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# Miniumum Viable Product Creation through Adaptive Project Management – An Extended Approach for the Management of Innovation Projects: the Ecochallenge Case

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***Abstract*—Innovation Project Management has gained a lot of attention in the recent years given its complexity and the challenging questions innovation projects pose to traditional project management. Literature shows high rates of failure, for numerous reasons, when it comes to innovation projects, among which are the project management approach and the inability to tackle the complexity and uncertainty connected to the project.**

**This paper will discuss the concept of innovation projects and the challenges they face then propose means to address those challenges by proposing an adaptive project management approach based on agile-thinking. This approach is then extended to include the concept of minimum viable product delivery, known from the fields of product development, engineering and start-ups. The combination of the two concepts, with reflection on the peculiarities of innovation projects, offer a novel approach to work in adaptive life-cycles, while focusing on creating an incremental, deployable product. To test its validity, this approach is then applied on a case study from an innovation project with the aim to create a cargo vessel in a competition setting.**

***Keywords—Innovation projects; Minimum viable product (MVP) Adaptive project management; Agile life-cycles; Ecochallenge.***

## I. Introduction

In time of increasing global socioeconomic challenges, creating means to enable technological development and innovation that address the societal, environmental and economic needs becomes inevitable. Research is the key element to overcome this [1][2]. Since the increased interest of the European Commission in research & innovation and the launch of their relevant Framework Programs, interest of the scientific community and of research and academic institutes in studying different aspects of innovation management intensified [1]-[15]. However, innovation projects pose a number of difficulties, specifically when it comes to existing knowledge, uncertainty, complexity, change and collaboration [6]-[15].

Analysis of the literature concerned with this topic shows the need to exceed the traditional project management thinking to include the analysis of the peculiarities and challenges of an innovation project, the understanding of its success, and the specific processes needed to implement it [7]-[9], [16]-[22]. According to Jetter & Albar [23], the project management field is accused of excessively emphasizing linear project management that can be applied to controllable projects and of losing relevance when it comes to efforts with high-uncertainty.

The authors of this paper suggest combining two concepts trending in the literature connected to innovation, uncertainty and project management, in order to overcome several financial and planning challenges of innovation projects: (1) the adaptive project management [24] approach and (2) the delivery of a “minimum viable product” (MVP) [25]-[28]. The authors reflect that on a case study of an innovative student project that faced challenges and delays in the start due to using traditional project management approaches. The ability of the project team to adjust its approach to a more adaptive one and focusing on delivering the minimum viable product is what eventually helped achieve some of the desired results of the project.

## II. Innovation Projects and the Challenges Posed to Their Management

The European Commission (EC), currently the funding organization with the largest budget dedicated to research & innovation activities in the world [1][2] defines innovation projects as those aiming to create new, innovative market-exploitable outputs based on existing knowledge, designs or prototypes. The technology readiness level (TRL) of an innovation project starts at a minimum of 6 (technology demonstrated in relevant environment) and should end at a minimum of 8 (system complete and qualified) or 9 (actual system proven in operational environment) [1], [3], [29]. Innovation projects are in many ways unconventional. They are characterized by: [6]-[15]

- high uncertainty of the project outcome and of the individual tasks.
- higher ratio of new tasks in comparison to the routine tasks.
- limited existing knowledge about the methods to reach project outcome.
- consequent difficulty in project planning and reciprocal interdependence of plans.
- need for collaborative project management, thus adding to the complexity of stakeholder management.
- need for a project team that is willing to learn and adapt to changes in scope and work mechanisms.
- difficulty in measuring and quantifying project progress.

As formerly noted, linear project management approaches fail to address the uncertainty and complexity posed by innovation projects [23], thus creating the need for adaptation of the project management approaches and iteration of the project tasks to obtain smaller functional deliverables. In the following section, the concept of Adaptive Project Management will be introduced along with a discussion of its ability to solve those challenges.

## III. Addressing the Challenges of Innovation Projects through Combining Adaptive Project Management Approach with the Delivery of a Minimum Viable Product

### *A. Defining Adaptive Project Management*

Adaptive management is "a structured and systematic process for continually improving decisions, management policies, and practices by learning from the outcomes of decisions previously taken" [30]. It was originally developed in the 1970s by leading ecologists Holling and Walters who were looking to understand how different living entities adapt to their environment [30]. According to Wysocki [31] the majority of contemporary projects are challenged at the start of the project when it comes to specifying scope and requirements, due to "constant change, unclear business objectives, actions of competitors", etc. Based on anecdotal data collected by him, he suggests that "at least 70 percent of all projects do not fit the traditional, linear project-management life cycle" [31]. The higher the innovativeness of the project outcome, the more confusing and challenging it is to define requirements and create accurate estimates and thus the risk of diversion from desired goals is higher [32].

### *B. Defining the Minimum Viable Product (MVP)*

The concept of a "minimum viable product" arises from literature of product development, start-ups and the innovativeness connected to them. According to Erder and Pureur [33], an MVP "has just those core features that allow the product to be deployed – and no more". The product needs to be operational and can be tested, however it is at that point deployed to the more forgiving subset of customers. The point here is to have a functional output, which the end-users/customers can provide early feedback about and through which the product vision can be understood, thus avoiding the costs and time of building a complete product which may or may not be desired by the end-users/customers.

### *C. Approach for Addressing the Challenges of Innovation Projects*

As an instrument to indicate where each project stands in terms of novelty, innovativeness and complexity it lies, and thus understand the type and extent of challenges to be faced at the start and during the project, Shenhar and Dvir [24] propose the Diamond Framework (also called the NTCP model) to understand the nature of a project, and diagnose the gaps or challenges between capabilities of the project manager and team and those capabilities that are needed to make the project a success. They use four indicators to help the project team choose the right method for their project [24] (See Fig. 1).

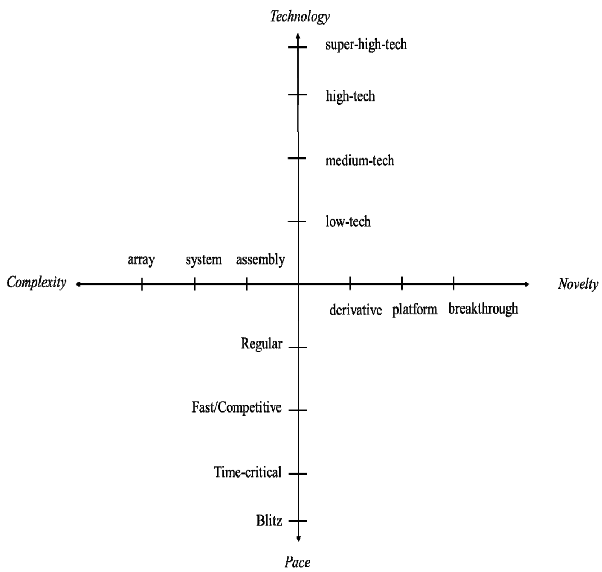


Figure 1. Diamond NTCP model [24]

These indicators are:

- Novelty: indicates new creations: is the final project output a "derivative product" or a "breakthrough product"?
- Technology: indicates technical difficulty: "the uncertainty in a project is a measure of the mix of

new and mature technology it requires, as well as the company's existing knowledge".

- Complexity: indicates the complications involved in reaching the final output/product of the project.
- Pace: indicates the sense of urgency in the project tasks: "is the timing normal, fast, time-critical or blitz"?

If a project scores relatively high on multiple indicators or extremely high on a single indicator that this should be indicator enough for the project manager that traditional project management approaches are not advisable for his/her project [24].

In order to address some of the challenges of an innovation project, as uncertainty and inaccuracy in developing a project plan and project estimates, the traditional and linear project management life cycles can be replaced by adaptive life cycles. They are also known as "change-driven cycles" or "agile cycles". Their purpose is to respond to frequent and significant changes due to strong stakeholder (especially customer) involvement [34]. Adaptive project management is also an iterative and incremental approach to project management, but differs in that "iterations are very rapid (usually with duration of 2 to 4 weeks) and are fixed in time and cost. Change during the project is naturally handled in rapid iterations. The end result is delivered at the end of each 2-4 week iteration" [34]. Table 1 provides a summary of the main similarities and differences between a traditional/predictive project management life-cycle and an adaptive life-cycle.

TABLE I. PREDICTIVE VS. ADAPTIVE PROJECT MANAGEMENT: SIMILARITIES AND DIFFERENCES (MODIFIED BY AUTHORS) [24]

| Life-cycle | Predictive (Traditional) PM | Adaptive PM |
|---|---|---|
| Phases | Can happen sequentially or overlap | Can happen sequentially or overlap |
| Scope | Defined upfront and described in the project plan at the beginning of the project | Scope is set in the form of features/requirements. A number of features are picked for the current iteration |
| Risks & Costs due to changes | At initial project phases can be accommodated, increase the later they appear in the project | Minimized as risk & cost planning takes place at the beginning of each iteration and iterations are short |
| Customer Feedback | Customer is mainly involved in the beginning and end of the project | Customers are engaged continuously in the planning and delivery of iterations |
| Value | Customer receives value at the end of the project | Customer receives value at the end of each iteration |

Wysocki [35] suggests that Adaptive Project Management planning should be just-in-time planning. As the project team at each phase or beginning of a cycle has the knowledge that would enable them to only create a 'current version scope plan' for the phase, it does not make sense to try to generate a complete work breakdown structure (WBS) of the project. There are four deliverables of a 'Cycle Plan Phase': a low-level WBS for the cycle's functionality; assignment of activities to sub-teams; dependencies and schedule; and finally micro-plans for sub-teams.

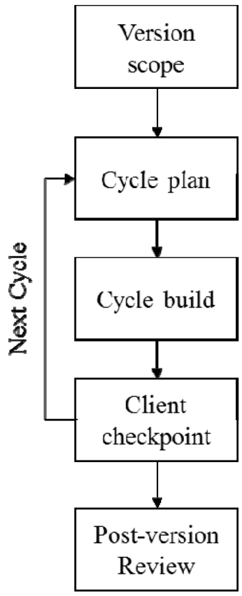


Figure 2. The Adaptive Project Framework [35]

The adaptive project framework [35] can be extended to include the emphasis on the creation of a minimum viable product. The cycles can be adjusted to emphasize the creation of additional features to be added on top of the features or deliverables of the previous cycles. Then, before the client checkpoint, the team should ask itself if the product they have created with its additional features is sufficient to allow the product to be deployed to early adopters. If the answer is no, then the team moves to the next cycle and proceeds to build additional features into the product. This continues until the answer to the questions:' Does the product have the core features that allow it to be deployed to early adopters?' is yes. When the answer is yes, then the team has reached this minimum viable product and can deploy it to their early adopters, in hope for feedback that would allow appropriate adjustment to the specifications of the product and project plan and more realistic and accurate estimates for the project time, cost and outcomes. Several MVPs can be deployed, each followed by adjustments to the scope and estimates, until the product becomes satisfying to the end users/customers and fulfills all desired features. At that point, the product can be considered ready for release and the project can be closed. The authors suggest extending the adaptive project framework [35] to include the aforementioned steps. This is described in Fig. 3.

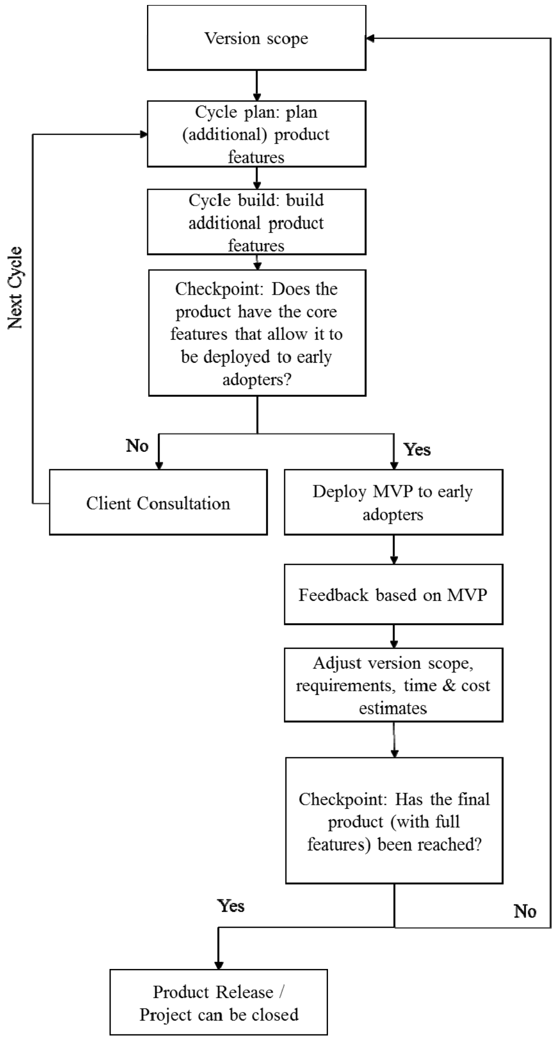


Figure 3. Combining Adaptive Project Management Approach with the delivery of a Minimum Viable Product (own source)

From all above, it appears that agile thinking is very strongly present in the adaptive project management approach. This is easily justifiable as agile thinking fits very well into innovation projects: it provides flexibility; puts people (and customer requirements) before processes; emphasizes the creation of a learning curve; and self-organization without strict hierarchies [14]. With the increased emphasis on the creation of an MVP, the agile thinking can guarantee goal-orientation and faster delivery than traditional, linear approaches.

In the next section, a case study of an innovation project will be presented and discussed to reflect on the previous content and the potential the authors' suggestions bring for solving the challenges of innovation projects.

## IV. The Ecochallenge Case Study

### A. *Ecorace Challenge Competition and Ecochallenge Team*

The innovation project discussed in this case study was held as a part of the Postgraduate Programme in Innovation and Entrepreneurship in Engineering at Katholieke Universiteit Leuven. The goal of the project was to construct a cargo vessel and present it at the Ecorace Challenge Competition held on 14th and 15th of May, 2016 in Brugge, Belgium [36].

Ecorace Challenge Competition presents the Flemish waterway operators. This is government organization that aims to encourage different forms of cooperation and efforts to find durable solutions to the contemporary challenges. The aims of the race are mainly the "promotion for the inland waterways as well as for the sustainable mode of transport and the motivation of young graduates to innovations in inland navigation are clearly come forward" [36].

The duration of the project was 2 academic semesters. The project team was composed of a group of seven international post-graduate students, majoring in the fields of electrical engineering, business studies and project management; the latter being one of the authors of this paper, Maria Zadnepryanets. The team took the name 'Ecochallenge Team'.

The scope of the project addressed the engineering aspects (development and implementation of innovative solutions in areas of autonomous sailing, improvement of the vessel's maneuvering characteristics and efficiency through the advanced bow propulsion system and innovative drive train solution), and also the development of a business plan and proof of feasibility of the proposed solution in the real life. The effort was handled as a project; meaning project management methods, tools and approaches were applied to it in order to ensure the project success and to help the Ecochallenge Team win in the Ecorace Challenge Competition [14].

### B. *Tasks and Team Composition*

The team of students was divided according to area of knowledge into following teams, each with a number of tasks: [14]

- Autonomous Sailing: main task is to equip the boat with digitalized controls, which will allow remote sailing, short-range sensors to provide a virtual bumper as well as long-range sensors to analyze the environment. In addition, the rules of the waterways and a pathfinding algorithm are added on top of the system to allow fully autonomous sailing.
- Bow Propulsion: main task is to introduce innovative bow propulsion system, which would allow the captain to leave the dockyard and improve maneuvering in tighter canals or spots.
- Drivetrain Solution: main task is to implement an innovative type of the drivetrain system, which would provide higher efficiency and autonomy of the vessel.
- Business Development: main tasks are to develop the Business Plan aimed to outline innovative techniques and materials used during

the course of the project and explain their benefit for the inland waterway navigation.

- Project Manager: main task is to coordinate work within the team, tracking and reporting the project status, ensuring quality of communications within the team and with the external and internal stakeholders and overseeing the team finance. In addition to any other tasks, essential for the organization of work and public relations activities.

### *C. Project Management Approach Applied during the Ecochallenge Project*

Upon start of the project, the team used traditional project management approach, planning complete time, scope and budget upfront. However, as the main objective of the project was to present an innovative solution that requires knowledge not available to the team, a lot of research was required throughout the project. The project team was overly optimistic, when planning the task durations. In addition, due to uncertainty about the final result and lack of knowledge in that area, the team could not plan the project scope in detail. The team underestimated the technical complexity of the tasks and the interdependencies between those tasks.

In reality the time dedicated to research and design took longer than planned, therefore the implementation and testing phases of the project had to be shortened, which lead to the inability to deliver a fully functional boat with all the described features according to the original scope planning.

As problems and discrepancies started arising between the plan and reality, the project manager wondered about the choice of the project management approach. The project manager did not lead engineering projects before and therefore started researching and testing several approaches.

During the course of the project several project management approaches were applied in pursue of the optimal solution. The project manager posed following questions:

- What are the key recommendations to manage innovation projects from the project management point of view?
- What concepts are presented in the well-adopted project management methodologies?
- What are the specifics of an innovation project?
- How to keep task interdependencies within sight?
- How to prevent unrealistic estimations and be able to correct mistakes and adapt to new realizations quickly?
- How to reach a point where there can be a tangible, functional deliverable, even if it is not perfect?

After the first two months of the project it became obvious that a more iterative approach to the project planning and project scope management and an alternative approach to the project progress tracking should be chosen.

The project management used the NTCP model [24] to understand the project and realized the following: (See Fig. 4)

- High level of novelty of the project, in the context of the Ecochallenge Project, reveals the need of the involvement of the Business Development sub-team starting the beginning of the project. High level of effort is needed to present and justify the team's proposal in the Business Plan.
- Relatively high level of the technology, in the context of Ecochallenge Project, could impact the project schedule – more interactions with the subject matter expert should have been planned and more time left for the research and design phases of the project.
- The complexity of the Bow Propulsion and Drivetrain Solution parts of the project were underestimated, which would later lead to the delays at the end project and not allow the team to deliver the full scope.

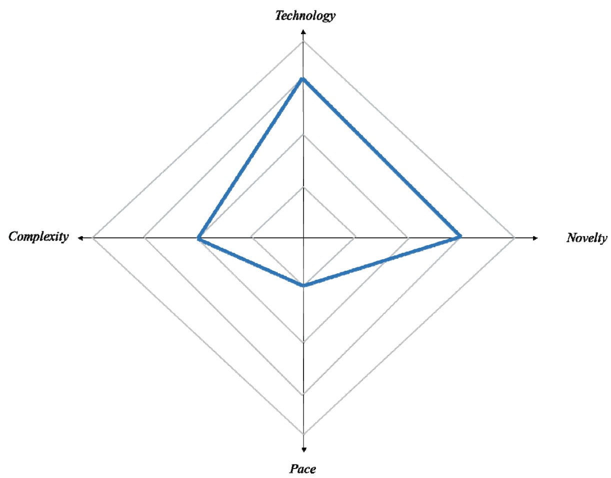


Figure 4. Applying Diamond NTCP model to Ecochallenge Project (own source)

The team then decided to arrange their scope planning differently. The following figure (Figure 5) shows how the scope planning looked after adopting the adaptive project management approach. The project team decided to adopt adaptive project management approaches, focusing more on regular meetings, on planning in iterations based on the adaptive life-cycles [24], [35], on creating incremental features in order to reach an operational product (even if it was not complete or perfect), which in fact was any minimum viable product they could produce, then collecting team and stakeholder feedback in order to adjust the iteration scope plan to the new or changed requirements or to the new knowledge obtained. This approach proved more fitting to this project.

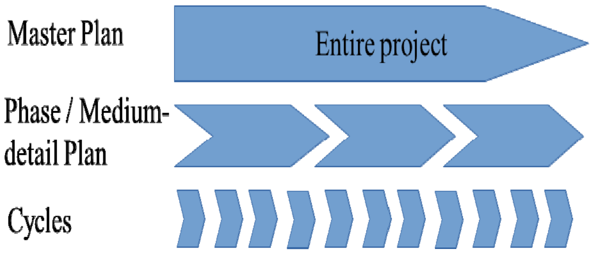


Figure 5. Adapted overall project planning (own source)

The main phases of the PMBOK® [37] were used as basis. On the second stage, three levels of planning took place: Master plan for the entire project, medium detail plan for each intermediary deliverable (autonomous sailing, bow propulsion, drivetrain solution, product integration) and then iterative cycle plans. Each of these iterative cycles included research, iteration planning, iteration implementation through delivery of incremental features, checkpoints to identify whether a minimum viable product can be deployed and the overall product and review with team and stakeholders. This was in line with the extension of the adaptive project management approach to include the minimum viable product concept as shown in Fig. 3. After the last intermediary deliverable, the boat should have the core features to be operational. Additional cycles would then allow for additional features to improve it, if time and cost would allow for that.

### D. *Project Outcome*

After the adjustment in the approach, the team had more realistic plans and estimates and succeeded in submitting all the intermediary deliverables in time. The team presented a cargo vessel at the Ecorace Challenge Competition. However, due to the delays at the start of the project, all what the team could deliver was the core functionality of the boat without any additional features or enough testing to ensure its stability. The final project budget appeared to be lower than originally planned. Nevertheless, Ecochallenge Team became all-round winner in the cargo category and vessel "Galena" was recognized as the most innovative vessel.

The team saw that its quick reaction and adaptation of the project management approach to the needs helped mitigate the problems at the beginning of the project and allowed the project outcome to still be outstanding to deserve awards [14]. Instead of a traditional approach that aims to plan and solve everything upfront and instead of an 'all-or-nothing' thinking, which proved to be inefficient at the beginning of the project, the adaptive approach that combined an orientation towards delivering a minimum viable product was enough to win.

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