Mazandaran University of Science and Technology

Available online at www.iiec2017.com

13th International Conference on Industrial Engineering

(IIEC 2017)

Iran Institute of Industrial Engineering

Order acceptance, scheduling and pricing model for unrelated parallel machines with controllable processing time

Sahebe Esfandiari[a] , Hamid Mashreghi[b] and Saeed Emami [c]

*[a] Department of Industrial Engineering,
Babol Noshirvani University of Technology, Shariati Ave., Babol, Iran
Post Code: 47148-71167, Tel: +989118650162, E-mail:s7_esfandyari@yahoo.cpm*

*[b] Corresponding Author: Department of Industrial Engineering,
Babol Noshirvani University of Technology, Shariati Ave., Babol, Iran
Post Code: 47148-71167, Tel: +989112100647, E-mail: Mashreghi.h@nit.ac.ir*

*[c] Department of Industrial Engineering,
Babol Noshirvani University of Technology, Shariati Ave., Babol, Iran
Post Code: 47148-71167, Tel:+989111179804 , E-mail: S_emami@nit.ac.ir*

Abstract

The main scheduling problems in the literature have focused on analyzing the problem of organizing machines and production capabilities in an environment with fixed selling price. However, in a make-to-order (MTO) environment the assumption of pricing can be followed in an interface with scheduling problem. In this research we first review the existence literature of order acceptance and scheduling in particular in a MTO environment. Using an OASP problem, the orders are calculated by their controllable processing time, due date, deadline, release date and sequence dependent setup time. Then under joint optimization approach, the pricing decisions set for unrelated parallel machine environment. The objective of the problem is to maximize the total net profit. The results show that the basic developed problem can solve the scheduling decisions based on different levels of products' priced. Thus the problem solves these two categories of decisions simultaneously.

Keywords:
Order acceptance, scheduling and pricing (OAS), Pricing, Make-to-order (MTO) environment, unrelated parallel machine.

1. Introduction

The majority of deterministic scheduling problems assume fixed price levels and processing times for the orders. In various real systems, not only changing selling price would be possible but also the processing time of production is controllable by allocating resources. Moreover, in and integrated view, controllable processing times allow us to compress this time for compression costs.

This view points out that using different levels of processing time and selling price in and scheduling model should be followed based on reality. We consider the problem of order acceptance, scheduling and pricing (OASP) with controllable processing time in a MTO system. Order acceptance involves determining the orders that should be accepted for processing, while scheduling involves deciding the production sequence of the accepted orders. In practice, decisions on order acceptance and scheduling are often functionally separated. The purpose of the sales department is to get much revenue as possible. The trend of sales department will be to accept all orders, regardless of the available capacity because the aim of this department is to maximize the sales' revenue.

On the other hand, manufacturing is concerned with limited capacities. The goal of this department is to minimizing the total cost of scheduling. How should the two functional areas coordinate their efforts in order to maximize profit for the firm as a whole? Hence, the trade-off between revenue and cost is inevitably in the decision making of order processing. Trade-offs often occurs in MTO system. We know that in MTO system, the decisions of order acceptance, lead time, due date and pricing are closely related. In this study we focus on MTO environments where the manufacturing department customized the accepted and scheduled products and the production initiated by a customer order. Typically, no finished goods inventory is carried for this type of products. The manufacturer gains revenue if a particular order is manufactured before its deadline by using the production resources. Since the main production resource, i.e. the capacity, is limited, manufacturing one order may cause delay for another ones. The manufacturer will incur a penalty for the orders which are delayed beyond their due dates. Orders with past deadlines result in zero revenue. In addition under a competitive MTO environment, a manufacturer should use the capacity efficiently and satisfy the expectations of the end customers and gain the maximum revenue from incoming orders. Hence, the question is which orders to accept and in what sequence to process them to maximize the revenues (Oguz et al. 2010).

Moreover, pricing decision is one of the essential decisions in MTO environment, which may depend on several factors. Given the relationship between pricing and the other components of marketing strategy, it should be noted that pricing is the only element within this strategy that is associated directly with revenues and profits, while the others are associated with costs and expenses. For example, an advertising campaign or a decision to modify an existing product entails expenses. We consider unrelated parallel machine environment. The decision to make is which order with controllable processing time to accept and how to schedule it in order to maximize the profit. Our research attempts to build on coordination order acceptance, scheduling and pricing (OASP). The purpose of OASP system is to improve the overall performance of an organization so that orders and manufacturing activities are handling correctly and efficiently. This paper organized as follows. In section 2, we review relevant literature on order acceptance and scheduling problem. We discuss the model in section 3. In section 4, we discuss some special cases of the problem and present their solution. We conclude the paper and suggest some topic for future research in the last section.

2. Literature review

The order acceptance and scheduling (OAS) problem has attracted considerable attention both from researchers and practitioners. Various OAS problems with variety characteristics have been studied over the last two decades. Many of papers use an integer, linear, or mixed integer linear program (MILP) to solve the OAS problem. When the problem size is large, the researchers present a heuristic algorithm in order to find an optimal solution. For example, Slotnick and Morton (1996) apply a branch-and-bound (B&B) and high-quality heuristic to solve the OAS problem. Rom and Slotnick (2009) presented a genetic algorithm for the OAS problem. Talla Nobibon and Leus (2011) studied a generation of the OAS problem with weighted-tardiness penalties. They considered two mixed integer formulation and two B&B algorithms to find optimal solution. Slotnick and Morton (2007) presented a model that considered a pool of order and used B&B algorithm for the model.

Oguz et al. (2010) investigated the OAS problem in a single machine environment. In their study, the orders was defined by their due dates, release dates, processing times, deadlines, sequencing dependent setup time and revenues. The objective was to maximize the net profit which was equal the total revenue of all accepted orders minus any lateness penalties. They gave an MILP formulation that could be solved optimally for instances with up to 10 jobs within a one-hour time limit. They also developed three heuristics. Emami et al. (2015) considered the order acceptance and scheduling problem in a Make-To-Order system with non-identical parallel machines. The problem was computationally intractable; therefore, they developed a Benders decomposition approach to solve it. Mestry et al. (2011) proposed a Mixed-Integer Linear Program (MILP) to model MTO as a job shop with multiple resources. Ventura and Kim (2003) considered parallel machines scheduling problem where jobs have non common due dates and may require, besides machines, certain additional limited resources for their handling and processing with the goal of minimizing total absolute deviation of job completion times about the corresponding due dates. Jansen and Mastrolilli (2004) studied the identical parallel machines makespan problem with controllable processing time. Job is allowed to compress its processing time in return for compression cost. As another work on non identical parallel machine, Gurel et al. (2010) considered a status in which processing times could be controlled at a certain compression cost. They used an anticipative approach to form an initial schedule so that the limited capacity of the production resources is utilized more effectively. Aktürk et al. (2010) considered a non-identical parallel machining where processing times of the jobs are only compressible at a certain manufacturing cost, which is a convex function of the compression on the processing time. They introduced alternative match-up scheduling problems for finding schedules on the efficient frontier of time/cost tradeoff. Li et al. (2011) considered the identical parallel machine scheduling problem to minimize the makespan with controllable processing times, in which the processing times are linear decreasing functions of the consumed resource. In addition to the mentioned studies, there are some ones which addressed the parallel processors with fuzzy processing times. Of them, one could refer to Peng and Liu (2004) which developed a methodology for modeling parallel machine scheduling problems with fuzzy processing times. They presented three novel types of fuzzy scheduling models.

Also, Balin (2011) addressed parallel machine scheduling problems with fuzzy processing times in which a robust GA approach embedded in a simulation model is proposed to minimize the maximum completion time. Kwong et al. (2006) used GA and fuzzy-set theory to generate fault-tolerant fabricating schedules in a JIT production environment. Their proposed method is demonstrated by two cases with production data collected from a Hong Kong-owned garment production plant in China. Charnsirisakskul et al. (2006) investigated the pricing, order acceptance, scheduling, and lead-time decisions, both in the cases where the manufacturer has and does not have the flexibility to charge different prices for different customers. They showed that in most environments, price flexibility outperforms the high level of lead-time flexibility.

3. Model

We formulation the problem under study as follows: there is a set of n independent orders $N = \{1,2,..,n\}$ to be processed on m unrelated parallel machine $M = \{1,2,\dots,m\}$. Each order $i \in N$ has a due date d_i, which is the preferred delivery date of customer, a release date r_i as an earliest start time of the order and a deadline $\overline{d_\iota}$ which is the latest possible completion time (c_i) of the order. The orders that completed after their due dates are also subject a penalization by a rate of w_i as a lateness cost. Any order that would be completed after its deadline should not be accepted in the beginning. The normal processing time of order i $(i = 1,\dots,n)$ on machine M $(m = 1\dots,m)$ is given by $p_{im} > 0$. Sequence dependent setup time where each element s_{ijm} is the time that has to be incurred before order j is processed, if order i precedes order j on machine m. v_i represent the price of order i that is fixed. Let p'_{im} and p''_{im} denote the minimum and maximum allowable processing time of order i on machine m. c'_{im} and c''_{im} represent the compression and expansion unit cost of order i on machine m. Let A_{im} and A'_{im} denote the compression and expansion amount of order i on machine m. We define three sets of binary variables to handle order acceptance and sequencing decisions accordingly:

x_i : 1 if order i is accepted; 0 otherwise $i \in n$

E_{im} 1 if order i is processed n machine m; 0 otherwise $i \in N$, $m = 1,\dots,M$

y_{ijm} 1 if order i is immediately precedes j on machine m; 0 otherwise $i,j \in N$, $i \neq j, m = 1,\dots,M$

Given a sequence π_s of the selected of the order set $s \subset N$, we can calculate the completion time c_i of each order $i \in s$. Using the completion time c_i and the due date d_i of an order, we can calculate the tardiness T_i of order $i \in s$ with the formula $max\{0, C_i - d_i\}$. The OASP problem is to find the set s, and the sequence π_s in order to maximization profit for the firm. The proposed model is constructed according to the following assumptions.

3-1- Assumptions

The proposed model is constructed according to the following assumptions.

- All the orders are non preemptive and available for processing at time zero.
- Each machine (order) can process only one order (machine) at a time.
- Each order will be delivered immediately after completion; hence there is no holding cost.
- The setup time for each order on each machine is sequence-dependent.
- No order operation preemption is allowed.
- All machines are unrelated with different speeds and each order could be processed by a free machine.
- Each machine is capable of processing on only some given orders.
- The processing time and release date of each order on each machine is differs.
- All data are known at the beginning of the planning horizon.

3-2- The mathematical model

This section defines the OAS and formulates it a mixed integer linear programming (MILP) model. Before this, the following notations are defined to simplify the exhibition of this formulation.

MILP:

$$maxz = \sum_{i=1}^{n}\Big(v_i x_i - w_i T_i - \sum_{m=1}^{M}\sum_{n=1}^{N}\big(c'_{im}A_{im} + c''_{im}A'_{im}\big)\Big)$$

s.t.

$$\sum_{m=1}^{M} E_{im} = x_i \qquad \forall \quad i = 1,2,\dots,n \qquad (1)$$

$$\sum_{i=0}^{n} L_{im} = 1 \qquad \forall m = 1,\dots,M \qquad (2)$$

$$\sum_{j=1}^{n} y_{ijm} = E_{im} - L_{im} \qquad \forall\ i = 1, \dots, n, i \neq j \quad \&\ \forall m = 1, \dots, M \qquad (3)$$

$$C_i + (s_{ijm} + p_{jm})y_{ijm} - A_{jm} + A'_{jm} + G(y_{ijm} - 1) \le C_j \qquad \forall\ i = 0, \dots, n, j = 1, \dots, n, i \neq j, \forall m = 1, \dots, M \qquad (4)$$

$$(r_j + p_{jm} + s_{ijm})y_{ijm} - A_{jm} + A'_{jm} \le C_j \qquad \forall\ i = 0, \dots, n, j = 1, \dots, n, i \neq j, \forall m = 1, \dots, M \qquad (5)$$

$$T_i \ \ge C_i - d_i \qquad \forall\ i = 1, \dots, n \qquad (6)$$

$$(p_{im} - p'_{im})E_{im} \ge A_{im} \qquad \forall\ i = 1, \dots, n \quad , m = 1,2, \dots, M \qquad (7)$$

$$(p''_{im} - p_{im})E_{im} \ge A'_{im} \qquad \forall\ i = 1, \dots, n \quad , m = 1,2, \dots, M \qquad (8)$$

$$E_{0m} \ = 1 \qquad \forall m = 1, \dots, M \qquad (9)$$

$$L_{im}, E_{im}, x_i \in \{0,1\} \qquad \forall\ i = 0, \dots, n, \quad \forall m = 1, \dots, M \qquad (10)$$

$$y_{ijm} \in \{0,1\} \qquad \forall\ i = 0, \dots, n, j = 1, \dots, n, i \neq j \quad \& \quad \forall m = 1, \dots, M \qquad (11)$$

$$T_i, C_i, A_{im}\ , A'_{im} \ge 0 \qquad \forall\ i = 0, \dots, n \qquad (12)$$

The objective formulated to maximize the total net profit over the planning horizon. Constraint set (1) requires that for an order to be accepted, it must be assigned to a machine. Constraint set (2) defines last order on each machine. Constraint sets (3) and (4) make it obligatory to deal with the fact that if an order is processed on machine m, it must precede only one job and it should be succeeded by only one job. Constraint sets (5) and (6) are added to the model in order to adjust the completion time of the orders on each machine. Constraint set (6) represents the tardiness of each order. Constraints (7) and (8) together define the limit the amount of compression and expansion of each job on each machine. Constraint (9) defines the yummy order 0 correctly. Constraint sets (10), (11) and (12) define the value ranges of the variables.

4- Numerical experiment

4-1- Data generation

We used two predefined parameters, the due date range $R = 0.7$, and the tardiness factor $\tau = 0.3$ to vary the problem instances to cover a wide range of cases. The following problem parameters are integer numbers which were generated randomly from a uniform distribution in the following intervals: release dates r_i in $[0, \tau p_T]$ where p_T is the total processing time of all orders; processing time p_{im} in [1,20]; sequence dependent setup time s_{ijm} in [1,10]; and prices v_i in [1,20] that we consider 5 sets of this range . The generation of the release date is similar to the study of Akturk and Ozdemir (2000). The setup times are generated using discrete uniform distribution, which is also consistent with the existing scheduling literature (Rubin and Ragatz, 1995; Tan and Narasimhan, 1997).

Table 1. Price sets

Item Price	Set 1	Set 2	Set 3	Set 4	Set 5
v_1	1	2	18	8	13
v_2	9	7	4	7	6
v_3	1/5	16	16	2	19
v_4	19	7	5	2	15
v_5	18	19	8	7	4
v_6	7/5	13	1	6	16
v_7	10	10	16	9	7
v_8	15	11	4	20	2
v_9	12	18	12	4	2
v_{10}	14	16	11	19	19

Since we study a make-to-order system, we consider the case where setup times are significant. Hence, processing time-setup time ratio is relatively small in our instance. The tardiness penalty costs w_i are selected from the discrete uniform distribution in the range [1,10] as used in Talla Nobibon and Leus (2011). Similar to keyvanfar et al. (2014), Crash and expansion processing times (p'_{im}, p''_{im}) are discretely uniformly distributed as follows, respectively: $(0.5 * p_{im}, p_{im})$ and $(p_{im}, 1.5 * p_{im}\ )$. also Compression and expansion unit cost (c'_{im}, c''_{im}) are uniformly distributed as [0.1,2.5]. the due date d_i are selected from the discrete uniform in the range [1-5], [1-10], [5-10] and [1-20].

4-2- GAMS settings

The MILP model was implemented in GAMS and tested on a PC with a 2.7 GHz Intel® Core™ i5-5200 processor and 8GB RAM memory.

Mazandaran University of Science and Technology

Available online at www.iiec2017.com

13th International Conference on Industrial Engineering (IIEC 2017)

Iran Institute of Industrial Engineering

IIEC (2017) 000–000

Table2. The accepted and scheduled orders based on different due dated and price sets

Due date $(d(i))$	Average of due date $md(i)$	Price set	Average of selling prices $mv(i)$	Net Profit (z)	Reduced Profit (z_r)	$\Delta Z = z - z_r$	ΔR	ΔC	Scheduling decisions x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	Solution No.	CPU Time
[1-5]	3	1	8/5	56	41/5	14/5	5	9/5	1	0	0	0	0	1	1	1	0	1	5/10	0:00:04/670
		2	9/5	57	42/33	14/67	5	9/67	1	0	1	0	0	1	1	0	1	0	5/10	0:00:07/347
		3	10/3	69	55/16	13/84	6	7/84	1	0	1	1	0	1	1	0	0	1	6/10	0:00:03/354
		4	10/7	60/5	31/66	28/84	6	22/84	1	0	0	1	1	1	0	1	0	1	6/10	0:00:05/963
		5	11/9	65	44	21	7	14	1	1	1	0	1	1	0	0	1	1	7/10	0:00:08/546
[1-10]	5/5	1	8/5	62	46/33	15/67	6	9/67	1	0	0	1	0	1	1	1	0	1	6/10	0:00:03/149
		2	9/5	59	48/83	10/17	6	4/17	1	0	1	1	0	1	1	0	0	1	6/10	0:00:06/808
		3	10/3	87	67/16	19/84	6	13/84	1	0	1	0	1	1	1	0	0	1	6/10	0:00:02/592
		4	10/7	72/5	55/08	17/42	6	11/42	1	0	0	1	1	1	0	1	0	1	6/10	0:00:04/472
		5	11/9	73	55	18	6	12	1	0	0	1	1	0	0	0	1	1	5/10	0:00:09/598
[5-10]	7/5	1	8/5	67	53/33	13/67	7	6/67	1	1	0	1	0	1	1	1	0	1	7/10	0:00:02/415
		2	9/5	69	48/5	20/5	8	12/5	1	1	1	1	0	1	1	0	1	1	8/10	0:00:08/250
		3	10/3	86/99	72/33	14/66	7	7/66	1	1	1	1	0	1	1	0	0	1	7/10	0:00:03/294
		4	10/7	85/5	60/41	25/09	9	16/09	1	1	0	1	1	1	1	1	1	1	9/10	0:00:09/187
		5	11/9	86	63	23	8	15	1	1	1	1	1	1	0	0	1	1	8/10	0:00:08/867
[1-20]	10/5	1	8/5	72	53/5	18/5	7	11/5	1	1	0	0	1	1	1	1	0	1	7/10	0:00:02/866
		2	9/5	77	56/5	20/5	8	12/5	1	1	1	1	0	1	1	0	1	1	8/10	0:00:05/978
		3	10/3	95	73/33	21/67	7	14/67	1	1	1	1	0	1	1	0	1	1	7/10	0:00:03/223
		4	10/7	91/5	66/41	25/09	9	16/09	1	1	0	1	1	1	1	1	1	1	9/10	0:00:09/243
		5	11/9	91	69/5	21/5	8	13/5	1	1	1	0	1	1	1	0	1	1	8/10	0:00:09/105

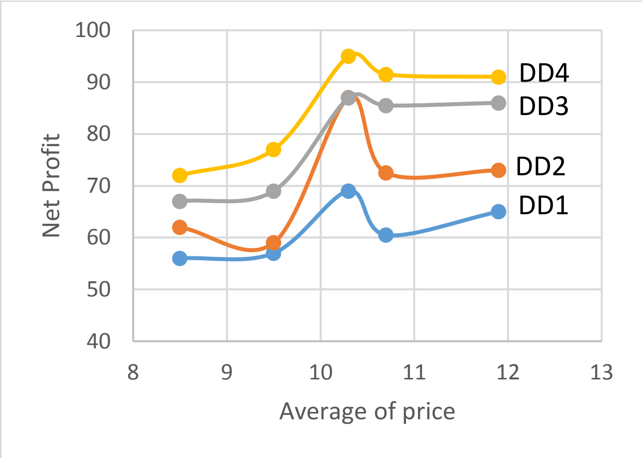


Fig. 1. Net profit of price sets with respect to average prices under different due date levels

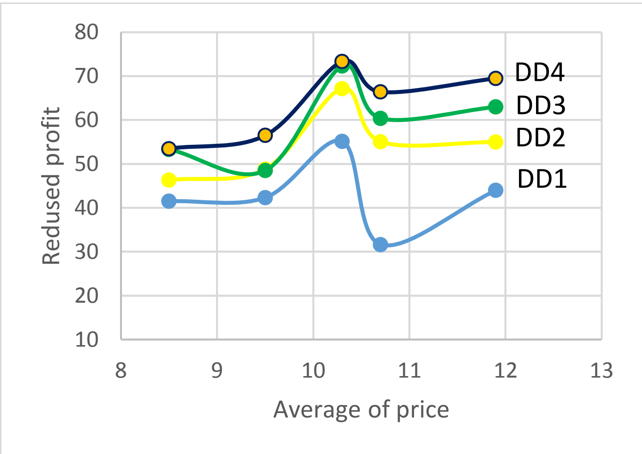
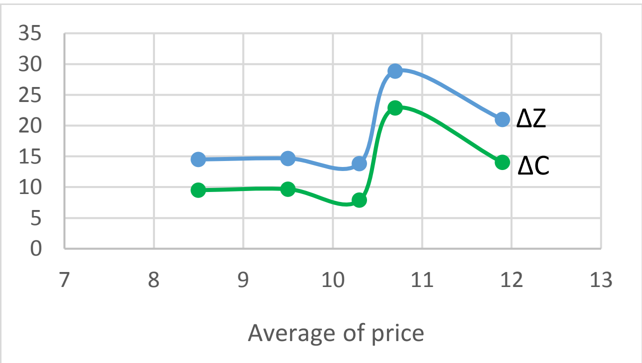
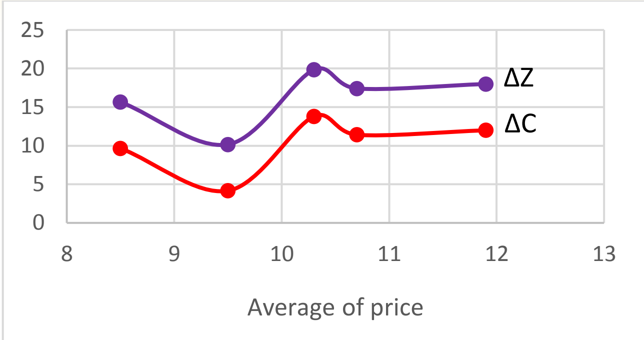


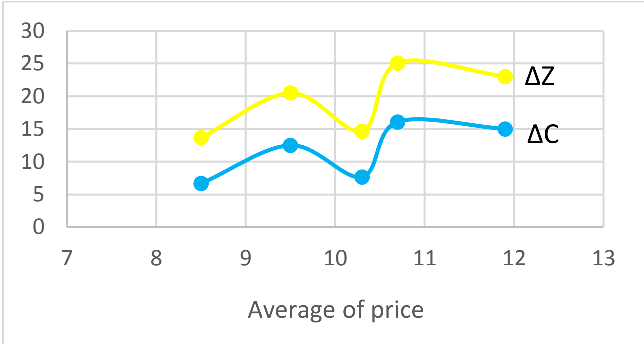
Fig. 2. Reduced profit of price sets with respect to average prices under different due date levels



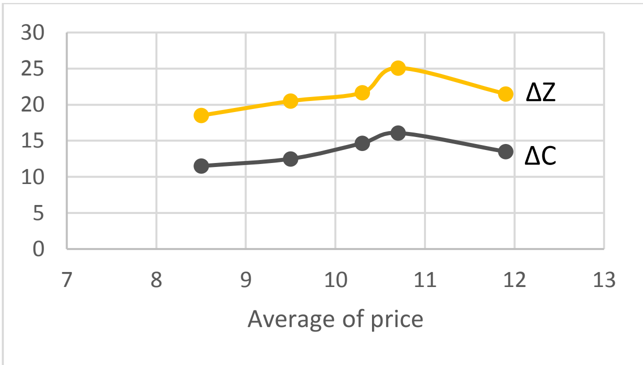
a) DD1



b) DD2



c) DD3



d) DD4

Fig. 3. Difference of net profit (Δz) and total cost (Δc) for different due date levels (a to d for DD1 to DD4)

4-3- Result analysis

In this section, we will interpret the results from the model. By entering data, we first determine the accepted orders in a bundle of products with 10 items. Table 3 shows that number of accepted items generally increases with increasing due date levels (from average of 3 to 10.5).

Then after setting these decisions, we fixed the orders decisions in any set and decrease the price level of products for 1 unit. Thus, if the problem would be reduced to a scheduling model, the differences in net profits and reduced profits should be equal to the number of accepted orders. However, our analysis show that in all of the cases regarding different levels of prices and due dates, the differences of net and reduced profits can be decomposed into two main measures. The first one is originally based on the difference of price levels (Δv). Moreover the second term of difference (ΔC) is dependent to new set of schedule based on processing time, delay of orders. Therefore it indicates that the basic developed model for scheduling/pricing model is reliable in order to find better scheduled order sets under different price levels.

Moreover Fig. 2 and 3 shows that differences of net profits and reduced profits would be concave under different average levels of price sets. Here under a limited numerical experiment we see that if the model would develop for larger number of products, the concavity of the profit function can be investigated where the optimal pricing strategies are more preferable for the firms. Similar results can be seen in Fig. 3 where the difference levels of total cost can be analyzed as a convex function in DD1 to DD3 sets. However it seems irrationality in DD4 where the total cost function is concave which is required more analysis.

In conclusion the solved sets of problem under limited number of products and price sets show that the idea of integrating the decisions of order acceptance, scheduling and pricing can be pursued for more developed data sets with assumptions of MTO environment. This model is more reliable when the price-dependent demands is investigated in the model structure and the firm would be balance the production scheduling costs with sales revenue in a price-dependent market.

3- Conclusions and future researches

In this study we have successfully implemented maximizing the problem of total net profit as well as orders cost compressing and expanding depends on the amount of compression/expansion on unrelated parallel machines environment in which orders processing times are controllable. A mixed linear programming (MILP) for the considered problem and solved via GAMS software. The output data shows the coordination of order acceptance, scheduling and pricing.

Extending the multi-objective model of the above-mentioned problem could be regarded as a direction for future research in order to observe more features in approaching to JIT policy. Also research efforts should be made in the future to implement the considered problem with the same approach on other environments such as job shop and also the structure of problem can be developed under real situation of pricing/scheduling problems for higher levels of products and machines with price-dependent demands for future research.

References

Aktürk M, Atamtürk A, Gürel S. "Parallel machine match-up scheduling with manufacturing cost considerations*,"* *J. of Journal of Scheduling* 13(1):95–110, 2010.

Akturk, M.S., Ozdemir, D. "An exact approach to minimizing total weighted tardiness with release dates*,"* *J. of IIE Transactions* 32 (11), 1091–1101, 2000.

Balin S. "Parallel machine scheduling with fuzzy processing times using a robust genetic algorithm and simulation," *J. of Information Sciences*;181 (17):3551–69, 2011.

Charnsirisakskul, K., Griffin, P.M., and Keskinocak, P., "Order selection and scheduling with lead time flexibility," *IIE Transactions*, Vol. 36**,** No. 697–707, 2004**.**

Charnsirisakskul, K., Griffin, P.M., and Keskinocak, P. "Pricing and scheduling decisions with lead time flexibility," *J. of Operational Research and production Economics*, Vol. 171**,** No. 153–169, 2006.

Emami, S, Moslehi, GH, and Sabbagh, M. "A Benders decomposition approach for order acceptance and scheduling problem: a robust optimization approach," *J. of Computational and Applied Mathematics,* 10.1007/s40314-015-0302-8, 2015.

Gürel S, Körpeoğlu E, Aktürk MS. "An anticipative scheduling approach with controllable processing times," *J. of Computers & Operations Research*;37 (6):1002–13, 2010.

Jansen K, Mastrolilli M. "Approximation schemes for parallel machine scheduling problems with controllable processing times," *J. of Computers & Operations Research* ;31(10):1565–81, 2004.

Kayvanfar V, Mahdavi I, Komaki GM. "Minimizing total tardiness and earliness on unrelated parallel machines with controllable processing times," *J. of Computers & Industrial Engineering* 2013 65(1): 166–75, 2014.

Kwong CK, Mok PY, Wong WK. "Determination of fault-tolerant fabric-cutting schedules in a just-in-time apparel manufacturing environment," *J. of International Journal of Production Research*;44(21):4465–90, 2006.

Li K, Shi Y, Sl Yang, Cheng By. "Parallel machine scheduling problem to minimize the makespan with resource dependent processing times," *J. of Applied Soft Computing*;11(8):5551–7, 2011.

Mestry S, Damodaran P, Chen CS. "A branch-and-price solution approach for order acceptance and capacity planning in make-to-order operations," *J. of Eur Oper Res* 211:480–495, 2011.

Oguz, C., Salman, F.S., and Yalcin, Z.B., "order acceptance and scheduling decisions in make-to-order systems," *J. of Production Economics*, Vol. 125, No. 200-211, 2010.

Peng J, Liu B. "Parallel machine scheduling models with fuzzy processing times," *J. of Information Sciences*;166(1–4):49–66, 2004.

Rom, W.O.,Slotnick, S.A., "Order acceptance using genetic algorithms," *J. of Computers and Operations Research*, Vol. 36 No. 1758–1767, 2009.

Rubin, P.A., Ragatz, G.L., "Scheduling in a sequence dependent setup environment with genetic search," *J. of Computers and Operations Research* 22, 85–99, 1995.

Slotnick, S.A.,Morton, T.E., "Order acceptance with weighted tardiness," *J. of Computers & Operations Research*, Vol. 34**,** No. 3029-3042., 2007.

Slotnick, S.A., "Order acceptance and scheduling: a taxonomy and review," *J. of European Journal of Operational Research,* Vol. 212, No. 1–11, 2011.

Talla Nobibon, F.,Leus, R., "Exact algorithms for a generalization of the order acceptance and scheduling problem in a single-machine environment," *J. of Computers and Operations Research*, Vol. 38, No. 367–378, 2011.

Tan, K.C., Narasimhan, R., "Minimizing tardiness on a single processor with sequence dependent setup times," *J. of Management Science* 25 (6), 619–634, 1997.

Ventura JA, Kim D. "Parallel machine scheduling with earliness-tardiness penalties and additional resource constraints," *J. of Computers & Operations Research*;30(13):1945–58, 2003.