

Arkadiusz Gola, DSc., PhD., Eng.
Lublin University of Technology
Faculty of Mechanical Engineering
Department of Production Computerisation and Robotisation
ul. Nadbystrzycka 36
20-618 Lublin, Poland

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REVIEW

the doctoral dissertation of Selma Gutmen, M.A.

under the title of: „**A Novel Decision Making Framework for Robust-Reliable
Aggregate Production Planning Problem**”

(review prepared on the basis of the letter from the Dean of the Faculty of Management Engineering, Poznań University of Technology – Marcin Butlewski, DSc., PhD., Eng., no. WIZ-08/118/2025 of April 30, 2025).

1. The problem area of the dissertation – assessment of the advisability of taking up the topic of the work

The issue of aggregate production planning falls within the realm of tactical planning, which refers to the medium-term development of plans for utilizing existing production capacity. Although aggregate production plans are used much less frequently in industrial practice than short-term plans (production schedules; Gantt charts), they are of great importance, especially for companies producing products characterized by high seasonality.

In general, aggregate planning enables decisions about staffing levels, inventory levels, and capacity utilization. Classically, its goal is to develop a production plan that will enable production to meet demand within a defined planning horizon while minimizing overall production and storage costs.

Although both scientists and practitioners have been studying the issue of designing aggregated production plans for several decades, a universal solution for achieving an optimal plan that takes into account all factors influencing production and storage costs is still lacking. This is due, among other things, to the NP-difficult nature of the issue, which prevents the use of classical optimization methods. The author's attempt to develop a planning model that considers reliability, stability, and the impact of the human factor on plan implementation costs is undoubtedly important, purposeful, and consistent with current research trends.

2. Assessment of the structure and scope of work

2.1. Scope and structure of the work

The reviewed work has 173 pages (including appendices) and consists of a table of contents, lists of tables and figures, summaries (in English and Polish), four parts (chapters), seven appendices and a bibliography.

The first part of the work (titled "Introduction") contains the justification for undertaking the work topic, the definition of the research problem, the objectives of the work, the hypothesis, eight research questions, and a description of the structure of the work.

The second part of the thesis is devoted to an analysis of the literature on methods for designing aggregate production plans, the importance of the human factor in production planning, and the importance of aggregate production planning in light of the Industry 4.0 and Industry 5.0 paradigms. Furthermore, this chapter presents the results of a literature analysis on mathematical models used in the design of aggregate production plans, as well as statistical and machine learning tools. An important element of this part of the thesis is defining the identified research gap and the rationale underlying the research topic being the subject of the reviewed work.

The third chapter (titled "Methodology") is devoted to presenting the developed approach to designing aggregated production plans. Specifically, it presents the developed mathematical model, research methodology, and the results of the experiment conducted to validate the proposed solution.

Chapter four ("Discussion and Conclusions") presents the results of the sensitivity analysis of the developed model, its practical applications, and its potential for use in real industrial conditions. An important element of this chapter is also the description of the limitations of the proposed solution and directions for further research.

The assessed dissertation is complemented by appendices presenting both the questionnaires used for data collection purposes, as well as the results of numerical analyses carried out at the stage of validation and sensitivity assessment of the presented model.

2.2. Notes on the structure of the work

The structure of the work is correct. After an introduction containing the rationale for the topic, the research problem, the work's objectives, the hypothesis, the research questions, and a description of the work's structure, a chapter is devoted to an analysis of the literature on the subject matter of the work being evaluated. The final element of the literature analysis in this part of the work is the identified research gap, which served as the premise for developing the model



in its presented form. Chapter 3 is of a purely practical nature, presenting the assumptions of the proposed approach to designing aggregated production plans, as well as the results of the experiment aimed at its evaluation. The final chapter is a discussion summarizing both the strengths of the developed solution and its limitations, which may become areas for further research.

Although the overall structure of the work raises no objections, I feel it would be better to place the list of tables and figures at the end of the work. Furthermore, the bibliography should be placed before the appendices. Another criticism is the introduction of subsections when the number of subsections within a given section is one (specifically, subsections 3.2.1 and 3.3.1). Furthermore, it would be valuable to include a list of symbols and abbreviations used (with their explanations) at the beginning of the work – this would make the work easier to read.

3. Substantive evaluation of the dissertation

The dissertation being evaluated is a project-based project, and its primary goal (defined in section 1.2) is "developing a decision-making framework that helps practitioners maintain sustainable and reliable systems in today's markets while considering human factors." The work, by addressing the issues of planning and organizing production processes (including social aspects), undoubtedly falls within the scope of the scientific discipline of "Management and Quality Sciences."

From a substantive perspective, I give this work an unequivocally positive assessment. The methodological structure of the work deserves positive attention. The author justified the choice of the work's topic based on literature analysis and current needs, defined the research problem ("breaking it down" into eight research questions), defined the work's purpose and hypothesis, and clearly described the research methodology used.

The research itself was divided into two parts. In the first part, new data (including human factors) have been added to the existing models. These data have been collected using the Matrix Questionnaires from an automotive company located in Iran. To expand the obtained data simulation methods have been used. After Multivariate Adaptive Regression Splines (MARS) method have been applied to provide the best values for the most important factors. Herewith, the Score Matrix was prepared as a part of the outcomes from MARS models by stating the percentage values of the importance of each variable. The weight value of each factor was calculated based on the ratio between summed weighted values of the related criteria and sum of the weighted values from all factors. The most important factors according to calculated scores have been



determined and these parameters were included into the APP problem. In the second part the inclusion of new three parameters (i.e. products during normal and overtime working, training cost of a worker from workforce group and reliability factor of a worker from workforce group in department during work shift) were applied. Additionally, the uncertainty factor was defined as triangular fuzzy numbers. The proposed model was developed using weighted goal programming and fuzzy programming. For finding the solution the software CONOPT solver/GAMS was used. Finally the sensitivity analysis was applied to demonstrate the effect of each parameter.

The author's literature review deserves a positive assessment. As part of this analysis, she conducted a comprehensive review of previously published works – both in the area of models and methods for designing aggregate production plans, as well as the methods, models, and tools that were innovatively used in this work. I consider the model presented in this work to be innovative, taking into account the current requirements and barriers encountered during the preparation of an aggregate production plan.

An important and valuable element of the work is the method of identifying social factors (aspects) that influence the reliability of the designed production plan, as well as their inclusion in the developed model.

Although the work is written in an understandable way, reading the content of the work leads to the formulation of the following questions and comments of a debatable nature:

1. One of the key factors in assessing a developed production plan is its reliability. However, it seems that this concept has not been defined precisely enough (especially since the author treats it as synonymous with "quality").
2. Figure 1 (page 12) includes a graphic presenting the objectives and inflows/outflows of aggregate production plans. However, the source of this data is missing.
3. The objective functions (page 17) in the plan design process are defined as: (1) minimizing the total cost and (2) maximizing the reliability. However, there is no explanation of what total cost the author means and what is the subject of maximizing reliability.
4. As stated in the thesis hypothesis, the aim of the research is to determine the impact of human factors on the cost and reliability of the proposed aggregate production plan. The study analyzed results from a single enterprise, defining specific factors influencing the production plan. Therefore, the following questions arise: To what extent can these results be accepted as universal? Will these factors differ from those identified in the study for enterprises of different sizes or from different industries?

5. When developing the research model, one of the assumptions was: "Inventory/shortage should be zero at the end of the planning horizon." Consequently, the so-called minimum (safety) inventory, which in the classical approach serves as a buffer against demand variability, was not taken into account. So where does this assumption come from? Is it related to the reliability factor included in the proposed model?
6. The developed model takes into account 35 constraints defined on pages 47 and 48. Unfortunately there were not explained what criteria have been taken into account when defining these specific constraints.
7. In page 49 the Author explain that „*In this work fuzzy logic can be employed in production planning (PP) to manage uncertainties related to demand, production capacity, and lead times, and to help managers make production planning and resource allocation decisions*”. While the uncertainty of demand and lead times is clear it is difficult to guess what the Author means by „uncertainty of production capacity”.
8. To study the uncertain nature of demand parameters a fuzzy linear programming has been applied. For this purpose two specific values of γ and α (i.e. $\gamma = 0.3$ and $\alpha = 0.8$) have been taken into account. Why did you decide to / How did you select such values of these criteria?
9. In both – MQ1 and MQ2 questionnaires you took specified factors (i.e. 15 factors in MQ 1 and 35 factors in MQ2). How did you select these criteria? Are these criteria universal for all companies or should they be adjusted each time taking into account specific character of a company (i.e. size, branch, etc.).
10. In the work, the Author repeatedly states that the proposed approach has a positive impact on the environment (sustainability). After reviewing the essence of the developed model, it is difficult to unequivocally conclude that it provides a positive impact on sustainable development. Therefore, this aspect should be explained in more detail.

In summary, I conclude that the entire work was methodologically sound and represents a truly original achievement by the author. A significant strength is the inclusion of human factors in the production planning process – in many cases, these factors determine the feasibility of implementing the plan according to the adopted assumptions. Although the presented solution appears difficult to implement in real-world industrial settings (due to the labor-intensive nature of acquiring the appropriate data and the need to use specialized software), I consider its scientific value to be high.

4. Formal evaluation of the work

The formal aspects of the work are beyond reproach. The work was prepared with care, and the presented content is skillfully illustrated with tables, charts, and drawings. The author uses language appropriate for scientific papers, and editorial errors are very sporadic. The only criticism concerns the poor quality of the Polish summary on page 9.

5. Summary and final conclusion

Considering the overall work being evaluated, I certify that the reviewed doctoral dissertation by Selma Gutmen, M.A., represents an original solution to a scientific problem, demonstrates the candidate's general theoretical knowledge in the discipline of "Management and Quality Sciences" and the ability to conduct research. I consider the developed two-criteria model for optimizing aggregate production plans, taking into account the so-called human factor, as an original solution to the scientific problem, as well as the stability and resilience of the proposed production plan. The work submitted for evaluation confirms that the doctoral candidate has demonstrated knowledge of the literature in the subject matter of the dissertation, as well as the ability to practically utilize existing modern methods and tools for the design of aggregate production plans. The deficiencies noted in the doctoral dissertation are not fundamental to the substantive value of the work, which meets contemporary standards for doctoral dissertations. Therefore, the dissertation as a whole can be assessed positively.

In conclusion, I believe that the reviewed work meets the conditions set by the Act of 20 of July 2018 on academic degrees and titles (Journal of Laws of 2018, item 1668) in the discipline of "Management and quality sciences" and I request its admission to public defense.

Armediusz Gola