Using the Techniques of Scheduling the Production Processes and Supply Chain Management in the Foggy Environment; Applied Research of the Electronic Production Plant at Al - Zawra General Company – Iraq

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***Abstract*— This paper gives an overview of the theory and practice of planning and scheduling in supply chains. For this purpose it seeks to solve the problem of loading the machines in the electronic production plant at Al-Zawra General Company, in the case of having more than one order at the same time, one of them within the overall plan (MPS), which in turn was the result of "the overall planning using its various strategies and other sudden orders and emergency outside the total plan, which is forced to work overtime and regular and how to deal whit hit within the rules of scheduling production processes in the foggy environment. The goal of the research is to find a mechanism for working in the plant in case the three levels of total planning progresses, and which begins with forecasting the demand in the foggy environment, and fixing them in order to obtain accurate results to build on them the overall plan in preparing the necessary resources for production according to the product structure (BOM) reaching to scheduling different fixed and working operations using scheduling rules on one machine (FCFS, LPT, SPT), in addition to identifying a mechanism that works regularly on the distribution of orders on the business through the fixed and multiple scheduling in the foggy environment and choosing the optimal strategy for action. In order to achieve this, the researcher used the MATLAB in designing the databases using two types of artificial intelligence algorithms (TOPSIS, SPEAII), which provide multiple decision-making criteria through which she could find the best solution for the sequential work on machines, which reduced the time of achievement and reduced the four kinds of costs which are (cost of production, cost of scheduling, cost of storage, cost of subcontractor, the cost of extra work and unemployed).**

***Keywords*—** *Supply Chain Management, scheduling production, MATLAB, Aggregate Planning, Multi-Period Scheduling, Optimization.*

1. Introduction

. This paper focuses on models and solution approaches for planning and scheduling in supply chains. It describes several classes of planning and scheduling models that are currently being used in systems that optimize supply chains. It discusses the architecture of decision support systems that have been implemented in industry and the problems that have come up in the implementation and integration of systems in supply chains. In the implementations considered, the total cost in the supply chain has to be minimized, i.e., the stages in the supply chain do not compete in any form with one another, but collaborate in order to minimize total costs. This paper focuses primarily on how to integrate medium term planning models (e.g., lot sizing models) and detailed scheduling models (e.g., job shop scheduling models) into a single framework. Industrial companies face many challenges and difficulties arising from the frequent fluctuations and changes associated with the work environment, which are difficult to predict, this is what drives managers and all those involved in the work to seek the development of methods and procedures to keep pace with these changes and control the workflow, which is achieved through the development of a comprehensive and flexible plan that helps the guidance of available materials and allocate them for the greater benefit of the company, and it’s done only by preparing a production schedule to determine the times needed for the production process. And in light of the difficulties and fluctuations surrounding the work environment, and the changing and sudden demands of customers, it became difficult to respond to these changes and maintain customers and market share based only on fixed scheduling.

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1.1. Research problem

The electronic production plant in Al-Zoraa Company suffers from a problem of loading the machines when there are more than one order at the same time one of them within the overall plan (MPS), which in turn was a product of "total planning and the other within the sudden and emergency orders outside the plan, which makes them work in the normal extra time and deal with them within the rules of scheduling production processes in its foggy environment. The problem is identified by raising the following questions:

1. To what extent fixed scheduling can be effective in facing the changes in demand for sample products?
2. Is it possible to meet the obligations of the inspected company and deliver its orders within the specified time only through fixed scheduling?
3. Where does the scheduling of fixed operations meet with multi-paragraph scheduling and where do they diverge from each other?
4. Is it possible to meet the uncertainty in the demand through multi-period scheduling?
5. How does the integration of the three levels of overall planning affect the company's ability to meet its customers' commitments?

1.2. The research objectives

Determining the mechanism of multi-scheduling and fixed scheduling of the foggy. environment and solving the problem of blurry in the demand, and other information of the researched company and the construction of a proposed system for the preparation of the sequence and distribution of tasks on machines in fixed and changing periods to prepare the delivery at the specified time.

1.3. The importance of the research

The use of artificial intelligence algorithms (TOPSIS, SPEAII), which provide multiple decision-making criteria in the design of databases which are capable of finding the optimal solution for the following work on the machines and provide an integrated framework for the company surveyed for the three levels of overall planning.

Table 1. Steps to use time series to predict demand

First step	Apply the blurry time series method to the available data of the demand to be processed. These historical data are arranged in ascending order.	
Second step	Find the difference between successive values of the ascending order for the purpose of extracting the average values according to the equation:	9651 – 9701= -50 9701 – 970$x_{p(i)} - x_{p(i+1)}$ ….(1) 7= -6 9707 – 9751= -44 .|-50 | = 50 / |-6 | = 6 / |-44 | The same for all values $\left| x_{p(i)} - x_{p(i+1)} \right|$ …..(2)2 = 44
Third step	Calculate the mean of absolute value of the difference between ascending order according to the following equation:	$\mathbf{AD} = \frac{\sum\|x(p(i))-x(p(i+1))\|}{n}$ ….(3) $= \frac{11254}{138}$ = 81.5507 ≅ 82.1 Then we use the mean to calculate standard deviation for data according to the following equation

		$\sigma\ AD = \sqrt{\frac{1}{n}\sum_{1=1}^{n}(x_1 - AD)^2 = 84.1}$ ....(4)
Forth step	Both mean and standard deviation are used to determine the extreme values in the set of absolute values of the extracted data in ascending order, and the extreme values refer to values that do not satisfy the following condition:	$AD - \boldsymbol{\sigma} \leq X \leq AD + \boldsymbol{\sigma}$ -2 $\leq$ X ≤ 166.30264 $\frac{\sum\lvert x(p(i)) - x(p(i+1))\rvert}{n} = \frac{9071}{132} = 69.24427481$ / AD = 69. 24427481
Fifth step	Formation of a comprehensive set of ambiguous values by specifying the lowest value of the ordered data set ascending (Dmin = 9651) And subtract the average (69) of them and then determine the highest value of the same data set (Dmax = 20905) and combined with the average (69) so that the time demand data of the company becomes within these two values	
Sixth step	In this step the number of subtotals within the whole set is extracted by the equations	$\boldsymbol{R = UB - LB}$ ....(5) $\boldsymbol{R = 20974 - 9582 = 11392}$ $\boldsymbol{N = \frac{R - AD}{2 * AD}}$ ....(6) $\boldsymbol{N = \frac{11392 - 82}{2 * 82} = 68.963 \approx 69}$
Seventh step	The formation of blurry groups, as shown in Fig.2 which refers to the blurry aggregates according to the form of its function	

2. Theoretical Perspective

2.1. Aggregate Planning

Supply chain scheduling coordination issues arise in a number of specific practical situations. For example, Blumenfeld consider a manufacturing model where one producer has several customers, each cyclically receiving a given product type. The production schedule is based on setup and inventory costs, however the distribution schedule depends on freight and load inventory costs. Their objective is the minimization of overall inventory costs, and they analyze the trade-off between the benefits of coordination and increased management complexity. As shown in Figure 1, the term Aggregate refers to the long-standing, undifferentiated lines of production capacity and the demand for production, when multi-product companies with total planning integrate all types of products that share resources, demand and planning for production capacity [10-12].

2.2. Fixed operation Scheduling

Slack [15] explained that the concept of scheduling includes the identification of priorities and the sequence of work to be addressed by knowing and determining the necessary time schedule in terms of start dates and completion of the processing of required orders. Therefor schedules are known data in terms of size and time in many consuming environments [1, 2]. defines the schedule as the formulation and development of a multi-stage plan and objectives to solve the problems of loading of machines and their timing, and he developed complete and detailed information about the method of implementation of the work and the timing and how to start processing and completion of them and according to the sequence of the subject with the identification of machines and equipment for the process of treatment.

*rules of work sequence on one machine

1. First come first serve rule (FCFS): upon this rule, the requirements of the work and the customer are first given to the initial workstations in the treatment. This rule is the most dynamic rule in all parts of the work, where the orders are met quickly without making any other step towards orders on the same product line [16-18].

2.3. Short process time rule (SPT): The base of the business sequence can show the minimum processing of shorter time which is equivalent to the time flow in the workshop on one machine, this rule is presumed to be ideal for solving or facing many dynamic and complex problems, despite the performance actions being verified. This rule is considered a procedure for processing shorter-term production orders without a precedence of work [5, 6].

3.2 multi period scheduling

Silva & Klement [13] emphasized that it is a multi-function processing process that includes many different orders in terms of the nature of the treatment and the time needed to do so:

1. Access the lowest costs of the production process.

2. Optimize scheduling and working upon it to satisfy customers' requirements at the lowest cost.

3. Work with maximum stability in order to avoid the economic losses of the company.

4. Set two periods of the scheduling process in order to avoid exposure to bottlenecks during work [19].

In addition, both call for enabling the company to respond to the demands of the market and its customers on time, and considering the total cost in order to achieve profits, which means the objectives of the tables are identical.

Table 1. Comparison of fixed and multiple scheduling

Fixed scheduling	Multi scheduling
1. Works in normal working hours	1. Work in extra time outside the established work plan
2. Works to deal with the agreed works and orders.	2. Works to handle new and urgent business orders and orders that will interfere with planned work orders.
3. Works within the normal general planning.	3. Works within the overall multiple planning
4. Schedule fixed target, time and standards.	4. There are multiple targets, periods and criteria.

Silva & Klement [13] “Solving a multi-periods job-shop scheduling problem using a generic decision support tool”, 27th International Conference on Flexible Automation and Intelligent Manufacturing, NO. 11, PP 1759 - 1766.

2.3. Fuzzy Environment

The answer to any question posed by an expert system is accompanied by a certainty factor which gives the user an indication of the degree of confidence of the system in the conclusions, and to achieve certainty, existing expert systems employ probabilistic methods, and considering the uncertainty in the knowledge base of any expert system method which is caused by blurry and incomplete data and randomness, the values calculated as a certainty factor lack reliability very much, and it is one of the shortcomings of expert systems. To solve this problem, the blurry logic came to provide a single deductive system to deal with blurry, incomplete, and randomized information in the knowledge base, and in fact, the design of expert systems may prove to be one of the most important applications of fuzzy logic [3,4]. Also Sivanandam & Others explained the definition of blurry group as a mean of modeling uncertainties related to ambiguity, inaccuracy and lack of information about a particular problem [14].

* Fuzzy demand prediction methods:

1. Time series analysis: Most prediction problems involve the use of time series data that represents a chronological sequence of observations on a given variable. The data may be immediate and may be cumulative or may be statistical in some way reflecting the activity of the variable over the period of time [7- 9].

2. topsis and speaii algorithm: First developed by Eng and Rolon in 1981, he arranged the alternatives according to the distance between the ideal solution and the negative solution, and algorithms have been defined as a useful and practical technique for classifying and identifying a number of alternatives and specific decisions which are taken, and therefor provide a few arbitrary choices.

3. Applied Perspective

3.1. Fuzzy demand prediction

Historical demand data and forecasting data are one of the most important inputs of the overall planning process, from which the overall plan emerges, and according to which the total products that the company is working on, by details of kinds and delivery dates. Table (2) shows below the demand of the electronic plant for the time from January 2006 to July 2017.

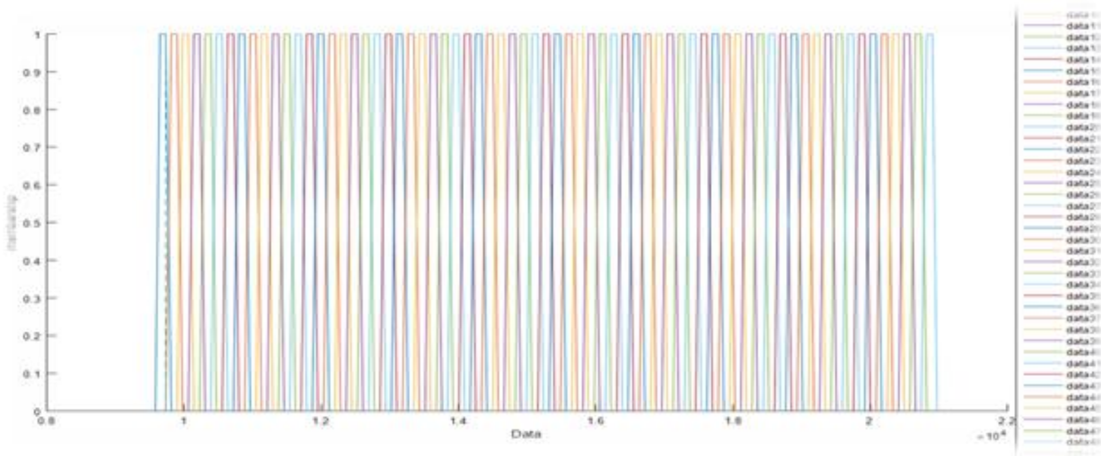


Figure 2. Blur aggregates according to their function

Table 2. Historical demand data

year	January	February	March	April	May	June	July	August	September	October	November	December
2006	9651	10451	9801	9901	9751	9701	9707	10071	10051	10177	10251	10382
2007	10494	11294	10644	10744	10594	10544	10550	10914	10894	11020	11094	11225
2008	11508	12308	11658	11758	11608	11558	11564	11928	11908	12034	12108	12239
2009	12850	13650	13000	13100	12950	12900	12906	13270	13250	13376	13450	13581
2010	13827	14627	13977	14077	13927	13877	13883	14247	14227	14353	14427	14558
2011	14967	15767	15117	15217	15067	15017	15023	15387	15367	15493	15567	15698
2012	15801	16601	15951	16051	15901	15851	15857	16221	16201	16327	16401	16532
2013	16823	17623	16973	17073	16923	16873	16879	17423	17223	17349	17423	17554
2014	18311	19111	18461	18561	18411	18361	18367	18826	18711	18837	18911	19042
2015	19261	20061	19411	19511	19361	19311	19317	19681	19661	19787	19861	19992
2016	20105	20905	20255	20355	20205	20155	20161	20525	20505	20631	20705	20836
2017	13883	14247	14227	14353	14427	14558						

Eighth step: After obtaining the blurry aggregates in the previous step, the degree of belonging to each request of the historical applications available for each group will be determined by using the special equations of belonging to the trapezoidal function.

$$\text{Xgmir} = \frac{a_1+2(a_2)+2(a_3)+a_4}{6} \quad \text{....(8)}$$

$$x_1 = \frac{9582 + 2(9651) + 2(9733) + 9851}{6} = 9694.166667$$

$$x_2 = \frac{10389 + 2(10471) + 2(10553) + 10635}{6} = 10513.5$$

The tenth step: prediction of the demand for the product for twelve months from the middle of 2017 to the middle of 2018 according to the demand prediction equation:

$$\hat{y} = ax + bx + c \quad \text{.... (9)}$$

The results of the prediction, as shown in Table (3) below, are the results that the application of the company's overall planning will depend on and then using it in the scheduling of operational processes, as opposed to the product structure (BOM)

Table 3. Demand forecast for (12) months

7/2017	8/2017	9/2017	10/20174	11/2017	12/2017
20475.11	20551.3	20627.49	20703.68	20779.88	20856.07
1/2018	2/2018	3/2018	4/2018	5/2018	6/2018
20932.26	21008.45	21084.64	21160.83	21237.02	21313.21

Source: Prepared by the researcher based on (MATLAB 2015a

Table 4. the natural distribution for data of predicted order using MATLAB software ANOVAa

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	1264244508.00	1	1264244508.00	651.212	.000b

Coefficientsa

		B	Std. Error	Beta	T	Sig
1	(Constant)	9892.431	238.512		41.476	.000
	VAR00001	75.980	2.977	.910	25.519	.000

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.910a	.827	.826	1393.33146

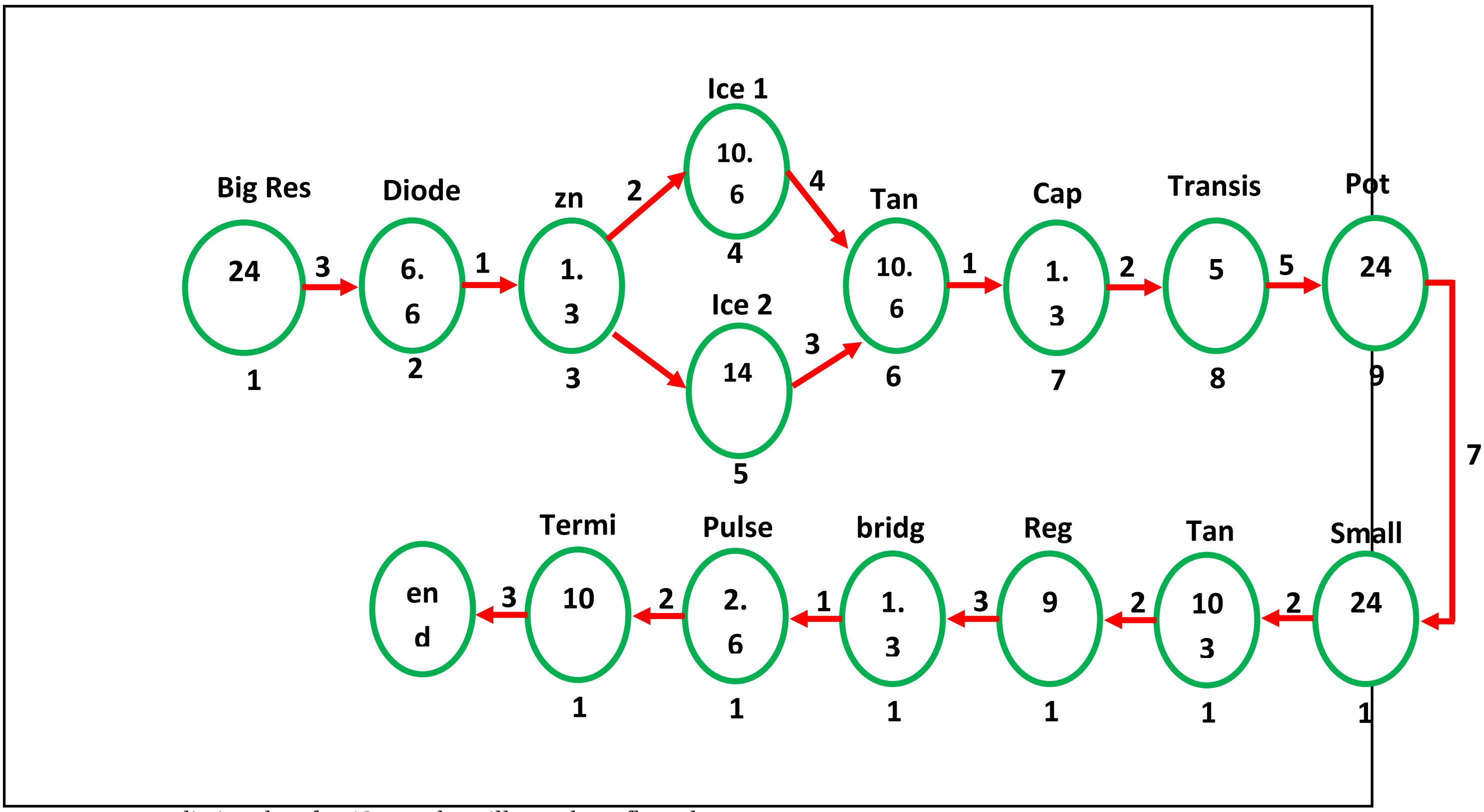
The eleventh step: examining the meaningfulness of the data of the order predicted and being naturally distributed, as shown in the table (4)

3.2. The overall planning and fixed scheduling

1. Overall planning

First step: developing the overall plan depending on the prediction in table (3) from the previous step.

Second step: Drawing the technological course to determine the level of use for each part of the BOM product, as shown in Figure 3:



prediction data for 12 months will now be reflected on the needs of the parts of the product under the path of its production processes, To configure the order matrix of the parts according to the level of

Table 5. Usage rate of the parts (BOM) in 12 months

Part	7/2017	8/2017	9/2017	10/2017	11/2017	12/2017	1/2018	2/2018	3/2018	4/2018	5/2018	6/2018
1	737104	739846.9	742589.7	745332.6	748075.5	750818.4	753561.3	756304.2	759047.1	761790	764532.8	767275.7
2	204751.1	205513	206274.9	207036.8	207798.8	208560.7	209322.6	210084.5	210846.4	211608.3	212370.2	213132.1
3	40950.22	41102.6	41254.99	41407.37	41559.75	41712.13	41864.52	42016.9	42169.28	42321.66	42474.05	42626.43

4	81900.44	82205.21	82509.97	82814.74	83119.5	83424.27	83729.03	84033.8	84338.56	84643.33	84948.09	85252.86
5	61425.33	61653.91	61882.48	62111.05	62339.63	62568.2	62796.77	63025.35	63253.92	63482.5	63711.07	63939.64
6	327601.8	328820.8	330039.9	331258.9	332478	333697.1	334916.1	336135.2	337354.3	338573.3	339792.4	341011.4
7	40950.22	41102.6	41254.99	41407.37	41559.75	41712.13	41864.52	42016.9	42169.28	42321.66	42474.05	42626.43
8	102375.6	102756.5	103137.5	103518.4	103899.4	104280.3	104661.3	105042.2	105423.2	105804.2	106185.1	106566.1
9	143325.8	143859.1	144392.5	144925.8	145459.1	145992.5	146525.8	147059.1	147592.5	148125.8	148659.2	149192.5
10	40950.22	41102.6	41254.99	41407.37	41559.75	41712.13	41864.52	42016.9	42169.28	42321.66	42474.05	42626.43
11	40950.22	41102.6	41254.99	41407.37	41559.75	41712.13	41864.52	42016.9	42169.28	42321.66	42474.05	42626.43
12	61425.33	61653.91	61882.48	62111.05	62339.63	62568.2	62796.77	63025.35	63253.92	63482.5	63711.07	63939.64
13	20475.11	20551.3	20627.49	20703.68	20779.88	20856.07	20932.26	21008.45	21084.64	21160.83	21237.02	21313.21
14	40950.22	41102.6	41254.99	41407.37	41559.75	41712.13	41864.52	42016.9	42169.28	42321.66	42474.05	42626.43
15	61425.33	61653.91	61882.48	62111.05	62339.63	62568.2	62796.77	63025.35	63253.92	63482.5	63711.07	63939.64

scheduling operations

Table 6. Operation times

Part	Least treatment time	Treatment time	Most treatment time	
Big Res	0.55	0.66	0.77	Factors that affect time 1. Employee experience 2. Machine quality 3. Machine productive age
Diode	0.5	0.66	0.75	
Zn	0.5	0.65	0.8	
Ice1	2.1	2.65	3.12	
Ice2	3.6	4.6	5.6	
Tan	0.53	0.66	0.78	
Cap	0.5	0.65	0.8	
Transistor	0.8	1	1.2	
Pot	0.78	1	1.2	
Small Res	0.5	0.65	0.8	
Tan(p)	0.5	0.65	0.8	
Rag	2.3	3	3.6	
bridge	1	1.3	1.6	
pulse	1	1.3	1.55	
terminal	2.6	3.3	4	

1. Fixed scheduling or sequencing of parts on the machine: in this stage there will be transference to the mechanism that will complete the scheduling of the operations of the work tasks in addition to determining the optimal succession according to some of the priorities of the scheduling of one of the referred to the theoretical side to work on determining the flow mechanism of business in the production line, the loading has been approved on one machine. According to this mechanism, the time of the production process or the processing time for each part of the product should be considered first as shown in Table 6.

Table (6) indicates that there are three times for the completion of the production process according to the records of the company in question and upon inquiry from the Department of Technology and technical engineer in charge of the management of the times of production processes and those in the Zoraa company in general, we see that that the time of the production process is stabilized by natural time but is not stable when applied, because of the difference in the efficiency of the employees and their ability to do work, which is due to the difference accumulated experience in addition to the different years of service between the old and the new appointment in addition to other factors such as the efficiency of the machine and the difference in its productive age, which made us calculate the time of the production process by the researcher using the (stop watch) and recording the times related to each part, taking into account the confusing conditions of the work of the power failure and impact on the time of completion, which gave us a set of time frames for the machines divided in three groups, named the normal time, more than normal time and lower than normal time. In addition to the processing time, the time of the setting for the parts that need to be re-configured for the machine must be considered when moving the machine to work from one part to another, therefor it's a general purpose machine and not individual one. And as shown in Table (7) these times has been considered within the time of completion of the production process described in Table (6)

Table 7. Preparation times

Part	1	10	13	4	8	6	7	5	9	3	11	12	2	14	15
Setting Time	-	1	1.3			1.98			2.1				1.8		

The flow and processing times for the 15 parts of the product composition are then determined according to the company records and based on the shorter processing time (SPT), and the rule what comes first serves first (FCFS) referred to in the theoretical aspect of the research and the three times that represent the reality of the company. After extracting the level of use, average delay time, average delivery time of the 15 parts and the three times of the production process, we move to the comparison between the above-mentioned factory performance standards and the SPT and FCFS To determine the best among them for the performance of the factory, as shown in Table (8):

Table 8. Comparison between factory performance standards

times \ Assessment benefits	Usage rate		Mean of delay		Time of progress mean	
Normal time	SPT	0.19	SPT	1.4	SPT	0.31
	FCFS	0.13	FCFS	5.8	FCFS	1.29
Less than normal time	SPT	0.19	SPT	0.34	SPT	0.89
	FCFS	0.13	FCFS	3.7	FCFS	1.5
More than normal time	SPT	0.19	SPT	2.83	SPT	0.17
	FCFS	0.13	FCFS	7.87	FCFS	1.10

The above results show that the level of use of the SPT and the three times is 0.19 and the level of use of the second rule (FCFS) is constant at (0.13) which proves that the level of use is constant for all times and therefore the second evaluation criterion will be chosen, which is the average time of progress and delay to choose the best among them for the performance of the plant, which showed that the least processing time is best for scheduling the parts on the machines because it gave a high level of use (0.19), And a low average lag time of (0.34), with an acceptable average time of progress of (0.89) and the lowest flow time of the production process which reached (89.64), therefore, applying less time to the SPT is the best option for the plant according to their current home.

2: Use the search algorithm to draw static scheduling policies

A. Remove blur for the three times: In this step, the three times of the production process will be addressed by removing the blur of these times to obtain only one time of the process by applying the law of blurry of trigonometric functions, as shown in Table (9)

$$\frac{a_1 + 2a_2 + a_3}{4} \quad \text{....(10)}$$

$$\text{Big Res } \frac{0.55+2(0.66)+0.77}{4} = 0.66$$

$$\text{Diod } \frac{0.5+2(0.66)+0.75}{4} = 0.6425$$

$$\text{Zn } \frac{0.5+2(0.65)+0.8}{4} = 0.65$$

Table 9. Operation times after removing the blurry

Part	Least treatment time	Treatment time	Most treatment time		Blurry removing
Big Res	0.55	0.66	0.77		0.66
Diode	0.5	0.66	0.75		0.648333
Zn	0.5	0.65	0.8		0.65
Ice1	2.1	2.65	3.12	Factors that affect the time	2.636667
Ice2	3.6	4.6	5.6	Employees efficiency	4.6
Tan	0.53	0.66	0.78	Differentiated staff experiences	0.658333
Cap	0.5	0.65	0.8	- Machine efficiency	0.65
Transistor	0.8	1	1.2	- Differential productive life	1
Pot	0.78	1	1.2	- Of the machine	0.996667
Small Res	0.5	0.65	0.8	- electricity	0.65
Tan(p)	0.5	0.65	0.8		0.65
Rag	2.3	3	3.6		2.983333
bridge	1	1.3	1.6		1.3
pulse	1	1.3	1.55		1.291667
Terminal	2.6	3.3	4		3.3

B. After removing the blur from the three times, the two rules for scheduling (SPT, FCFS) will be applied to extract the flow time and evaluate the factory performance parameters for the new time as shown below:

Level of use= $0.19 = \frac{22.64}{114.36}$ mean of submission time $= \frac{2.24}{15} = 0.4$

Mean of delay time = $\frac{18.55}{15}$ = 1.23

level of use = $\frac{22.64}{165.6}$ 0.13 = mean of submission time = $\frac{19.44}{15}$ 1.29 =

Mean of delay time = $\frac{86.99}{15}$ 5.7 =

The results indicate that the scheduling of the parts according to SPT rule is the best for the plant because it gives a higher level of use of the available resources by (0.19) with a small average delay time of (1.23) and less flow time of the production process (114.36).

3: Formulation of the mathematical model, which consists of two target functions including the first to reduce the oscillation in demand and the second seeks to reduce the working time and the total cost of production using the algorithms (TOP SiS) and (SPEAıı), which provides the best solution for scheduling parts on the machine in the multiple decision criteria.

4. The algorithm used in the research (TOPSiS) and (SPEAıı)

This algorithm generates a total of 100 possible solutions as shown in the first and second columns of Table (10) for part of the data and Figure (4), each point of the first column represents a possible solution for the first objective function in the mathematical model to reduce the oscillation in demand and the second column represents the second objective function. Below.

Table 10. Steps to Choose the Optimal Solution for fixed scheduling

Resulting Solutions The first Objective function X1	Fixed Objective function X2	$\sqrt{\sum(X1+X2)^2}$	$R = \frac{X1}{\sqrt{\sum(X1+X2)^2}}$	$R = \frac{X2}{\sqrt{\sum(X1+X2)^2}}$
1580294368	56662808487	56684840972	0.02787861	0.999611316
1507174520	56103774686	56124015440	0.02685436	0.999639357
1575471371	56626342445	56648254772	0.02781147	0.999613186
1530669949	56284845578	56305655065	0.02718501	0.999630419
1526045687	56249324720	56270021742	0.02712005	0.999632184
1559633810	56506182873	56527702594	0.02759061	0.999619307
1828530656	58470138979	58498723718	0.03125762	0.999511361
1675310134	57370295143	57394750882	0.02918926	0.999573903
1792704744	58217237055	58244832222	0.03077878	0.999526221
1535686514	56323351614	56344283384	0.02725541	0.999628502
1881600747	58840248247	58870325590	0.03196179	0.999489092
1477346324	55871817909	55891346277	0.02643247	0.999650601

1543535559	56383406787	56404530517	0.02736545	0.999625496
1478725205	55882591873	55902152934	0.02645203	0.999650084
1663282569	57281844987	57305988117	0.02902459	0.999578698
1482680215	55913476390	55933131351	0.02650809	0.999648599
1611466325	56897203114	56920018851	0.02831106	0.999599161
1665998615	57301853815	57326067386	0.0290618	0.999577617
1623059454	56983794549	57006904522	0.02847128	0.999594611
1515915587	56171312235	56191763794	0.02697754	0.99963604
1776035731	58098701770	58125841501	0.03055501	0.999533087

3.3 Multi-Period Scheduling

First step: The total plan is based on the forecasted data for 12 months in the foggy phase, which is the same as shown in Table (3). Second step: formulation of the mathematical model, which consists of two functions aim first seeks to reduce the fluctuation in demand while the second reduces the cost and time of the production process and also using the algorithm (Top sis), which gave 100 solution as alternatives to the company, and as shown in Table 11 and Figure 5, the difference between this multiple scheduling model and the fixed scheduling model referred to in the previous section is that there are two types of times that are associated with two types of costs, the first is the work of normal time and the second is working during overtime, also the change in some restrictions of the form, where the sub-contract and its costs has been deleted and added to it in time and cost.

Table 11. Steps to Choose the Optimal Solution for Multi - Period Table

Resulting Solutions The first Objective function X	Objective function	$\sqrt{\sum x^2}$	$R = \frac{x}{\sqrt{\sum x^2}}$		$\sum [(R - An)]^2$	$\sum [(R - Ap)]^2$	$\frac{DN}{DN - Dp}$
4549541519	30838741177	31172524527	0.145947163		8.27E-02	1.02E-02	0.890095906
5998777266	30029593676	30622897071	0.195891893	(An=max(X	5.67E-02	1.62E-02	0.777710131
7680974513	29205236550	30198397497	0.254350401	(Ap=min(X	3.29E-02	2.93E-02	0.529044705
7416534036	29328403255	30251615074	0.245161589	An=[0.433466 522359864	3.61E-02	2.68E-02	0.574380112
4880687016	30643645536	31029890710	0.157289855	0.9953341419 [24526	7.63E-02	1.12E-02	0.872460037
4545304220	30841299361	31174437232	0.145802286		8.28E-02	1.02E-02	0.890295024
7574152564	29254728987	30219314273	0.250639458	Ap=[0.096488 0610198349	3.42E-02	2.82E-02	0.547500026
7575977827	29253892785	30218962311	0.250702779	0.9011696699 25284]	3.41E-02	2.83E-02	0.547186583
12260226942	27374087756	29994230198	0.408752845		7.45E-03	9.76E-02	0.070875399

9156349897	28554172598	29986322152	0.305350881	1.83E-02	4.62E-02	0.283255823
9109236466	28574110228	29990964711	0.303732693	1.86E-02	4.56E-02	0.290149798
5721256450	30176264277	30713835662	0.186276195	6.13E-02	1.47E-02	0.806750746
8074081314	29026077558	30128125854	0.267991489	2.84E-02	3.33E-02	0.460379784
9891160117	28252266099	29933686512	0.330435749	1.33E-02	5.66E-02	0.19003543
8177595879	28979602039	30111300349	0.271578968	2.73E-02	3.44E-02	0.442326705
4417053471	30918786457	31232702690	0.141423991	8.53E-02	9.90E-03	0.896018211
12633406096	27246077204	30032510261	0.42065768	7.93E-03	1.05E-01	0.07013012
4167344977	31072992312	31351197989	0.132924585	9.03E-02	9.42E-03	0.905578282
4736617705	30727697939	31090625081	0.152348745	7.91E-02	1.07E-02	0.880650269
8748796291	28728396121	30031020299	0.29132531	2.17E-02	4.10E-02	0.345916882
4901752619	30631475596	31021193979	0.158013022	7.59E-02	1.12E-02	0.871193039
3083050404	31803575448	31952662034	0.096488061	1.14E-01	8.87E-03	0.927570298
4037119328	31155238040	31415715650	0.128506362	9.30E-02	9.22E-03	0.909792488
9046465285	28600752810	29997359808	0.301575383	1.92E-02	4.48E-02	0.299486495
4329919307	30972107783	31273305897	0.13845416	8.71E-02	9.72E-03	0.89958474
8798407856	28707010450	30025063360	0.293035447	2.13E-02	4.16E-02	0.337952599
6136416979	29958115179	30580128816	0.200666813	5.44E-02	1.70E-02	0.761894777
3747307006	31343167568	31566381849	0.118711958	9.91E-02	8.91E-03	0.917458654
5376881893	30363286819	30835694338	0.174372006	6.72E-02	1.30E-02	0.837577028
3959928571	31204619571	31454877473	0.125892354	9.46E-02	9.12E-03	0.912057634
4262248859	31013852695	31305364146	0.136150752	8.84E-02	9.59E-03	0.902181623
10542917854	27997684438	29916942537	0.352406261	1.01E-02	6.67E-02	0.131623258
4830081776	30673022663	31050990471	0.155553227	7.73E-02	1.10E-02	0.875430711
8498818453	28837318344	30063613295	0.282694511	2.40E-02	3.80E-02	0.387204682
6556641894	29744722872	30458793339	0.215262693	4.80E-02	1.98E-02	0.707914855
5199601666	30461909230	30902488110	0.16825835	7.04E-02	1.23E-02	0.85128169
5998777266	30029593676	30622897071	0.195891893	5.67E-02	1.62E-02	0.777710131

Step 3: Configure the array of storage quantities according to the storage level control strategy shown in Table (12).

Step 4: Provide the increase in demand through the work of additional times to ensure the fulfillment of needs and maintenance of customers and compensation of contracted amounts in the fixed schedule and as shown in table (12):

Table 12. Production quantities overtime

Time period												
part	7/2017	8/2017	9/2017	10/2017	11/2017	12/2017	1/2018	2/2018	3/2018	4/2018	5/2018	6/2018
1	273534.1	516512.6	731486.2	920792.6	1086575	1230797	1355260	1461614	1551371	1625918	1686525	1734358
2	75982.35	143477	203192.4	255778	301829	341891.1	376464.4	406007.3	430940	451647.7	468483.3	481770.5
3	15197.2	28696.78	40640.43	51158.05	60368.7	68381.51	75296.51	81205.39	86192.18	90333.92	93701.22	96358.8
4	30393.49	57391.83	81278.42	102313	120733.8	136758.9	150588.5	162405.9	172379.1	180662.4	187396.8	192711.7
5	22795.35	43044.3	60959.42	76735.54	90551.24	102570.2	112942.5	121805.6	129285.7	135498.1	140549	144535.3
6	121571.2	229562.1	325106.3	409242.9	482924.2	547023.3	602340.3	649608.8	689501	722633.1	749569.9	770829.2
7	15197.2	28696.78	40640.43	51158.05	60368.7	68381.51	75296.51	81205.39	86192.18	90333.92	93701.22	96358.8
8	37991.63	71739.35	101597.4	127890.5	150916.3	170947.6	188234.5	203006.1	215472.6	225826.6	234244.5	240888.2
9	53187.92	100434.4	142235.4	179045.5	211281.4	239325	263526.4	284206.6	301659.6	316155م	327940	337241.1
10	15197.2	28696.78	40640.43	51158.05	60368.7	68381.51	75296.51	81205.39	86192.18	90333.92	93701.22	96358.8
11	15197.2	28696.78	40640.43	51158.05	60368.7	68381.51	75296.51	81205.39	86192.18	90333.92	93701.22	96358.8
12	22795.35	43044.3	60959.42	76735.54	90551.24	102570.2	112942.5	121805.6	129285.7	135498.1	140549	144535.3
13	7599.06	14349.25	20321.44	25580.57	30186.17	34192.82	37650.53	40605.14	43098.7	45169.7	46853.46	48182.34
14	15197.2	28696.78	40640.43	51158.05	60368.7	68381.51	75296.51	81205.39	86192.18	90333.92	93701.22	96358.8
15	22795.35	43044.3	60959.42	76735.54	90551.24	102570.2	112942.5	121805.6	129285.7	135498.1	140549	144535.3

Fifth step: Scheduling the parts on the machines, by inserting the time and part data in the program used, the following results were found that specified the optimum time for the sequence of parts on the machine. The best way to process the parts on the machines where it is likely to begin to process the parts using the following sequence as in Table (13):

Table 13. Sequence of parts processing

Sequence	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Work	15	6	13	11	5	8	7	2	1	14	4	3	12	10	9

Source: Prepared by the researcher based on (MATLAB 2015a)

Sixth step: Determining the optimal costs for parts treatment ss shown in Table (14)

Table 14. Scheduling Cost

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	0	253	618	207	672	635	322	230	786	485	134	349	485	134	349
2	601	0	522	438	257	722	595	833	676	394	496	578	394	496	578
3	571	361	0	598	401	688	568	861	527	697	212	211	697	212	211
4	970	515	283	0	647	515	276	675	665	507	445	485	507	445	485
5	380	492	629	962	0	172	782	372	479	875	165	666	875	165	666
6	760	377	290	960	612	0	368	831	452	574	289	745	574	289	745
7	113	519	102	812	531	506	0	774	248	585	775	982	585	775	982
8	894	802	412	800	497	614	178	0	549	803	291	208	803	291	208
9	364	312	619	816	481	490	896	376	0	494	174	939	494	174	939
10	853	104	684	702	465	743	239	914	278	0	124	425	338	124	425
11	428	204	750	505	628	318	163	520	207	831	0	795	831	133	795
12	178	541	543	636	825	1000	536	540	853	637	654	0	637	654	294
13	870	277	518	536	761	246	396	816	484	229	508	384	0	508	384
14	140	117	631	764	264	392	199	239	126	981	895	317	981	0	317
15	628	848	797	925	514	888	175	113	684	468	536	595	468	536	0
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	332	253	618	207	672	635	322	230	786	485	134	349	485	134	349

We see that he results obtained from the two tables above that the total time with costs for multiple scheduling has increased by (53.67) dinars because of the work of additional times and load the machines additional parts and the consequent wages of workers and the purchase of raw materials and maintenance of the machines as a result of overloading the work in order to reach the required number of products to meet the sudden and changing orders, which is a slight increase compared to the costs of the quantities contracted with another company. 4. Search results and recommendations

4. Conclusions

1. The results show that storage strategy does not have the potential to cope with demand fluctuations.

2. The implementation of the subcontracting strategy led to the provision of the required requirements, but in turn led to increased costs and non-compliance with the required quality.

3. The implementation of the overtime strategy has enabled the company to provide the required products of the appropriate quality.

4. Through the application of the proposed system, the company was able to overcome the problem of fluctuation in demand that had previously suffered from.

5. The implementation of multi-period scheduling system increased production costs, but in turn led to increased productivity and higher profits for the company.

6. The application of the system in the electronic lab contributed to determining the optimal time to process and load the parts on the machines and thus reduce the lost time in the production process.

5. Recommendations

Efficient scheduling algorithms enable a supplier to schedule jobs optimally, while meeting the requirements of several manufacturers. A useful property of our algorithms is that their running times increase at most polynomially with the number of manufacturers. Our results can be summarized as:

1.he use of the scientific methods in the overall planning and scheduling of the production processes described in this research through the strategies followed and the multi-period scheduling system to ensure the management of the electronic lab as full control of the sudden, changing and new requests to the company.

2. Holding periodic training for the staff of electronic lab to avoid the problem of delay in the completion of work.

3. Implement the proposed system in the company and adopt it as a method to determine the optimal times and the lowest costs of the production process.

4. We propose that Zoraa General Company should adopt the technique of scheduling the blurry production processes to solve the problem of sudden requests. This technology gives the decision maker a wide possibility to choose decisions based on the degree of blur in the objectives of the problem covered in the study.

5. The importance to study the conditions of demands in the foggy environment instead of the normal environment.

6. Applying theoretical applications of blurry aggregates in their different fields, which helps to remove ambiguity and uncertainty of the Iraqi production environment.

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