Designing Scheduling Problem in Continuous Production System in Two-Level Supply Chain

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Abstract
Production schedule in a supply chain is found to be the most important inventory control and supply chain management which has been ignored so far. In today's world most of the products needed by applicants, due to their nature usually has a high production volume and diversity by a group of technology and cellular manufacturing method is performed. If the timing is not appropriate in a cell production system, the semi-finished products during the manufacturing cost can be enormous. These costs include the cost of storage and the cost of destroying them. Also, many customers are interested in that issue the order until the moment of delivery, spend less time waiting. It seems also important for production managers. Because of timing and delivery in the shortest time in addition to reducing maintenance costs increase the level of customer satisfaction. In this study, the question of the timing of the two-level system integration with supply chain is examined. Producers have the cell production system due to the nature of the system, a machine with speed and features are different. The customer demand in each period and must be fully met. The timing of production must be done in such a way that the parts are in the form of continuous production.

Keywords:
Supply chain, cell production, and scheduling, continuous production

1. Introduction

As mentioned, the supply chain is the most important research topics in the field of production and distribution in the past 20 years. A supply chain includes all the steps in creating a value-added product The importance of integrating and synchronizing the flow of materials and information in a supply chain system caused by industry and academic researchers is extremely high affinity owners. In general, supply chain issues, including the relationships between suppliers, producers, distributors and consumers . Schedule production in a supply chain, including inventory control and supply chain management is the most important topics that had not been paid little attention to it. In today's world most of the products needed by applicants, according to their nature usually has a high production volume and diversity by a group of technology and cellular manufacturing method is performed. If the timing is not appropriate in a cell production system, the semi-finished products during the manufacturing cost can be enormous. These costs include the cost of storage and the cost of destroying them. Also, many customers are interested in that issue the order until the moment of delivery, spend less time waiting. It seems also important for production managers. Because of timing and delivery in the shortest time in addition to reducing maintenance costs increase the level of customer satisfaction. In this study, the question of the timing of the two-level system integration with supply chain is examined. Producers have the cell production system due to the nature of the system, a machine with speed and features are different. The customer demand in each period and must be fully met. The timing of production must be done in such a way that the parts are in the form of continuous production. After production in the manufacturing sector with the help of cell production system, in order to send goods the transport system can be used without interruption. As the transport system is also different carrying capacity and speed of freight transport has the same average. The supply chain study consisted of two stages. In the first phase and the second phase includes a transportation manufacturer which is similar to vehicle routing problem and pass orders to customers. This type of scheduling production so far has not been comprehensively studied in the cell production system. Combine this with the real dimensions of the supply chain can be closer to real-world problems.

2. Literature

The research presented continuous production schedule [1] was. They cited different applications of the non-stop production. They also review of the relentless production schedule, and the number of different solutions to the problem presented.[2] A meta-heuristic search method used to solve this problem and an algorithm based on search was based on the work provided that it is based on two methods was defined. The bows that were removed were in the critical path and an alternate path for them was he continuous production method for a problem that needs to be studied in more than one source.[3] Of a hybrid

Manuscript received February 5, 2026
Manuscript revised February 20, 2026
https://doi.org/10.22937/IJCSNS.2026.26.2.13

genetic algorithm to solve this problem and restriction without interruption, there's no waiting time between the two operations to be considered. [4] An innovative method for the production of a workshop used endlessly. [5] A workshop production scheduling problem with two machines be evaluated by considering the limitations of nonstop and several algorithms for its bid. [6] A classic genetic algorithm for the production workshop presented without interruption. [7] A workshop production is continuous with regard to machine downtime examined for a journey which aims to find the best permutation. [8] A colonial competitive algorithm for this design was aimed at minimizing the total work time. [9] A new algorithm for n jobs and m innocent continuous production presented a problem, they were capacity constraints for each category in order to meet their goal was to minimize delays. In his new method of genetic algorithm (marriage-pregnancy) was used. [10] The issue of non-stop production for 2 cars and n jobs by taking the time to set up separate review which aims to minimize the total work time. They have developed a genetic algorithm for this problem. [11] Flexible manufacturing is a problem with regard to parallel machines. With the objective of minimizing the total working time taking into account the limits without interrupting production trolled and a Algorithm is also provided for. [12] A problem n * m, where the size of each batch is tested in a workshop production problem and to solve it offered a colonial competitive algorithm. [13] Presented a workshop production of a hybrid approach for multi-objective problem.

As one of the main sub-parallel machines scheduling a special place and an important technology foundation in prior the timing of the model based on various performance metrics and has been studied by many researchers. Parallel machines are classified into three different aspects of the issue [14] . 1. Identical machine in parallel: in this case several identical machines working in parallel. 2 Uniform parallel machines: in this type of machine are the same type, processing speed in this type of machine is different. In this case, the processing speed is independent of any car. 3 - unrelated in parallel machine : in this case, everything may be processed by a high-speed car. The first article on parallel machines by Mc Naughton [15] was presented. In this study, three types of performance benchmark for timing issues introduced similar machines in parallel. Chiu and colleagues [16] A mixed-integer programming model for parallel machines raised the sequence of operations. Alagöz and colleagues parallel machines scheduling problem was qualified by the limitations of their machinery. In this study, the total flow as a measure of efficiency and the number of jobs processed on the machines in primary schedules as a criterion for sustainability is considered. Azizoğlu and colleagues [17] work scheduling problem on parallel machines were introduced with the aim of minimizing the total time to complete tasks. So that tasks are able to interrupt operations as well as deadlines for delivery of the defined tasks. Tavakkoli-Moghaddam and colleagues [18] A two-objective mixed-integer programming model for parallel machines scheduling problem raised. So that the first objective of minimizing the number of jobs has delay and minimizing the total time the work is completed. Zhao and colleagues [19] related to two parallel machine scheduling problem with rate reform activities were examined. In this study, each machine has been modified so that the activity rate to the machine processing rate can change. It is intended targets for minimizing total completion time as well as minimizing the weighted sum is time to complete tasks. Yang and colleagues [20] examined the timing issue with multiple corrective actions Pierre rate paid on unrelated parallel machines. It is assumed that each machine includes multiple corrective actions and activities aimed to determine the optimal repetition rate of multiple modified, the optimum conditions Rate of corrective actions, Optimal Scheduling Minimize time to complete the work and the time of the car. Zhao and colleagues [21] timing issue related to the car that one of the machines were introduced in a given time period is not available. This time period is fixed and is aimed at minimizing the weighted sum of completion times. Lee and colleagues [22] similar machines at minimizing the maximum completion time scheduling problem with controllable processing times offered. Lin and colleagues [23] scheduling problem with a set of tasks simultaneously raised no waiting time for processing in the current workshop environment.

So that the aim of minimizing the maximum completion time is done. Operations related to the work done on the two car categories. Kim and colleagues [24] uneven parallel machine scheduling problem with the limits were considered a prerequisite for the job. So that the car has different processing speeds and minimizing the weighted sum of the target time work is complete. Sriskandarajah [25] to study the function of scheduling algorithms for parallel machines without the expected currency workshop with pay, to such a ~ way that each stage contains a certain number is workstation. Every job is actually processed by one of the cars workstation. In such a ~ way to determine the minimum time for the planned completion of the workshop with two work stations. Lee and colleagues [26] investigated the unrelated parallel machine scheduling process with the aim of minimizing the maximum completion time of tasks performed hands. In this work with dissimilar sizes on batch processing machines are capable of processing multiple jobs so that the capacity of the machinery should not be violated. Lin and colleagues [27] compared the heuristic solution methods on the timing issue unrelated to their cars. So that the objectives of minimizing the maximum completion time, total weight and total weight of delays in completion time is considered. Turabi and colleagues [28] A multi-objective models for unrelated parallel machine scheduling problem considering the uncertainty of processing times and due dates are presented. Mellouli and colleagues [29] studied the parallel machine scheduling problem by taking out a planned maintenance period. Three types definitive solution to this problem is intended to include 1. The mixed-integer linear programming 2. Dynamic scheduling and 3. The branch and bound. In addition, the goal is minimizing the total time to complete tasks. Jiang and colleagues [30] to introduce a model for scheduling tasks on unrelated parallel machines with the possibility of rejection of their work. In this model, all things available at the time, but some cars are not available at this time. The aim of also minimizing the time to complete all the tasks to be accepted, rejected, and the total cost of the work is done processing time.

The objective is to minimize the total time served, which includes production by the cell production system and transport system is, today. Constraints (1) and (2) states that every manufacturing operations for each piece must be performed by a machine. However, the machine must have the ability to perform the operation. Limitation (3) to calculate the number of machines required in each pay period. Under those restrictions, the total time used manufacturing machinery in each period is equal to the time required for production. This time by multiplying the number of pieces in the time it takes to produce each unit of product is obtained. Constraints (4) and (5) guarantee that the number of machines used in each of the cells of the upper and lower limits should not exceed the capacity of the cells. Limitation (6) to calculate the number of machines needed to buy or removed at any time deals. The number of machines in each period is proportional to the number of machines added and deleted at any time. Limitation (7) ensures that the desired operation for the production of each piece to be performed without interruption. This limits the calculation of production time per piece, Machine tools needed to carry out the next stage of production in Free Mode puts that each piece into the next campaign to be fought immediately after each operation. Restriction (8) Guaranteed to calculate the right time operation. Restrictions (9) to calculate the total production time in deals. Constraint (10) ensures that each consignment to be sent to the customer by a vehicle. Restrict (11) ensures that any vehicle that has been removed from the distribution center, then return to the center of its operations. Limitation (12) Morin, only a vehicle to be submitted for each client. In fact, the constraints (10) and (12) to allocate vehicles to their clients. One of the most important in the tour routing issues due to lack of organization. In fact the tour is to move steadily and tear on the vehicle are not permitted. This is by constraints (13) is guaranteed. Time to get anywhere by any vehicle at any time by constraints (14) are expressed. Restrictions (15) to calculate the total time required to serve customers pay the transportation system. The total time required to perform manufacturing operations and shipping to customers by constraints (16) is calculated. Constraints (17) are also describing the variables used in the model.

3. Numerical Approaches

In this chapter, some approaches will be numerical and survey design. Try that all possible scenarios have arisen in the examples provided and analyzed in real-world problems. All examples to help software Gomez and by solver Cplex in a system with a processor Core 5i and the amount of random access memory 4GB is solved.

A prime example assumes that the cell production system With the 2-cell and 4 production machine intended to produce four types of products to meet customer needs 4. also with the help of three different operations are produced by machines. The entire service operations in the transport sector and in the second period to help the two vehicles is done. The input data includes several items that are paid under the explanation.

Table 1. Components demand courses

the period	Part 1	Part 2	(Part 3)	**art 4**
1	100	50	80	**60**
2	90	85	100	**70**

Table 2: Ability to perform operations on each piece produced by each machine

the operation	Piece	Machine 1	Machine 2	Machine 3	**Machine 4**
1	1	1	1	0	**1**
1	2	1	0	1	**0**
1	3	1	1	0	**1**
1	4	1	0	0	**0**
2	1	0	1	1	**1**
2	2	0	1	0	**1**
2	3	1	0	1	**0**
2	4	0	1	1	**1**
3	1	0	1	0	**1**
3	2	1	0	1	**0**
3	3	1	0	0	**0**
3	4	0	1	1	**1**

Similarly, can be set for the second period.

Table 3. When operations on each piece produced by each machine

the operation	Piece	Machine 1	Machine 2	Machine 3	**Machine 4**
1	1	10	12	0	**12**
1	2	12	0	15	**0**
1	3	11	18	0	**18**
1	4	12	0	0	**0**
2	1	0	15	16	**14**
2	2	0	10	0	**10**
2	3	18	0	19	**0**
2	4	0	17	14	**17**
3	1	0	16	0	**16**
3	2	11	0	10	**0**
3	3	17	0	0	**0**
3	4	0	18	16	**18**

Similarly, can be set for the second period.

Table 4. The distance between customer areas

Customer	Customer		**Space**
		Volume 1	**Volume 2**
1	1	-	**-**
1	2	52	**52**
1	3	60	**60**
1	4	52	**52**
2	1	55	**55**
2	2	-	**-**
2	3	83	**83**
2	4	54	**54**
3	1	72	**72**
3	2	82	**82**
3	3	-	**-**
3	4	97	**97**
4	1	88	**88**
4	2	82	**82**
4	3	68	**68**
4	4	-	**-**

Table 5. Time of available machines

the period	Machine 1	Machine 2	Machine 3	**Machine 4**
1	200	400	300	**200**
2	300	500	400	**400**

After solving replies output in accordance with the following tables and figures

Table 6: Allocation of operations to machine parts

the operation	Piece	Machine	Volume 1	**Volume 3**
1	1	1	0	**1**
1	1	*2*	1	**1**
1	1	*3*	0	**1**
1	1	*4*	0	**1**
1	*2*	1	1	**1**
1	*2*	*2*	0	**0**
1	*2*	*3*	1	**1**
1	*2*	*44*	0	**1**
1	*3*	1	1	**0**
1	*3*	*2*	1	**1**
1	*3*	*3*	1	**0**
1	*3*	*4*	0	**1**
1	*4*	1	0	**1**
1	*4*	*2*	1	**0**
1	*4*	*3*	0	**1**
1	*4*	*4*	0	**1**
2	1	1	1	**1**

2	1	2	1	**0**
2	1	3	1	**1**
2	2	1	1	**0**
2	2	2	1	**1**
2	2	3	1	**0**
2	3	1	0	**1**
2	3	2	1	**1**
2	3	3	1	**1**
2	4	1	0	**1**
2	4	2	1	**1**
2	4	3	1	**1**
3	1	1	0	**1**
3	1	2	1	**0**
3	1	3	0	**1**
3	2	1	1	**1**
3	2	2	1	**0**
3	2	3	1	**1**
3	3	1	0	**0**
3	3	2	1	**1**
3	3	3	0	**1**
3	4	1	1	**1**
3	4	2	1	**1**
3	4	3	1	**1**

Table 7. The allocation of manufacturing operations to cells

the operation	Piece	Machine	Volume 1	**Volume 3**
1	1	1	1	**1**
1	1	2	1	**0**
1	2	1	1	**1**
1	2	2	0	**0**
1	3	1	1	**1**
1	3	2	1	**1**
1	4	1	0	**0**
1	4	2	1	**0**
2	1	1	1	**1**
2	1	2	1	**1**
2	2	1	1	**1**
2	2	2	1	**0**
2	3	1	0	**1**
2	3	2	1	**1**
2	4	1	0	**1**
2	4	2	1	**1**
3	1	1	0	**1**
3	1	2	1	**0**
3	2	1	1	**1**
3	2	2	1	**0**
3	3	1	0	**1**
3	3	2	1	**1**
3	4	1	1	**1**
3	4	2	0	**1**

Each time the operation is as follows.

Table 8. The allocation of parts to machinery manufacturing operations

the operation	Piece	Machine	Volume 1	**Volume 3**
1	1	1	-	**0**
1	1	2	0	**0**
1	1	3	-	**0**
1	2	1	0	**10**
1	2	2	-	**-**
1	2	3	0	**12**
1	4	1	24	**-**
1	4	2	35	**24**
1	4	3	12	**-**
1	4	1	-	**52**
1	4	2	32	**-**
1	4	3	-	**14**

2	1	1	42	**34**
2	1	2	18	**-**
2	1	3	20	**28**
2	2	1	10	**-**
2	2	2	45	**38**
2	2	3	24	**-**
2	3	1	-	**12**
2	3	2	36	**10**
2	3	3	52	**58**
2	4	1	-	**28**
2	4	2	18	**20**
2	4	3	46	**24**
3	1	1	-	**36**
3	1	2	32	**-**
3	1	3	-	**45**
3	2	1	64	**38**
3	2	2	24	**-**
3	2	3	10	**12**
3	3	1	-	**-**
3	3	2	10	**24**
3	3	3	-	**22**
3	4	1	38	**26**
3	4	2	52	**32**
3	4	3	28	**42**

Thus it can be seen that most of the production is 64. As a result of production operations until 64 ends.

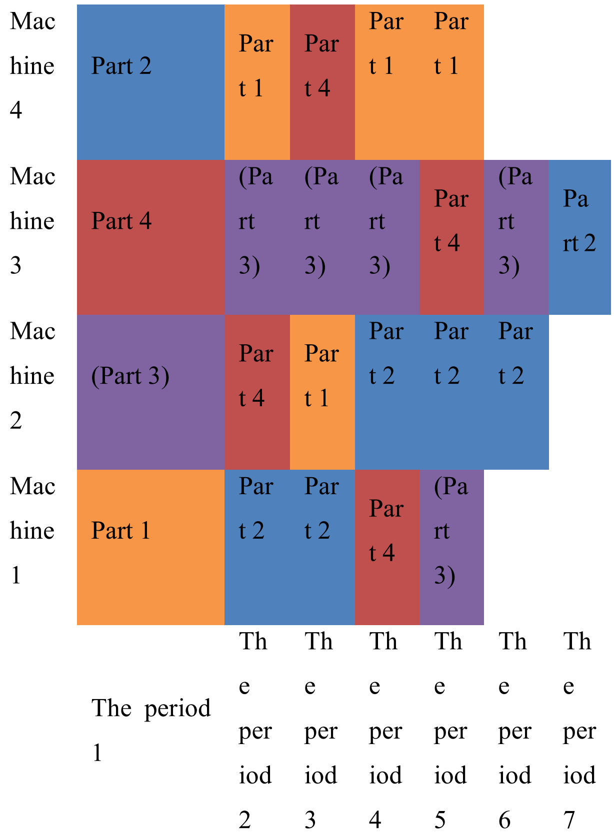

Figure 1: Timing allocation of parts to machines

In fact, the time of completion timescales for the operation of each piece. 7 the same time period 64 ends the whole operation. Similarly, the allocation for the second period shown. After manufacturing, transportation system to send goods into the system. The timing of sending goods by vehicles is also shown below.

How appropriate timing is also shown below.

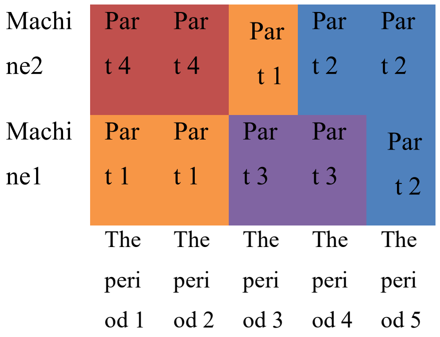

Figure 2: The timing of the allocation of parts to vehicles

As can be seen in manufacturing, Manufacture of parts 1 and 4 earlier has expired, Transport system in the form of non-stop action and then to write pieces when manufacturing parts 2 and 3 is completed, it sends each. Send piece 2 at 92 ends. So it can be concluded that the entire production operation and send the goods in time 92 ends. After solving the problem, total time and total transit operations produce the equivalent of 148 times in 271 is unit time. So the total time of 429 = 148 + 271 unit of time. Schedules manufacturing operations is shown below.

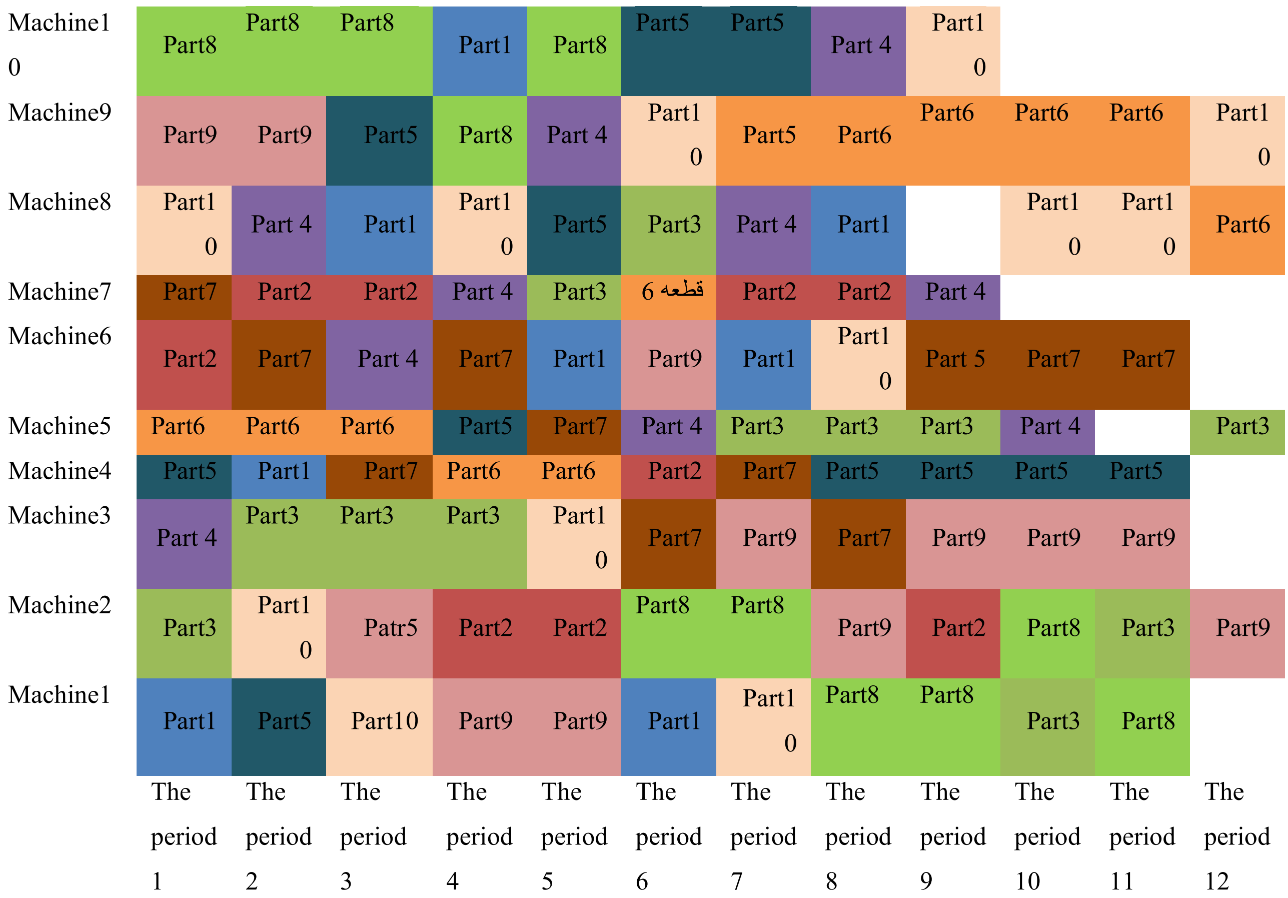

Figure 3: The timing of schedules manufacturing operations

4. Sensitivity Analysis Problem

To further investigate the issue of model sensitivity analysis is discussed in this section. With increased demand specific parameters and operational time in different scenarios will be discussed. It can be seen that the increase in demand increases the total duration of the service. But this increase in production over the shipping time is visible.

One of the most important factors in any production system for efficient use of machinery. So Muareh examines the maximum power used machines. One of the most important parameters affecting the ability to use the machines, the time available to them. In this part of the model sensitivity analysis in the time available machines. Time available for each machine with a certain ratio increases and the impact on results is checked. It should be noted that at each step only available when a machine is changed. In fact, if a car two times the available time, the condition of the change in the time available compared with other machines. Comparison of the busy ratio of the total time used car that has been in the relationship.

$$EFF_m = \frac{Busy\ Time_m}{Total\ Time_m}$$

Performance Machine	EFF_m
Busy time	$Busy\ Time_m$
All Time	$Total\ Time_m$

It is obvious that this performance is based on the ability of every car manufacturing operation. This means that if a car does not have sufficient ability in operations by reducing the time available for its efficiency goes up and vice versa. So we had.

Table 9. Performance machine to change in the time available

machinery	The increase in the time available				
	1.2	1.5	1.8	2	**2.2**
1	0.91	0.89	0.87	0.82	**0.81**
2	0.77	0.82	0.84	0.89	**0.94**
3	0.87	0.81	0.79	0.75	**0.67**
4	0.71	0.74	0.78	0.86	**0.89**
5	0.66	0.69	0.71	0.73	**0.88**
6	0.93	0.85	0.81	0.81	**0.77**
7	0.76	0.82	0.83	0.85	**0.92**
8	0.67	0.72	0.76	0.83	**0.88**
9	0.77	0.75	0.74	0.72	**0.78**
10	0.87	0.88	0.87	0.91	**0.93**

This is more clearly displayed than in the charts below. More details can be seen in the following graph.

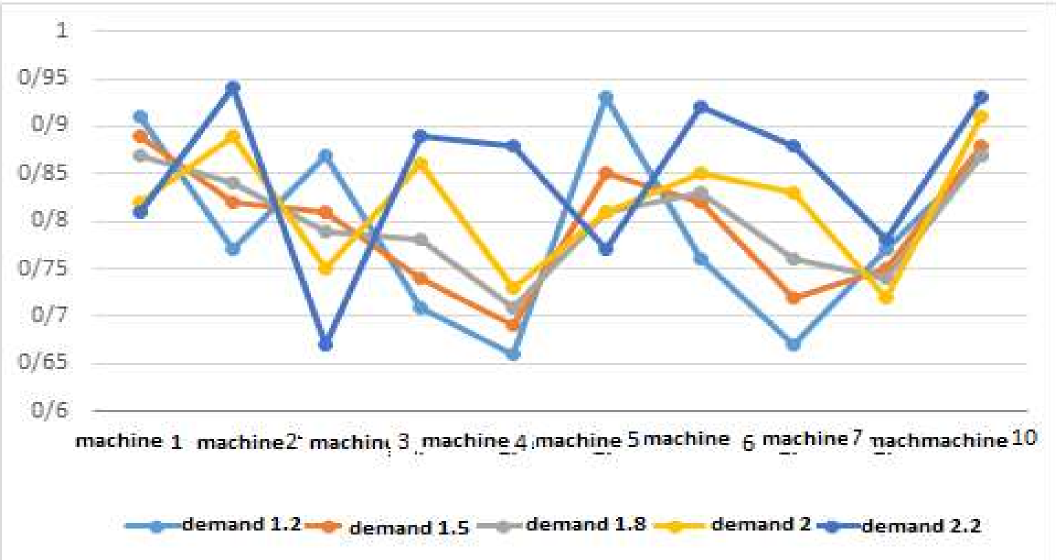

Figure 4: Performance flows to change in the time available

5. Conclusion

Given the importance of timing in the production system and supply chain products in a manufacturing organization, the maximum capacity of the system is necessary. One way to reduce the production time and achieve customer product obtained using the production system without interruption. In fact, this system has produced a product from moment to moment by customers, for continuous operations to be performed on it. This reduces the flow of semi-finished materials, reduce maintenance costs and increase customer satisfaction through timely delivery of the products. According to a literature review conducted so far no research has not addressed this issue and this research can be introduced as the first research in this area. With regard to the position expressed to comprehensive studies are necessary to evaluate the performance of the system. In this study, a mathematical model to solve the problem and by two numerical examples were provided. To ensure the accuracy of the model, the model sensitivity analysis are discussed. It is recommended for future investigations of real-world problem-solving met heuristic to be provided.

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