**Reviewer #1**

The paper presents an optimization algorithm based on BIM and MOGA model. The proposed approach is interesting and could be helpful for decision-making during the construction process. The article falls within the scope of the journal and can be considered for publication after the revision taking into account the comments below:

**Comments and Suggestions for Authors:**

The authors have chosen a really valuable subject for this study and have made considerable efforts to make it successful.

**Answer:** The authors are grateful for the positive assessment and valuable suggestions given by the reviewers. Please find below our response to the reviewers’ comments (the line numbering corresponds to the untracked file, **applsci-1185282**). The revised m/s addressing the reviewer 1’ comments are written in “Blue”

1) The first is language. This is an English language journal, and the paper needs an editing to improve the grammar and word choice.

**Pornpote**

**Answer:** Implemented. The m/s was thoroughly revised to improve flow and readability, particularly the Introduction (see tracked version of the m/s).

The careful reading and revision of text is needed. The structure of some sentences have to be revised, the corrections of syntax, structure, word choice and punctuation is needed. An example of unclear sentences see on rows 114-117: “An optimization technique such as genetic algorithm (GA) was used with BIM for possibilities usage of information from BIM directly and parsing it to data to GA directly [23]. More than the fuzzy-logic dataset was possibilities usages in GA for construction scheduling [24].”

**Manop**

**Answer:**

The authors should clarify the concepts of “construction” and “renovation” they used in the article. In many places in the article, these terms are used together, e.g. “Construction renovation is known...”, “…Scheduling of a Construction Renovation Project…”, “Construction renovation projects are particularly complex...“. What do the authors mean? Is it the construction and/or renovation of any building? Or, is this only renovation of any building? As authors state in the Abstract, “The data were retrieved from a renovation project...”, it is expected that the article analyzes the renovation project; therefore, I suggest considering a revision of title, abstract, and keywords, as well other places in the article were “construction renovation” appears. In any case, renovation is a type of construction. This could be mentioned and the concept of a construction project explained.

**Pornpote**

**Answer:**

“The BIM of the renovation project was initially created…”( row 163). BIM is a methodology. Use please “The BIM model of the renovation project …”. The same on rows 178, 182, etc.

**Pornpote**

**Answer:**

2) Introduction.

The background presented in the Introduction is weak. Add more recent sources on BIM advantages and challenges, and discuss more novel optimization techniques.

**Pornpote**

**Answer:**

Many of the statements in the Introduction are not supported by any citations, like “A BIM model consists of (1) physical properties in three dimensions, such as material, density, weight, or location; and (2) embedded information, such as construction specifications or repair manuals” or “Several researchers and practitioners have used BIM in a variety of aspects.” (rows 66-69); “Several researchers adopted optimization techniques 88 to solve construction planning and scheduling problems.” (rows 88-89). Provide references to literature sources.

**Manop**

**Answer:**

Sometimes there is a lack of links between individual statements. For example, the sentence on row 75 is not connected logically with the text earlier presented in that paragraph.

**Manop**

**Answer:**

3) The structure of paper.

The last paragraph in Introduction should describe the article structure. The latter is necessary to explain the logical flow of the presented research study.

**Pornpote**

**Answer:** Implemented. The m/s was thoroughly revised to improve flow and readability, particularly the Introduction (see tracked version of the m/s).

The BIM-MOGA Model presented in the section 3 is a part of the methodology, therefore must be presented as part of section “2. Materials and Methods”.

**Pornpote**

**Answer:**

The formulas associated with Optimization Definitions presented in section 2.2 must be moved to the section 3.1 were the main calculations described.

**Pornpote**

**Answer:**

4) The quality and relevance of Figures.

“The exterior and interior of the building are displayed on Figure 1.” The reader of the article cannot see the exterior of the building, and the picture of interior is inconclusive and has no connection with the investigation. Remove this figure or replace with relevant views.

**Pornpote**

**Answer:**

What was the purpose of showing an old image of a building plan on Figure 2? It is illegible, and therefore has no value for this study. Could the authors redraw and present this plan in a legible way?

**Pornpote**

**Answer:**

Gantt chart schedules depicted on Figure 5 are illegible. Provide a higher resolution versions.

**Pornpote**

**Answer:**

Check the numbering of the figures. The “Figure 5. The flow diagram of optimization procedure” must be figure 6, and so on. Make appropriate corrections in the text where the pictures are mentioned.

**Pornpote**

**Answer:**

5) Methods.

Provide more details on how BIM module connected with MOGA module, and how data from BIM model transferred to MOGA optimization algorithms.

**Pornpote**

**Answer:**

6) Results.

On the rows 420-422, authors compare the results of their proposed model with the results from the previous research [30]. However, there are no possibility to check these statements, as the source [30] is presented as article in press and not available yet:

Nusen, P.; Piyawongwisai, P.; Nusen, S.; Kaewmoracharoen, M. Resource Utilization Optimization using Genetic Algorithm 520 based on Variation of Resource Fluctuation Moment for Extra-Large Building Renovation. In Article in Press, ACM 6th 521 International Conference on Intelligent Information Technology, ICIIT 2021; 2021.

**Pornpote**

**Answer: https://doi.org/10.1145/3460179.3460183.**

Statement on rows 430-431 “When we looked at the original construction cost and time, we found that optimization is clearly better than non-optimization” is erroneous, as it is not supported by any proof. Moreover, Table 2 provides the same values for cost and time resulted from Original Plan and Optimal Plan. Provide a correct explanation for how the Optimal Plan differs from the Original Plan.

**Wanarut**

**Answer:** **When we considered the cost and time of both plans which are equal, we found that optimization’s Mx objective is clearly better than non-optimization’s Mx objective. This means we can reduce the worker density on the construction site. Furthermore, there are many optimal plans for utilizing that are better than one original plan.**

7) Conclusions.

The scientific contribution of the research findings needs to be better emphasized in Conclusions.

**Pornpote BIM MOGA**

**Manop BIM**

**Wanarut MOGA**

**Answer: Answer in Bullets**

* **BIM MOGA / Pornpote**
* **BIM / Manop**
* **MOGA / Wanarut**

**Reviewer #2**

**Comments and Suggestions for Authors:**

The authors have chosen a really valuable subject for this study and have made considerable efforts to make it successful.

**Answer:** The authors are grateful for the positive assessment and valuable suggestions given by the reviewers. Please find below our response to the reviewers’ comments (the line numbering corresponds to the untracked file, **applsci-1185282**). The revised m/s addressing the reviewer 2’ comments are written in “Green”

1. Selected parameters can be from one group. The focus on time parameter is the focus at the first.

**Manop อ่านคอมเมนท์แล้วผมไม่เข้าใจครับ**

**Answer:**

1. The detailed review with a selected problem of the topic can be presented as text or a review part;

**Pornpote**

**Answer:**

1. In paragraph 1.2. Construction planning and scheduling optimization must be presented analysis on all phase of construction (not only on pre-construction phase).

**Pornpote**

**Answer:**

1. The selected criteria with a focus on minimising project duration must be indicated and discussed widely.

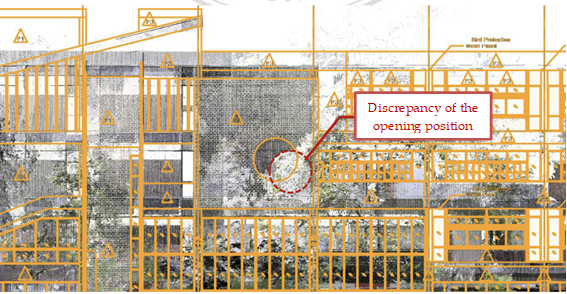
**Manop อ่านคอมเมนท์แล้วผมไม่เข้าใจครับ**

**Answer:**

1. Figure 3 can be present with better quality.

**Pornpote**

**Answer:** Revised. The m/s has included a high resolution for Fig. 3 below:



**Figure 3.** Point cloud dataset from terrestrial laser scanner overlaid on the existing building and its surrounding of Chiang Mai University Library.

1. In paragraph 2.2. (line 201) Optimisation parameters must be represented the time, modelling of  construction and building

**Manop อ่านคอมเมนท์แล้วผมไม่เข้าใจครับ**

**Answer:**

1. In manuscript two Figure 5. Please last only one.

**Pornpote**

**Answer:** The revised m/s has included the explanation of Fig .5. See m/s page 7, lines no. 214.

1. In Figure 5. the Construction data must be corrected with a focus on scheduling and modelling of construction and building technology parameters.

**Pornpote**

**Answer:**

1. Cost calculation is not the goal of this research (please correct the methodology and analysis of the selected case study;

**Pornpote**

**Answer:**

In this paper, the authors integrate ideas from previous studies to develop a BIM-based MOGA. A case study of the renovation of an extra-large building project was used to validate the proposed BIM-based MOGA.

Ex. From MDPI Paper

To date, existing research on the use of Ecofonts has focused on Latin typefaces, as most of the studies where carried out in countries where English is used. Therefore, the use of Ecofont cannot be extended to other non-Latin alphabets [25], which in turn hinders opportunities for material and cost savings elsewhere. In this study, the commonly used Latin typefaces are first modified by placing holes within the typeface, and image analyses on pixel removal is subsequently performed. Comparisons are made between less-ink intensive typefaces (Century Gothic and Times New Roman) and the Eco Vera Sans typeface. The removal of black pixels (leading to hollow-embodied typefaces) is also investigated using the Thai language as a case study of a non-Latin alphabet. Based on these results, the study proposes a new Ecofont typeface for the Thai language. The study also presents a mass analysis to examine ink/toner savings, as well as results from observers’ tests on visibility and legibility of texts printed with Ecofonts or solid (original) typefaces. The results of this study contribute towards promoting GIT printing, which is expected to bring benefits to the environment by reducing ink/toner consumption in South East Asia.

1. The genetic operations with pseudocode can be presented as an appendix.

**Pornpote**

**Answer:** Revised. The genetic operations is presented in appendix.

1. In Figure 10, 11 the calculation results with time parameters can be presented;

**Manop อ่านคอมเมนท์แล้วผมไม่เข้าใจครับ**

**Wanarut**

**Answer: The calculation results were shown in Table 2. We just plot the results on the graph for showing the trending.**

1. The literature analysis with a reference list with a new literature source (from the 2020-2021 year) can be presented.

**Pornpote BIM MOGA 4-5เปเปอร์**

**https://www.ciob.org/sites/default/files/M22%20%20OPTIMISATION%20OF%20CONSTRUCTION%20PROCESSES.pdf**

**https://www.sciencedirect.com/science/article/pii/S1110016814000556**

**http://site.iugaza.edu.ps/kshaath/files/2010/10/Construction\_Scheduling\_\_Cost\_Optimization\_and\_Management.pdf**

**https://link.springer.com/content/pdf/10.1057/jors.2012.174.pdf**

**https://res.mdpi.com/d\_attachment/sustainability/sustainability-10-01381/article\_deploy/sustainability-10-01381.pdf**

**https://res.mdpi.com/d\_attachment/algorithms/algorithms-11-00087/article\_deploy/algorithms-11-00087.pdf**

**https://www.researchgate.net/publication/332149626\_Optimization\_in\_Decision\_Making\_in\_Infrastructure\_Asset\_Management\_A\_Review/fulltext/5ca3694ca6fdcc12ee8c68b3/Optimization-in-Decision-Making-in-Infrastructure-Asset-Management-A-Review.pdf?origin=publication\_detail**

**https://res.mdpi.com/d\_attachment/energies/energies-10-01167/article\_deploy/energies-10-01167.pdf**

**https://res.mdpi.com/d\_attachment/buildings/buildings-04-00295/article\_deploy/buildings-04-00295.pdf**

**https://res.mdpi.com/d\_attachment/mti/mti-02-00021/article\_deploy/mti-02-00021.pdf**

[**https://res.mdpi.com/d\_attachment/sustainability/sustainability-12-03405/article\_deploy/sustainability-12-03405.pdf**](https://res.mdpi.com/d_attachment/sustainability/sustainability-12-03405/article_deploy/sustainability-12-03405.pdf)

**Manop BIM 4-5เปเปอร์**

**Wanarut ช่วยเขียน** **literature analysisที่เกี่ยวกับMOGA(from the 2020-2021 year) ให้สัก4-5เปเปอร์ครับ**

**Answer:** The revised m/s has updated and included the new references from 2020-2021, as details below:

1. In the reference list, p.23 (line 503) can be corrected.

**Pornpote**

**Answer:** The reference no. 13 is now correct.