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Concerns: Review PhD thesis Ing. Aleš Marek "Architect's role in design process of buildings using BIM method."

Dear Madam, Sir,

This letter concerns my review of the PhD thesis by Ing. Aleš Marek, titled "Architect's role in design process of buildings using BIM method." My review is written from the perspective of design research and design methodology, and informed from my knowledge of BIM in architectural design.

From my perspective, it is necessary to point out from the start a principled difference of understanding what the term "activity" means. In the research thesis by Ing. Aleš Marek, activities are equal to the documents and (sub)models produced by parties in the design and construction process. In my opinion, these are not activities but products. Not making this clear leads to a confusion between *means* and *ends*. The *end* of the architect is to make a good design; the several models offered by BIM are *means* to that end. Especially from an architectural point of view, this reversal does not help architects to understand *what* and *how* they should be doing things, only what should lie on the table at the end.

Similarly, method in the thesis is understood as the whole set of (sub)models related to BIM. Design methodology and similarly BIM method focuses rather on "…the establishment of appropriate structures for the design process; the development and application of new design methods, techniques, and procedures; and reflection on

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the nature and extent of design knowledge and its application to design problems" (Nigel Cross, 1984, Developments in Design Methodology). The closest to a methodology is the Works Scope Split on pages 1-6 of the third section of Annex C. However, dependencies of process order that are proper to a method are missing.

Having these basic assumptions identified, I can discuss the PhD thesis.

The PhD thesis is written in English language, which is recommendable for a dissertation work. The main text of the work is between pages 1-34. All the rest of the thesis (349 pages) is appendix. It is very confusing that each section in the annexes starts with new page numbering. For example, Annex C (Project Charts) starts with a new page numbering seven times. There is no unifying numbering system used throughout the whole thesis.

The style of writing throughout the whole thesis is extremely concise. The whole text resembles the printed-out version of bullet-points from a PowerPoint presentation. Going from one list of numbered items to another list of numbered items is accompanied by a minimum amount of text, sometimes just one sentence. The reasoning and explanation of logic and structure of the text is missing. For this reason, the text is very hard to understand.

There is a strong emphasis in the text on the results of the work. This goes at the expense of explaining why the methods and approaches chosen here are suitable and sufficient. The context that explains the method is missing.

The most basic question for the PhD work is: Is the level of BIM adaptation in Czech Republic much different from surrounding countries, and Europe in general? Does there exist an ideal level of BIM use in architecture and construction, and if so, what does it look like? There is of course no objective answer to this question. It is closely tied to a theoretical view what architectural/engineering design is, and how BIM supports this process. This is something that should be answered in Section 2.1. A further question is, whether different countries and regions can require different levels in BIM adaptation, or whether our discipline should aspire to a unified international approach? Without answers to these questions, it is not possible to say where in Czech Republic we are ahead, behind, or similar to the rest of the world. This should be answered in Section 2.2.

The answer to these questions then gives the backbone to the following three parts of the research work by Ing. Aleš Marek: the first part is literature analysis and the identification of BIM codes, norms, and regulations that are in

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effect (or soon to be) in Czech Republic. The second part is the analysis of projects undertaken by AED Project, Aleš Marek Division, in the period 2011-2021. The third part is a questionnaire sent to professionals.

Part one: Codes, norms, and regulations

The research literature on BIM is very large. The Scopus database on the search phrase "Building Information Model" gives 4627 results. Springer Link gives 3375 results. Web of Science gives 1586 results. It is of course impossible to read all sources. A literature review is always an informed choice of the available sources, where it can be argued that a representative selection of sources has been analysed and their findings presented. This part is missing in the thesis.

The second part of the literature review is the identification of codes, norms, and regulations that are in effect in Czech Republic. The collection presented in the thesis text is an important result.

Part two: Project analysis

The analysis of projects compares a total of 128 projects, of which 28 were done using BIM. The data was analyzed on 17 aspects, ranging from kind of "Contract Holder" (2.1, page 20) to "Completed International Cooperation" (2.17, page 25). Each aspect is briefly evaluated and conclusions are drawn.

A retrospective analysis of body of work has to deal with historical data that have accumulated over a period of time (in this case 2011-2021). This means that the analysis is dependent on available data, since it is most unlikely that from the very start the data has been organized to facilitate a later analysis. This is different from a controlled experiment, where the structure of the data is set up in advance, and the observations follow from the structure. Additionally, in time the technology of BIM and software develops as well. Therefore, there should be some explanation of the selection of aspects, why this particular selection gives us valuable information, and what may be missing. Comparison with similar research by other people gives an indication how complete the work is. This is missing in the thesis text.

To the best of my knowledge, a complete analysis of a firm's engagement with BIM in practice has not been done before in Czech Republic. Thus, the analysis by Ing. Aleš Marek is an important result of the work.

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Part three: questionnaire

In section 4.2., pages 25-30, a questionnaire containing 17 questions about BIM is described. On page 30-31 the results are summarized.

A research methodology utilizing questionnaire should have three aspects: (1) A description of the set of questions, and what kind of information the answers to the questions are expected to provide. This should be cross-checked with related work by other researchers. (2) Description of the respondents to whom the questionnaire is sent out, through which criteria they are selected, how the questionnaire is sent, how results are collected, the proportion of respondents that reacted, and the number of valid results. (3) The method for analyzing the results. None of these methodological aspects are described in the text.

It seems from the text that the questionnaire is sent out also to people outside Czech Republic, but this is never mentioned in the text.

The main text between pages 25-31 deals with the questionnaire responses from architects. Unless one remembers that on page 18 of Section 3.5. in point 4 it is stated: "…I conducted a survey among architects, designers (head engineers, engineers in charge and designers) and builders" this gives the impression that the questionnaire is sent out only to architects.

Research goals and conclusions

Chapter 5 summarizes the findings of the research. This should be done in the context of the research goals set out in Chapter 1 on page 1.

Concerning Chapter 1, at the start of this review I mentioned already the difference between activities and products. Thus, points 2 (key activities of the architect) and 4 (new demands on the architect's activities and specification of new job positions) are not fulfilled. Point 5 (requirements according to selected typological representatives) is discussed in so far, that it is stated that all building types can be done with BIM method (point 8 of the questionnaire summary discussion on page 30).

All other points mentioned in Chapter 1 on page 1 I consider as answered in the research work.

Concerning Chapter 5, there is a confusion between starting points of the research and results of the research. Section 5.1. (page 32) describes the credibility of the data. This should be in Section 3.4. (page 17-18) where the research and data processing method are discussed. Section 5.2. (pages 32-33)

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identifies new information. However, points 3 (current BIM legislation and standards), 5b (existing work plans – except for AED), 5c (Works Scope Split), 5d (Design Team Matrix), and 5e (schemas of BIM and DBIM) are existing documents and not new findings. Therefore, they should be in different sections of the thesis work.

The other points mentioned in Section 5.2. are proper results of the research work.

The final summary in Section 5.3. (page 34) is based on the research work.

Annexes to the research thesis

Annex A has the full text versions of earlier published papers by Ing. Aleš Marek. A PhD thesis is either a compilation of published papers, ideally in impacted journals, or a novel text that comprehensively describes the research. It is never a mix of both. Therefore, this Annex is superfluous for the thesis text.

Annex B lists the results of the analysis work of the projects done by by AED Project, Aleš Marek Division, in the period 2011-2021, and the results of the questionnaire.

Annex C lists a number of documents and diagrams concerning the organization of work using BIM.

- Item 1 (Actions related to BIM acc. to CCAET Standards) is co-produced by Ing. Aleš Marek and thus a new finding of the research.
- Item 2 (Plans of Work Overview) is a partial citation of "Figure 1: Comparison of international plans of work" on page 9 of "RIBA Plan of Work 2020 Overview." There is one novel element, the row for AED, and one novel column not present in the original RIBA document (column "Bidding")
- It is unclear what the source of items 3 (Works Scope Split) and item 4 (Design Team Matrix) is. It should be mentioned whether it is the result of original work by the author, or from which source it is taken. This information is not present.
- Item 5 (BIMo Scheme) and item 6 (DiBM Scheme) are shown without source reference nor explanation what they mean.
- Item 7 (Project Organizational Scheme) and item 8 (Life-Long Cycle of Construction) are shown without source reference or explanation whether this is the result of original work by the author.

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Annex D has the used literature list (Section 1), comprehensive list of documentation (Section 2), documents of the government (Section 3), and list of norms concerning BIM (Section 3).
All links in Section 2 and Section 3 are derived from the website https://www.koncepcebim.cz. Although each link points to a different URL, clicking on the link leads for each and every document to the same location, the main page of www.koncepcebim.cz.

Conclusion of the review

The dissertation text has considerable flaws in standards of scientific writing and reporting. Most notably, research methodology and state-of-the-art is missing, and there is no substantial literature review. However, it is clear from the presented work in the dissertation thesis that Ing. Aleš Marek has the required knowledge, expertise, and experience of an authority on the use of BIM in architecture. Therefore, I propose the dissertation thesis to be passed and recommend it to be defended.

Thank you very much for your consideration,

Yours faithfully,

Prof.dr.ir. Henri Achten

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