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Araştırma / Research

SALES FORCE ALLOCATION IN BANKING SECTOR

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ABSTRACT

Sales force deployment involves the simultaneous resolution of interrelated sub-problems like sales force sizing, sales representative location, sales territory alignment, and sales resource allocation. As the sales force size increases, the number of accounts to be visited increases that yields to a positive effect on sales rates but also an increase in operational costs. Therefore, the alignment decisions are vital for all issues such as the number of outbound calls to accounts, the operational expenses, and the sales representative asset (time) that might be allocated. All sub-problems have to be resolved in order to maximize the profit of the selling organization. In this paper, sales force allocation problems in the literature are examined and approaches to similar problems are compared. A non-linear mixed-integer quadratic programming model is formulated for sales force allocation in banking sector. And a heuristic approach is developed for big size problems. The comparison of approaches is reported.

Keywords: Sales force allocation, sales force deployment, non-linear complex integer programming

BANKACILIK SEKTÖRÜNDE SATIŞ GÜCÜ YERLEŞTİRME

ÖZ

Satış gücü yerleştirme problemleri; satış gücü sayısı belirleme, satışçıların yerleştirilmesi, satış alanının belirlenmesi ve satış kaynağının yerlerinin belirlenmesi olarak alt problemlerle bağlantılıdır. Satış gücünün büyüklüğü arttıkça, ziyaret edilecek lokasyon sayısı artar ve satışlar olumlu yönde etkilenir. Öte yandan, satış gücünün arttırılması işletme maliyetlerini arttırılmasına yol açar. Bu sebeple, ziyaret edilecek lokasyon sayıları, operasyonel maliyetler ve satış gücü(saat) yerleştirmesi çok önemlidir. Organizasyonlarda bu alt problemler kar maksimizasyonu yaklaşımıyla çözülmektedir. Literatürdeki satış gücü yerleştirme problemleri incelenmiş, benzer problemlere yaklaşımlar karşılaştırılmıştır. Bu çalışmada banka sektöründeki satış gücü yerleştirmesi için doğrusal olmayan karmaşık tam sayı programlama modeli oluşturulmuştur. Problemin büyük olabileceği durumlar için alternatif sezgisel model yaklaşımı yapılmıştır. Bu makalede de bu yaklaşımlar karşılaştırılıp raporlanmıştır.

Anahtar Kelimeler: Satış gücü yerleştirme, satış kaynağının yerlerinin belirlenmesi, doğrusal olmayan karmaşık tam sayı programlama

1. INTRODUCTION

Many firms believe sales force depend on the selection, training, and motivation of sales representatives. This idea does not seem right in all circumstances. Equally experienced and motivated two salespersons hired and compared in a month. In addition, one of theme's territory has enough opportunity to support more than two

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salespersons. In contrast, other one's territory has not an appropriate condition to selling even one salesperson. After a month, firm compared the performance and they believe that salespersons do not achieve the expected sales. The result of this experience show that poorly deployed market coverage of trading areas causes waste of sales force, demotivation of salesperson and profit loss even salespersons have the same experience.

Other very common thought is as the sales force size increases, the number of accounts visited increases. It is very clear it gives a positive effect on sales. On the other hand, an increase in sales force leads to an increase in operational costs. Moreover, the quantity of conceivable calls to accounts, the operational expenses and the sales representative asset (time) that might be allocated. Therefore, the alignment decisions are vital for all issues. Approaches can be divided into those that depend upon heuristics and those that utilize a mathematical programming model.

Heuristics have been proposed by Heschel [1] among others. On the other hand, two sorts of mathematical programming have been created. Shanker [2] defined a set-parceling model. From another perspective, the models developed by Segal and Weinberger [3] and those of Zoltners and Sinha [4] are sales coverage unit (SCU)-task models. Beswick [5] and Zoltners and Chong [6] examined the resource allocation sub-problem. In these studies, most important constraints are potential of sales and workload of the sales representative. Three sub-problems of allocation of sales representatives and calling time and aligning accounts have been addressed by Glaze and Weinberg [7]. Particularly, they show the system TAPS, which looks to sales maximization for a given sales force measure while likewise endeavouring to accomplish equal workload amongst sales representative and, moreover, minimize total travel time. For large-scale problems, an approximation technique has developed by Drexl and Haase [8]. Like Drexl and Haase, Haase and Müller [9] suggested an approximation on sales response function. They used piecewise linear relaxation to decreased number of factors. Howick et al. [10] review models which address one or more of the sales force deployment decisions of sales sizing, territory alignment, and time-effort allocation.

Naji-Azimi and Salari [11] introduce the time constrained maximal covering salesman problem (TCMCSP) which is the generalization of the covering salesman and orienting problems. The goal of this case to maximize the total number of covered customers by constructing a length constrained Hamiltonian cycle over a subset of facilities. They propose several mathematical programming models for the studied problem followed by a heuristic algorithm. Finally, an integer linear programming based improvement technique used to improve the quality of the solutions.

Skiera and Albers [12] propound to estimate and utilize a core sales response function as the basis for evaluating the profit implications of different actions that enable sales management to prioritize management investments. They present that administration can identify productivity changes concerning selling abilities by comparing actual sales with sales by the response function, which infers the sales accomplished by an average sales representative for a given level of exertion. Managers can then contrast the separate benefit suggestions and those accomplished by motivating sales representatives to make at least as many calls as the average sales representative.

In 1975, Lodish [13] promotes a different method by CALLPLAN. The goal of the method is to find sales resource profit contribution to regard elapsed time on the road and call frequencies. The approach additionally depends on SCU, and aims to find the best combination of sales representative and account. Since the regional alignments and subarea designs are not applicable; he wants to add the limitation of the time and cost of travel as constraints to compare it to his first approach. In any case, this research promotes that travel cost is more reasonable.

2. MATERIAL AND METHODS

Due to the increase in the competition, not only banks, but also companies from other sectors are more likely to consider options based on software, mathematical models, and other analysis that are not subjective. In this case, solving the efficiency problem of the sales force will result in increased profit.

The current sales force allocation structure of DBank is calculated manually. A sales representative is assigned to make subjective and manual administration decisions, which may yield to lose the potential benefit. In order to maximize profit, another framework can be developed to compose productive sales force deployment to each account. DBank's sales force deployment problem has larger data than other cases. DBank has 1050 accounts that can be nominated for allocation of the sales force. In the current arrangement of management, not each account must be gone too, as additionally, it is acknowledged for this case. As per the two-month information of past year that is given by the DBank, 67 sales representative are allocated to 286 accounts, and other accounts which are far from city centre or potentially low are not touched by a sales representative.

Figure 1 shows the time-dependent graph of sales percentage. It means when sales representative spend time in account then DBank gains percentage of credit sales in this account. In this graph the percentage of sales made by each sales representative in the account where it was assigned is taken into consideration and it is generated from a yearly dataset which represents the change in the percentage of sales due to the time spent by the sales representative in the account.

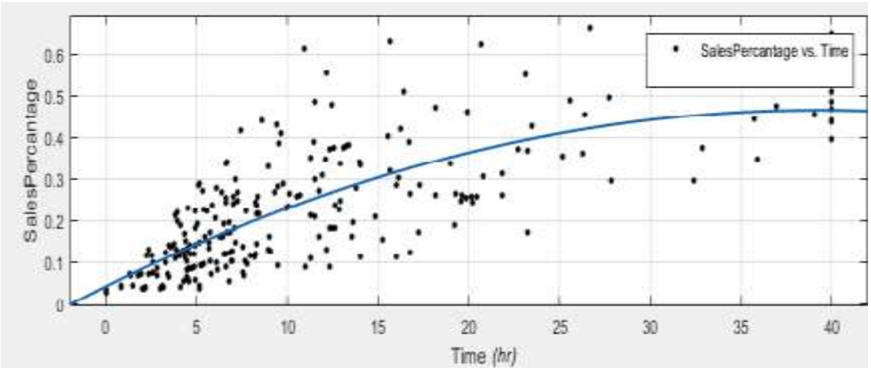

Figure 1. Time-dependent sales function Accordingly time-dependent sales response function F_{mn} is described by Equation (1)

$$F_{mn} = a_1 t_{mn}^2 + a_2 t_{mn} + a_3 \tag{1}$$

where,

m : sales representative
n: account
F_{mn} :sales response function
$t_{m,n}$: calling time allocated to account n by sales representative m
a_1, a_2, a_3 : constant numbers of function

Within the 95% confidence interval a_1 is determined by - 0.0003, a_2 determined by 0.0216 and a_3 determined by 0.0412.

As shown in Figure 1, DBank is not the only bank in the market, so it cannot reach 100% potential. Spending more time in the same account after a certain time does not make a significant difference in sales. Because of this, sending sales representative after a certain time to another account can lead to potential sales.

DBank considers the account's addresses, distances, distance costs and potential accounts when determining the sales force in the current situation. With this study, DBank computes their profit effectively; allocates sales representative with a scientific approach and saving time and money.

Accounts are accepted as candidate locations; hence the closest account to the sales representative was identified as the area where the sales representative lived. Thus, when the sales representative visits this account, the distance travelled is doubled. The duration of the work shift was determined by DBank to be 40 hours per weekend the cost is assumed to be 0.40 TRY for every kilometre. The distance between accounts and sales representative's place is calculated by Google Distance Service. Because of the cost and time limitation sales representative can't assign all of the accounts. According to marketing science and marketing management assumptions, accounts are assigned to each salesperson individually if binary assignment variables are used [14].

2.1. Mathematical Model

The problem is formulated as a nonlinear mixed-integer programming (MINLP) model as follows:

Indices

N: set of accounts, indexed by n
M: set of sales representatives, indexed by m ($M \subseteq N$)

Parameters

T: total calling time for each sales representative (40 hours per week)

F_{mn}: sales response function
p_n: anticipated potential in account n
c: cost of elapsed time in the road per unit
v: average velocity (50 km/hr is assumed)
d_{mn} : distance between account n to location m
E: average earning per credit (150 TL is assumed)
f: fixed cost (salary) per sales representative

Decision Variable

$$Y_{mn} = \begin{cases} 1; \text{ if account n is assigned to sales representative allocated at account m} \\ 0; \text{ otherwise} \end{cases}$$

t_{mn} = calling time allocated to account n by sales representative allocated at account m

Sales response function F_{mn} defined as;

$$F_{mn} = a_1 t_{mn}^2 + a_2 t_{mn} + a \quad (2)$$

a_1 is determined by - 0.0003, a_2 determined by 0.0216 and a_3 determined by 0.0412.

$$\max Z_{MIQP}(y,t) = E \sum_{n=1}^{N} \sum_{m=1}^{M} F_{mn} p_n - 2 \sum_{m=1}^{M} \sum_{n=1}^{N} c\, d_{mn} Y_{mn} \quad (3)$$

Subject to

$$\sum_{N=1}^{N} 2 \frac{d_{mn}}{v} Y_{mn} + \sum_{N=1}^{N} t_{mn} \leq T \quad (4)$$

$$t_{mn} + 2\frac{d_{mn}}{v} Y_{mn} \leq TY_{mn} \qquad \forall m, \quad \forall n \quad (5)$$

$$\sum_{m=1}^{M} Y_{mn} \leq 1 \qquad \forall n \quad (6)$$

$$t_{mn} \geq 0 \qquad \forall m, \quad \forall n \quad (7)$$

$$Y_{mn} \in \{0,1\} \qquad \forall m, \quad \forall n \quad (8)$$

M=67
N =286

The purpose of this problem is maximizing the total profit considering traveling cost of sales representatives on objective function (3). Each account has distinctive input to total sales that can be procured through account-level response functions defined at section 1.

Total estimated sales of accounts are calculated by multiplying the percentage which came in sales response function, and market potential of each account. Average earning per credit is assumed to be 150 TL and multiplied with total anticipated sales to define total revenue. Likewise, the cost of elapsed time in the road per unit is considered. Fixed costs are disregarded because it has no effect on optimality.

Finally, the objective function is intended to find optimal selling time allocated to account n by sales representative allocated at account m in order to maximize Z considering the cost of elapsed time on the road.

Model constraints are indicated as follows. When the salesperson is allocated to account n, she/he is available to extend time for selling and traveling to this account. Besides, there is a restricted time to allocate for a salesperson for calling and traveling. Moreover if the sales person visits account n, she/he has to assign at account m. Another case that is assumed, one salesperson can be aligned at a time to account n.

2.2. Heuristic Approach

This section discusses a solution approach, which has been developed specifically for the problem. As the number of variables and constraints increase, mixed-integer programming can be very hard to solve. However, even for small sized problems, the formulation converts into mixed-integer programs, which thusly result in restrictive running times. Furthermore, it is guessed that, no exact optimal solution a sensible amount of time for small sized problems. In this case, a greedy-based heuristic approach is developed to reach near optimality by considering the amount of data. Every sales representative assignment is considered as a sub problem. Solving the problem for every sales representative until last sales force is assigned ensures that all the resources are allocated. And each sales representative has local optimal solutions. At the end, the local optimal solutions are composed a near-optimal final solution. The algorithm allows that selected account can only be visited by a single sales representative. This approach recommends that using sales representatives nearest ten accounts without considering all accounts. In this method, selling time t_{mn} is defined as days $\{1, 2, 3, 4, 5\}$. With this relaxation, decision variable t_{mn} is evaluated like the daily variable. It is arranged that if a sales representative visits a record, she/he needs to spend least one day by day working hour (8 hours) for that account including travel time. This assumption is done to avoid routing problem, which is much more complex with a massive amount of data. Each sales representative's the maximum credit sales in his/her nearest ten accounts are determined according to the time slot. Table 1 shows a heuristic approach demo of sales representative number one called S1. The ten closest branches to S1 are identified and the potential sales numbers in these accounts are defined. The daily working time is assumed to be 8 hours. The time they spend on the road and net calling time is calculated, accordingly. After the daily net calling time calculation for each account is calculated according to the day slot.

Table 1. Heuristic approach net calling time calculation

S1	Distance (km)	Acct ID	Potential Sale	Travel Time (hour)	Calling Time (hour)	Slot Based Net Calling Time (hour)				
						5 day	4 day	3 day	2 day	1 day
1	0,000	1	51.0	0.00	8.00	40.00	32.00	24.00	16.00	8.00
2	2,570	2	24.5	0.05	7.95	39.74	31.79	23.85	15.90	7.95
3	3,316	3	0.0	0.07	7.93	39.67	31.73	23.80	15.87	7.93
4	4,122	4	117.0	0.08	7.92	39.59	31.67	23.75	15.84	7.92
5	4,849	5	95.0	0.10	7.90	39.52	31.61	23.71	15.81	7.90
6	5,195	6	0.0	0.10	7.90	39.48	31.58	23.69	15.79	7.90
7	5,534	7	117.5	0.11	7.89	39.45	31.56	23.67	15.78	7.89
8	5,685	8	220.5	0.11	7.89	39.43	31.55	23.66	15.77	7.89
9	5,865	9	4.5	0.12	7.88	39.41	31.53	23.65	15.77	7.88
10	5,997	10	144.0	0.12	7.88	39.40	31.52	23.64	15.76	7.88

Note: Slot based net calling time calculated by calling time times number of day.

Table 2. Heuristic approach profit calculation

S1	Distance (km)	Acct ID	Potential Sale	Travel Time (hour)	Calling Time (hour)	Slot Based Profit Calculation				
						5 day	4 day	3 day	2 day	1 day
1	0,000	1	51.0	0.00	8.00	21.69	21.69	19.73	15.81	9.93
2	2,570	2	24.5	0.05	7.95	10.43	10.41	9.45	7.56	4.75
3	3,316	3	0.0	0.07	7.93	0.00	0.00	0.00	0.00	0.00
4	4,122	4	117.0	0.08	7.92	49.86	49.65	45.05	36.04	22.63
5	4,849	5	95.0	0.10	7.90	40.50	40.30	36.54	29.23	18.35
6	5,195	6	0.0	0.10	7.90	0.00	0.00	0.00	0.00	0.00
7	5,534	7	117.5	0.11	7.89	50.11	49.83	45.16	36.11	22.67
8	5,685	8	220.5	0.11	7.89	94.04	93.50	84.74	67.75	42.53
9	5,865	9	4.5	0.12	7.88	1.92	1.91	1.73	1.38	0.87
10	5,997	10	144.0	0.12	7.88	61.42	61.05	55.32	44.22	27.76

Note: Slot based profit calculation calculated by objective function.

The concave sales function is used to determine the sales percentage after the net time calculation on the. Considering the percentage of sales with potential sales, a number of sales to be made by the sales representative are obtained. After this step, the maximum number of credit sales is determined for each sales representative. On the other hand, traveling time is decreased from eight hours to reach a real world result. In Table 2, the example shows that sales representative S1 obtains 141 credit sales if she/he makes f (2,1,1,1)combination.

Therefore, replication number has a significant effect to find the best near-optimal solution. In addition, to strengthen the heuristic approach, the proposed algorithm is replicated many times. In any case, this outcome may change as per request of priority. To summarize this method, the best solution is calculated for the first selected sales representative. At the same time, the possibility of a better result for unselected sales representative is unnoticed. In this case, the solution is shaped according to the first selected salesperson and it may not be efficient. Repetition of the method is recommended for near-optimal result. The pseudo code of algorithm presents in Figure 2:

Table 3. Combinations of working hours in account

Combination of Days	Total Profit Calculation					Total Profit (TRY)	Final Account Id Combination
f(5)	94.04					94.04	8
f(4,1)	93.50	27.76				121.26	8,10
f(3,2)	84.74	44.22				128.96	8,10
f(3,1,1)	84.74	27.76	22.67			135.17	8,10,7
f(2,3)	67.75	55.32				123.07	8,10
f(2,2,1)	67.75	36.04	27.76			131.55	8,7,10
f(2,1,1,1)	67.75	27.76	22.67	22.63		140.81	8,10,7,4
f(1,4)	42.53	61.05				103.58	8,10
f(1,2,2)	42.53	44.22	36.11			122.87	8,10,7
f(1,1,3)	42.53	27.76	45.16			115.46	8,10,7
f(1,1,1,2)	42.53	27.76	22.67	36.04		129.00	8,10,7,4
f(1,1,1,1,1)	42.53	27.76	22.67	22.63	18.35	133.94	8,10,7,4,5
MAX						140.81	

Sales Representative Time Allocation Heuristic

H: Available time slots {8,16,24,32,40}
Account list=A
Visited Account List=V=Ø
For each salesman m
$X_{(Account,Time)}$: Account visited by salesman m
C:Closest 10 accounts to salesman m from A/V
P_c:Associated potential amount of credit obtained from closest 10 accounts
(Expected Credit) $_{(C,H)}=\alpha_0+\alpha_1+\alpha_2 H^2)*P_c$
Obtain $X_{(Account,Time)}$list for salesman m
V=V U X

Figure 2. Sales Representative Time Allocation Heuristic

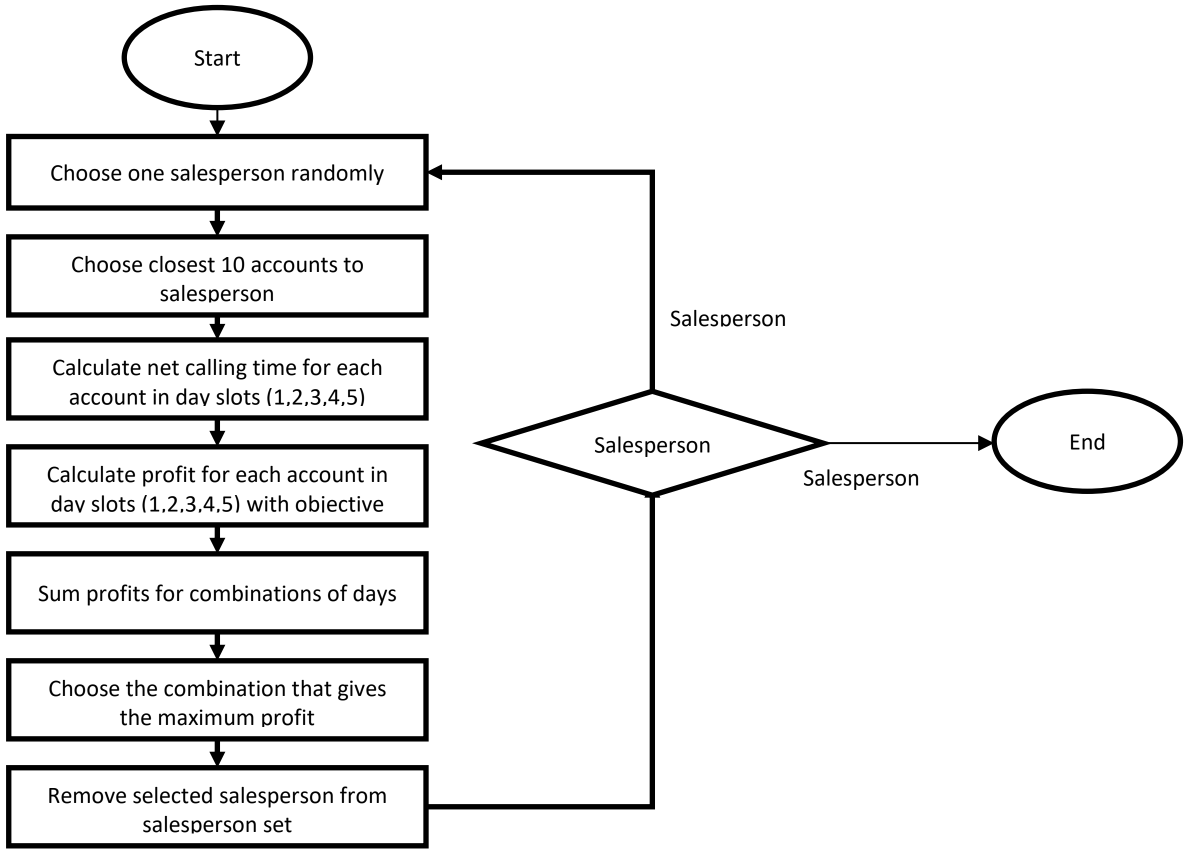

Figure 3. Heuristic Approach Flow Chart

3. RESULTS AND DISCUSSION

This study is proposed a mathematical model and heuristic algorithm based a formulation that generates a fair assignment of all salesperson. Problem contains 67 sales representatives, 286 accounts and account's potential. The output of the model returns the account where each sales representative will be allocating as well as the calling time for the account.

The performance of the model is calculated with the objective function. Therefore, it may not always be possible to achieve the optimal result in large-scale problems that's why Heuristic algorithm is developed. After deployment of proposed method for each sales representative optimum total profit value is set to '525.113'. Associated result of manual approach and the mathematical model is shown in Table 3.

Table 4 represents how many hour sales person spends in which account and the total profit of these combinations are calculated by current methods and mathematical model for first 6 sales person. As shown, the mathematical model gives better results than the current calculation. The sales person can provide more profit less visited branches in some cases.

The result of mathematical model and current manual approach is shown in Table 5. The same notation in Table 6 also compares the mathematical model and heuristic approach. Heuristic approach close to optimal solution in 96%. The result of the heuristic method is better than the current situation. Heuristic approach may be preferred in the massive amount of data instead of the current approach.

Current manual calculation, mathematical model and heuristic approach's compared total profit calculation presented below.

Table 4. Comparison of objective function

Current Manual Approach	Mathematical Model	Heuristic Algorithm
376.731 TRY	525.113 TRY	504.937 TRY

Table 5. Comparison of current manual calculation and model

MATEMATICAL MODEL							CURRENT MANUAL APPROACH						
Agent	Calculated Account ID	Potential Sales	Distance	Calling Time	MAX Z	TOTAL PROFIT	Agent	Calculated Account ID	Potential Sales	Distance	Calling Time	MAX Z	TOTAL PROFIT
1	21	133	608	10	4,554	13,360	1	164	13	2.107	10	443	2,986
1	43	89	1,070	10.07	3,047		1	110	21	7.267	10	716	
1	47	88	476	7.83	2,533		1	38	15	4	10	511	
1	57	84	597	11.92	3,226		1	113	10	2.785	10	341	
2	256	12	21	32	767	767	2	32	47	12.03	13	1,913	4,167
							2	9	40	3.5	13	1,628	
							2	35	14	0	13	570	
							2						
3	8	167	440	13	6,882	15,416	3	30	63	2.515	13	2,564	4,873
3	23	132	165	12.03	5,101		3	115	43	4.133	13	1,750	
3	62	78	674	14.67	3,434		3	50	12	5.571	13	488	
							3						
							3						
4	3	245	1,172	17	11,809	23,518	4	17	57	4.193	13	2,320	3,752
4	7	167	729	12.3	6,550		4	92	10	12.27	13	407	
4	15	145	0	10.65	5,159		4	256	24	0	13	977	
5	28	122	11	22	6,845	7,289	5	33	57	25	10	1,943	4,574
5	267	9	35	17.66	444		5	49	10	23.759	10	341	
							5	87	24	0	10	818	
							5	28			10		
6	188	28	142	32	1,789	1,789	6	4	191	388	10	6,199	9,969
							6	53	86	42	10	2,897	
							6	172	33	905	10	401	
							6	183	29	645	10	472	

Table 6. Comparison of model and heuristic approach

MATEMATICAL MODEL							HEURISTIC APPROACH						
Agent	Calculated Account ID	Potential Sales	Distance	Calling Time	MAX Z	TOTAL PROFIT	Agent	Calculated Account ID	Potential Sales	Distance	Calling Time	MAX Z	TOTAL PROFIT
1	21	133	608	10	4,554	13,360	1	30	119	14	23.16	6,781	11,955
1	43	89	1070	10.07	3,047		1	25	127	12	7.76	3,624	
1	47	88	476	7.83	2,533		1	110	54	8	7.84	1,550	
1	57	84	597	11.92	3,226								
2	256	12	21	32	767	767	2	33	112	9	15.64	5,128	13,781
							2	53	86	11	7.78	2,456	
							2	115	51	6	7.88	1,470	
							2	9	163	4	7.92	4,757	
3	8	167	440	13	6,882	15,416	3	159	37	9	7.82	1,057	1,439
3	23	132	165	12.03	5,101		3	255	12	13	7.74	332	
3	62	78	674	14.67	3,434		3	276	3	114	5.72	-21.5	
							3	274	5	134	10.64	71	
4	3	245	1172	17	11,809	23,518	4	17	139	5	23.7	8,015	11,969
4	7	167	729	12.3	6,550		4	49	88	19	15.24	3,954	
4	15	145	0	10.65	5,159							0	
5	28	122	11	22	6,845	7,289	5	28	122	11	15.56	5,567	8,642
5	267	9	35	17.66	444		5	91	61	8	7.84	1,751	
							5	164	36	14	7.72	1,015	
							5	261	11	9	7.82	309	
6	188	28	142	32	1,789	1,789	6	138	42	9	7.82	1,201	5,235
							6	128	48	18	7.64	1,344	
							6	267	9	12	15.52	401	
							6	61	81	16	7.68	2,288	

4. CONCLUSIONS

Sales managers have to make important decisions in order to maximize profit. On the other hand, these kinds of decisions are important cause of budget and time constraints. In literature, sales force compensation, sales resource allocation, sales territory design, sales force sizing and sales forecasting problems take place in the scope of sales management, which includes utilization of manual techniques or simple heuristic approach indecisive activities in many organizations. It is difficult to approximated volumes of sales without enhanced techniques in the real world since sales volume is relying on different related phenomena.

Sales force deployment involves the simultaneous resolution of interrelated subproblems like sales force sizing, salesman location, sales territory alignment, and sales resource allocation. These subproblems have to be resolved in order to maximize the profit of the selling organization.

This research concentrates on improving sales representative assignment keeping in mind the end goal to profit maximization while diminishing conceivable expenses through travels. The MIQP model was calculated by GAMS.

Additionally, a greedy heuristic algorithm was determined and coded in Microsoft Visual Studio with C#. Finally, comparison of heuristic solution and the current solution was made. This study is made with only two months' potential credit sales data. If DBank could gather more long-term data, the study is designed more realistic and efficient solution. Moreover, DBank did not measure sales representative performance. In this problem, every salesperson's performance is assumed to be the same. With this research, effective and realistic algorithms are developed for DBank.

This problem will be a good vehicle-routing problem too. When the model designed, some assumptions is made to solve it like an assignment problem such as salesperson's live closest accounts, when salesperson leave her/his house, the distance will be double. In future work, it will be used like real-world assumptions and will give more realistic and more efficient results.

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