibility of monitoring and keep track of the process, otherwise daily responsibilities deviate the attention from the project and decrease its momentum.

The survey performed to second year master's degree students of Politecnico di Torino confirms the importance of interactive lectures complemented with applied activities to give a first exposure to Agile methodologies, highlighted on literature.

Base on the Case study, three steps were derived for performing the design of implementation of Agile methodologies on a manufacturing company.

For the first step, *Exposure and comprehension of Agile methodologies*, interactive lecture and the use of simulation activities available in literature are used to reach the goal of getting the team familiarized with Agile project management.

The second step, *Analysis of current Project Management process and best fit for implementation*, should be performed by the core team with help of the coach, trough activities and discussion, in order to focus the implementation in a particular process and product.

The final step is the *Design of blended Agile Project Management method*, the expected outcome is a set of steps that the team should follow working cross-functionally in order to implemented Agile methodologies, focus on a particular project and product.

Performing the three steps could take 4 to 5 workshops with the core team, which can be translated into one to four months depending on team's availability. Meanwhile, the implementation could last up to three years to have it properly on going and polished, according to what was exposed by the representant of *Summo Riko*.

With respect to leadership of the design, and the further implementation, it should be understood that the changes must come from a bottom-up approach, for a first launch in a particular project and then escalated it to other units in the company. As it is state on the theory, managers need to look carefully on not just thinking new methodologies are just tools to improve the profit and efficiency of work procedures, but embrace the ideas and values with a vertical change as long-term objective, for a complete and serious implementation.

5.2. Further research

This thesis addresses the design of implementation, which is a particular section a broader topic: Agile project management implementation on manufacturing companies. Therefore, it must be complemented with other studies that refers to the implementation process and its monitoring, that comes after.

As it is based on a case study on a metalwork company, it would be interesting to do research over how different types of manufacturing companies (such as food processing, chemical, textile, miscellaneous manufacturing) may applied the three steps, depending on the different requirements of the industry. Despite the steps where tried to be set-up as generic as possible, there must be some considerations depending on the industries and companies, in the way each of them developed their own project management processes.

With respect to the Agile framework presented on this work, it is of interest to go deeper into tools that could be apply from other frameworks, such as Xtreme Programming, and to further research the role that DSDM tools could play when designing he implementation, and review better interactive ways to deliver a first approach for this methodology.

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Appendix A

Survey I for Project Management Students

Agile. Initial questionnaire

This questionnaire was developed by a Master's student for research purposes. Its objective is to measure your first perception, as student, of Agile approach to Project Management and its methodologies.
You are kindly asked to reply with the knowledge you have and be honest with your answers. (Don't worry if you don't know something, that is the idea of this questionnaire)

Contact information
Stundent: José Casciola
mail: S265106@studenti.polito.it
*Required

1. Student ID *

2. Have you heard about Agile Project Management before? *

   Mark only one oval.

   - ◯ Yes
   - ◯ No

3. What do you think is more relevant for a Business? (1 means you think left option is highly more relevant than right one; 5 means you think right option is highly more relevant than left one) *

   Mark only one oval.

	1	2	3	4	5	
Process and Tools	◯	◯	◯	◯	◯	Individuals and Interactions

4. *

Mark only one oval.

	1	2	3	4	5	
Working product	◯	◯	◯	◯	◯	Comprehensive documentation

5. *

Mark only one oval.

	1	2	3	4	5	
Customer collaboration	◯	◯	◯	◯	◯	Negotiation of a proper contract

6. *

Mark only one oval.

	1	2	3	4	5	
Follow a plan	◯	◯	◯	◯	◯	Respond to change

7. When planning a project, some factors could fixed beforehand and some of them may vary during the development of the project. From Agile Project Management perspective, which of the following elements could be variable when planning a project? *

Tick all that apply.

- [ ] Time
- [ ] Cost
- [ ] Quality of product
- [ ] Features on the product
- [ ] All of them needs to be fixed before starting the project

8. Evaluate the following assumptions about Agile Project Management *

Mark only one oval per row.

	Strongly Disagree	Disagree	I do not know	Agree	Strongly Agree
Is a software	◯	◯	◯	◯	◯
Is only use for software development	◯	◯	◯	◯	◯
Is a methodology	◯	◯	◯	◯	◯
Uses evolutionary, incremental, and iterative delivery	◯	◯	◯	◯	◯
Helps organisations to be more adaptive, creative and resilient	◯	◯	◯	◯	◯
Is normally use by big companies	◯	◯	◯	◯	◯
Have a strong and authoritarian sense of leadership	◯	◯	◯	◯	◯
Cost and Time are fixed on an Agile project	◯	◯	◯	◯	◯
Helps organizations to respond to change	◯	◯	◯	◯	◯
Needs to carry out extensive documentation	◯	◯	◯	◯	◯
I think is useful	◯	◯	◯	◯	◯

9. Do you have any experience with Agile Project Management? *

Mark only one oval.

◯ Yes
◯ No

Appendix B

Survey II for Project Management Students

Agile. Progress questionnaire

ANSWER THIS QUESTIONNAIRE ONLY IF YOU ARE ONE OF THOSE WHO ANSWERED "Agile. Initial questionnaire".

This questionnaire was developed by a Master's student for research purposes.
Its objective is to measure your progress, as student, on the learning of Agile approach to Project Management.
You are kindly asked to reply with the knowledge you have, and to be honest with your answers.
(Don't worry if you don't know something)

Contact information
Stundent: José Casciola
mail: S265106@studenti.polito.it
*Required

1. Student ID *

2. With reference to this semester: How would you describe your learning about Agile Project Management methodologies? *

   Mark only one oval.

   - ◯ I was not able to properly learn them
   - ◯ Not enough
   - ◯ Good enough
   - ◯ I learned everything I was though about them

3. How useful do you think Agile Project Management methodologies have been on your project work this semester?

   Mark only one oval.

   - ◯ Not useful
   - ◯ Useful
   - ◯ Highly useful
   - ◯ I did not use them

4. What was more useful for you to understand Agile Project Management methodologies?

   Mark only one oval.

   - ◯ Lectures
   - ◯ Practical example
   - ◯ Group project

5. What do you think is more relevant for a Business? (1 means you think left option is highly more relevant than right one; 5 means you think right option is highly more relevant than left one) *

   Mark only one oval.

	1	2	3	4	5	
Process and Tools	◯	◯	◯	◯	◯	Individuals and Interactions

6. *

   Mark only one oval.

	1	2	3	4	5	
Working product	◯	◯	◯	◯	◯	Comprehensive documentation

7. *

Mark only one oval.

	1	2	3	4	5	
Customer collaboration	◯	◯	◯	◯	◯	Negotiation of a proper contract

8. *

Mark only one oval.

	1	2	3	4	5	
Follow a plan	◯	◯	◯	◯	◯	Respond to change

9. From Agile Project Management perspective, which of the following elements could be variable when planning a project? *

Tick all that apply.

- [ ] Time
- [ ] Cost
- [ ] Quality of product
- [ ] Features on the product
- [ ] All of them needs to be fixed before starting the project

10. Evaluate the following assumptions about Agile Project Management *

Mark only one oval per row.

	Strongly Disagree	Disagree	I do not know	Agree	Strongly Agree
Is a software	◯	◯	◯	◯	◯
Is only use for software development	◯	◯	◯	◯	◯
Is a methodology	◯	◯	◯	◯	◯
Uses evolutionary, incremental, and iterative delivery	◯	◯	◯	◯	◯
Have a strong and authoritarian sense of leadership	◯	◯	◯	◯	◯
Cost and Time are fixed on an Agile project	◯	◯	◯	◯	◯
Helps organizations to respond to change	◯	◯	◯	◯	◯
Needs to carry out extensive documentation	◯	◯	◯	◯	◯
I think is useful	◯	◯	◯	◯	◯

11. Are you interested in deepen your knowledge about Agile Project Management?

Mark only one oval.

◯ Yes
◯ No