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Determine The Optimal Sequence - dependent Setup Cost and / or Setup Time for Single Demand with Multiple Products Using Modified Assignment Method

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Abstract
Sequencing is the most impact factor on the total setup cost and / or time and the products sequences inside demands that consist from muti-products . It is very important in assembly line and batch production . The most important drawback of existing methods used to solve the sequencing problems is the sequence must has a few products and dependent setup cost or setup time . In this paper we modify the assignment method –based goal programming method to minimize the setup cost and / or setup time. The main advantage of this new method , it is not affected by the number of products in the sequence and can treatment the sequence problems with two or more objectives .
Keywords: products sequences , setup cost , setup time , travel salesman problem (TSP) , modified assignment method , goal programming .

1. Introduction

The set-up operation is to change the manufacturing condition from those for producing certain product to those for producing a different product . It can also defined as "The total elapsed time from making the last good item of item A to the first good item of item B "as shown in figure 1(Greg 2001). Setup time is the time between last good pieces of the current run and the first good pieces of the next run while running at optimum rate (Jerry 2002) , it is the work required to convert process from running one part or operation to running another (Thaney 2009) also it is total time it takes to convert an individual machine, measured from the last good part of the previous run until the first acceptable part of next run.

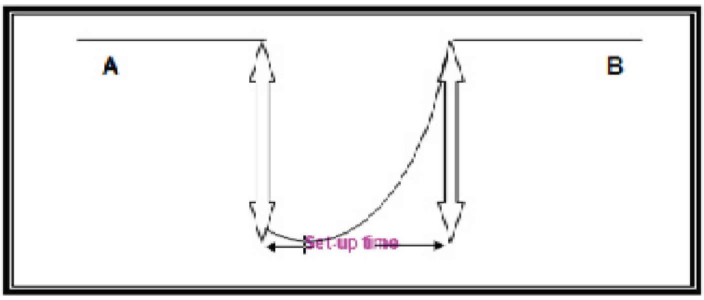

Figure 1. Setup Time Identification

In general, setup time can be defined as the transition time from state A to state B while state A refers to part A and state B refers to part B. The significance of this definition is that it implies the important concept of *changeover* between two parts. Besides, common sense and real practice both imply that changeover must take place on a *common* machine. The term 'common' should be stressed since it is a key factor in the definition that might lead to confusion if neglected or understated. In fact, setup time depends on three elements without which part of the information for obtaining the changeover time would be missing (Allahverdi et al. 1999; Al-Mubarak et al.2002) , can be divided into two types as shown in figure 2. (Schalleret al. 2000) setup times: sequence-dependent and sequence-independent. In a sequence-independent setup time, the setup time of the incoming part is independent and has nothing to do with what it is going to replace on the common machine. In sequence-dependent setup time, the setup time of the incoming part may vary based on the part it is going to replace, implying a joint changeover time Sequence-dependent setup times are usually found in the situation where the facility has multipurpose machines. Some examples of sequence-dependent setups include chemical compounds manufacturing, where the extent of the cleansing depends on both the preceding chemical processed and the chemical about to be processed, the printing industry, where the cleaning and setting of the press for processing the next job depend on its derogation from the color of ink, size of paper and types used in the previous job Sequence-dependent setups can also be found in many other industrial systems, some of which include the stamping operation in plastic manufacturing, die changing in metal processing shops, and roll slitting in the paper industry, etc. (Yang, & Deane 1993; sharifi 2012) .

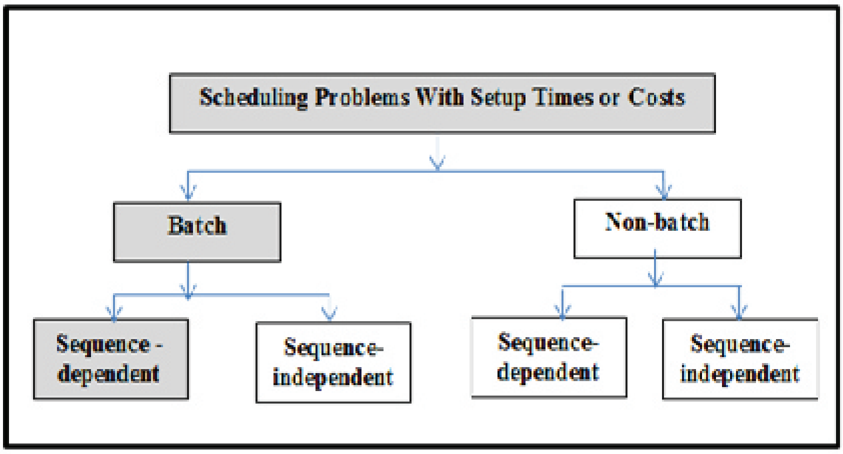

Figure 2. Classification of Separate Setup Time (Cost) Scheduling Problems

There is an important relationship between setup time and batch production , where according to American Production and Inventory Control Society (APICS) defines batch production as a form of manufacturing in which the job pass through the functional departments in lots or batches and each lot may have a different routing. It is characterized by the manufacture of limited number of products produced at regular intervals and stocked awaiting sales. Batch Production is characterized by :

1. Shorter production runs.
2. Plant and machinery are flexible.
3. Plant and machinery set up is used for the production of item in a batch and change of set up is required for processing the next batch .
4. Manufacturing lead-time and cost are lower as compared to job order production (Kumar & Suresh 2009) .

When it comes to determining the importance of reducing set-up time as opposed to cycle time the most important factor is your typical lot size ,the larger lot size the greater percentage of time that the machine will be in production and fewer number of set-up .As shown in figure 3.

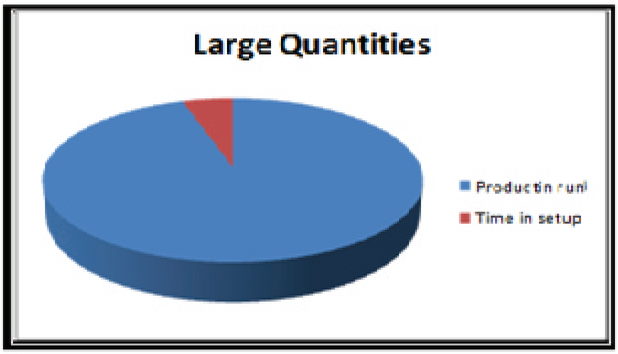

Figure 3. Large Lot Size

In versus aspect if small quantities that mean greater percentage of time in set-up and small percentage time in production. as shown in figure 4 (Dirk & Henndrik 2002).

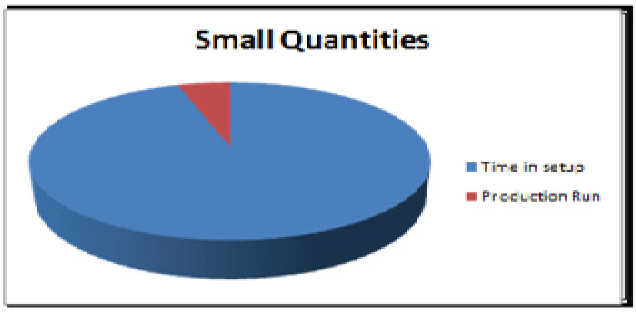

Figure 4. Small Quantities Production

Samadar et al. (Samadar et al 1999) developed the mathematical model for resource sharing and scheduling for a class of computer-integrated manufacturing cells with sequence dependent setup times. A similar work has

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been done by Schaller et al. [Schaller 2000) , who have addressed the problem of scheduling part families and jobs within each part family in a flow line manufacturing cell, where the setup times for each family are sequence dependent and it is desired to minimize the makespan while processing parts together in each family. Franca et al.(Francaet al. 2005) proposed six evolutionary heuristic algorithms to minimize makespan for permutation schedules in a pure flow shop manufacturing cell with sequence-dependent setup times between families of jobs. Lin et al. (Linet al. 2009) developed a meta-heuristic for a non-permutation flow line manufacturing cell with sequence-dependent family setup time. Hendizadeh et al (Hendizadeh et al 2008) applied various Tabu Search based meta-heuristics to scheduling of the part families and jobs within each family in a flow line manufacturing cell with sequence dependent family setup times.

2. Assignment method and Travelling salesman problem (TSP)

An assignment problem is a particular case of transportation problem where the objective is to assign a number of resources to an equal number of activities so as to minimize total cost or maximize total profit of allocation.

The problem of assignment arises because available resources such as men, machines, etc. have varying degrees of efficiency for performing different activities. Therefore, cost, profit or time of performing the different activities is different. Thus, the problem is how the assignments should be made so as to optimize the given objective. The assignment problem is one of the fundamental combinatorial optimization problems in the branch of optimization or operations research in Mathematics (Gaglani 2011).Then, the mathematical model of the assignment problem can be stated as:

The objective function is to,

$$Minimize = \sum_{i=1}^{N}\sum_{j=1}^{N} C_{ij}X_{ij} \qquad (1)$$

Subject to the constraints

$$\sum_{j=1}^{N} X_{ij} = 1 , \quad for\ all\ i\ (\ resourxe\ availability\ ) \qquad (2)$$

$$\sum_{i=1}^{N} X_{ij} = 1 , \quad for\ all\ j\ (\ activity\ requirement\ ) \qquad (3)$$

Where:

X_{ij}: assignment variable $=\begin{cases} 1 & when \text{ assignment} \\ 0 & Otherwise \end{cases}$

cij : represents the cost of assignment of resource i to activity j.

The assignment problem is a variation of the transportation problem with two characteristics: (i) the cost matrix is a square matrix, and (ii) the optimal solution for the problem would always be such that there would be only one assignment in a given row or column of the cost matrix(Lawler*, et al.* 1986) .

In this paper, we have applied new method of an assignment problem for solving Travelling salesman problem where it is shown that this method also gives optimal solution. However the technique for solving Travelling Salesman problem using our method is more simple and easy for the optimal solution. The travelling salesman problem is one of the problems considered as puzzles by the mathematicians. Suppose a salesman wants to visit a certain number of cities allotted to him.

He knows the distances (or cost or time) of journey between every pair of cities, usually denoted by cij i.e. city i to city j . His problem is to select such a route that stars from his home city. Passes through each city once and only once and returns to his home city in the shortest possible distance (or at the least cost or in least time) (Keller 2004) .

Figure 5.shows an example of the simple TSP diagram.

corresponds to the cost(or time) of the edge joining node *i* to node *j* . The integer programming pormulation for TSP is given as follows (. Ji & Ho 2005) ;

$$Minimize = \sum_{i=1}^{N}\sum_{\substack{j=1 \\ j\neq i}}^{N} C_{ij}X_{ij} \qquad (4)$$

Subject to :

$$\sum_{i=1}^{N} X_{ij} \leq 1, \; for\ j = 1,2, \ldots \ldots, N \quad i \neq j \qquad (5)$$

$$\sum_{j=1}^{N} X_{ij} \leq 1, \; for\ i = 1,2, \ldots \ldots, N \quad i \neq j \qquad (6)$$

$$\sum_{i=1}^{N} \sum_{j=1}^{N} X_{ij} = N - 1, \; for\ j = 1,2, \ldots \ldots, N, \; i = 1,2, \ldots \ldots, N \qquad (7)$$

Where:

X_{ij}: variable $= \begin{cases} 1 & when \text{ Passes salesman travels } from\ city\ i\ to\ city\ j \\ 0 & Otherwise \end{cases}$

c*ij* : denoted to The distance (or cost or time).

The objective function (4) is simply to minimize the total cost or distance travelled in a tour. Constraint set (5), (6) and (7) ensures, respectively that the salesman enter and leaves each city exactly once (Keller 2004).

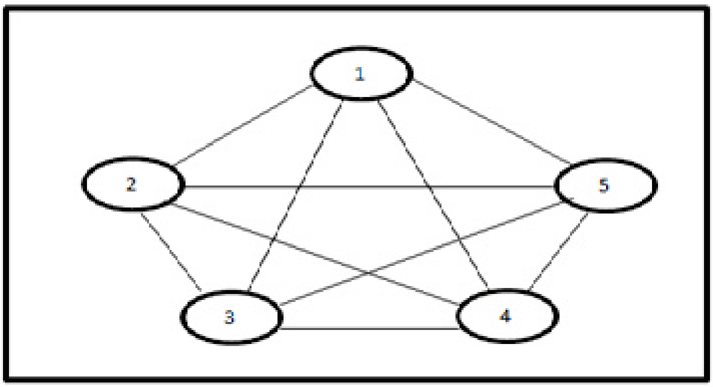

Figure 5. Graphic for Five City for TSP .

3. Goal Programming

Goal programming is a solution method commonly used in practice to convert a multiple objective program into a solvable single objective program. Goal programming requires that the decision maker specifies a goal for each criterion. It may not be possible to achieve all the specified goals simultaneously. Therefore, the sum of the weighted deviations from the preset goals is minimized during the optimization. Depending on how the Decision maker is asked to specify their goal preferences, the goal program can be identified as either a non-preemptive or preemptive goal programming.goal programming problem model as the following **:**

Min $a^{--} = \{ p_1[g_1 (d_1^+ , d_1^-)] , p_2 [g_2(d_2^+ , d_2^-)] ,\ldots.. p_k[g_k(d_i^+ , d_i^-)] \}$ (8)

S.t

$\sum^{m}_{i=1} C_{in} X_n + d_i^+ + d_i^- = b_i$ (9)

$X_j , d_i^+ , d_i^- \geq o$

$n = 1,2,3,\ldots\ldots, N$

Preemptive goal programming compares goals to each other and assigns a priority variable, or an ordinal weight, to the goal. The priorities are represented by the vector (*P1, P2,…,Ps*). Therefore the goals are put in order of most important first and least important last and are solved sequentially with the most important goal being satisfied as far as possible before moving on to the next goal, or objective. First, just the goals affiliated with *P1* are satisfied. Then, attempts are made to improve *P2* goals without destroying the achievement levels of P1 goals. Essentially, preemptive goal programming solves a sequence of single objective problems and optimal solution would minimize the of deviational variable, d^+ *and* d^- (Niman 2010) .

4. Modified Assignment Method (MAM) :

The main idea of the proposed algorithm (modified assignment method) is to convert TSP from closed loop (return to the original point) to open loop (no need to return to the original point) to agree sequence products problem with single demand multiple products depend on setup time and/or setup cost .

The terms of the application of (MAM)algorithm as following :

1. Number products manufactured within a production line are known and specified.
2. Setup time and/or setup cost between products an known .
3- Demands consist from one or more products .
4 - products within the same demand not to be repeated .
5- A product is manufactured within single batch .

The table 1 represents the assignment matrix **.**

The table 1. Modified Assignment Method

From product i	To product j								
	Products \ Products	A		B		....		N	
		Cost	Time	Cost	Time	Cost	Time	Cost	Time
	A	C_{11}	t_{11}	C_{12}	t_{12}	C_{1j}	t_{1j}	C_{1N}	t_{1N}
	B	C_{21}	t_{21}	C_{22}	t_{22}	C_{2j}	t_{2j}	C_{2N}	t_{2N}
	....	C_{i1}	t_{i1}	C_{i2}	t_{i2}	C_{ij}	t_{ij}	C_{iN}	t_{iN}
	N	C_{N1}	t_{N1}	C_{N2}	t_{N2}	C_{Nj}	t_{N}	C_{NN}	t_{NN}

4.1.The modified assignment method algorithm :

The algorithm can be described as following :

1. Configure assignment table, which rows and columns represent products manufactured within the production line , as shown in table 1 .
2. Set of intersection point of the same products an infinite amount , so as to be ruled out in the assignment process and the rest are placed according to setup time and/or setup cost of products , as shown in table 2 .
3. Each row and each column in the modified assignment matrix is smaller than or equal to one as described equations (10 and 11) ; except mentioned in step 9 .

$$\sum_{j=1}^{N} X_{ij} \leq 1\,, \quad for\ i = 1,2,\dots\dots,N \quad , \qquad (10)$$

$$\sum_{i=1}^{N} X_{ij} \leq 1\,, \quad for\ j = 1,2,\dots\dots,N \quad , \qquad (11)$$

The table 2. Modified Assignment Method to TSP

From product i	To product j								
	Products \ Products	A		B		....		N	
		Cost	Time	Cost	Time	Cost	Time	Cost	Time
	A	∞	∞	C_{12}	t_{12}	C_{1j}	t_{1j}	C_{1N}	t_{1N}
	B	C_{21}	t_{21}	∞	∞	C_{2j}	t_{2j}	C_{2N}	t_{2N}
	....	C_{i1}	t_{i1}	C_{i2}	t_{i2}	∞	∞	C_{iN}	t_{iN}
	N	C_{N1}	t_{N1}	C_{N2}	t_{N2}	C_{Nj}	t_{N}	∞	∞

4. If there is a transaction between two products such that $A \rightarrow B$, $B \rightarrow A$; then select one transaction ,i.e $X_{ij} + X_{ji} \leq 1$.
5. Number of transaction constrain as described equation (12) .

$$\sum_{i=1}^{N} \sum_{j=1}^{N} X_{ij} = N \qquad (12)$$

6. Intersection point between the same products clown and row which ended with previous demand set to be zero if this product found within the demand .Else set to be infinity (or large amount) . assume product A which ended with previous demand will be change table 2 to table 3 .
7.The column contains the intersection point in step 7 set to be infinity for other products , as shown in table 3 .

The table 3. Modified Assignment Method to TSP After Applied Step 6 and 7

From product i	To product j								
	Products \ Products	A		B		....		N	
		Cost	Time	Cost	Time	Cost	Time	Cost	Time
	A	0	0	C_{12}	t_{12}	C_{1j}	t_{1j}	C_{1N}	t_{1N}
	B	∞	∞	∞	∞	C_{2j}	t_{2j}	C_{2N}	t_{2N}
	....	∞	∞	C_{i2}	t_{i2}	∞	∞	C_{iN}	t_{iN}
	N	∞	∞	C_{N2}	t_{N2}	C_{Nj}	t_{N}	∞	∞

8. Row constraint for the product which is ended the previous demand will be equal to :

a) 2 If the product within the demand .

b) 1 If not within the demand . As described in equation (13) .

$$\sum_{j=1}^{N} X_{ij} = \begin{cases} 1 \text{ if product which it ended the previous demand not within demand} \\ 2 \text{ if product which it ended the previous demand within demand} \end{cases} \quad (13)$$

9. If the Product in the assignment matrix has no demand then its constrain equal to be zero except for the product which ended with previous demand .

10. The mathematical model of the modified assignment method can be solved by goal programming method because contain the problem on two objective as:

Goal 1 : Minimize Setup time $=\sum_{i=1}^{N}\sum_{j=1}^{N} t_{ij} X_{ij}$ (14)

Goal 2 : Minimize Setup cost $=\sum_{i=1}^{N}\sum_{j=1}^{N} c_{ij} X_{ij}$ (15)

Where :

X_{ij}: assignment variable = $\begin{cases} 1 \ when \text{ Passes salesman travels } from\ city\ i\ to\ city\ j \\ \quad 0 \quad Otherwise \end{cases}$

cij : represents the cost of passes salesman travels $from\ city\ i\ to\ city\ j$.

tij : represents the time of passes salesman travels $from\ city\ i\ to\ city\ j$.

Can be described modified assignment method as diagram show in figure 6 .

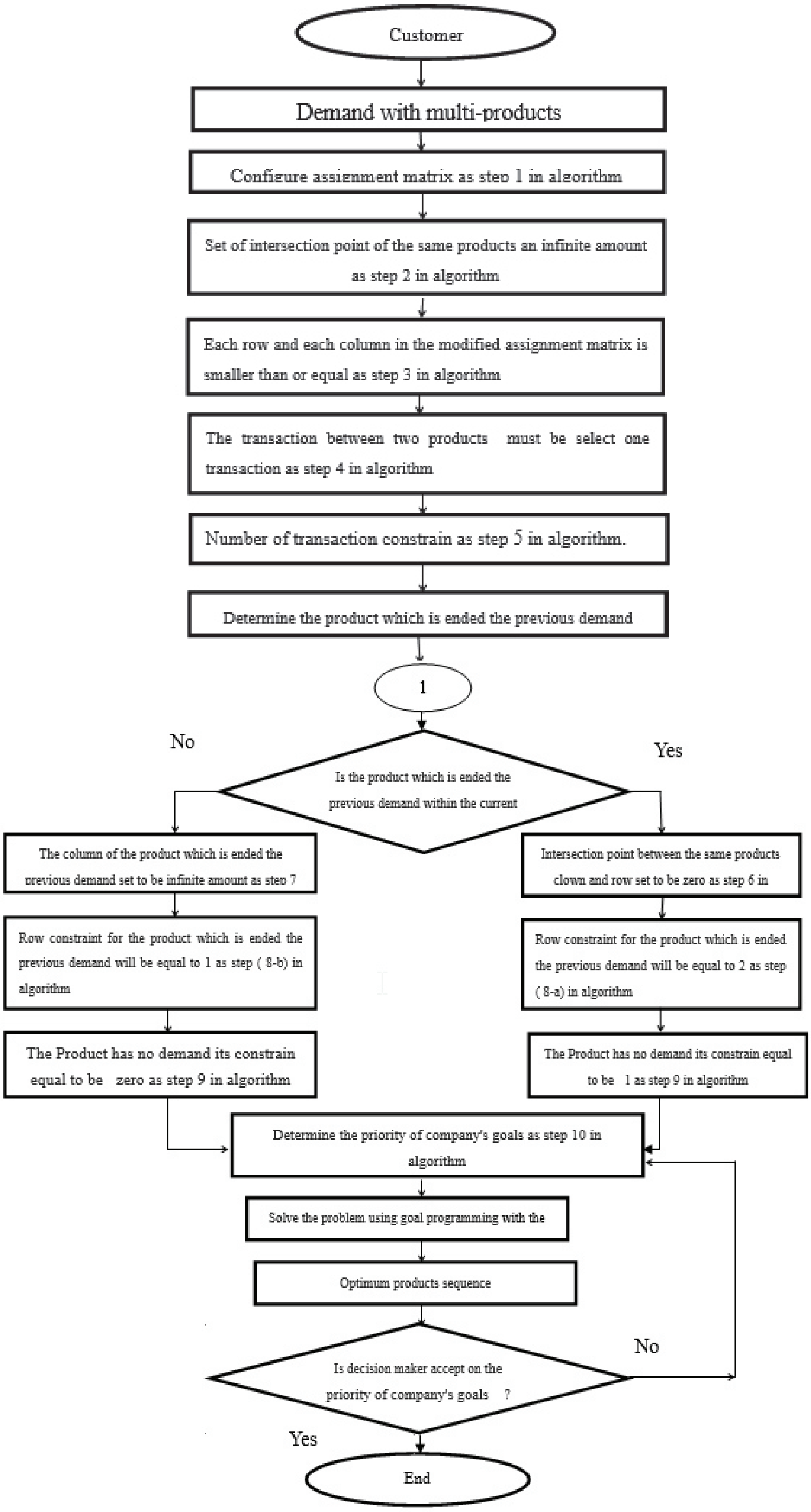

Figure 6. Diagram Describe Algorithm of Modified Assignment Method

5. Computational Example

The proposed algorithm could be explained with the following numerical example . This example is a production line that can manufacture five products : A , B , C , D , E ; where the product (D) is the ended the previous demand , Setup time and cost matrix as show in table 4 and goals of company are optimum sequence of demand products with minimum cost and time .

Table 4.Setup Time and Setup Cost Matrix

Products \ Products	A		B		C		D		E	
	cost	time	cost	time	cost	time	cost	time	cost	Time
A	0	0	4	5	8	10	3	8	5	16
B	14	8	0	0	15	6	7	4	8	8
C	6	12	5	16	0	0	8	5	10	10
D	3	18	17	4	8	15	0	0	15	9
E	15	6	5	18	10	15	12	9	0	0

Since the previous demand finished product D so it will be the assignment matrix depend on the modified assignment method algorithm as table 5.

Table 5. Setup Time and Setup Cost Matrix After Applied Algorithm

Products \ Products	A		B		C		D		E	
	cost	time	cost	time	cost	time	cost	time	cost	Time
A	∞	∞	4	5	8	10	∞	∞	5	16
B	14	8	∞	∞	15	6	∞	∞	8	8
C	6	12	5	16	∞	∞	∞	∞	10	10
D	3	18	17	4	8	15	0	0	15	9
E	15	6	5	18	10	15	∞	∞	∞	∞

Suppose the company's goal is to get a less cost first then less time to sequence company's products .The problem can be formulated using the program (win QSB) and use goal programming method . The infinite amount is replaced by the number (1000) or any large number , then the mathematical model will be as following :

Suppose the company's goal is to get a less cost first then less time to sequence company's products .The problem can be formulated using the program (win QSB) and use goal programming method . The infinite amount is replaced by the number (1000) or any large number , then the mathematical model will be as following :

$$MinZ1=1000X_{11}+4X_{12}+8X_{13}+1000X_{14}+5X_{15}+14X_{21}+1000X_{22}+15X_{23}+1000X_{24}+8X_{25}+6X_{31}+5X_{32}+1000X_{33}+1000X_{34}+10X_{35}+3X_{41}+17X_{42}+8X_{43}+0X_{44}+15X_{45}+15X_{51}+5X_{52}+10X_{53}+1000X_{54}+1000X_{55} \quad (16)$$

$$MinZ2=1000X_{11}+5X_{12}+10X_{13}+1000X_{14}+16X_{15}+8X_{21}+1000X_{22}+6X_{23}+1000X_{24}+8X_{25}+12X_{31}+16X_{32}+1000X_{33}+1000X_{34}+10X_{35}+18X_{41}+4X_{42}+15X_{43}+0X_{44}+9X_{45}+6X_{51}+18X_{52}+15X_{53}+1000X_{54}+1000X_{55} \quad (17)$$

Where :

Z_1,Z_2 represent first and second of company goals respectively .

$$\left.\begin{aligned} &X_{11}+X_{12}+X_{13}+X_{14}+X_{15} \leq 1 \\ &X_{21}+X_{22}+X_{23}+X_{24}+X_{25} \leq 1 \\ &X_{31}+X_{32}+X_{33}+X_{34}+X_{35} \leq 1 \\ &X_{41}+X_{42}+X_{43}+X_{44}+X_{45} = 2 \\ &X_{51}+X_{52}+X_{53}+X_{54}+X_{55} \leq 1 \end{aligned}\right\} \quad (18)$$

Note all row constrain is smaller than or equal to one ; except fourth constrain equal to two depend to step (8-a) from the proposed algorithm to modified assignment method .

$$\left.\begin{aligned} &X_{11}+X_{21}+X_{31}+X_{41}+X_{51} \leq 1 \\ &X_{12}+X_{22}+X_{32}+X_{42}+X_{52} \leq 1 \\ &X_{13}+X_{23}+X_{33}+X_{43}+X_{53} \leq 1 \\ &X_{14}+X_{24}+X_{34}+X_{44}+X_{54} \leq 1 \\ &X_{15}+X_{25}+X_{35}+X_{45}+X_{55} \leq 1 \end{aligned}\right\} \quad (19)$$

Note all column constrains is smaller than or equal to one depend to step (7) from the proposed algorithm .

$$\left.\begin{array}{l} X_{12}+X_{21} \le 1 \\ X_{13}+X_{31} \le 1 \\ X_{14}+X_{41} \le 1 \\ X_{15}+X_{51} \le 1 \\ X_{23}+X_{32} \le 1 \\ X_{24}+X_{42} \le 1 \\ X_{25}+X_{52} \le 1 \\ X_{34}+X_{43} \le 1 \\ X_{35}+X_{53} \le 1 \\ X_{45}+X_{54} \le 1 \end{array}\right\} \qquad (20)$$

Note all above constrains is smaller than or equal to one depend to step (8) from the proposed algorithm .

$$X_{11}+X_{12}+X_{13}+X_{14}+5X_{15}+X_{21}+X_{22}+X_{23}+X_{24}+X_{25}+X_{31}+X_{32}+X_{33}+X_{34}+X_{35}+X_{41}+X_{42}+ X_{43}+ X_{44} +X_{45} +X_{51} +X_{52} + X_{53}+X_{54}+X_{55} = 5 \qquad (21)$$

Note the constrains is equal to five depend to step (9) from the proposed algorithm .

From figure (7) note the assignment variables are :

$X_{44}=X_{41}=X_{15}=X_{53}=X_{32}=1$

This means that the optimal sequence is

D-D-A-E-C-B = 0+3+5+10+5=23 (Setup cost)

D-D-A-E-C-B = 0+18+16+15+16= 65 (Setup time)

07-17-2015 12:46:23	Decision Variable	Solution Value	Basis Status	Reduced Cost Goal 1	Reduced Cost Goal 2
1	X11	0	at bound	997.00	978.00
2	X12	0	at bound	2.00	-21.00
3	X13	0	at bound	1.00	-13.00
4	X14	0	at bound	1,000.00	996.00
5	X15	1.00	basic	0	0
6	X21	0	at bound	8.00	-6.00
7	X22	0	at bound	995.00	982.00
8	X23	0	at bound	5.00	-9.00
9	X24	0	at bound	997.00	1,004.00
10	X25	0	basic	0	0
11	X31	0	basic	0	0
12	X32	1.00	basic	0	0
13	X33	0	at bound	990.00	987.00
14	X34	0	at bound	997.00	1,006.00
15	X35	0	at bound	2.00	4.00
16	X41	1.00	basic	0	0
17	X42	0	at bound	15.00	-18.00
18	X43	0	at bound	1.00	-4.00
19	X44	1.00	basic	0	0
20	X45	0	at bound	10.00	-3.00
21	X51	0	at bound	9.00	-8.00
22	X52	0	basic	0	0
23	X53	1.00	basic	0	0
24	X54	0	at bound	997.00	1,004.00
25	X55	0	at bound	992.00	992.00
	Goal 1:	Minimize	G1 =	23.00	
	Goal 2:	Minimize	G2 =	65.00	

Figure 7. Result of Program Win QSB for This Example

Table 6 shows the results sequence product depend on setup cost and /or setup time a number of possibilities for priority of company's goals .

Table 6. All Possibilities for Priority of Company's Goals for This Example

s	priority of company's goals	Optimum Products Sequence	Sequence Cost	Sequence time
1	less cost first then less time	D -D - A - E - C- B	23	65
2	less time first then less cost	D -D - E -A - B - C	49	26
3	Equal priority of company's goals	D -D - C-A – B- E	26	40

Also we can find all possibilities products sequence using the probability method then find the best sequencing which has the minimum total setup time and / or setup cost as shown in table 7 . This method has two cases as following:

1- The first case is when the product which is with ended the previous demand within current demand . In this case the number of possibilities is equal to (N-1)! because determine start sequence of products where start with product similar product which is with ended the previous demand to setup time and cost is zero as this numerical example where number of possibilities is equal 4!=24 .

2- The second case is when the product which is with ended the previous demand not within current demand . In this case the number of possibilities is equal to (N)! .

In this example is all possibilities products sequence start with product (D) .

Table 7. All Possibilities Products Sequence for This Example

s	Products Sequence	Sequence Cost	Sequence time
1	D -D- A - B - C- E	0+3+4+15+8=30	0+18+5+6+10=39
2	D -D - A - B - E- C	0+3+4+8+10=25	0+18+5+8+15=46
3	D -D - A - C - B– E	0+3+8+5+8=24	0+18+10+16+8=52
4	D -D - A - C - E - B	0+3+8+8+5=24	0+18+10+10+18=56
5	D -D - A - E - C- B	0+3+5+10+5=23	0+18+16+15+16=65
6	D -D - A - E - B - C	0+3+5+5+15=28	0+18+16+18+6=58
7	D -D - B - A - C- E	0+17+14+8+8=47	0+4+8+10+10=32
8	D -D - B - A - E - C	0+17+14+5+10=46	0+4+8+16+15=43
9	D -D - B - C - A - E	0+17+15+6+5=43	0+4+6+12+16=38
10	D -D - B - C - E - A	0+17+15+10+15=57	0+4+6+10+6=26
11	D -D - B - E - C - A	0+17+8+10+6=41	0+4+8+15+12=39
12	D -D - B - E - A – C	0+17+8+15+8=48	0+4+8+6+10=28
13	D -D - C - A - B - E	0+8+6+4+8=26	0+15+12+5+8=40
14	D -D - C - A - E - B	0+8+6+5+5=24	0+15+12+16+18=61
15	D -D - C - B - A – E	0+8+5+14+5=32	0+15+16+8+16=55
16	D -D - C - B - E - A	0+8+5+8+15=36	0+15+16+8+6=45
17	D -D - C - E - A - B	0+8+8+15+4=35	0+15+10+6+5=36
18	D -D - C - E - B - A	0+8+8+5+14=35	0+15+10+18+8=51
19	D -D - E -A - B - C	0+15+15+4+15=49	0+9+6+5+6=26
20	D -D - E -A - C – B	0+15+15+8+5=43	0+9+6+10+16=41
21	D -D - E – B- A - C	0+15+5+14+8=42	0+9+18+8+10=45
22	D -D - E - B - C - A	0+15+5+15+6=41	0+9+18+6+12=45
23	D -D - E – C- A - B	0+15+10+6+4=35	0+9+15+12+5=41
24	D -D - E - C - B - A	0+15+10+5+14=44	0+9+15+16+8=48

This method use to few product because depend on (N)! or (N-1)! as number of possibilities products sequence . Table 8 explain number of possibilities products sequence to variant number of product .

Table 8. All Possibilities Products Sequence for This Example

Number of Products	Number of possibilities products sequence	
	(N)!	(N-1)!
4	24	6
5	120	24
6	720	120
7	5040	720
8	40320	5040
9	362880	40320
10	3628800	362880

6. Conclusion

We have presented exact method for determine the optimal products sequences in single demand , that consist of multi-products by using the modified assignment method based on goal programming method .As noted this method can be find the optimum solution directly , also help the change in priority of goals of company lead to multiple alternatives , that can help the decision maker to select the best alternatives to minimize setup cost and / or setup time.

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