Comparison Study about Production Scheduling System from Some Paper Case Studies

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Abstract. Scheduling is one of the most important classes of combinatorial problems. One of the first problem to be studied in the scheduling theory is the problem of minimizing the makespan in flowshop. In flowshop, the products which is produced have the same sequences. The heuristic algorithms are the key to solving the problem with the optimal solution. To find or to approach nearer to the optimal solution, the meta-heuristic algorithms can be used and the heuristic algorithms as the first solution. One of heuristic algorithm that can be used is Campbell, Dudek and Smith (CDS). Also, the meta-heuristic algorithms that can be used are Tabu Search and Genetic Algorithm. The aim of this paper is to know the gap among the other methods in flowshop scheduling system to reach the optimum makespan.

Keyword: production scheduling, flowshop scheduling, heuristic algorithm, metaheuristic algorithm

1. Introduction

Manufacturing industries is determined by their competitiveness in the market. To maintain competitiveness, their products should be delivered on time with the best service and quality. Flowshop scheduling problem has been one of the most classical problem in the production scheduling. To improve the production and to reach the minimum makespan or completion time, a company needs to establish an optimal production sequences. The main objective of scheduling is to minimize the total manufacturing time, denoted C_{max} (total completion time or makespan) and the values of manufacturing time on each machine denoted P_{ji} (j=1,2,..,m, i= 1,2,..,n); are previously known, constant and positive in this case [1]. Among the various flowshop scheduling heuristic, Campbell, Dudek and Smith (CDS) can be applied. To reach the nearer optimal solution, meta-heuristic algorithms can be applied, such as Tabu Search and Genetic Algorithm.

2. Literature study

Scheduling is one of the critical problems in a manufacturing system. The problem in scheduling focuses on how to allocate the limited resources of production [2]. Production scheduling problem had begun by developing algorithms for generating an optimal sequence to complete the required tasks considering either only one processor (machine) or multiple processors (machines) [3]. In scheduling, the main objective of the problem is to determine best job sequence that optimizes the makespan of job shop problem [4]. In the meantime, effective planning and control of material flows and production processes are a key to the success of a manufacturing company [5].

In general, scheduling deals with the temporal assignment of jobs to the resources within a given time framework while maintaining various constraints [6]. A good schedule is a key to success in today's competitive market, and have a variety of benefits such as production improvement, production cost reduction, supports resource allocation, plant optimization, etc., and these make the scheduling problem very interesting to deal with.

CDS algorithm of Campbell, Dudek, and Smith is one of the best heuristic found next to the efficient algorithm NEH (Nawaz, Enscore & Ham), and it has the performance to generate a more economical approximate solution to any size of "n" job, "m" machine problem [7].

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CDS is one of heuristic method that can be applied for flowshop problem.

Tabu search is a local search algorithm that restricts the feasible neighborhood by neighbors that are excluded. In tabu search, such states are maintained in a data structure called a tabu list. Parameters of tabu search, are [8]: local search procedure; neighborhood structure; aspiration conditions; form of tabu moves; addition of a tabu move; maximum size of tabu list; stopping rule.

A genetic algorithm is a method that is inspired by Charles Darwin's theory of natural evolution. This algorithm reflects the process of natural selection where the fittest individuals are selected for reproduction in order to produce offspring of the next generation. Five phases are considered in a genetic algorithm, are [9]: initial population; fitness function; selection; crossover; mutation.

3. Comparison study and research gap

3.1 Research of hybrid flowshop scheduling system with tabu search method

Liesly, Lina Gozali, and Lilyana Jap (2019) research title is The design of Hybrid Flowshop Scheduling System with Tabu Search (TS) Method to Minimize Makespan at PT. Plasindo Elok. The objective of this research is to design a scheduling system to minimize makespan which could reduce WIP and total production cost. Flowshop heuristic method which is used as a basis to get the optimal makespan are NEH and CDS algorithm. Furthermore, the scheduling sequence of NEH and CDS are used to generate an initial sequence for meta-heuristic method, Tabu Search (TS). The result of this research showed that CDS algorithm represented the minimum makespan compared to NEH algorithm. NEH-TS was the best algorithm compared to NEH, CDS and CDS-TS because it produced the least makespan and mean flowtime. To facilitate the company for scheduling calculation, researchers design a scheduling program with java based [10].

3.2 Research of flowshop scheduling with tabu search method

Lina Gozali and Viktor Aditya (2013) research title is Flowshop Scheduling with Tabu Search and Genetic Algorithm Approach at PT. Super Metal Bangka Jaya Abadi. The purpose of this research is to minimize the completion time of the job is to do effective production scheduling. The scheduling of production process at the company is first come first serve, without considering processing time so the delay often happened in order fulfillment. It makes operating cost increased, also production process both labor and machine can't achieve production target. The method used in this research is tabu search algorithm and genetic algorithm that will be compared to search the best method. The result of this research is tabu search algorithm

represented the best result. If it's compared to the company schedule, the makespan and the flowtime reduced [11].

Silaban Triwiyanto (2014) research title is Production Scheduling Using Tabu Search Algorithm. PT. MBG Putra Mandiri is a manufacturing company with make to order system. In this research, tabu search is used to minimize the makespan and reduce the delivery lateness in manufacturing industry. The result of this research is with tabu search method, makespan can be minimized, and the makespan is lower than before the research held [12].

3.3 Research of flowshop with sequence-dependent

Keshavarz, Salmasi, and Varmazyar (2015) research title is Minimizing Total Completion Time In The Flexible Flowshop Sequence-Dependent Group Scheduling Problem. This research considers a flexible flowshop sequence-dependent group scheduling problem with minimization of total completion time. A meta-heuristic algorithm that applied in this research is Memetic Algorithm (MA). In order to evaluate the performance of the proposed algorithm, random test problems, ranging in size from small, medium, to large are generated and solved by the MA and the lower bounding method [13].

Cheng C., Ying K., Li S (2019) research title is Minimizing Makespan In Mixed No-Wait Flowshop With Sequence-Dependent Setup Times. This research proposes an extension of the mixed no-wait flowshop scheduling problem which considers sequence-dependent setup times. A mixed integer linear programming model is presented to solve small problems with respect to the makespan criterion. A metaheuristic algorithm that used for this research is Pairwaise Iterated Greedy (PIG) Algorithm. This algorithm is proposed to solve medium and large size problems. This innovative research will help to narrow the gap between scheduling theory and practical applications [14].

3.4 Research of subjects scheduling in academy using genetic algorithm

Sari (2015) research title is Scheduling Optimization Using Genetic Algorithm (Case Study: SMPN Gondang Mojokerto). This research shown that genetic algorithm can also be used for any field, not only in production. The aim of this research is to minimize the problem that often happened in subjects scheduling at the academy. The result of this paper is the best cromossom give the best scheduling with the highest fitness value [15].

Saryati, I Gusti Ayu Desi and I. Kadek Wijanegara (2017) research title is Genetic Algorithm for Teaching Scheduling at SMK Giri Pandawa. In this case, the academy has a problem with the teaching scheduling. To solve the problem and to get the best scheduling at this academy, the researcher used genetic algorithm for optimized the teaching scheduling. The conclusion of this research are the algorithm method could help the developer to develop the teaching scheduling at the academy and the genetic algorithm is effective to be used at the academy [16].

3.5 Research of production scheduling using genetic algorithm

Viviana Sitompul (2018) research title is Production Scheduling Using NEH Algorithm and Genetic Algorithm at PT. XXX Tanjung Morawa. The aim of this research is to reach the best scheduling at the company, with NEH and genetic algorithm. PT. XXX is an industry that produced bird and fish food. The production capacity is 500 ton/day. The system of this industry is make to stock. The production scheduling of this company depends on the highest forecast

to the lowest forecast. Sometimes the company couldn't reach the production target. The result of this paper is with genetic algorithm, the makespan and waiting time can be reduced [17].

Clalita Christina (2019) research title is Job Scheduling Using Weighted Shortest Processing Time and Genetic Algorithm (Case Study: PT. Modera Furintraco). The aim of this research is to help the company for achieving production target by generate a schedule which can reduce total production time (makespan). The heuristic method used is Weighted Shortest Processing Time. The meta-heuristic method used is Genetic Algorithm. The result that used heuristic and meta-heuristic method both provide better scheduling. In this research, also made a simple software that could help the company job scheduling, based on MATLAB programming [18].

3.6 Research about production scheduling using CDS

Antoni Yohanes (2014) research title is Production Scheduling in Line B Using Campbell, Dudek and Smith (CDS) Method. The researcher did the research at automotive industry that produced motorcycle. The objective of this research is to know the makespan and the efficiency of the company's scheduling using CDS method. The result for this research is the total makespan and the efficiency of the motorcycle production [19].

4. Research and Discussion

Based on study and research among all papers, we can conclude that to minimize makespan or completion time in production system through production scheduling, we can use many methods or algorithms. We can use heuristic or meta-heuristic method. Algorithms can be used for every industry. The algorithms such as Campbell, Dudek and Smith (CDS), Tabu Search, Genetic Algorithm, Memetic Algorithm (MA), Pairwaise Iterated Greedy (PIG), NEH, and many more. We also can combine more than 2 methods to find the nearer optimal result.

Table 1 Research Gap

Description	**Authors**									
	Liesly	Gozali	Triwiyanto	T. Keshavarz	C. Cheng	Sari	Saryanti	Vivina	Clalita	Antoni Y.
Method	CDS, NEH, Tabu Search	NEH, Tabu Search, Genetic Algorithm	Tabu Search	MA	PIG	Genetic Algorithm	Genetic Algorithm	NEH, Genetic Algorithm	WSPT, Genetic Algorithm	CDS
Makespan	1697,93 minutes	725,067 seconds						3394 minutes	2458,03 minutes	
Improvement	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Production Capacity per year	37 ton							180000 ton		
Institution/ Publisher	Universitas Tarumanagara	Universitas Tarumanagara	IEC	Semnan University	Chang Gung University	Universitas Brawijaya	STIKOM Bali	Universitas Sumatera Utara	Universitas Tarumanagara	Dinamika Teknik

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