Skoltech
Skolkovo Institute of Science and Technology

Jury Member Report – Doctor of Philosophy thesis.

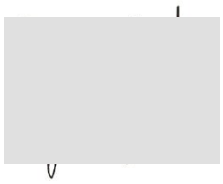
Name of Candidate: Sabah Farshad

PhD Program: Engineering Systems

Title of Thesis: Improving collaborative engineering design and learning through feedback systems in the age of digitalization and AI

Supervisor: Professor Clement Fortin

Name of the Reviewer: Julie Stal-Le Cardinal

I confirm the absence of any conflict of interest 	**Date: 15/01/2024**

The purpose of this report is to obtain an independent review from the members of PhD defense Jury before the thesis defense. The members of PhD defense Jury are asked to submit signed copy of the report at least 30 days prior the thesis defense. The Reviewers are asked to bring a copy of the completed report to the thesis defense and to discuss the contents of each report with each other before the thesis defense.

If the reviewers have any queries about the thesis which they wish to raise in advance, please contact the Chair of the Jury.

Reviewer's Report

Reviewers report should contain the following items:

- Brief evaluation of the thesis quality and overall structure of the dissertation.
- The relevance of the topic of dissertation work to its actual content
- The relevance of the methods used in the dissertation
- The scientific significance of the results obtained and their compliance with the international level and current state of the art
- The relevance of the obtained results to applications (if applicable)
- The quality of publications

The summary of issues to be addressed before/during the thesis defense

Sabah Farshad's research work is part of the PhD Program in Engineering Systems at Skoltech and was supervised by Professor Clément Fortin.

The thesis is a monograph with a clear structure and a coherent presentation of the study divided in 6 chapters of in total 152 pages besides glossary, publications and around 300 references. Publications include 2 proceedings, 1 conference paper, 1 published journal paper and 1 accepted journal paper.

The introduction (20 pages) presents the context of the research, the scope, the relevance and the research methodology. The PhD student presents here 3 Research Questions. Two of them are coherent and comprehensive, but the second, on dashboards to improve collaboration, is much more restrictive and already provides a solution. Why restrict the issue? We don't see the justification. Moreover, these questions are different from the 5 research questions presented later on page 85, chapter 3. A clarification is necessary here.
The concept of collaboration is then defined, along with collaborative engineering design, collaborative learning and poor collaboration. As the research main objective is to improve the collaboration, we don't understand why so much emphasis is placed on the concept of poor collaboration. This might be interesting if a risk analysis were then carried out, but here no conclusions are drawn from the analysis of poor collaboration.
In our view, the scope and relevance sections could be merged. This would simplify the subject and avoid certain redundancies.
At last, the presentation of the research methodology, based on DRM, is really clear as well as the content of each chapter (pages 32-33). Unfortunately, we miss a clear PhD thesis structure in figure 1.5. A way to do it could be to merge DRM (figure 3.1), thesis structure and chapter content in a more complex figure. This can be presented during the oral defense. This kind of figure could also support the explanation of the scientific approach in pages 77-78.

The second chapter concerns the literature revue on collaboration (40 pages).
This part aims to explore approaches to enhance collaborative engineering design and learning with the context of digitalization, while focusing on the potential of feedback systems and cutting-edge technologies.
In this chapter, we would also have liked to see a clear statement from the doctoral student on the key concepts of his research and on the different definitions used for the presentation of the work. This would have ensured a degree of consistency and enriched the glossary, in which some concepts are missing. For example, it defines active engagement, but not engagement, motivational interviewing, but not motivation...
We would like to make one formal comment about the figures. Figures 1.3 on page 25, 1.4 on page 28 and 1.3 on page 53 add no value to the text and take up a lot of space in the manuscript. Note that figure 1.3 on page 53 is subject to a numbering error.
Finally, we really appreciate the highlight on the research gaps which enables the research work to be clearly positioned in relation to the state of the art. We also appreciate the Chapter Summary sub-section, which summarizes the content and contribution of each chapter, although it's a shame this isn't systematic (it doesn't exist for chapter 4, for example).

Chapter 3 (15 pages) presents the research methodology, the thesis objectives and the Research Questions.

4 goals of the research are presented on page 81:

1. Provide a better understanding;
2. Design and propose supporting technology-based tools;
3. Propose human-centered approaches;
4. Explore potentials of cutting-edge technology.

And then 5 Research Questions (RQ) are proposed. With the exception of RQ3, the link between goals and RQs is clear and unambiguous. On the other hand, QR3 needs to be better introduced, apparently, RQ3 is not goal related… A way to do it might be to present Research Hypothesis… indeed, according to me, one of your research hypotheses is that Feedback systems is a solution.

5 case studies are analyzed in chapter 4 (50 pages).
All the case studies took place in an academic context/course.
Concerning case study 2, figure 2.4 already exists and was presented before in the document with another reference number. It losses the reader, you should have referred to the figure so as to simplify.
Concerning case study 3 about Feedback on active Engagement, we lack definition of engagement compared to motivation for instance. How can you measure engagement? Or motivation?
It is important to be consistent in the terms used. So sometimes the word feedback is written in one word (page 86) and sometimes in two, as in feed-back (page 123).
Finally, the fifth case study is more a proposition and a test of a model created and proposed by Sabah Farshad thanks to the work done through the 4 other case studies. According to me, this part should have been presented as a proposition of a ML-NLP model so as to highlight more the value creation of the research done.
All the case studies took place in an academic context and in Russia. This raises the question of the generalizability (or genericity) of the research and its conclusions. Could the model proposed in Case Study 5 be applied as it stands in an industrial context and in countries other than Russia?

The fifth chapter concerns the discussion (8 pages) and the last one the conclusion (6 pages).
In the discussion part, the PhD student summarizes how the work done answers each research question. In the conclusion, there is a brief recap of all the case studies. I suggest to merge discussion and conclusion parts to as to have a more consistent last chapter. I am missing the highlight of value created by this research work: academic value, research value and industrial value.
During the final presentation, it will be useful to have a clear and concise answer to the general question of the thesis: how can we improve collaborative engineering Design and Learning?

Finally my last question will be about gamification. Dashboard and measurement are two ways to analyze engagement and motivation, but it can be a wrong way and might kill motivation to do it. The concept of gamification is very lightly mentioned, particularly in the summary of this thesis work, and we think it would be appropriate to raise it during the oral questions, as a means of increasing engagement.

Overall opinion:
The work carried out is substantial, based on a good review of the literature and carried out within a broad academic framework (five case studies). The results address the issue in question, although the approach still needs to be validated on a broader, more general level, in particular by opening it up to the industrial world. The sustainability of the proposed processes is also questionable for the time being.
The structure of the document is consistent with what you would expect from a doctoral dissertation.
The form of the document is clear, even if it is sometimes difficult to distinguish between what the author brings to the table through his research work and what he takes from the literature and what already exists.
These comments do not call into question the relevance of this work, nor the rigor with which it was carried out, but highlight the interest shown in this research.

Consequently, the document reports a substantial amount of work. We give a favorable opinion for the defense of this thesis with a view to obtaining the degree of Doctor of Philosophy thesis for Sabah Farshad.

Provisional Recommendation

■ *I recommend that the candidate should defend the thesis by means of a formal thesis defense*

☐ *I recommend that the candidate should defend the thesis by means of a formal thesis defense only after appropriate changes would be introduced in candidate's thesis according to the recommendations of the present report*

☐ *The thesis is not acceptable and I recommend that the candidate be exempt from the formal thesis defense*