Skoltech

Skolkovo Institute of Science and Technology

## Thesis Changes Log

**Name of Candidate:** Nicola Garzaniti

**PhD Program:** Engineering Systems

**Title of Thesis:** A decision support system for agile development of complex hardware systems

**Supervisor:** Associate Professor Alessandro Golkar

**Co-Supervisor**: Professor Clement Fortin

*The thesis includes the following changes as a response to the comments of external reviewers. Changes are presented according to their location in the final thesis version. For each change, this document provides a description of the amendments made, the location in the final thesis version, and the traceability to reviewers' comments. The reviewers' comments and related comments codes are presented in Appendix A.*

# List of Symbols and Abbreviations

**Change #LS&A.1**

Change: The "*List of Symbols and Abbreviations*" has been added.

Location: page IX and X of the thesis final version.
Traceability: In response to the comment of the Associate Professor Dzmitry Tsetserukou *(T-C2)*.

# Chapter 1

**Change #1.1**

Change: RQ 1 has been amended. Further details on the concept of understating have been added.

Location: page 9 of the thesis final version.
Traceability: In response to the comment of the Associate Professor Alejandro Salado (*S-C16*)
In response to the comment of the Associate Professor Dzmitry Tsetserukou *(T-C4)*

**Change #1.2**

Change: Additional details on the concepts addressed by RQ 2 have been added.

Location: page 9 of the thesis final version.
Traceability: In response to the comment of the Associate Professor Alejandro Salado (*S-C16*)
In response to the comment of the Associate Professor Dzmitry Tsetserukou *(T-C5)*

# Chapter 2

**Change #2.1**

Change: Section "*2.3.2 Agile for hardware*" has been added. In the section, the author provided details on how the literature review has been conducted. The author also uses the section to offer an overview of the Agile for hardware topic, updating the literature and enriching the references. The discussion of crucial topics related to the implementation of Agile for hardware (i.e., Iteration, MVP, Sprint planning) is left instead to dedicated sections.

Location: page 27,28 of the thesis final version.
Traceability: In response to the comment of the Associate Professor Alejandro Salado (*S-C7*)

**Change #2.2**

Change: Section "*2.5 An industry perspective*" has been revised. Scientific literature substantiating the claims inferred from the analysis of Agile use in the industry has been added where needed.
Data presented in Figures 14, 15 and 16 were also cited in-text as needed. Table 4 has been revised, adding the chapter section where the presented gaps and challenges have been analysed. The reader can refer to those sections for in-depth analyses and related underpinning literature.

Location: page 40, 41, 42, 43, 44, 45, 46, 47 of the thesis final version.
Traceability: In response to the comment of the Associate Professor Alejandro Salado (*S-C8*)

**Change #2.3**

Change: Section "*2.6 Summary of literature review and industry evaluation*" has been added to summarize and consolidate the findings from the literature review and the industry evaluation. It is also serves as closure to the research gap identification.

Location: page 48,49 of the thesis final version.
Traceability: In response to the comment of the Associate Professor Alejandro Salado (*S-C9*)

# Chapter 3

**Change #3.1**

Change: Information on the motivation behind the structure on the decision support system has been added. Regarding the comparison with other currently available method please refer to section "*3.4.4 Comparison with traditional project management approaches*" that has been added within the thesis revision

Location: pages 51 of the thesis final version.
Traceability: In response to the comment of the Associate Professor Dzmitry Tsetserukou *(T-C6)*

**Change #3.2**

Change: The sentence concerning the chapter contribution in answering the research questions has been amended in order to convey the right message.

Location: pages 54 of the thesis final version.
Traceability: In response to the comment of the Associate Professor Dzmitry Tsetserukou *(T-C7)*

**Change #3.3**

Change: Section "*3.1.5 Agile implementation viability*" has been significantly revised, explaining how the equations from 1 to 5 have been derived. The body of knowledge and the reasoning underpinning the construction of each formula has been expanded and discussed in depth.
Data used in the estimation of the functions approximating the different indexes as well as the thresholds adopted in the formulas have been explicitly reported, referenced (i.e., Age-of-Product.com, 2018, Atzberger et al., 2020; Saat Network GmbH, 2008, 2011, Schmidt et al., 2018b, 2019, Schwaber & Sutherland, 2020), and graphically summarised in Figure 24.

Location: pages 60, 61, 62, 63, 64, 65 of the thesis final version.
Traceability: In response to the comments of the Associate Professor Alejandro Salado (*S-C1, S-C14)*
In response to the comment of the Associate Professor Dzmitry Tsetserukou *(T-C8)*

**Change #3.4**

Change: Additional details on the thresholds and their effect on the recommendations provided by the proposed framework have been added

Location: pages 63, 64 of the thesis final version.
Traceability: In response to the comments of Associate Professor Alejandro Salado (*S-C13*)

**Change #3.5**

Change: Specific references to the scientific literature covering the last twenty years of research in the field that underpins the statement in the thesis have been added. Specifically, the thesis leverages two seminal research articles discussing the concept of modularity and granularity in engineering systems design and their effect on process cost and time performance. The relation between those concepts and the Agile implementation suitability is then further discussed in the case studies and summarised in the interim conclusion of each case study.

Location: pages 65 of the thesis final version.
Traceability: In response to the comment of Associate Professor Alejandro Salado (*S-C2*)

**Change #3.6**

Change: Further details on how to use the different thresholds and parameters during Sprint planning phase have been added.

Location: pages 72 on the thesis final version.
Traceability: In response to the comment of Associate Professor Alejandro Salado (*S-C14)*

**Change #3.7**

Change: A section "*3.3.1 Continuous process tracking and improvement*" has been added to expand what was mentioned at the trough Chapter 3 and summarized at the beginning in figure 20.

Location: pages 74, 75 on the thesis final version.
Traceability: In response to the comment of Associate Professor Alejandro Salado (*S-C12)*

**Change #3.8**

Change: Section "*3.3.2 MVP*" has been amended. Although the literature offers metrics to evaluate the maturity of a technology such as the TRL, it has been decided not to use it in the thesis due to a lack of consensus on the definition. The final taxonomy account for the MVP characteristics (Fidelity, Artefacts, Representation mode) and related verification targets.

Location: pages 76, 77 on the thesis final version.
Traceability: In response to the comment of Associate Professor Alejandro Salado (*S-C3)*

**Change #3.9**

Change: Conclusion sentences have been formulated.

Location: pages 82 on the thesis final version.
Traceability: In response to the comment of Associate Professor Dzmitry Tsetserukou (*T-C9*)

**Change #3.10**

Change: Section "*3.4.4 Comparison with traditional project management approaches*" has been added. The section provides a comparison of the approach prosed in the thesis against traditional PERT/CPM, thus highlighting the benefits and the novelty of the proposed framework.

Location: pages 87, 88, 89, 90 on the thesis final version.
Traceability: In response to the comment of Associate Professor Alejandro Salado (*S-C11)*
In response to the comment of Associate Professor Dzmitry Tsetserukou (*T-C9*)
In response to the comment of Associate Professor Anton Ivanov (*I-C2*)

**Change #3.11**

Change: It has been explained what the product composition measures. The author decided to provide details on the product composition in the section "*3.6 Deployment in development projects*", where the general structure of all the case studies is presented, to have a more coherent thesis structure and to avoid explaining the metric in each case study chapter.

Location: pages 102 Figure 47 on the thesis final version.
Traceability: In response to the comment of Associate Professor Alejandro Salado (*S-C4*)

# Chapter 4

**Change #4.1**

Change: The title of the chapter has been modified. The new title is "Cast study: New Space mission payload"

Location: pages 105 of the thesis final version.
Traceability: In response to the comment of Associate Professor Dzmitry Tsetserukou (*T-C11*)

**Change #4.2**

Change: The roles in the team and their relationship with the product composition have been elaborated in more detail. The number of people involved in the project, their specialisation, and the set of tasks they will be held accountable for (mapped on the product composition) has been specified.

Location: pages 109 of the thesis final version.

Traceability: In response to the comment of Associate Professor Alejandro Salado (*S-C5*)

**Change #4.3**

Change: The details about the organisations/teams that are used in the cases study have been elaborated in more detail. Specifically, it has been stated the number of people in the R&D team as well as their background. Additionally, the statement of the interviewee concerning the drivers that encouraged the Agile adoption has been reported

Location: pages 109 of the thesis final version.
Traceability: In response to the comment of Associate Professor Alejandro Salado (*S-C6*)

# Chapter 5

**Change #5.1**

Change: The title of the chapter has been modified. The new title is "Cast study: A consumer product"

Location: pages 129 of the thesis final version.
Traceability: In response to the comment of Associate Professor Dzmitry Tsetserukou (*T-C12*)

**Change #5.2**

Change: Additional details about the organisations/teams are provided in the extent the non-disclosure agreement in place with the organization allows it.

Location: pages 132 of the thesis final version.
Traceability: In response to the comment of Associate Professor Alejandro Salado (*S-C5, S-C6*)

# Chapter 6

**Change #6.1**

Change: The thesis contributions section has been improved providing additional details on how the proposed framework addresses the different concerns related to the implementation of Agile for physical systems development.

Location: pages 155, 155, 156, 157 of the thesis final version.
Traceability: In response to the comments of Associate Professor Alejandro Salado (*S-C10)*
In response to the comment of Associate Professor Dzmitry Tsetserukou (*T-C13*)

# Miscellaneous clarifications and edits

**Change #m.1**

Change: Multiple typos have been corrected.

Location: Multiple locations
Traceability: In response to the comment of Associate Professor Dzmitry Tsetserukou (*T-C3*)

**Change #m.2**

Change: Tiles of chapters and sections have been modified.

Location: Multiple locations
Traceability: In response to the comment of Associate Professor Dzmitry Tsetserukou (*T-C1*)

**Change #m.3**

Change: It has been amended the faculty position of the supervisor adding *"Associate"* Professor

Location: Frontpage
Traceability: Request from the Education Office

**Change #m.4**

Change: The dissertation has been amended, replacing the first-person plural (e.g., we) with first-person singular (e.g., I), or third person.

Location: Multiple locations
Traceability: In response to the comment of Associate Professor Alejandro Salado (*S-C15*)

**Change #m.5**

Change: In-text citations formatting has been corrected
Location: Multiple locations

Traceability: In response to the comment of Associate Professor Alejandro Salado (*S-C17*)

**Change #m.6**

Change: The wording Human-Computer Interface has been replaced with Graphical User Interface (GUI).

Location: Multiple locations
Traceability: In response to the comment of Associate Professor Dzmitry Tsetserukou (*T-C10*)

**Note #1**

As requested, the comments of Associate Professor Anton Ivanov (I-C1, I-C2, I-C3) will be addressed during the presentation.

**Appendix A**. Summary and ID of the comments provided by the reviewers.

| **Summary of the comments provided by Associate Professor Alejandro Salado** | |
|---|---|
| **ID** | **Comment** |
| S-C1 | The candidate should explain how the formulas used in the dissertation (equations 1 through 5) have been derived/constructed/defined. This is necessary to assess their adequacy.<br>Explanations of how the different thresholds for using the formulas (or defined as part of the formulas) lack. The candidate should explain how the used thresholds have been defined |
| S-C2 | The statement that "These metrics, providing a measure of tasks' intrinsic characteristics, can be used as a proxy to understand if both work and system decomposition … are suitable for Agile implementation" is unsubstantiated, at least when made. Explain how this has been validated. |
| S-C3 | The use of TRLs is inconsistent with their use in industry practice. TRL refers to the maturity of a technology under development, not of a component under development. For example, one does not simply move from TRL 3 to 4 because a design is built, or from TRL 5 to 6 because a performance test is carried out. Having said that, I do not see why mentioning TRLs are relevant for the work and the examples provided in the dissertation. I suggest removing TRLs and simply discuss verification targets during the system development. |
| S-C4 | In the cases, it is not clear what the percentages measure in product composition (e.g., number of parts of a specific kind, level of effort…?). Please, explain what product composition measures. |
| S-C5 | It is not clear why defining roles in the teams is important. Please, describe how these roles are used in the cases and map them to product composition. |
| S-C6 | The details about the organisations/teams that are used in the cases should be elaborated in more detail. For example, in the third paragraph in Section 4.3, the term "some" is vague, the process to identify drivers is not described, what do team members mean by "interesting" results? |
| S-C7 | I am cautious about the depth of the literature survey, since the review omits arguably the most relevant author in implementing Agile practices for HW systems, Rick Dove. The candidate should revisit the literature review explaining how the literature search has been conducted. If necessary, the literature review should be updated to include a deeper critique of current work that addresses the use of Agile practices for HW systems. |
| S-C8 | The second part of the literature review chapter, which addresses use in industry, often uses unsubstantiated claims (e.g., "The problem can be partially mitigated by adopting Model-Based Systems Engineering (MBSE) approaches and tools. However, this would make the process lose momentum, introducing additional complexity due to reconciling two quite far methodologies." The purpose of this chapter is to justify the research gap addressed in the dissertation. The first part achieves so, but the second seems too anecdotal. The candidate should either support some of those findings with results from existing literature or explain why those anecdotes may be confidently used as supporting |

| | |
|---|---|
| | evidence. For example, I believe that there is sufficient literature to substantiate some of the claims in Table 4. |
| S-C9 | The candidate should consider adding a section that consolidates the findings from the literature review and the industry evaluation, as closure to the research gap identification. |
| S-C10 | In terms of the proposed framework and cases, while the examples clearly introduce HW-specific issues, it is unclear how the proposed framework addresses them for the implementation of agile. A detailed explanation of this unique aspect is necessary. |
| S-C11 | While I believe there are unique differences between the proposed approach and using, for example, traditional schedule optimisation techniques, these differences are not explicitly conveyed in the dissertation. The candidate should explain what is novel in the proposed framework or what benefits the proposed framework provides when compared to traditional schedule or resource allocation optimisation methods. For example, a comparison against a traditional critical path approach may be useful. |
| S-C12 | The cases seem to address only planning of sprints, not execution and re-planning, which is one of the key aspects of Agile (the adaption of the development process as the development progresses). This is a major omission when working with Agile. There are two possible courses of action for the candidate here. First, update the framework to incorporate the iterative nature of agile and extend the cases with notional scenarios of progress to see how the planning adapts to different types of results. Second, update the dissertation to be explicit about this limitation throughout the document. |
| S-C13 | Given that the choice of tasks depends on the viability metrics, it would be useful to incorporate a sensitivity analysis to show how choosing different thresholds affects the recommendations of the proposed framework. |
| S-C14 | The candidate should explain how to use the different thresholds and other user-defined parameters in the framework. |
| S-C15 | The dissertation should be written as the work of a single individual. Therefore, please reword the use of first-person plural (e.g., we) by first-person singular (e.g., I) or third person. |
| S-C16 | The RQ could be formulated to read less vague and more actionable. For example, what is the meaning of “support” in RQ2? What is the meaning of “understand” in RQ1? |
| S-C17 | In-text citations formatting seems incorrect at times (e.g., Dikert (Dikert et al., 206) instead of Dikert et al. (2016)). Please, correct throughout the dissertation. |

| Summary of the comments provided by Associate Professor Dzmitry Tsetserukou | |
|---|---|
| **ID** | **Comment** |
| T-C1 | The names of the chapters are short that does not allow the reader to get the idea of their content. Therefore, I recommend to include meaningful titles, e.g. Agile can be replaced with Agile Methodology and Approaches. |
| T-C2 | It is important to include the Glossary to define a plenty of abbreviation used in the thesis. |
| T-C3 | The grammar quality of scientific English is good, however, there are typos and some grammar mistakes through the text |
| T-C4 | I suggest to reformulate the research question 1 to: “How to understand when and how to use Agile methods within the development of physical systems on the specific project context and system features?”. |
| T-C5 | The Research Question 2 is not comprehensive, specifically “How to support” can be formulated “Which infrastructure should be developed to make Agile methods more effective for physical systems development”. |
| T-C6 | Chapter 3 starts with introducing proposed CURSIVE depiction support system. However, the explanation of the problem that it solves comparing with other decision support system should be presented. Additionally, the motivation behind its structure should be explained |
| T-C7 | In the section 3.1 Structuring, it is stated “the approach proposed in this first stage answers the first research question” is not technically correct because it is not clear from approach when and how to use Agile |
| T-C8 | The time-based index is not defined on page 56. All equations that are taken from the literature must have the reference to the source just before the Equation. |
| T-C9 | There must be conclusion on results of the evaluation of the proposed decision support system. Conclusion on the page 73 should be reformulated as “This situation poses the trade-off between technical risks and the impact on cost” is obvious and does not proved a valuable data for the specialist. |
| T-C10 | Human-Computer Interface is a topic mostly related to the technologies to interact with computers, therefore, I suggest to change this term to Graphical User Interface (GUI). |
| T-C11 | Title of the Chapter 4 is too general. I recommend to change it to Case study of CURSIVE framework for New Space Mission Payload. |
| T-C12 | Name of Chapter 5 should be replaced with “Case study for a consumer product development”. |
| T-C13 | In the Chapter 6 Conclusion there must be given numerical values proving that the proposed framework is effective in some cases of product development |

| Summary of the comments provided by Associate Professor Anton Ivanov | |
|---|---|
| **ID** | **Comment** |
| I-C1 | I am always looking for validation of the method proposed. In section 3.5, you are proposing validation of the technique. There are a few approaches that you mention, but what I'm looking for is some kind of graph "expectation vs reality", and you are showing that, for example, your method is 95% close to something. Maybe this approach is not applicable in your case, but I am looking for some metric of validity of your method. |
| I-C2 | Clearly, Chapter 4 describes in detail the application of the method - this is great. But do you have a comparison of your method and "business as usual". The main argument people have against systems engineering is that it carries significant overhead relative to a process we have a team. E.g. it was great that you were able to contribute to the workings of the startup, but I do not think startups typically have the luxury of employing these techniques. There is probably an optimal size of the enterprise where this method is applicable. that is, if you only have 3 people, the overhead will be too much, but if you have like 50 people, probably it is going to be ok. |
| I-C3 | Also, it seems to me that your method requires a very good knowledge of task durations and how long things will take. My experience tells me that, especially in research projects, it is very difficult to estimate the times and resources required for tasks. That is why all the projects are late. |