BAMS 508 FINAL PROJECT:

Reassign Regions to Sales Representatives at Pfizer Turkey

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Executive Summary

Pfizer Inc is one of the world's largest pharmaceutical companies. In 2003, Pfizer had approximately $180 million sales in Turkey. However, the company faced a slow-down decreasing by around $10 million in sales from 2003 to 2004 in Turkey while the industry was growing overall in the same duration. Pfizer Turkey's immediate customers are medical doctors and a majority of its products are prescription drugs, so it's important for Pfizer's Sales Representatives (SRs) to maintain close relationships with doctors through regular visits. Management of Pfizer Turkey notified the slow-down problem could be caused by the long travel distance and the uneven distribution of workload among their SRs since the construction of sales territories was done several years ago, and workload distributions have been changed in recent years.

Given the data on workload of and distance travelled by the SRs, our group developed two models mainly aiming to 1) rebalance workload index to a reasonable range, and 2) reduce the total travel distance to save costs, accordingly. Meanwhile, we only want to reassign as few relationships between Sales Representatives and doctors since we learned from the Management of Pfizer that the cost of reassignment of sales region is high.

Our first model resulted in a significantly reduced standard deviation of workload index from 0.2256 to 0.0535, or a 76.29% decrease. Our second model successfully decreased total travel distance from 187.41 km to 160.22 km, or a 14.51% decrease given that the workload range [0.8, 1.2] holds. The reason why we consider two independent models is that, in this case, workload is expressed by workload index, and it does not include the travel distance from one region to another. However, traveling should be calculated into the workload since it takes up SRs' time and energy.

We then took a closer look at these two models by extending our discussion on tightening/relaxing the expected range of workload index. Last but not least, we reconciled the limitations of each model and recognized the need to obtain further detail on the relationship between workload index and distance travelled to refine a unique solution to better suit the need of the business.

1. Introduction

Pfizer Inc is one of the world's largest pharmaceutical companies. It was founded in 1849 and it aims to help people and animals live longer and healthier. To obtain this goal, Pfizer discovers and develops breakthrough medicines and provides high quality manufacturing of medicines. As a part of Pfizer's global expansion, Pfizer Turkey was founded in Istanbul in 1957. In 2003, Pfizer had approximately $180 million sales in Turkey. However, the company faced a slow-down decreasing by around $10 million in sales from 2003 to 2004 in Turkey while the industry was growing overall in the same duration.

Pfizer Turkey's immediate customers are medical doctors and a majority of its products are prescription drugs, so it's important for Pfizer's Sales Representatives (SRs) to maintain close relationships with doctors through regular visits. Management of Pfizer Turkey notified the slow-down problem could be caused by the long travel distance and the uneven distribution of workload among their SRs since the construction of sales territories was done several years ago, and workload distributions have been changed in recent years.

Therefore, in our report, we try to reduce the total travel distance to save costs and rebalance workload to a reasonable range to maintain high efficiency. In the meantime, we only want to reassign as few relationships between Sales Representatives and doctors as possible because redistribution means re-establishing the relationships, which means high cost.

In this case, doctors in a certain region are assigned to a brick, and the workload in a specific brick is expressed as the workload index of the brick. Travel distance from SRs' offices to brick is expressed in kilometers. Since we do not have enough proportional relation data between the workload index and travel distance, we build two models. Model 1 is mainly focusing on minimizing the percentage of change in workload assignment among SRs and reducing the variation of workload; Model 2 is mainly concentrated on minimising total travel distance of different SRs.

2. Model Structure

2.1 Variables used in this paper

2.1.1 MD: medical doctor

2.1.2 SR: Sales Representative

2.1.3 X_{bs}: X_{bs} is a binary value indicating if brick b is assigned to Sales Representative s. Each SR is assigned to a working region, called a sales territory or simply a territory, which is a list of MDs to be visited. Territories are formed by combining smaller geographical units, called bricks.

2.1.4 D_{bs}: D_{bs} means the total travel distance if a SR, s, returned to the office after visiting each brick, b.

2.1.5 I_b: workload index of each brick.

2.1.6 I_s: workload index of each SRs, which equals to $\sum b\, X_{bs} \times I_b$.

2.1.7 C_{bs}: the number of changed bricks. We also define it as “disruption”, which is the inclusion of new bricks in the territories of SRs compared to the current assignment. C_{bs} = 1 when $\Delta(X_{bs}$ (resultant) - X_{bs} (current)) = 1, and C_{bs} = 0 otherwise.

2.2 Business cases for the models

To meet the real use of business, a few business cases were discussed to meet the needs of the management and the organisation. They are, namely:

2.2.1 Quick fix. Simply get workload levels of every Sales Representative back within the acceptable range of workload index. The only business consideration is to minimize the disturbance to the established relationships between Sales Representatives and Doctors. This is the simple solution to the problem. See 2.3.1 Model 1.

2.2.2 Minimize other costs, i.e., travelling cost (in terms of travelling distance) of all Sales Representatives.

To management, the time spent in travel by the Sales Representatives is an unknown cost to the business. A fair expectation is if Sales Representatives travel a shorter distance, the overall cost should be minimized. See 2.3.2 Model 2.

2.3 Building the models

2.3.1 *Model 1 - The simplest model*

The model will suggest to reassign the minimum number of bricks by the minimum value of workload (index value) between sales managers.

Decision

The decision needs to be made as to how to assign the 4 SRs to 22 bricks. We formulate such decisions into 88 (4×22) binary decision variables, X_{bs}, which equals 1 if SR s (s = 1 to 4) was assigned to brick b (b = 1 to 22).

$$Decision\ Variables,\ X_{bs}, b \in [1, 22], s \in [1,4]$$

Objective

The objective value of this model consists of and is a sum of two parts. Part one is the summation value of workload index changes. For example, if a brick of workload index 0.25 transferred from SR1 to SR2, the summation of value of this change would be 0.25 (transfer out) + 0.25 (transfer in) = 0.5. Part two is the total summation value of the number of bricks changes. For example, if brick 4 is transferred from sales manager SR1 to sales manager SR2, the summation of value of this change would be 1 (transfer out) + 1 (transfer in) = 2.

The objective value, based on the example above is 0.5 + 2 = 2.5. The model will seek the minimum of this value through running in solver.

$$\text{Minimize } \sum C_{bs} * I_b + \sum C_{bs}, \quad C_{bs} = \Delta X_{bs}$$

$$\text{Subject to } X_{bs} = \{0,1\},$$

$$0.8 \le I_S \le 1.2,$$

$$\sum_{s=1}^{4} X_{bs} = 1, for\ each\ b \ \in [1,22]$$

Constraints

The optimization model shall have the following constraints:

C1. Decision variables are binary variables;

Set X_{bs} = 1 if the brick would be assigned to ***SR**s1*, and X_{bs} = 0 if the brick would not be assigned to ***SR**s2*.

C2. The maximum number assignment of any brick (sales territory);

Sale territories are non-splitable to two or more sales managers. One brick could only be assigned to one and only one sales manager.

*for each brick **b*** $\sum_s X_{bs} = 1$

C3. The maximum and minimum workload of any sales manager

The management indicated the acceptable range of workload index is [0.8,1.2]. This is based on the workload indices created before and used currently.

*for each SR **s*** $\sum_b X_{bs} \le 1.2$

$\sum_b X_{bs} \ge 0.8$

Results

Only 1 brick (Brick 10) is reassigned from Sales Representative SR2 to Sales Representative SR3. This result is within expectation. The main reason is that only one Sales Representative (SR2) was overloaded (@index 1.3377) and only one Sales Representative (SR3) is underloaded (@index 0.7048) per acceptable workload index range [0.8,1.2]. The system shall search one brick of the minimum feasible workload value to reassign from SR2 to SR3 to satisfy all constraints.

This change also has a benefit of reducing standard deviation of workload index from 0.2606 to 0.0618, or a 76.28% decrease. Standard deviation is an accurate measure of variation between samples. If we successfully decrease standard deviation of workload index, we can say that the workload distribution is fairer than previous one.

Graph 1 Illustration of the Excel Environment of Model 1

Binary variables for new assignment							Constraints to minimize the change of bricks, by number				
SR number											
1	2	3	4								
0	0	0	1	1	=	1	0	0	0	0	
0	0	0	1	1	=	1	0	0	0	0	
0	0	0	1	1	=	1	0	0	0	0	
1	0	0	0	1	=	1	0	0	0	0	
1	0	0	0	1	=	1	0	0	0	0	
1	0	0	0	1	=	1	0	0	0	0	
1	0	0	0	1	=	1	0	0	0	0	
1	0	0	0	1	=	1	0	0	0	0	
0	0	1	0	1	=	1	0	0	0	0	
0	0	1	0	1	=	1	0	1	1	0	
0	1	0	0	1	=	1	0	0	0	0	
0	1	0	0	1	=	1	0	0	0	0	
0	1	0	0	1	=	1	0	0	0	0	
0	1	0	0	1	=	1	0	0	0	0	
1	0	0	0	1	=	1	0	0	0	0	
0	0	1	0	1	=	1	0	0	0	0	
0	0	1	0	1	=	1	0	0	0	0	
0	0	1	0	1	=	1	0	0	0	0	
0	0	0	1	1	=	1	0	0	0	0	
0	0	0	1	1	=	1	0	0	0	0	
0	0	0	1	1	=	1	0	0	0	0	
0	0	0	1	1	=	1	0	0	0	0	
0.9507	1.0848	0.9577	1.0068								
							2				2.5058
1.2	1.2	1.2	1.2								
0.8	0.8	0.8	0.8								Overall minimizing the sum of workload changes and no of bricks changed

2.3.2 *Model 2 - The reduced hidden cost model*

The model will suggest the shortest total travel distance for Sales Representatives (SRs), and the resultant workload index shall be within the acceptable range, and the number of bricks reassigned is also controlled within a limit.

Decision (same as Model 1)

The decision needs to be made as to how to assign the 4 SRs to 22 bricks. We formulate such decisions into 88 (4×22) binary decision variables, X_{bs}, which equals 1 if SR s (s = 1 to 4) was assigned to brick b (b = 1 to 22).

$$Decision\ Variables,\ X_{bs}, b \in [1,22], s \in [1,4]$$

Objective

Set minimizing the total travel distance of SRs as our objective function.

$$Minimize \sum D_{bs}$$

Constraints

The optimization model shall have one additional constraint to all constraints in Model 1:

C1, C2, C3 of Model 1

C4. Disruption is measured by the number of bricks reassigned in Model 2. Set C as the number of bricks reassigned. C_{bs} are binary variables of the values below:

$$\sum C_{bs} \leq a, for\ each\ s\ \in [1{,}4]$$

where a = 2

Results

If we set each SR's range of workload as [0.8, 1.2] and each SR's disruption less than 2 bricks (total changed bricks less than 8), we can get an optimal solution with the total travel distance as 160.22 km, workload between 0.837 and 1.1275, and disruption being the total of 5 bricks, including 2 bricks for SR1, 2 bricks for SR2, and 1 brick for SR3.

Graph 2 Illustration of the Excel Environment of Model 2

Variables								
brick number	center brick1	center brick2	center brick3	center brick4		**Constraints 2**		
1	0	0	0	1	1	=	1	
2	0	0	0	1	1	=	1	
3	0	0	0	1	1	=	1	
4	1	0	0	0	1	=	1	
5	1	0	0	0	1	=	1	
6	1	0	0	0	1	=	1	
7	1	0	0	0	1	=	1	
8	1	0	0	0	1	=	1	
9	1	0	0	0	1	=	1	
10	0	0	1	0	1	=	1	
11	0	1	0	0	1	=	1	
12	0	1	0	0	1	=	1	
13	0	1	0	0	1	=	1	
14	0	1	0	0	1	=	1	
15	0	0	1	0	1	=	1	
16	0	0	1	0	1	=	1	
17	0	0	1	0	1	=	1	
18	0	1	0	0	1	=	1	
19	0	0	0	1	1	=	1	
20	0	0	0	1	1	=	1	
21	1	0	0	0	1	=	1	
22	0	0	0	1	1	=	1	
Objective function	160.22	**minimise travel distance**						
Constraints	1.decision variables binary							
	2.each brick is assigned to 1 SR							
	3.each SR has a workload between 0.8 an	0.9206	>=0.8		0.9206	<=	1.2	for SR1
		1.1275	>=0.8		1.1275	<=	1.2	for SR2
		1.1149	>=0.8		1.1149	<=	1.2	for SR3
		0.837	>=0.8		0.837	<=	1.2	for SR4
	4.limit the disruptions for each SR	2	<=	2	for SR1			
		1	<=	2	for SR2			
		2	<=	2	for SR3			
		0	<=	2	for SR4			

3. <u>Result interpretation:</u>

In Model 1, our optimal solution, suggests the resultant workload indices of [0.9507, 1.0848, 0.9577, 1.0068] for Sales Representatives SR1 to SR4 respectively. This solution set has a range of [0.9507, 1.0848] in workload indices and is narrower than the acceptable range [0.8, 1.2] indicated by the management. The standard deviation of this solution set is 0.0535, just short of 25% of the standard deviation, valued at 0.2256, before optimization. In business context, this solution also provides a result of fairness, a relatively equal workload between all Sales Representatives considered in the model.

In Model 2, our optimal solution, compared with the original assignment, the total travel distance is decreased by 27.19 km from 187.41 km to 160.22 km, or a 14.51% decrease. It means that travel distance, travel time, and transportation costs will be reduced by 14.51% for each total visit distance if per km cost and time is indifferent. It can not only reduce costs but also enable SRs to spend more time talking with MDs. In the meantime, the resultant workload indices are between 0.837 and 1.1275. It indicates that this solution can also effectively solve the staff's complaints about unbalanced workload. It can avoid work overtime and increase SRs' satisfaction with the company, thereby enabling the salesperson to communicate with MDs better. Eventually, by reassigning just 5 bricks, and none of the four SRs changes more than 2 bricks. In other words, each salesperson only needs to re-establish the connection with at most MDs in 2 bricks among 22 bricks. We think this solution can not only minimize the total travel distance but also ensure balanced workload among each SR with limited disruption.

4. Limitation of the 2 models and improvements

Model 1 **-** The results suggest a narrower range than the acceptable range [0.8, 1.2] on workload indices. This might not be something the management would love to see. One of the reasons could be the management would hope to see the possibilities that lead to a wider range of workload indices where disruption is further reduced, or an even narrower range where a few more bricks will be reassigned (for some reasons). What-if analysis is conducted as our extended discussions in Section 5 below to evaluate the sensitivity of variance in acceptable range of workload index to the model.

Model 2 **-** We have no measurements on the actual impact of travel distance and reassignment of bricks to the business as a whole and the Sales Representatives as individuals. Model 2 prioritized travel distance while bounded by the allowed number of bricks that can be reassigned. What-if analysis is conducted as our extended discussions in Section 5 below to evaluate the sensitivity of allowed number of bricks to be reassigned to the model.

5. Extended Discussions:

5.1 What if we relax or tighten the acceptable workload index range [0.8, 1.2]?

In this what-if analysis, we tested workload index range [0.7, 1.3] and [0.9, 1.1] in both models.

As a brief summary, if the range is relaxed or tightened, both disruption and total travel distance will be affected.

Relaxed range [0.7, 1.3]

Model 1 - The model will suggest to reassign Brick 12 (of index 0.0828) from SR2 to SR1. The resultant range of assigned workload index is [0.7048, 1.2549]. The model no longer provides a 'fair' workload distribution amongst Sales Representatives, making full use of the allowable range instead. A result of fairness is not necessary given if we do not specify in the model configurations. However, this might be a result the management would welcome. The objective value is decreased further from 2.5058 to 2.1656, which means even less disruption to current business.

Graph 3 Illustration of the Excel Environment of Model 1 Relaxed Range

Binary variables for new assignment							Constraints to minimize the change of bricks, by number							
SR number														
1	2	3	4											
0	0	0	1	1	=	1	0	0	0	0				
0	0	0	1	1	=	1	0	0	0	0				
0	0	0	1	1	=	1	0	0	0	0				
1	0	0	0	1	=	1	0	0	0	0				
1	0	0	0	1	=	1	0	0	0	0				
1	0	0	0	1	=	1	0	0	0	0				
1	0	0	0	1	=	1	0	0	0	0				
1	0	0	0	1	=	1	0	0	0	0				
0	0	1	0	1	=	1	0	0	0	0				
0	1	0	0	1	=	1	0	0	0	0				
0	1	0	0	1	=	1	0	0	0	0				
1	0	0	0	1	=	1	1	1	0	0				
0	1	0	0	1	=	1	0	0	0	0				
0	1	0	0	1	=	1	0	0	0	0				
1	0	0	0	1	=	1	0	0	0	0				
0	0	1	0	1	=	1	0	0	0	0				
0	0	1	0	1	=	1	0	0	0	0				
0	0	1	0	1	=	1	0	0	0	0				
0	0	0	1	1	=	1	0	0	0	0				
0	0	0	1	1	=	1	0	0	0	0				
0	0	0	1	1	=	1	0	0	0	0				
0	0	0	1	1	=	1	0	0	0	0				
1.0335	1.2549	0.7048	1.0068											
							2				2.1656			
1.3	1.3	1.3	1.3											
0.7	0.7	0.7	0.7								Overall minimizing the sum of workload changes and no of bricks changed			

Model 2 - The total travel distance will decrease further to 149.22 km and the total number of bricks reassigned is 5, including 2 bricks for SR1, 1 brick for SR2, and 2 bricks for SR3.

Graph 4 Illustration of the Excel Environment of Model 2 Relaxed Range

Variables							
brick number	center brick1	center brick2	center brick3	center brick4		Constraints 2	
1	0	0	0	1	1	=	1
2	0	0	0	1	1	=	1
3	0	0	0	1	1	=	1
4	1	0	0	0	1	=	1
5	1	0	0	0	1	=	1
6	1	0	0	0	1	=	1
7	1	0	0	0	1	=	1
8	1	0	0	0	1	=	1
9	0	0	1	0	1	=	1
10	0	1	0	0	1	=	1
11	0	0	1	0	1	=	1
12	0	1	0	0	1	=	1
13	0	1	0	0	1	=	1
14	0	1	0	0	1	=	1
15	0	0	1	0	1	=	1
16	0	0	1	0	1	=	1
17	0	0	1	0	1	=	1
18	0	1	0	0	1	=	1
19	1	0	0	0	1	=	1
20	0	0	0	1	1	=	1
21	1	0	0	0	1	=	1
22	0	0	0	1	1	=	1
Objective function	149.22	**minimise travel distance**					
Constraints	1.decision variables binary						
	2.each brick is assigned to 1 SR						
	3.each SR has a workload between 0.7 an	0.8133	>=0.7		0.8133	<=	1.3
		1.2936	>=0.7		1.2936	<=	1.3
		1.1604	>=0.7		1.1604	<=	1.3
		0.7327	>=0.7		0.7327	<=	1.3

Tightened range [0.9, 1.1]

Model 1 - The model will result exactly the same as original Model 1. When further tightened the range to [0.95, 1.05], the model started to react by reassigning 1 more brick, i.e., Brick 12 from SR2 to SR1 then Brick 10 from SR2 to SR3.

Graph 5 Illustration of the Excel Environment of Model 1 Tightened Range

Binary variables for new assignment							Constraints to minimize the change of bricks, by number				
SR number											
1	2	3	4								
0	0	0	1	1	=	1	0	0	0	0	
0	0	0	1	1	=	1	0	0	0	0	
0	0	0	1	1	=	1	0	0	0	0	
1	0	0	0	1	=	1	0	0	0	0	
1	0	0	0	1	=	1	0	0	0	0	
1	0	0	0	1	=	1	0	0	0	0	
1	0	0	0	1	=	1	0	0	0	0	
1	0	0	0	1	=	1	0	0	0	0	
0	0	1	0	1	=	1	0	0	0	0	
0	0	1	0	1	=	1	0	1	1	0	
0	1	0	0	1	=	1	0	0	0	0	
1	0	0	0	1	=	1	1	1	0	0	
0	1	0	0	1	=	1	0	0	0	0	
0	1	0	0	1	=	1	0	0	0	0	
1	0	0	0	1	=	1	0	0	0	0	
0	0	1	0	1	=	1	0	0	0	0	
0	0	1	0	1	=	1	0	0	0	0	
0	0	1	0	1	=	1	0	0	0	0	
0	0	0	1	1	=	1	0	0	0	0	
0	0	0	1	1	=	1	0	0	0	0	
0	0	0	1	1	=	1	0	0	0	0	
0	0	0	1	1	=	1	0	0	0	0	
1.0335	1.002	0.9577	1.0068								
							4				4.6714
1.05	1.05	1.05	1.05								
0.95	0.95	0.95	0.95								Overall minimizing the sum of workload changes and no of bricks changed

Model 2 - The total travel distance will increase from 160.22 km to 171.68 km and the total number of bricks reassigned is 4, including 1 brick for SR1, 1 brick for SR2, and 2 brick for SR3.

Graph 6 Illustration of the Excel Environment of Model 2 Tightened Range

Variables							
brick number	center brick1	center brick2	center brick3	center brick4		Constraints 2	
1	0	0	0	1	1	=	1
2	0	0	0	1	1	=	1
3	0	0	0	1	1	=	1
4	1	0	0	0	1	=	1
5	1	0	0	0	1	=	1
6	1	0	0	0	1	=	1
7	1	0	0	0	1	=	1
8	1	0	0	0	1	=	1
9	0	0	1	0	1	=	1
10	0	0	1	0	1	=	1
11	0	0	1	0	1	=	1
12	0	1	0	0	1	=	1
13	0	1	0	0	1	=	1
14	0	1	0	0	1	=	1
15	1	0	0	0	1	=	1
16	0	0	1	0	1	=	1
17	0	0	1	0	1	=	1
18	0	1	0	0	1	=	1
19	1	0	0	0	1	=	1
20	0	0	0	1	1	=	1
21	0	0	0	1	1	=	1
22	0	0	0	1	1	=	1
Objective function	171.68	**minimise travel distance**					
Constraints	1.decision variables binary						
	2.each brick is assigned to 1 SR						
	3.each SR has a workload between 0.9 and 1.1	1.055	>=0.9		1.055	<=	1.1
		1.0407	>=0.9		1.0407	<=	1.1
		1.0018	>=0.9		1.0018	<=	1.1
		0.9025	>=0.9		0.9025	<=	1.1

We notice that the number of bricks in SR4 has not changed regardless of relaxing or tightening of the workload index. We think the main reason is that the average distance between the central bricks of SR1-3 and related bricks are shorter within a range of 11-14km. However, the average travel distance between the center brick of SR4 and the related bricks is 33.8km, which is nearly three times more than the travel distance of SR1-3, so the number of bricks of SR4 remains unchanged in all optimal schemes.

In general, the tightening of the workload index has a negative effect on total travel distance. Disruption will also be affected by the range of workload.

5.2 *What if we relax or tighten disruption (the number of bricks change) in Model 2?*

We also focus on disruption because change of brick assignment means the new SR needs to rebuild his or her relationship with MDs in the brick. In this model, we want to find a balance between reducing disruption and reducing total travel distance. We keep the range of workload index as [0.8,1.2].

If we tighten our constraint that disruption towards less than or equal to 4 bricks (each SR is reassigned to at most 1 brick), the total travel distance will be up to 172.06 km, the workload index will be between 0.837 to 1.1275, and in total 3 bricks was reassigned.

Graph 7 Illustration of the Excel Environment of Model 2 Tightened Disruption

Variables							
brick number	center brick1	center brick2	center brick3	center brick4		**Constraints 2**	
1	0	0	0	1	1	=	1
2	0	0	0	1	1	=	1
3	0	0	0	1	1	=	1
4	1	0	0	0	1	=	1
5	1	0	0	0	1	=	1
6	1	0	0	0	1	=	1
7	1	0	0	0	1	=	1
8	1	0	0	0	1	=	1
9	0	0	1	0	1	=	1
10	0	0	1	0	1	=	1
11	0	1	0	0	1	=	1
12	0	1	0	0	1	=	1
13	0	1	0	0	1	=	1
14	0	1	0	0	1	=	1
15	1	0	0	0	1	=	1
16	0	0	1	0	1	=	1
17	0	0	1	0	1	=	1
18	0	1	0	0	1	=	1
19	0	0	0	1	1	=	1
20	0	0	0	1	1	=	1
21	1	0	0	0	1	=	1
22	0	0	0	1	1	=	1
Objective function	172.06	**minimise travel distance**					
Constraints	1.decision variables binary						
	2.each brick is assigned to 1 SR						
	3.each SR has a workload between 0.8 an	1.1205	>=0.8		1.1205	<=	1.2
		1.1275	>=0.8		1.1275	<=	1.2
		0.915	>=0.8		0.915	<=	1.2
		0.837	>=0.8		0.837	<=	1.2
	4.limit the disruptions for each SR	1	<=	1			
		1	<=	1			
		1	<=	1			
		0	<=	1			

If we relax our constraint that disruption towards less than or equal to 12 bricks (each SR is reassigned to at most 3 brick), the total travel distance will down to 154.63 km, the workload index will be between 0.8028 to 1.1275, and in total 6 bricks were reassigned, including 3 bricks for SR1, 1 brick for SR2, and 2 bricks for SR3.

Graph 8 Illustration of the Excel Environment of Model 2 Relaxed Disruption

Variables							
brick number	center brick1	center brick2	center brick3	center brick4		**Constraints 2**	
1	0	0	0	1	1	=	1
2	0	0	0	1	1	=	1
3	0	0	0	1	1	=	1
4	1	0	0	0	1	=	1
5	1	0	0	0	1	=	1
6	1	0	0	0	1	=	1
7	1	0	0	0	1	=	1
8	1	0	0	0	1	=	1
9	1	0	0	0	1	=	1
10	0	0	1	0	1	=	1
11	0	1	0	0	1	=	1
12	0	1	0	0	1	=	1
13	0	1	0	0	1	=	1
14	0	1	0	0	1	=	1
15	0	0	1	0	1	=	1
16	0	0	1	0	1	=	1
17	0	0	1	0	1	=	1
18	0	1	0	0	1	=	1
19	1	0	0	0	1	=	1
20	1	0	0	0	1	=	1
21	0	0	0	1	1	=	1
22	0	0	0	1	1	=	1
Objective function	154.63	**minimise travel distance**					
Constraints	1.decision variables binary						
	2.each brick is assigned to 1 SR						
	3.each SR has a workload between 0.8 and 1.2	0.9548	>=0.8		0.9548	<=	1.2
		1.1275	>=0.8		1.1275	<=	1.2
		1.1149	>=0.8		1.1149	<=	1.2
		0.8028	>=0.8		0.8028	<=	1.2
	4.limit the disruptions for each SR	3	<=	3			
		1	<=	3			
		2	<=	3			
		0	<=	3			

We think there is a negative relationship between the travel distance and the number of reassigned bricks. If we allow more disruptions, we can reduce travel distance. If we tighten our disruption constraint, we have to bear higher total travel distance.

This analysis is irrelevant to Model 1.

6. Conclusion

In this article, we analysed the workload distribution problem of Pfizer's Sales Representatives (SRs) in Turkey. Pfizer is the fourth largest pharmaceutical company in Turkey, but its growth has been slowing down recently. One of the main problems is that the original workload distribution of SRs, which was developed a few years ago, cannot fit into today's real workload situation. Some SRs' workloads exceed their limit, and thus cannot provide high-quality services to their customers.

We chose 4 SRs as our representative and tried to find models to optimize workload assignment given the current workload of different bricks. Combining the background with information provided by the case, we suggest that the system can be optimized in two aspects: 1. Minimize disruptions and variation of workload. 2. Minimize travel distance.

The reason why we consider two independent models is that in this case, workload is expressed by workload index, and it does not include the travel distance from one region to another (in this case, bricks). However, traveling should be calculated into the workload since it takes up SRs' time and energy. The more a SR travels, the less time he or she can spend on meeting customers. We do not have appropriate measures to convert travel distance into a part of the workload index, and thus we decided to keep both models. If the manager thinks travel time occupies a great portion of workload, he or she can choose Model 2, otherwise he or she can choose Model 1.

Model 1 is minimizing disruption of current work assignments. In this model, we only change 1 brick (brick 10) from SR2 to SR3, and we significantly reduce the standard deviation of workload index from 0.2256 to 0.0535, or a 76.29% decrease.

Model 2 is minimizing travel distance. In this model, we try to minimize the total distance that 4 SRs travelled. As we change 5 bricks, we successfully decrease total travel distance from 187.41 km to 160.22 km, or a 14.51% decrease given that the workload range [0.8, 1.2] holds.

Also, by changing the constraint of workload range, we can further improve both models' performances. For example, if we tighten the workload index range to [0.95, 1.05], the standard deviation of workload index can further decrease to 0.027 with 4 bricks reassignments. If we loosen workload index range to [0.7, 1.3], we can decrease the total travel distance to 149.22 km. In general, if the workload index range is tightened, the standard deviation of workload index will decrease, but total travel distance and number of bricks reassigned will increase. In this case, the range [0.8, 1.2] is fixed, but it is meaningful to do What-if analysis because workload index range may be different if we generalize our model nationally.

All in all, both of our models can significantly improve the workload assignment system of Pfizer's SRs in Turkey. In the future, if we can get the conversion rate between workload index and travel distance, we can improve our model by providing a uniformed model instead of 2 separate models.

7. The next step

Management may be able to pick their favourite solution from our models and what-if analysis. If they don't, a viable next step is to identify specific bricks to the reassignment exercise, as an added constraint to the model. This comes with a reason that management might in fact have some targeted bricks of poor performances and give an effort to turnaround in the name of 'workload reassignment'.

Appendix

Table 1: Current Structure of Sales Territories

SR number	Center Brick number	Bricks assigned
1	4	4, 5, 6, 7, 8, 15
2	14	10, 11, 12, 13, 14
3	16	9, 16, 17, 18
4	22	1, 2, 3, 19, 20, 21, 22

Table 2: Index Values of Bricks

Brick number	Index value	Brick number	Index value
1	0.1609	12	0.0828
2	0.1164	13	0.0975
3	0.1026	14	0.8177
4	0.1516	15	0.4115
5	0.0939	16	0.3795
6	0.1320	17	0.0710
7	0.0687	18	0.0427
8	0.0930	19	0.1043
9	0.2116	20	0.0997
10	0.2529	21	0.1698
11	0.0868	22	0.2531

Table 3: Travel Distances between SR offices and Bricks (in kilometers)

Brick number	SR 1	SR 2	SR 3	SR 4
1	16.16	24.08	24.32	21.12
2	19.00	26.47	27.24	17.33
3	25.29	32.49	33.42	12.25
4	0.00	7.93	8.31	36.12
5	3.07	6.44	7.56	37.37
6	1.22	7.51	8.19	36.29
7	2.80	10.31	10.95	33.50
8	2.87	5.07	5.67	38.80
9	3.80	8.01	7.41	38.16
10	12.35	4.52	4.35	48.27
11	11.11	3.48	2.97	47.14
12	21.99	22.02	24.07	39.86
13	8.82	3.30	5.36	43.31
14	7.93	0.00	2.07	43.75
15	9.34	2.25	1.11	45.43
16	8.31	2.07	0.00	44.43
17	7.31	2.44	1.11	43.43
18	7.55	0.75	1.53	43.52
19	11.13	18.41	19.26	25.40
20	17.49	23.44	24.76	23.21
21	11.03	18.93	19.28	25.43
22	36.12	43.75	44.43	0.00

Table 4: Assignment Model Comparison

	Current Assignment	Model 1	Model 2
Brick Assignment	SR1: 4, 5, 6, 7, 8, 15 SR2:10, 11, 12, 13, 14 SR3: 9, 16, 17, 18 SR4: 1, 2, 3, 19, 20, 21, 22	SR1: 4, 5, 6, 7, 8, 15 SR2:11, 12, 13, 14 SR3: 9, **10**, 16, 17, 18 SR4: 1, 2, 3, 19, 20, 21, 22	SR1: 4, 5, 6, 7, 8, **9**, **21** SR2: 11, 12, 13, 14, **18** SR3: **10**, **15**, 16, 17 SR4: 1, 2, 3, 19, 20, 22
Workload index of each SR	SR1: 0.9507 SR2: 1.3377 SR3: 0.7048 SR4: 1.0068	SR1: 0.9174 SR2: 1.0245 SR3: 0.9055 SR4: 1.1526	SR1: 0.9206 SR2: 1.1275 SR3: 1.1149 SR4: 0.837
Standard Deviation of workload index, σ	0.2256	0.0535	0.1248
Total distance travelled in kilometers, $\sum Dbs$	187.41	187.24	160.22
Number of bricks change, $\sum Cbs$	0	1 (10)	5 (9, 10, 15, 18, 21)

Reference

Murat Köksalan, Sakine Batun, (2009) Case—Assigning Regions to Sales Representatives at Pfizer Turkey. INFORMS Transactions on Education 9(2):72-76. https://doi.org/10.1287/ited.1090.0021cs