Doc. Ing. Martin Pavlas, Ph.D.
Institute of Process Engineering
Faculty of Mechanical engineering
Brno University of Technology
e-mail: martin.pavlas@vutbr.cz

Review Report for the Doctoral thesis

Submitted to: Brno University of Technology, Faculty of Mechanical Engineering, institute of Process Engineering

Author: **Ing. Teng Sin Yong**

Supervisor: doc. Ing. Dr. Vítězslav Máša, PhD

The submitted PhD. thesis is approx. 450 pages long and it is composed of twelve chapters/sections. The organization of all sections is similar and follows the recommended structuring of journal papers (Introduction, Material/Methods, Results, Conclusions, References).

The quality of the research

Worth mentioning is the Appendix, where the author summarises his publications and research achievments. The Appendix is structured as follows: Selected publications, Other Related Publications, Softwares. The list contains 20 items, 14 of them have been published in recognised journals with impact factor. The journals are prestigious with a very high impact factor for the field and belonging to the first quartile. Many papers were published in Renewable and Sustainable Energy Reviews journal with IF = 12, for instance. Teng Sin Yong is the leading author in seven of these papers, which confirms the high scientific relevance of the work and his high share of involvement. The work passed through the stringent peer-reviewing process and has been accepted by the community. Quick inspection of author's details in the Scopus database revealed 19 documents, 69 citations and Hirsch index (H-index) 4 without self-citations. This an excellent score at this stage of the scientific career.

The Objective of the Research

Teng Sin Yong proved a substantial contribution in the field since he mastered many latest methods of big data processing and applied them newly for improvements of energy-intensive processes. This knowledge transfer between Informatics/Applied informatics and Process industry is essential to make the manufacturing processes more sustainable. Besides, it contributes to the use of data, which is frequently gathered but not effectively utilised to save raw materials, energy and cost.

The main objective of the research is outlined in Section 3, where a general framework for process improvements is presented. It smartly integrates several techniques, which are then individually tested through industrial case studies in Sections 4 to 11.

Comments

The work is too long and unfriendly to the reader and/or reviewer. The electronic version is not interactive. It is without any cross-references to chapters, figures and tables, which makes the navigation through the document clumsy.

In addition, Sections 4 to 11 are based on manuscripts of recently published papers and it has undergone minimum changes, i.e. it includes abstract, introduction, nomenclature, conclusions and even references. The journal, to which the work was submitted, is mentioned at the beginning of each section. However, this layout causes several problems and is highly impractical. The issues are as follows:

- Repeated explanation of abbreviations (for instance see "CHP") in nomenclatures and in the body text.
- Repeated references.
- Poor interactions between sections.
- Repeated facts in introductory sections.
- Poor contribution of individual conclusions to the thesis objective expressed in Figure 3.2.

Specific comments are raised to Section 3. I consider it a crucial part of the thesis, where a novel framework how to carry out process improvement in existing plants is proposed. It describes the methodology. However, what I am entirely missing is the description of the process leading to the framework. It is not explained how the student developed the framework, what are the pros and cons of each method, etc.. Here better interactions with other section could lead to clearer text.

The thesis is demanding on knowledge of the readers. It is expected that the reader is familiar with the terminology. Individual methods are not explained in an accessible way. For example, term *"Deep learning"* is explained as *"Deep learning is a subset of machine where the primary algorithm of interest is the deep artificial neural network (Lecun et al., 2015)*", „Data reconciliation" is not explained. This is not in line with the objective of the thesis, and it hinders the practical impact of the work. In this respect, Figure 3.1. is mentioned.

The thesis is accompanied by many attractive illustrations, which is highly appreciated. Since there are no references in the figure captions, one assumes that the author did them. However, this is not highlighted in the text body. Besides, the text is referenced, which makes the impression that the figure has been published before. Frequently, the graphic is too complicated and is not fully explained. For instance, see Figure 1.3 and the only sentence referencing to this figure: *„Ćwikła (2014) discussed that at the current situation, industrial processes data acquisition method can be categorised as manual methods, semi-automatic stationary, semi-automatic mobile and automatic (see Figure 1.3)".*

Questions to the defendant:

Could you confirm that you are the author of figures, which are without reference in the figure caption?

In Section 1.1. the term "velocity of data" is used. Could you explain what it is and how important is the velocity for the methodology proposed?

CHP unit is mentioned in Chapter 4. However, the term „CHP" is used for combined heat and power in general, i.e. for any facility which produces heat and power at the same time in one process. It is not clear what type of CHP are you working with (CHP based on internal combustion engine, CHP based on gas turbine, etc.). What types of CHP unit do you know and which one has been used?

The case study presented in Chapter 4 is based on CHP performance database consisting of 613 datasets from 64 units. Could you comment on how this database was made available for you?

Conclusion:

The thesis addresses essential and relevant topics of Big data utilisation for industrial processes improvements. It demonstrates the authors' broad horizons, the ability of critical thinking and systematic scientific work in this specific field. The scientific achievements are impressive and well accepted by the scientific community. Despite my reservations to the arrangement of the thesis, which is not typical for Brno University of Technology and follows the style of the University of Nottingham Malaysia, I recommend awarding the PhD degree to Teng Sin Yong.

doc. Ing. Martin Pavlas, PhD

V Brně 23. 10. 2020