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Integrating simulation modelling and multi criteria decision making for customer focused scheduling in job shops

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ABSTRACT

Today, customer centricity is an important strategy in business-to-business markets and manufacturing companies need decision support systems that provide adequate information for customer centric applications. This study proposes an integrated decision support system that combines simulation modelling and multi-criteria decision making. More specifically, job shop lot streaming problem is dealt with, and it is aimed to determine the best dispatching rules to schedule batches on machines. To this aim, three renowned performance-oriented criteria; (i) mean flow time, (ii) percentage of tardy orders, (iii) makespan and one customer-oriented criterion; (iv) mean percentage deviation from the customer expectations are considered. Effect of different classical and customer-oriented dispatching rules on these performance criteria are investigated. The performance criteria are weighted using analytical hierarchy process by considering the level of bottleneck resource utilization and customer importance weights. The results reveal that customer-oriented dispatching rules provide better outcomes in case of high level of bottleneck resource utilization and high fluctuation amongst the customer importance weights.

1. Introduction and background

With the appearance and the development of new economic phenomena like diversification and globalization of world markets, the companies move in a more and more challenging environment [1]. In this environment, many sellers compete with each other in order to maintain their market share. At this point, customer relationship management (CRM) is a powerful tool that helps companies in gaining sustainable competitive advantage [2].

CRM is an important topic in marketing and it can be defined as “a comprehensive strategy and process of acquiring, retaining, and partnering with selective customers to create superior value for the company and the customer. It involves the integration of marketing, sales, customer service, and the supply chain functions of the company” [3]. The basic idea behind CRM is that customers are more likely to be loyal and may create a long-term revenue stream as long as the companies create a strong and trusting relationships with their customers by understanding and satisfying their expectations with the help of business intelligence [4].

Today, CRM is not only applicable for business-to-consumer (B2C) markets, but even more crucial for business-to-business (B2B) markets [5]. In B2B markets, number of prospective customers is few and long-term commitments are essential for both buyers and sellers [6–8]. However, increased information technologies and remarkable changes in social, cultural and economic areas have changed market conditions and customer expectations dramatically. Today, customers become more demanding and selective due to the increasing number options. It is therefore, very important to use CRM in B2B markets as a differentiating bridge to get closer to

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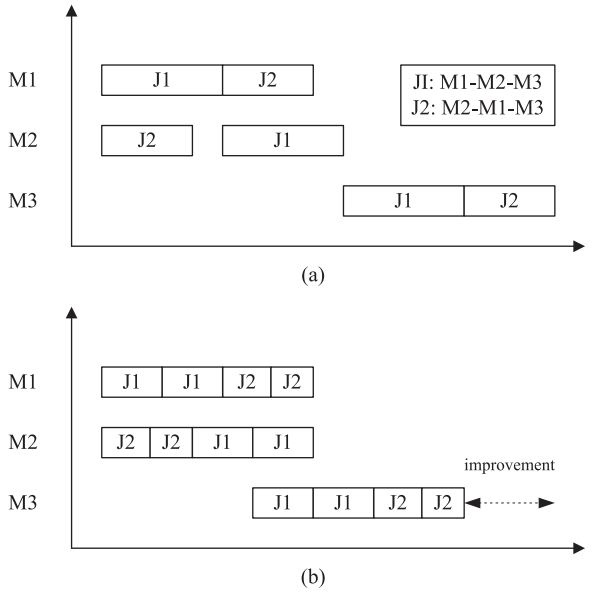

Fig. 1. (a) Job shop scheduling without LS (b) Job shop scheduling with LS.

customers and also use resources effectively with well-timed decisions [9,10].

In order to build strong customer relationships in B2B markets, companies first track their customers' transactions and segment their customers in accordance with their value to the company and perform profitability analysis. Then, they should differentiate their products, operations and services based on the customer value and expectations. Finally, they should measure the performance of their efforts in terms of customer satisfaction level. In this regard, we conducted our current study for the manufacturers in B2B markets and we aimed to reflect a customer-oriented view to production scheduling decisions. For this purpose, we handled job shop lot streaming problem (JLSP) and evaluate the effectiveness of scheduling decisions in terms of customer satisfaction.

JLSP is a special case of a job shop scheduling problem where production lots are split into smaller sized batches. In this problem, each batch is considered as an independent job and those batches are scheduled on machines [11]. Lot streaming (LS) problem consists of two major parts namely lot splitting and batch scheduling, and it deals with the determination of optimal number of batches, their sizes and processing sequences that optimize the pre-specified criterion. The criterion can be time or cost based, or combination of them. In recent years, researchers heavily focus on scheduling problems with multiple objectives and use combination of production efficiency-based performance criteria such as makespan, total weighted tardiness, mean flow time, mean tardiness and number of tardy jobs [12–14].

LS, accelerates the flow of a production lot through a production system, shortens the manufacturing lead time and improves due date performance, reduces the work-in-process and associated costs and also reduces the capacity requirements of material handling system [15,16]. As an illustration of LS concept in job shops, in the following example, two jobs (J1 and J2) to be processed on three machines (M1, M2 and M3) based on the production sequence (route) are identified. If the lots are not to be split, then it will be processed as shown in Fig. 1.a. However, if the lots are split into two batches then these batches are processed simultaneously over the machines (see Fig. 1.b) and this leads to a reduction in makespan.

LS problem in flow shops has been extensively studied, and it is also applied to job shops in recent years [17]. In this work, the studies handling the JLSP is overviewed. There exist numerous studies that aim to find LS conditions of static job shop problems where order set is finite, known and ready for processing at time zero. However, this assumption is unrealistic in many real life cases. In addition, there exist some studies extending traditional JLSP by including transportation activities [11,17]. On the other hand, most of the studies focus on production efficiency-based performance criteria such as makespan [18–21], tardiness [11], flowtime [11,22,23], and employ commonly used metaheuristic approaches such as tabu search [24,25], genetic algorithm [20,26] as the solution methodology. However, customer satisfaction is the key success factor for the companies, and greater satisfaction leads to greater profit and collaborative business relationships [27]. Therefore, it should be used as a performance criterion in handling the scheduling problems. The reader may refer to our previous study [28] for a detailed discussion on abovementioned studies, and also refer to Chang and Chiu [29] and Cheng et al. [15] for detailed review of the studies on LS.

As stated before, most of the studies in this field ignore dynamic and stochastic nature of the manufacturing environment and do not consider customer-oriented performance criteria and customer related issues such as customer value, customer expectations, customer satisfaction and customer tolerances. Additionally, performance criteria and their importance levels may change with many factors such as job shop conditions, market structure, customer base etc. Therefore, these factors should be analyzed and effective production strategies should be developed in accordance with them. In this concern, there is a scarce of a decision support system (DSS) which integrates production scheduling and CRM issues in order to satisfy customers by providing timely and effective scheduling decisions. To bridge this gap, an integrated DSS that combines simulation and multi-criteria decision making (MCDM)