

Factors of the Analytical Hierarchy Process for Industry 4.0 Technology Adoption in Manufacturing SME

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ABSTRACT – Adoption of new technology as part of Industry 4.0 provides opportunities to businesses regardless of their size. SMEs face challenges in adopting I4.0 and needed a decision-making process for adopting advanced technologies. This study employed an analytical hierarchy process (AHP) to weigh the different criteria based on the priorities of the business. Different criteria based on data gathered from the SME will be considered and three technologies will be presented to the key decision-maker of the company. The conclusion of this study is an impartial and objective decision that could aid the company in its adoption of Industry 4.0.

1. INTRODUCTION

The world of business has undergone a tremendous transformation since the first industrial revolution. From solely relying to water and steam to automating processes, Industry 4.0 (I4.0) has changed a normal machine to intelligent machines to upgrade how business is being conducted [1]. The benefits of I4.0 are not only concentrated in the manufacturing industry [2], but also improve the supply chain integration works [3]. Examples of I4.0 technologies are cloud solutions, additive manufacturing, robotics, smart factory, and the Internet of things (IoT), among others. These technologies have proven to provide advantages to businesses in different industries regardless of their size, including for Small and Medium Enterprises (SMEs) to stay competitive and innovative through I4.0 [4].

Conversely, SMEs face challenges in adopting I4.0 which, although they don't diminish the benefits that these companies will reap, slow down the decision-making process of introducing advanced technologies to the business. Some of the hiccups that restrict SMEs in their adoption process are budget, limited knowledge of key decision-makers, and insufficient research on the return of capital in I4.0 technologies [5]. Determining the profitability of a new technology will require a company to assess the cost of the opportunity being presented [6]. Limited resources of competent persons with in-depth knowledge of I4.0 are some of the reasons why SMEs feel hesitant to utilize I4.0 technologies [7]. Some of the reasons why employees don't support new technologies are complexity and lack of required skills

[6], although it can be improved by providing training for new technology adopted. Moreover, some SMEs might have difficulty deciding which technology they should invest in. Thus, the authors aim to aid the decision-maker of a manufacturing SME in coming up with a decision in choosing the technology that will best serve their interest.

Previous studies have utilized AHP as a method in different aims such as material selection [8, 9], technology selection and assessment [10, 11, 12], and transformation analysis. Although some of the studies combined AHP with other tools like TOPSIS, using AHP alone like this paper still justifies the effectiveness of this tool in decision making. This study employed an analytical hierarchy process (AHP) to weigh the different criteria based on the priorities of the business. The different technology options that the business may consider is discussed in the succeeding parts of the paper. This study assumes that the SME can only invest in one technology at a time and therefore, a decision-making tool will be helpful in determining the right technology for the company.

2. METHODOLOGY

This study attempted to aid a manufacturing company in their decision-making process on which technology it should invest to. As the company is a SME, one of its challenges aside from limited budget is the absence of an R&D team that could provide an in-depth study about these technologies. According to QAT Global [13], some of the factors that a company should consider when investing in new technology are profitability, employees' support, and relevance. Investing in new technologies will push the SMEs to investigate their processes closely before arriving to a decision [6], as they should not be pressured in investing in a technology. Further, the technology adopted should be compatible with the company's values and able to minimize the uncertainties brought about by new changes [14]. These three factors is being applied as the criteria for this study. Through the software *Super Decisions*, each criterion was assigned with different weight by means of conducting an interview with the decision maker of this study object, a manufacturing SME specialized in welding. As the

company is an SME, there is only one director who has the authority to decide the appropriate technology that the company should invest to through the use of AHP.

In accordance with that, three (3) new technologies that the company can invest in are selected as alternatives, including robotic arm, automated welding solution, and cloud storage. The robotic arm can be installed in a manufacturing setting for those repetitive jobs such as assembly, testing, machining, and even packing of finished products. As the company's main production work is welding, it is important to consider automating the welding process to ensure quality, productivity, weld integrity and to reduce cost in manufacturing [15]. Lastly, cloud solution for data storage is part of the options of new technologies that the company may consider, to improve data handling and reports. Figure 1 shown factors used as the criteria in the AHP formulation. Moreover, the model utilized software *Super Decisions* to compute for the best option among all the alternatives and in consideration of the given criteria.

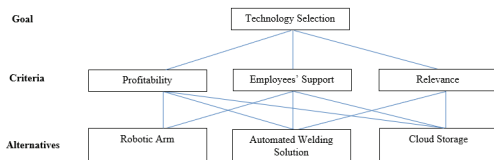


Figure 1 AHP Model

A pairwise comparison matrix in the form of questionnaire in *Super Decisions* was accomplished. The same process was done to each alternative using each criterion as the basis. Based on the model developed, the consistency ratio is also computed for each criterion and alternative.

3. RESULT AND DISCUSSION

The result of the AHP shows how important it is for the business to focus on any improvement and upgrade to their main production process which is welding. The decision-maker of the company sees that investing in such technology will increase the company's profit and will add more value to their current process as shown in the result of the pairwise comparison matrix. Figure 2 shows each criterion and alternative weight according to decision maker. The result of the AHP model is 12.77% for robotic arm, 60.15% for automated welding solution, and 27.08% for cloud storage. The result shows that technology the company should consider investing to is automated welding solution, based on the priority of the company which was measured in the criteria provided.

The result of the AHP shows how important it is for the business to focus any improvement and upgrade to their main production process which is welding. The decision maker of the company sees that investing in such technology will increase the company's profit and will add more value to their current process. Although it might be challenging for the business to deploy this solution to its production process as automated welding solution has the lowest weight in employees' support, ample of assistance such as training and back-end

support should be provided.

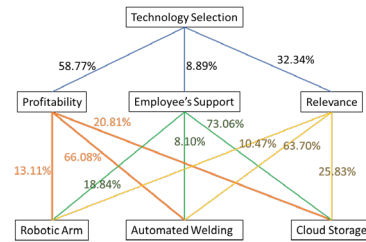


Figure 2 The weight of each criterion and alternative

4. CONCLUSION

The ability of any business to improve its process is necessary for it to remain competitive and relevant. Regardless of the company's size, employing new technology is important as this is seen as the direction of everyone in the business world. This study proposed an AHP method to help decision maker in manufacturing SME find the best alternative technology based on three criteria. For future research, it is recommended to employ the same decision-making tool in a business with a larger size and with more decision-makers. This future research will signify that AHP is also applicable to business with more complex structures than SMEs.

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