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Modelling of Assembly Line Balancing with Energy Consumption

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Abstract. One of the most gravitate issues in the world is energy usage. As the largest consumer in terms of energy usage, the manufacturing sector had introduced a lot of approaches to decrease their energy utilization. As the energy usage issue becomes more prominent, researchers had applied the Assembly Line Balancing (ALB) optimization that considers energy utilization as one of their efforts in reducing energy consumption. This paper discusses the related papers done by researchers, demonstrates the ALB model developed with electrical energy consideration by the application of the Matlab simulation and its validation through the manual hand calculation. The ALB with Energy Consideration (ALB-EC) was modelled into a mathematical model that could be used in solving the Simple Assembly Line Balancing Problem (SALBP), with the application of the Matlab application. The Particle Swarm Optimization (PSO) algorithm was applied and the model was tested by using three problems which consist of each of a small, medium, and large-sized test problem. Based on the finding, we could achieve the same results on the computational method along with the manual hand calculation for the evaluated total energy and objective functions. Besides, the advantages and limitations of the proposed model were also discussed in this paper. Through the application of this study, it could contribute to the reduction of electrical energy usage in the production line, which can reduce the overall energy usage CO_2 gas production and prevent climate change.

INTRODUCTION

The activity of line balancing can be regarded as one of the essential factors when we go deeper into the design and management of a production assembly line, as the strategy needs to be applied to achieve balanced numbers between the operator quantity and machine time [1]. Assembly Line Balancing (ALB) is also described as understanding how tasks in the production line are organized in a workstation, to investigate the capability to achieve the defined objective. A succeeding production line and lean management system could be achieved by assembly lines that are balanced fairly in terms of cycle time. Most of the papers focused on the probability to achieve a workstation number and cycle time cut by the application of some methods in ALB problems [2].

In addition, to determine an assembly line with the consideration of energy efficient usage, researchers had also studied the related factors of energy in the ALB. Nonetheless, the quantity of papers that had to consider the energy utilization in the ALB is considered as small compared to the overall ALB published research. Next, the amount of published works that study on reducing electrical energy of the production equipment is more concerned, as the quantity is even smaller. In the previous work by the researcher, the task of assembly needs to be designated into the related robots. In their study, the different robots that perform different tasks would be consuming a difference in energy consumption. A similar energy model is shown in a different published work [3].

The study of the relationship that relates with Assembly Line Balancing (ALB) and the reduction of energy consumption in their respective production line had been performed by various researchers. The most popular study was focused on minimizing the energy consumption in a robotic assembly line by the usage of the ALB method, as benchmarked with the other assembly line types. With the application of ALB in minimizing the energy consumption