Research Inventy: International Journal of Engineering And Science
Vol.8, Issue 1 (January 2018), PP -01-09
Issn (e): 2278-4721, Issn (p):2319-6483, www.researchinventy.com

The Algorithm Scheduling Times (N) Work Requires Sequential Passing through (M) Action Center

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Abstract;*This study aimed to provide scientific algorithms process to schedule times to end (M) of business that requires sequential completion through (N) machine or a service center in the production halls or maintenance or service centers in banks, airlines, hospitals, hotels .., in the light of improve productivity and quality of products and services requirements, thus increasing the competitiveness of companies on the basis of least cost and accuracy in the delivery and completion dates of service.*

Keywords: *Algorithm, scheduling, Gantt Charts, CDS Algorithm, Sequencing,*
Algorithm , scheduling, Gantt charts , CDS algorithm , starting matrix , the matrix of termination , short-term scheduling , Johnson base , the raw data matrix , the matrix ideal arrangement, matrix idle times , optimization solutions , the quality of services .

Date of Submission: 20-02-2018 Date of acceptance: 07-03-2018

I. Introduction

In classical Job Shop Scheduling Problem (JSSP), there are (1, …,*n*) jobs must be processed on (1, …, *m*) machines in predefined operation sequences. Decision makers then need to determine the processing sequence of jobs on all machines such that each job can visit all machine once with all system constraints satisfied(Wong, T. et al, **2009**). The flow shop scheduling has been a very active and prolific research area since the seminal paper of Johnson [1]. In the flow shop problem (FSP) a set *N* of *n* unrelated jobs are to be processed on a set *M* of *m* machines. These machines are disposed in series and each job has to visit all of them in the same order(B. Naderi, Rubén Ruiz,2010). The study of scheduling problems with earliness and tardiness (E/T) penalties is relatively recent. For many years, the research of scheduling problems focused on minimizing measures such as mean flow-time- maximum tardiness, and makespan, all non-decreasing in the completion times of tasks. For these measures, delaying execution of tasks results in a higher cost. However, the current emphasis in industry on the just-in-time (JIT) philosophy, which supports the notion that earliness, as well as tardiness, should be discouraged, has motivated the study of scheduling problems in which tasks are preferred to be ready just at their respective due dates, and both early and tardy products are penalized(RefaelHassin, MatiShani, 2005).

Despite the importance of scheduling in the planning and control of the flow of production and service delivery processes , as well as ensure the exploitation of energy machinery and manpower to better face the practical life in this field lacks the ways and means of adequacy can be easily and simply used in business that require completed the process of scheduling through a chain on number of machines or the workplace (Al mansour, 2001)), thus ensuring a level of credibility in the completion and delivery of services to the customer.

II. Problem Of The Study

Most organizations rely on business scheduling solution on the experiences and skills of managers and production monitors or operations issues, and use the Gantt charts on a large scale despite the limited benefits. Thus, the difficulties and problems associated with scheduling Keep existing in the organizations, which cost those organizations a lot of effort and money and pay the stakeholders concerned towards the search for solutions (ways and means of general application and high adequacy) help to simplify and clarify the scheduling process, and reduce the burden of planning and scheduling, production control and operations (CS Sung, Hyun Ah Kim, 2008).

The use of Gantt charts asas a main key in scheduling completion and processing business does not provide the desired benefit in the case of large business that requires longaccomplishment, knowing that these schemes are not merely a means of illustrative not based on scientific or mathematical logic in resolving the issues based on actual data and scientificprocedures. And because the problem remains valid in light of Gantt charts , it is essential to look for ways and more efficient methods based on scientific principles such as algorithms (Shu-Shun Liu, Chang-Jung Wang, 2011), and applications of software .

III. Importance Of The Study

This study comes in the context of improving the quality of services and increase customer satisfaction , because the scheduling processing and completion of the work in the production halls and assembly , and in the maintenance workshops and reform, and in the service centers ... , stays one of the difficult issues , and vary from one organization to another , and depend on the experience and skill , and because of the low adequacy methods of scheduling particularly the weakness and the difficulty to clarify operations scheduling points (Bechlold et al, 1991) .

With the exception of regular and developed Gantt Charts There are no other means known widely help in scheduling business in such a situation (Harvey Maylor, 2001). Since these schemes demonstrated limited success in existing business schedule on the web Analysis " Project Management, it has failed at the level of business that requires sequential passing through a number of workshops or machinery or the workplace scheduling (Sha et al, 2008), As well as in service centers that requires high flexibility in scheduling its scale with manufacturing centers, they do not remember the benefits of progress in this area. For this business scheduling remained a problem in both the manufacturing sector and the service sector which urgently needs the list of solutions, methods and techniques of high and adequacy of general application. That is why the present study is in the area of interestedengineers,production managers, operations managers and service centers, especially in government institutions, as well as the owners of jurisdiction and concerned at the scientific level and in practical life to the industry and services (Blum, 2005).

IV. Objective Of The Study

This study aims to find scientific methods (algorithms) and techniques of process for the scheduling times end business that requires sequential passing through a number of duty stations (work centers), whether such centers in the industrial production system or service production system, without the need for means of additional clarification of the complexity of The solution of the scheduling and increase costs.

Previous studies

Short-term Business Scheduling Procedures (Short - term Scheduling Tactics) is linked closely with the sequential business rules on duty stations (Work Center), (Baker and Trietsch, 2009b). These rules are the following:

First: Johnson's Rule: Johnson’s rule consists of two cases, namely, (Johnson, 1954):(1) Base order (N) work on the two machines, a general rule applied without conditions or exceptions. (2) Base order (N) work on three machines, a special rule requires the availability of specified conditions to apply, and in the absence of those conditions the application of this rule cannot be applied.

The Johnson’s rule in both cases uses Gantt charts to schedule and calculate the completion time of each work center , and calculate the total time to complete all the work at all work centers , in addition for use in clarifying the scheduling of such acts , as it shows the following example:

Example No. 1: The following table shows the business and the times required to address each of them on the machines available in the system:

Time (H)

Business	Machine (1)	Machine (2)
A	**3**	**6**
B	**5**	**2**
C	**1**	**2**
D	**7**	**5**

By applying Johnson’s rule the ideal arrangement is (C, A, D, B), and the time needed to complete the work on each machine, as well as to schedule the completion of the business Gantt charts must be used, and as shown in Figure (1) .

Table 1

Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Machine1	C		**A**					**D**						**B**				
Machine 2			**C**					**A**						**D**				**B**

Second: CDS algorithm to arrange passage and treatment (N) work on (M) machine:

The application of CDS algorithm requires the use of Gantt charts in order to test ideal solutions offered by this algorithm and down to choose the optimal solution (Cambell, et al, 1970). In practice, Gantt charts must be prepared for each solution provided by this algorithm, and compare solutions through calculate the total time required to complete all the work on all machines or work stations, and choose the right solution. Business scheduling must be arranged by the optimal solution as required by Gantt charts to clarify (TCE Chenga, BMT Linb, 2009). As illustrated by the following example :

Example No. 2: The following table shows the business and the times required to address each of them on the machines in the system:

Time (H)

Business	Machine 1	Machine 2	Machine 3	Machine 4
A	**3**	**1**	**11**	**13**
B	**3**	**10**	**13**	**1**
C	**11**	**8**	**15**	**2**
D	**5**	**7**	**7**	**9**
E	**7**	**3**	**21**	**4**

The solutions offered by CDS algorithm to arrange the passage of these actions are:

M-1 = 4-1 = 3 three solutions
Where: M = is the number of machines in the system

These solutions are the following:

The first solution:B ، C ، E ، D ، A
The second solution: C ، B ، D ، E ، A
The third solution:B ، C ، E ، D ، A

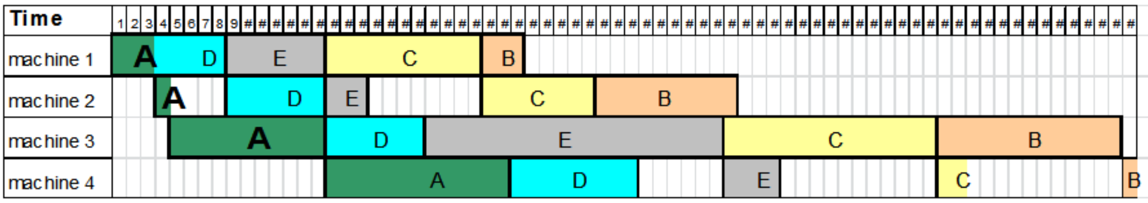
To test the ideal solutions and choose the best solution we need to clarify each solution using Gantt charts. Where we choose the solution that requires less processing time for all work on the machines. Compared solutions on Gantt charts shows that the ideal solution is the first or the third solution as it is describedin Gantt charts (Figure 2).

Table 1

Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Machine1	C		A					D						B				
Machine 2			C					A						D				B

Table 2.the first solution

Table 3.third solution



We note the importance of Gantt charts in scheduling the completion of those business actions, being the only means available to it in spite of being inadequate (B. Naderi, Rubén Ruiz, 2010).

The use of Gantt charts in case of scheduling (N) work on one or two machines, and a max on three machines can be useful or technicallyaccepted, but more than that the use of charts is not useful at all, but a waste of time, effort, and an increase in the complexity of scheduling (Gong Tang, 2011), and that for the defects that characterize these schemes such as:

• Need great efforts to set up, especially when complicated and intertwined business operations.
• Need to use many illustrative means such as colors, coding and the others.
• Assume the continued implementation of business plans as scheduled, without pauses or interruptions or errors.
• Any amendment to the times given (increase or decrease) lead to the abolition of existing schemes, and develop new schemes.
• Can not explain the overall scheduling plan, because it depends on the vocabulary of the detailed plan, and the fragmentation of the plan to its elements.
• Difficult to read and interpret forthe non-professionals, especially when they are complicated.
• The delay implementation of any work on any machine eliminates Gantt charts for subsequent work on all subsequent machines, as well as the Order for the early implementation of any action.
• Vocabulary is difficult to translate into practice when new developments occur in the work system (crashes,festivals, special circumstances).

The problems resulting from the application of Gantt charts to clarify the scheduling process is shrouded in a lot of difficulties and complexities and cost (Lluis -Arbos, Jordi y-Santos, Carla -Sanchez, 2011)

The proposed algorithm

First: The scientific basis for the proposed algorithm: as the scientific basis of this algorithm, we will use the basic form of matrices to ensure the simplification of the proposed algorithm and give clarity, precision and innovation advantage. To this end, the use of two forms of matrices, are the Preliminary data matrix and the ideal arrangement matrix.

1. Preliminary data matrix: This matrix contains the preliminary data for the business, and duty stations (machinery, staff), and the times required to address all the work in each work center. The matrix form a number of rows for the work center in the system .where each center Bookers a row - and columns same as the number of the business work to be addressed , which requires sequential passing through all the centers in the system , where each work books one column – and the cells represent the times of handling all the work on each work center . The overall shape of this matrix as follows:

Business / Work centers	w1	w2	3w	……	wn
M1				……	
M2				……	
M3				……	
……	……	……	……	……	……
Mm				……	

Whereas:i=center, w=work, t=time

2. Ideal arrangement matrix: This matrix contains the same preliminary data matrix, but with different data arrangement in columns, arranged as Business arrangement (perfect order) in the system, which is determined by following known rules previously displayed.

Second: The proposed algorithm

This algorithm is based on converting a matrix arrangement to a finishing matrix to accomplish business in the workplace and to clarify the steps of this algorithm we go back to our former example, and we take a matrix arrangement. To illustrate the steps of this algorithm we take the following example:

Example (3): The following table shows the business and the times required to address each of them on the machines available in the system:

Time (T)

machines / business	(1) M	(2) M	(3) M	(4) M	(5) M
A	10	11	4	11	12
B	6	10	3	9	10
C	8	12	8	8	8
D	11	8	6	12	10
E	9	6	5	7	5

Steps for setting up matrix termination times.

Step # 1: Keep the above data in the form of a matrix, rows for machinesand the columns for the business, and thus we get the preliminary data matrix, and this matrix takes the following form (previous matrix):

business / machines	A	B	C	D	E
M1	10	6	8	11	9
M2	11	10	12	8	6
M3	4	3	8	6	5
M4	11	9	8	12	7
M5	12	10	8	10	5

Step # 2: we convert the abovepreliminary data matrix to a matrix order using CDS algorithm. And the perfect arrangement for the sequence of actions of this algorithm is as follows: B, A, D, C, and E. and become as follows:

Business / machines	B	A	D	C	E
M1	6	10	11	8	9
M2	10	11	8	12	6
M3	3	4	6	8	5
M4	9	11	12	8	7
M5	10	12	10	8	5

Step # 3: We prepare a matrix of termination by addressing the data matrix arrangement as follows:
First, start putting the times of end business processing on the first machine (the first row of the machine) by giving the first time work on the first machine as a time to end and put it in the cell m 1 1 p . Add the second work processing time on the first machine to end the cell m 1 p 1 time.We get time to end the second work on the machine on the first one, and we put it in a column No. 2 and so on until the end of first grade, according to the following equation:

$\tau_{i1w1} = t_{i1w1}$
$\tau_{i1w2} = t_{i1w1} + t_{i1w2}$
$\tau_{i1w3} = t_{i1w1} + t_{i1w2} + t_{i1w3}$
$\tau_{i1wn} = t_{i1w1} + t_{i1w2} + t_{i1w3} + \cdots + t_{i1wn}$

The result of this step as follows:

business / Machines	B	A	D	C	E
M1	6	16 =10+6	27=11+16	35=8+27	44=9+35

Second: put an ending times for the first processing work on the rest of the machines by adding the processed time on the second machine until the finishing time on the first machine we get a finishing time on a second machine processing time, and so on for the remaining machines. The same can be applied to the previous equation with a different mechanism of cell numbers as follows:

$\tau_{i2w1} = t_{i1w1} + t_{i2w2}$
$\tau_{i3w1} = t_{i1w1} + t_{i2w1} + t_{i3w1}$
$\tau_{imw\,1} = t_{i1w1} + t_{i2w1} + t_{i3w1} + \cdots + t_{imw\,1}$

The result of this step as follows:

business / Machines	B	A	D	C	E
M1	6	16	27	35	44
M2	16=10+6				
M3	19=3+16				
M4	28=9+19				
M5	38=10+28				

Third: completing matrix cells by following the following rule:

$$\tau_{ilwk} = t_{ilwk-1} + \max\{\tau_{ilwk-1}, \tau_{il-1wk}\}, for\ l, k > 1$$

For example on:

$$\tau_{i2w3} = t_{i2w2} + \max\{\tau_{i2w2}, \tau_{i1w3}\} = 11 + \max\{16,16\}$$

Thus, the matrix termination time as follows:

business / Machines	B	A	D	C	E
M1	6	16	27	35	44
M2	16	27=11+16	35=8+27	47=12+35	53=6+47
M3	19	31=4+27	41=6+35	55=8+47	60=5+55
M4	28	42=11+31	54=12+42	63=8+55	70=7+63
M5	38	54=12+42	64=10+54	72=8+64	77=5+72

Thus, the termination times of the matrix are as follows:

business / machines	B	A	D	C	E
M1	6	16	27	35	44
M2	16	27	35	47	53
M3	19	31	41	55	60
M4	28	42	54	63	70
M5	38	54	64	72	77

Through this matrix (the last row in which) we can determine the time of the completion of all the work and thus determine the time to hand over to the client as that shown in the following table:

Business in the order	B	A	D	C	E
Termination time	38	54	64	72	77
Due date	-	-	-	-	-

The importance of the proposed matrix termination time

The preparation of the matrix termination time to schedule the completion of (N) over (M) work center (machine, place of business, employees) available in the system achieves a lot of benefits, such as:

1. Scheduling the termination time of each work in each work center,can easily translate these scheduling over the Production and Operations Management Agenda. The termination time in all centers is determined by the value of the last row in this matrix.
2. . Determination of the final time to complete all the work in all the centers in the system based on the termination of the last working on another machine,means termination time for the cell$i_m w_n$. In our former example No. (3) the time of termination of the cell$i_m w_n$ = 77 hour , and this time is the total time to finish work on all five machines in the system.From the last row we can find out the time of final completion of each action.

3. It does help to control completion of business through the following:
A) Any action which did not end before the date of termination at the center will be delayed, and requires the administration intervention to speed up the completion of the remaining work .
B) Any action which ends before the date of termination at the duty station is early and does not require administration intervention.
4.Ideal solutions offered by CDS algorithm as well as the ranking algorithms without the need to use Gantt charts , and we will explain this later

V. Applications Of The Proposed Algorithm

In addition to the benefits of the proposed matrix algorithm termination at the level of work scheduling, it points out that this algorithm can be applied effectively in ideal test solutions offered by the previous rules – Johnson's rule and algorithm CDS - and to provide quick solutions . And make it clear through processing data in example number (3) to search for the optimal solution and scheduling the work required.

The number of tested solutions by CDS algorithm in our example (3) is (4) solutions and calculated at the following form m -1 = 5-1 = 4 solutions.
Where m = the number of machines in the system.
Access to these four solutions requires many actions and efforts, the bottom CDS algorithm application procedures are the following solutions:

The first solution is the arrangement as follows:E ، D ، A ، C ، B

The second solution is the arrangement as follows:E ، C ، A ، D ، B

Figure (3): the first solution

M1	B	C	A	D	E				82
M2		B	C	A	D	E			
M3			B	C	A	D	E		
M4				B	C	A	D	E	
M5					B	C	A	D	E

Figure (4): the second solution

M1	B	D	A	C	E				79
M2		B	D	A	C	E			
M3			B	D	A	C	E		
M4				B	D	A	C	E	
M5					B	D	A	C	E

Figure (5): the third solution

M1	B	A	D	C	E				77
M2		B	A	D	C	E			
M3			B	A	D	C	E		
M4				B	A	D	C	E	
M5					B	A	D	C	E

Figure (6): the fourth solution

M1	B	A	C	D	E				82
M2		B	A	C	D	E			
M3			B	A	C	D	E		
M4				B	A	C	D	E	
M5					B	A	C	D	E

The third solution is the ranking as follows:E,C,D,A, B
The fourth solution is the arrangement as follows:E ، D ، C ، A ، B
The selection of the optimal solution requires testing the four solutions using Gantt charts , where these charts show the total time to complete all the work on all machines in the system . A comparison between these times is to choose a solution that requires less achievement for all the work on the machines in the system, and the solutions exposed in forms (3.4 , 5.6) .

By comparing Gantt charts for the four solutions and also shown in shapes(3.4,5.6), we find that less completion time is 77 hours and resulting from the third solution, where the arrangement of the work on the sequence B, A, D, C, E, while the time of completion in the first solution is (82) hours , and in the second solution (79) hours , and in the fourth solution (82) hours. And thus the third solution is optimal or near- optimal solution.

As it noted that access to the optimal solution require preparation Gantt charts four times , and what is needed is a single scheme provides scheduling , and it is the third solution scheme . The other three schemes are to test the remaining best solutions. This work is difficult and hard , and requires great efforts , and can be replaced easily by preparing matrices termination times of the four solutions , the choice of the optimal solution , and this requires simple arithmetic operations without effort or the complexities as it is in Gantt charts . We will explain that ideol test solution as follows:

VI. Experimental Results

To test solutions using matrices termination we must put termination solution matrix for each mode, and the total time to handle all the business .

1) Matrix termination in the first solution: the total time (82 hours) .

Business / Machines	**B**	**C**	**A**	**D**	**E**
M1	6	14	24	35	44
M2	16	28	39	47	53
M3	19	36	43	53	58
M4	28	44	55	67	74
M5	38	52	67	77	" 82 "

2) Matrices termination in the second solution : the total time (79 hours)

Business / Machine	**B**	**D**	**A**	**C**	**E**
M1	6	17	27	35	44
M2	16	25	38	50	56
M3	19	31	42	58	63
M4	28	43	45	66	73
M5	38	53	66	74	" 79 "

3) Matrix termination in the third solution : total time (77 hours)

Business / Machines	B	A	D	C	E
M1	6	16	27	35	44
M2	16	27	35	47	53
M3	19	31	41	55	60
M4	28	42	54	63	70
M5	38	54	64	72	77

4) Matrix termination in the fourth solution : the total time (82 hours) .

business / machines	**B**	**A**	**C**	**D**	**E**
M1	6	16	24	35	44
M2	16	27	39	47	53
M3	19	31	47	53	58
M4	28	42	55	67	73
M5	38	54	63	77	"82"

The results of the comparison between the total times of achievement shown by the termination of the four matrices solutions turned out to be the perfect solution is the third solution, where the least achievementtime is(77 hours), which is the same solution as that Gantt charts.

VII. Conclusions And Recommendations

The importance of scheduling in production and operation management beyond its borders for the planning and control of production and operations technical issues to reach economic issues relating to l exploitation optimal production capacity (machinery, workers) and reduce costs , and thus access to achieve main competitive advantage of cost as well as quality . . Therefore, the omission of this issue by specialists, researchers and administrators is not justifiedalthough it is difficult to look into this issue.It has been the practice to develop means and methods based on trial and error to reach reasonable solutions to the issue of scheduling; such schemes have been developed, but the use of these means for the purposes of scheduling. However, the use of Gantt charts can in many cases form big difficulties or obstacles that lead to a fall in scheduling errors which are based mainly on quantitative data . As is known, the quantitative analysis found mainly to deal with the accomplishment of quantitative data requires sequential passing through the serial number of duty stations, whether they are machines or places of work with the staff.

Based on this and using arrays method we introduced an algorithm to schedule times to end (N) work on (M) work center, and we were able to prove the adequacy of itsGantt scale schemes through real life examples.

These algorithms are based on the use of matrices in the business schedule. And we made clear the importance of each matrix and how to prepare and we demonstrated through examples the possibility of using a matrix scheduling times of termination in finding the ideal solution for arranging the passage of (N) work on (M) Action Center. And therefore we made in our work this is what is scientifically alternative to Gantt charts .And contributed to the provision of generic models solve the problem of lack of organizations to experts and specialists in the field of scheduling . It can also evaluate this algorithm to solve some of the issues of the economics of production processes in the future, in banks,hospitals, airports as well as all kinds of industrial organizations.

Finally , we recommend the adoption of this algorithm in production and services sector , and support of developed computer programs in order to be easy to implement with low cost, and a short time to process data so results will be ready to use .

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Suhail Ahmad Samhan.“ The Algorithm Scheduling Times (N) Work Requires Sequential Passing through (M) Action Center” Research Inventy: International Journal of Engineering And Science, vol. 08, no. 01, 2018, pp. 01–09.