INTEGER QUADRATIC OPTIMIZATION MODEL TO SOLVE SUPPLIER SELECTION PROBLEM WITH BUDGETARY CONSTRAINT

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ABSTRACT : *In this paper, we propose an integer quadratic optimization model to determine the optimal decision for a supplier selection problem. The decision is the optimal product volume that has to be purchased from each supplier so that the total cost is minimum and the constraints are satisfied. The cost function that we used is containing the purchasing cost, transportation cost, penalty cost for product that not satisfy the quality level, penalty cost for product that is late and the holding cost whereas the constraints are consisting of supplier capacity constraint, demand satisfying, supplier assignment, inventory management, and budget constraint. A numerical experiment with generated random data is given to illustrate how the supplier selection problem can be solved by using the proposed mathematical model. From the results, the optimum product volume from each suppliers was determined so that the total cost is minimum.*

Keywords– *Budgetary constraint, Integer Quadratic Programming, Supplier selection*

I. INTRODUCTION

As the growth of the time, all of the businesses are expected to gain the maximum profit and minimum total cost. This minimum total cost has an impact on the selection of business owner to choose the supplier which will supply the product they sell. This is so important because each of supplier has their own characteristic. This supplier selection in the economy sector is known as a Supplier Selection Problem (SSP). This SSP can be solved mathematically, so for the optimal strategy, firstly we formulate a mathematical model and then we can find the minimal total cost with Branch and Bound algorithm where the subproblem will be solved by Karush-Kuhn-Tucker method. This SSP has been already discussed by many researcher. A common discussed SSP is Traditional Supplier Selection Problem (TSSP). In the TSSP, the supplier will be ranked and then the top ranked supplier will be chosen to supply the product continuously till it will be re-ranked. In the DSSP, the suppliers are chosen by the calculation of some factors.

The SSP can be categorized into two models which are quantitative model and qualitative model. For quantitative model, reference [1] had proposed four different vendors, based on their time (short and long term) and based on their content (logistics and strategic). Reference [2] used Genetic Algorithm (GA) based on SSP optimization methodology. Reference [3] proposed a multi objective model for supplier selection and negotiation process that will affect the manufacturing plan. Reference [4] used Data Envelopment Analysis (DEA) to compare the performance evaluations of each suppliers for the best selection. The DEMATEL fuzzy method was used to develop supplier selection criteria in [5]. For qualitative model, it had many models such as Analytical Hierarchy Process (AHP) in [6], [7], seller performance matrix approaches in [8], seller's profile analysis in [9], Analytical Network Process (ANP) in [10], [11] and Technique For Others Reference by Similarity to Ideal Solution (TOPSIS) and Fuzzy TOPSIS in [12].

In this paper, we formulated an integer quadratic optimization model to solve supplier selection with inventory management and budgetary constraint. A numerical experiment is performed to evaluate the model.

II. MATHEMATICAL MODEL

DSSP problem that will be discussed in this paper relates to the environment of an organization related to business. The organization is a company, in this case the company must optimize the total cost with the several suppliers to supply some products to the company. Supplier that supply some of these products are seen from several constraints, there is different unit cost for each products, total transportation cost, quality of the products, delay time, and storage price per unit. From some evidence, this company as a buyer already has historical data from each supplier such as the additional amount of each supplier's time in delivery products within an approved deadline. From that data, it shows that each supplier shows different level of quality for different products. In addition, supplier capacity is always different from time to time due to internal or external problems. A company's demand also varies for each product following the fluctuations of market trends. An optimization method can be used to select the right supplier for a product that can optimize the total cost due to the supplier selection. The total cost of this problem is consider of various parameters, such as unit product price, delay cost, compensation costs due to poor product quality, transportation costs of all suppliers, storage cost product. For the notations used in this model are as follows:

T : Optimization time set

S : Supplier set

P : Product set

X_{tsp} : Product volume (unit) $p \in P$ which supplied by supplier $s \in S$ on the period $t \in T$

UC_{tsp} : Unit price of product $p \in P$ which supplied by supplier $s \in S$ on the period $t \in T$

TC_{ts} : Total transportation cost for all product by supplier $s \in S$ on the period $t \in T$

Y_{ts} : Biner constraint which value is 1 if choose supplier $s \in S$ on the period $t \in T$ and value 0 if don't choose supplier $s \in S$ on the period $t \in T$

SC_{tsp} : Maximum capacity (unit) supplier $s \in S$ to supply product $p \in P$ on the period $t \in T$

D_{tp} : Volume (unit) of demand product $p \in P$ on the period $t \in T$

UPC_{tsp} : Penalty cost per unit under the standart quality to supplier $s \in S$ for product $p \in P$ on the period $t \in T$

UDC_{tsp} : Delay cost per unit from supplier $s \in S$ for product $p \in P$ on the period $t \in T$

DLT_{tsp} : Delay lead time from supplier $s \in S$ for product $p \in P$ on the period $t \in T$

Q_{tsp} : Quality level of product supplied on the period $t \in T$ by supplier $s \in S$ for product $p \in P$

Q_o : Minimum standart quality of product set by the company

H_p : Holding Cost for each product p on the period t

M_p : Capacity storage for product p

I_{tp} : The volume of product stored on the period t for product p

B_t : Budget provided by company for purcashing the product on the period t

DSSP with inventory management can be modelled as

$$\min Z = \sum_{t=1}^{T}\sum_{s=1}^{S}\sum_{p=1}^{P} X_{tsp}UC_{tsp} + \sum_{t=1}^{T}\sum_{s=1}^{S} TC_{ts}Y_{ts} + \sum_{t=1}^{T}\sum_{s=1}^{S}\sum_{p=1}^{P}(1-Q_{tsp})UPC_{tsp}X_{tsp}Y_{ts}$$
$$+\sum_{t=1}^{T}\sum_{s=1}^{S}\sum_{p=1}^{P} UDC_{tsp}DLT_{tsp}X_{tsp}Y_{ts} + \sum_{t=1}^{T}\sum_{p=1}^{P} H_p I_{tp} \quad (2.1)$$

subject to:

$$X_{tsp} \le SC_{tsp} \forall t \in T, \forall s \in S, \forall p \in P \quad (2.2)$$

$$\sum_{t=1}^{T} D_{tp}Y_{ts} \ge X_{tsp} \forall t \in T, \forall s \in S, \forall p \in P \quad (2.3)$$

$$Q_{tsp} \ge Q_o \forall t \in T, \forall s \in S, \forall p \in P \quad (2.4)$$

$$Y_s = \begin{cases} 1 \; for X_{tsp} > 0 \\ 0 \end{cases} \forall s \in S \quad (2.5)$$

$$X_{tsp} \ge 0 \forall t \in T, \forall s \in S, \forall p \in P \quad (2.6)$$

$$\sum_{s=1}^{S} X_{tsp} - I_{tp} \geq D_{tp}, t = 1, \forall p \in P \quad (2.7)$$

$$I_{t-1,p} + \sum_{s=1}^{S} X_{tsp} - I_{tp} \geq D_{tp}, t > 1, \forall p \in P \quad (2.8)$$

$$I_{tp} \leq M_p \forall t \in T, \forall \mathrm{p} \in \mathrm{P} \quad (2.9)$$

$$(\sum_{s=1}^{S}\sum_{p=1}^{P} X_{tsp}UC_{tsp}) + (\sum_{s=1}^{S} TC_{ts}Y_{ts}) + (\sum_{s=1}^{S}\sum_{p=1}^{P}(1-Q_{tsp})UDC_{tsp}X_{tsp}Y_{ts}) + (\sum_{s=1}^{S}\sum_{p=1}^{P} UDC_{tsp}DLT_{tsp}X_{tsp}Y_{ts}) + (\sum_{p=1}^{P}\mathrm{H}_p\mathrm{I}_{tp}) \leq B_t \forall t \in T, \forall s \in S, \forall p \in P \quad (2.10)$$

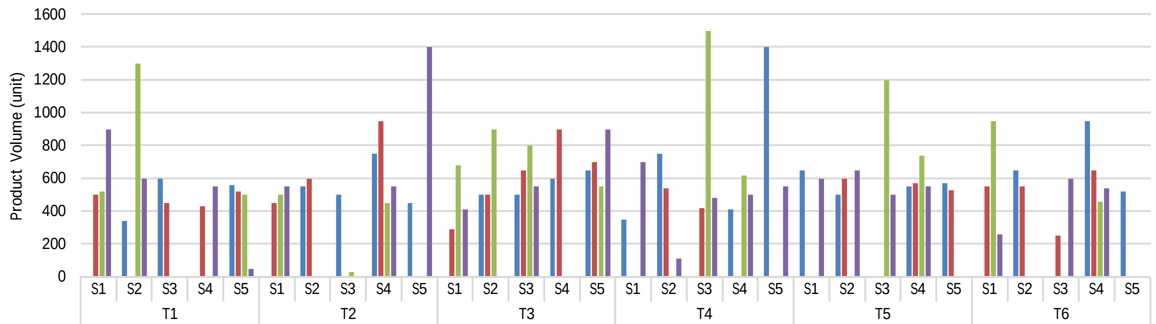
$$X_{tsp}, I_{tp} \text{ integer} \quad (2.11)$$

The above model consists of 11 equations. Equation (2.1) is an objective function consisting of product purchase cost, transportation cost, transportation cost, penalty cost, and inventory cost. Equation (2.2) is a supplier capacity constraint. Equation (2.3) is a demand constraint that must be complete each period. Equation (2.4) is a quality level constraint of a product must be greater than the quality specified by a company. Equation (2.5) is a binary constraint Y which 1 if we order to that supplier and 0 for the others. Equation (2.6) is an constraint that X must be positive. Equation (2.7) is an inventory constraint for period 1, while constraint (2.8) is an inventory constraint for period more than 1. Equation (2.9) is a storage capacity constraint, whereas equation (2.10) is a budget constraint per period for purchasing products. And the last equation (2.11) is an integer constraint.

III. NUMERICAL EXPERIMENT

The following numerical experiment will give example of DSSP with inventory management for company Y with 5 suppliers that are S1, S2, S3, S4, S5 and 4 types of products are P1, P2, P3, P4 which will plan for purchasing 12 periods. With the data of each parameter presented in the appendix, the problem will be solved using LINGO. The solution of this problem will be illustrated in Fig. 1 - 3. It can be explained that for period 1, the purchase of product 1 will buy to supplier 2 as many as 340 pieces, supplier 3 as many as 600 pieces, supplier 5 as many as 560 pieces without storage in the warehouse.

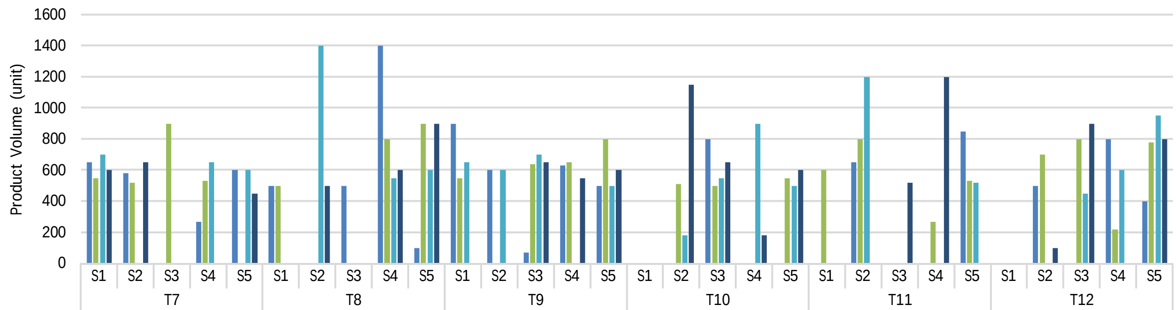
For product 2, purchase will buy to supplier 1 as many as 500 pieces, supplier 3 as many as 450 pieces, supplier 4 as many as 430 pieces, supplier 5 as many as 520 pieces by storing products as many as 200 pieces. For product 3, purchase will buy to supplier 1 as many as 520 pieces, supplier 2 as many as 130 pieces, supplier 5 as many as 500 pieces by storing products as many as 1020 pieces. For product 4, purchase will buy to supplier 1 as many as 900 pieces, supplier 2 as many as 600 pieces, supplier 4 as many as 550 pieces, supplier 5 as many as 50 pieces, without storage in the warehouse. The next period will be decided analogously.



	T1					T2					T3					T4					T5					T6				
	S1	S2	S3	S4	S5	S1	S2	S3	S4	S5	S1	S2	S3	S4	S5	S1	S2	S3	S4	S5	S1	S2	S3	S4	S5	S1	S2	S3	S4	S5
P1	0	340	600	0	560	0	550	500	750	450	0	500	500	600	650	350	750	0	410	1400	650	500	0	550	570	0	650	0	950	520
P2	500	0	450	430	520	450	600	0	950	0	290	500	650	900	700	0	540	420	0	0	0	600	0	570	530	550	550	250	650	0
P3	520	1300	0	0	500	500	0	30	450	0	680	900	800	0	550	0	0	1500	620	0	0	0	1200	740	0	950	0	0	460	0
P4	900	600	0	550	50	550	0	0	550	1400	410	0	550	0	900	700	110	480	500	550	600	650	500	550	0	260	0	600	540	0

P1 P2 P3 P4

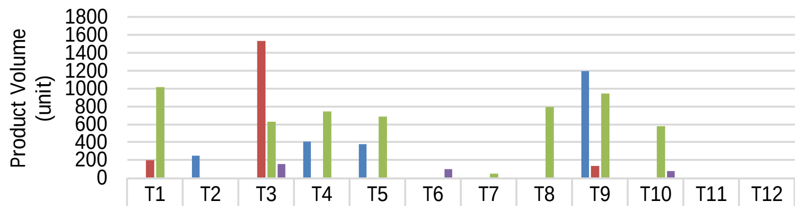
Figure 1. Volume product which bought at period 1 - 6



	T7					T8					T9					T10					T11					T12				
	S1	S2	S3	S4	S5	S1	S2	S3	S4	S5	S1	S2	S3	S4	S5	S1	S2	S3	S4	S5	S1	S2	S3	S4	S5	S1	S2	S3	S4	S5
P1	650	580	0	270	600	500	0	500	1400	100	900	600	70	630	500	0	0	800	0	0	0	650	0	0	850	0	500	0	800	400
P2	550	520	900	530	0	500	0	0	800	900	550	0	640	650	800	0	510	500	0	550	600	800	0	270	530	0	700	800	220	780
P3	700	0	0	650	600	0	1400	0	550	600	650	600	700	0	500	0	180	550	900	500	0	1200	0	0	520	0	0	450	600	950
P4	600	650	0	0	450	0	500	0	600	900	0	0	650	550	600	0	1150	650	180	600	0	0	520	1200	0	0	100	900	0	800

P1 P2 P3 P4

Figure 2. Volume product which bought at period 7 - 12



	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12
P1	0	250	0	410	380	0	0	0	1200	0	0	0
P2	200	0	1540	0	0	0	0	0	140	0	0	0
P3	1020	0	630	750	690	0	50	800	950	580	0	0
P4	0	0	160	0	0	100	0	0	0	80	0	0

P1 P2 P3 P4

Figure 3. Volume product which storage at period 1 – 12

IV. CONCLUSION

In this paper, the supplier selection problem was considered with inventory management and budgetary constraint. The problem has been modeled into the mathematical model of IQP. The model has evaluated with some random data using branch and bound algorithm performed in LINGO 16.0 software. From the result, the optimal decision was determined for each time period.

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Appendix. Parameter values for numerical experiment

SC																				
S1					S2				S3				S4				S5			
Product	P1	P2	P3	P4	P1	P2	P3	P4	P1	P2	P3	P4	P1	P2	P3	P4	P1	P2	P3	P4
T1	700	500	520	900	620	700	1400	600	600	450	620	500	700	600	600	550	560	520	500	1200
T2	500	450	500	550	550	600	900	700	800	500	600	500	750	950	450	900	450	600	700	1400
T3	900	460	750	410	500	500	900	520	500	650	800	550	600	900	800	550	650	700	550	900
T4	500	1000	480	700	750	540	450	800	500	420	1500	480	410	600	620	500	1400	500	550	550
T5	650	540	520	600	500	600	480	650	520	900	1200	500	550	570	740	620	570	900	450	1400
T6	460	550	950	1000	650	550	600	500	520	1000	640	600	950	650	460	540	520	520	500	640
T7	650	550	700	600	580	520	980	650	530	900	800	670	600	1000	650	520	600	500	600	450
T8	500	500	620	800	530	500	1400	500	500	620	1200	520	1400	900	550	600	500	900	600	900
T9	900	550	650	900	600	700	600	500	520	640	700	650	630	650	510	550	500	800	500	800
T10	650	700	500	900	1200	650	1400	1150	800	500	550	650	750	630	900	730	600	550	500	600
T11	900	600	900	650	650	800	1200	500	850	500	1600	520	650	800	1400	1200	1400	530	520	600
T12	900	1200	1200	480	500	700	600	980	700	800	700	900	800	600	600	1600	1800	780	950	800

UC

S1					S2				S3				S4				S5			
Product	P1	P2	P3	P4	P1	P2	P3	P4	P1	P2	P3	P4	P1	P2	P3	P4	P1	P2	P3	P4
T1	25	22	18	25	23	30	26	25	22	18	26	25	28	26	26	22	18	25	24	28
T2	26	26	22	18	25	24	28	26	24	20	18	25	25	26	26	24	20	20	26	24
T3	25	25	25	21	20	25	26	25	25	25	21	19	25	25	30	26	24	22	18	24
T4	25	30	25	24	23	19	24	24	29	26	27	24	20	27	25	32	28	27	24	20
T5	27	30	28	28	24	20	27	26	30	28	26	22	20	27	27	28	28	26	22	22
T6	28	26	27	27	27	23	22	27	28	27	28	26	23	22	27	27	32	25	26	24
T7	20	26	27	32	27	26	25	21	26	26	31	28	27	24	20	27	25	32	28	27
T8	24	20	28	27	30	28	28	24	20	27	26	30	28	26	22	20	27	27	28	28
T9	26	22	22	28	26	27	27	27	23	22	27	28	27	27	27	23	21	27	28	27
T10	28	26	23	22	27	27	32	25	26	24	20	26	27	32	27	26	25	21	26	26
T11	31	28	32	29	25	32	30	37	33	32	29	25	33	32	35	33	33	29	25	32
T12	31	35	33	31	27	25	32	32	33	33	31	27	27	33	31	32	32	32	28	27

Q

S1					S2				S3				S4				S5			
Product	P1	P2	P3	P4	P1	P2	P3	P4	P1	P2	P3	P4	P1	P2	P3	P4	P1	P2	P3	P4
T1	0.85	0.9	0.89	0.92	0.89	0.92	0.92	0.87	0.87	0.91	0.9	0.91	0.96	0.98	0.95	0.95	0.95	0.95	0.95	0.95
T2	0.95	0.92	0.94	0.94	0.92	0.99	0.98	0.93	0.96	0.84	0.92	0.86	0.95	0.92	0.92	0.89	0.97	0.96	0.98	0.97
T3	0.82	0.8	0.95	0.89	0.93	0.91	0.91	0.91	0.91	0.92	0.93	0.94	0.94	0.98	0.98	0.87	0.9	0.92	0.94	0.93
T4	0.94	0.87	0.92	0.9	0.92	0.92	0.91	0.91	0.81	0.8	0.85	0.9	0.89	0.92	0.89	0.92	0.92	0.87	0.87	0.91
T5	0.9	0.91	0.96	0.98	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.92	0.94	0.94	0.92	0.99	0.98	0.93	0.96	0.84
T6	0.92	0.86	0.95	0.92	0.92	0.89	0.97	0.96	0.98	0.97	0.82	0.8	0.95	0.89	0.93	0.91	0.91	0.91	0.91	0.92
T7	0.93	0.94	0.94	0.98	0.98	0.87	0.9	0.92	0.94	0.93	0.94	0.87	0.92	0.9	0.92	0.92	0.91	0.91	0.81	0.8
T8	0.8	0.91	0.92	0.98	0.91	0.86	0.95	0.85	0.89	0.91	0.97	0.97	0.91	0.92	0.82	0.82	0.92	0.84	0.95	0.92
T9	0.96	0.91	0.91	0.96	0.89	0.92	0.93	0.95	0.91	0.91	0.93	0.96	0.95	0.91	0.91	0.93	0.91	0.92	0.91	0.96
T10	0.92	0.92	0.98	0.95	0.97	0.89	0.91	0.96	0.95	0.95	0.96	0.95	0.92	0.97	0.97	0.97	0.92	0.96	0.95	0.92
T11	0.98	0.92	0.91	0.91	0.94	0.96	0.92	0.91	0.95	0.97	0.98	0.8	0.91	0.92	0.98	0.91	0.86	0.95	0.85	0.89
T12	0.91	0.97	0.97	0.91	0.92	0.82	0.82	0.92	0.84	0.95	0.92	0.96	0.91	0.91	0.96	0.89	0.92	0.93	0.95	0.91

UPC

S1					S2				S3				S4				S5			
Product	P1	P2	P3	P4	P1	P2	P3	P4	P1	P2	P3	P4	P1	P2	P3	P4	P1	P2	P3	P4
T1	2	1.5	1.5	2.5	2	1.5	2	2	1.5	1.5	2.5	2	2	1.5	2	2	1.5	1.5	2.5	2
T2	1.5	2	2	1.5	1.5	2.5	2	1.5	2	2	1.5	1.5	2.5	1.5	2	1.5	2	2	1.5	1.5
T3	2.5	2	1.5	2	2	1.5	1.5	2.5	2	1.5	2	2	1.5	1.5	2.5	2	2	1.5	2	2
T4	2.5	1.5	2.5	3	1.5	2.5	2	2.5	1.5	2.5	3	1.5	2.5	2	2.5	1.5	2.5	3	1.5	2.5
T5	2	2.5	1.5	2.5	3	1.5	2.5	2	2.5	1.5	2.5	3	1.5	2.5	2	2.5	1.5	2.5	3	1.5
T6	2.5	2	2.5	1.5	2.5	3	1.5	2.5	2	2.5	1.5	2.5	3	1.5	2.5	2	2.5	1.5	2.5	3
T7	1.5	2.5	2	2.5	1.5	2.5	3	1.5	2.5	2	2.5	1.5	2.5	3	1.5	2.5	3	3.5	2.5	3.5
T8	4	2.5	3.5	3	3.5	2.5	3.5	4	2.5	3.5	3	3.5	2.5	3.5	4	2.5	3.5	3	3.5	2.5
T9	3.5	4	2.5	3.5	3	3.5	2.5	3.5	4	2.5	3.5	3	3.5	2.5	3.5	4	2.5	3.5	3	3.5
T10	2.5	3.5	4	2.5	3.5	3	3.5	2.5	3.5	4	2.5	3.5	3	3.5	4	3.5	4	2.5	3.5	3
T11	3.5	2.5	3.5	4	2.5	3.5	3	3.5	2.5	3.5	4	2.5	3.5	3	3.5	2.5	3	4	2.5	3.5
T12	3	3.5	2.5	3.5	4	2.5	3.5	3	3.5	2.5	3.5	4	2.5	3.5	3	2.5	3.5	3.5	4	2.5

DLT

S1					S2				S3				S4				S5			
Product	P1	P2	P3	P4	P1	P2	P3	P4	P1	P2	P3	P4	P1	P2	P3	P4	P1	P2	P3	P4
T1	2	1	0	0	2	3	0	2	0	2	3	3	2	1	3	3	0	0	0	1
T2	3	0	0	3	0	1	2	2	2	3	4	2	1	0	0	2	3	4	3	0
T3	3	1	1	1	2	0	0	3	1	1	1	1	1	0	0	2	2	0	2	2
T4	3	4	4	2	2	0	3	4	2	1	0	0	2	3	0	0	0	2	3	1
T5	2	5	3	0	2	3	1	2	5	3	0	0	0	0	1	2	2	2	3	4
T6	2	1	0	1	2	3	4	5	3	2	2	0	1	0	0	1	1	2	4	4
T7	0	0	0	0	0	2	3	1	4	1	1	2	2	2	2	2	2	1	1	1
T8	2	3	3	3	3	3	1	2	3	4	3	2	1	1	2	2	3	0	0	0
T9	0	1	0	2	0	3	0	4	3	0	2	0	1	0	2	1	1	1	1	1
T10	3	3	3	2	2	2	1	1	1	0	0	0	4	3	2	3	4	2	3	1
T11	2	1	2	3	0	0	0	1	2	2	3	1	1	2	3	0	0	0	1	1
T12	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

UDC

S1					S2				S3				S4				S5			
Product	P1	P2	P3	P4	P1	P2	P3	P4	P1	P2	P3	P4	P1	P2	P3	P4	P1	P2	P3	P4
T1	3	3	5	3.5	3.5	5	3.5	3	3	5	3.5	3.5	3.5	5	3.5	3	3	3	5	3.5
T2	5	3.5	3	3	5	3.5	3.5	3.5	3.5	5	3	3.5	5	5	3.5	3.5	3.5	5	5	3
T3	3.5	5	3.5	5	3	3	5	5	5	3	3.5	3	3	3	5	5	3.5	5	3.5	3.5
T4	3	3	3.5	3.5	5	5	3.5	3	5	3	3.5	3.5	5	5	3.5	3.5	3	5	3	3.5
T5	2	3	3.5	2.5	5	4	4.5	3	2	2.5	4.5	5	3	4	2.5	4	2	3	4.5	4
T6	5	5	4	4	2	2	3.5	2	5	4	3.5	4.5	3	2	3.5	2.5	2.5	5	5	3.5
T7	3	4	5	4.5	3.5	2	2.5	2.5	2.5	3	3	4	3.5	5	3.5	4	3.5	3	3.5	2
T8	2	2.5	3	3.5	4	4.5	5	2	3	4	4.5	3.5	2	3.5	3.5	5	2.5	3.5	5	4.5
T9	3	2	2.5	5	3.5	5	4	4.5	3	3.5	2	2.5	5	4	3.5	4	4	4	4	3
T10	4.5	3.5	5	5	4	3.5	3	2	2.5	3.5	5	4	4.5	3.5	3	2	5	4.5	3	3.5
T11	2	3.5	4.5	5	3.5	3	4.5	2.5	2.5	2.5	5	5	2	2	2	2	2	3.5	3.5	3.5
T12	4.5	4.5	5	4	4.5	3.5	4.5	2	2	3	3	4	5	4	5	3.5	4.5	5	2.5	3

	D			
	Product			
Time	P1	P2	P3	P4
T1	1500	1700	1300	2100
T2	2000	2200	2000	2500
T3	2500	1500	2300	1700
T4	2500	2500	2000	2500
T5	2300	1700	2000	2300
T6	2500	2000	2100	1300
T7	2100	2500	1900	1800
T8	2500	2200	1800	2000
T9	1500	2500	2300	1800
T10	2000	1700	2500	2500
T11	1500	2200	2300	1800
T12	1700	2500	2000	1800

Product	H
P1	2
P2	3
P3	1
P4	3

Product	M
P1	1250
P2	1700
P3	2000
P4	1500

	TC				
	Supplier				
Time	S1	S2	S3	S4	S5
T1	300	300	400	350	450
T2	350	500	350	500	400
T3	400	400	500	450	550
T4	450	600	450	600	500
T5	600	600	700	650	750
T6	650	800	650	800	700
T7	1100	1100	1200	1150	1250
T8	1150	1300	1150	1300	1150
T9	1300	1200	1000	1050	1300
T10	1350	1150	1250	1400	1350
T11	1600	1550	1300	1250	1600
T12	1650	1450	1350	1750	1800

Time	B
T1	500000
T2	450000
T3	300000
T4	350000
T5	400000
T6	500000
T7	450000
T8	300000
T9	500000
T10	400000
T11	450000
T12	300000