

TEAM PROJECT

SCMA 645-902

VIRGINIA COMMONWEALTH UNIVERSITY

SUBMITTED BY:

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Executive Summary:

The Federal Reserve Bank of Richmond reorganizes the functional groups of the department of information technologies into smaller multi-function teams every six-month based on certain criteria. These new teams should be able to complete the process of the products within themselves and hence save the time of transition of projects between the existing groups. We are students at Virginia Commonwealth University and the problem was assigned to us by Professor Christopher Fauerbach. As part of the class project, we were asked to work on the project of assigning teams to the employees of the department based on the data. As a sample, a prototype consisting of 20 workers grouped as a team of 2 was created by considering the factors.

The main problem was to produce new multi-function teams within the existing functional group. There were around 200 employees assigned in 20 teams with the team size ranging from 8 to 12. Developer, quality assurance testers, user acceptance testers, networking professionals, security experts, analysts, architects were some of the expertise levels mentioned. Variety of the expertise in the team helps the team in completing the project within each team.

Different time zones must be considered as that might affect the team. Even though the teammates are preferred to have similar time zones, the teams could meet virtually to facilitate the scheduling. Other criteria such as the experience level of the team members, years of experience, and the functions of the workers are considered while working on the project.

This model is estimated for the time period of six months with the goal of reducing the cost of the teams generated.

Python was the software used for the purpose of analysis and pyomo and gurobi were used as the solver. Hence the model was developed for 200 employees splitting them into twenty teams and the objective and constraints were set. The optimal cost objective obtained for this project was \$26,000 and no team was assigned with an agile coach.

Problem Statement:

The Federal Reserve Bank of Richmond is one of the of the Federal Reserve Bank working for the healthy economy of the country. Every six month the bank reorganizes the functional group in the department of information technologies. This is to ensure that the projects are completed in much faster rate and eliminate the time loss of the transfer of works between functional groups.

Hence the problem is to assign different multi-functional group of employees for the next six month for the better performance of the department and the teams must consist of workers from different expertise, experience and but mostly similar time zone. The question for the need of an agile coach is also to be resolved.

Assumption:

There are few assumptions that we have considered while analysing the project excluding the constraints. They are:

1. The weekly cost for an agile coach would be = \$2286.
2. Time zone cost will be \$200.
3. Experience cost will be \$100.
4. The cost for product owner would be \$50.
5. The expertise cost per team would be \$80.

Objective:

Determine the number of employees out of two hundred employees that must be allocated into twenty different groups such that the cost spent on each team is minimized, subject to following constraints:

Constraints:

- The team size should be between 8 to 12 employees.
- The team with same time zones is preferred.

- The team should have workers from different product area expertise.
- Each team should have at least one member from each function.
- If the team have at least two members with hands-on experience, then an agile coach is not required otherwise they require an agile coach.
- Every employee is desired to allocated into different teams.
- Each team should have a scrum master and product owner or an agile coach.

Data:

Worker_ID	Expertise	Time_zone	Function	Experience	A.Experience	years_of_experience
101	Developer	CT	Build	Senior	hands-on experience	0-5
102	Developer	PT	Plan	Associate	hands-on experience	0-5
103	Analyst	PT	Scrum	Associate	trained but no experience	10-20
104	Architect	ET	Build	Senior	No experience/no training	0-5
105	Security Experts	CT	Plan	Intermediate	hands-on experience	10-20
106	User Acceptance tester	ET	Run	Associate	No experience/no training	20+
107	User Acceptance tester	PT	Plan	Associate	hands-on experience	5-10
108	Product Owner	ET	Run	Advanced	trained but no experience	5-10
109	Security Experts	PT	Scrum	Senior	hands-on experience	10-20
110	Product Owner	PT	Build	Advanced	trained but no experience	20+
111	Developer	CT	Scrum	Associate	hands-on experience	20+
112	User Acceptance tester	ET	Plan	Advanced	hands-on experience	10-20
113	Network Professional	ET	Run	Advanced	trained but no experience	10-20
114	Quality Assurance Tester	PT	Plan	Senior	trained but no experience	5-10
115	Developer	CT	Plan	Senior	trained but no experience	20+
116	Network Professional	CT	Run	Advanced	No experience/no training	20+
117	User Acceptance tester	ET	Run	Intermediate	hands-on experience	5-10
118	Network Professional	PT	Build	Advanced	trained but no experience	5-10
119	Network Professional	ET	Plan	Intermediate	hands-on experience	0-5
120	Security Experts	CT	Build	Senior	hands-on experience	5-10
121	User Acceptance tester	CT	Build	Associate	hands-on experience	10-20
122	Developer	ET	Plan	Associate	trained but no experience	0-5
123	Analyst	ET	Build	Advanced	No experience/no training	0-5
124	Developer	PT	Run	Advanced	No experience/no training	0-5
125	Developer	CT	Run	Intermediate	hands-on experience	5-10
126	Analyst	PT	Scrum	Advanced	No experience/no training	5-10
127	Product Owner	CT	Build	Senior	No experience/no training	10-20
128	Product Owner	ET	Scrum	Senior	trained but no experience	20+
129	Developer	PT	Build	Senior	trained but no experience	20+

Going through the data set :

$W = [101, 102, 103, 104, \dots, 300]$ be the set of worker id for each employee

$T = [1, 2, 3, 4, \dots, 20]$ be the set of teams

$F = [\text{Plan}, \text{Build}, \text{Run}, \text{Scrum}]$ be the set of functions.

$E = [\text{Developer, Quality Assurance Tester, User Acceptance Tester, Network Professionals, Security Experts, Scrum master, Product Owner, Analyst, Architect}]$ be the set of expertise level for each employee

$P = [\text{No experience/No training, Trained but No Experience, Hands-on Experience}]$ be the set agile experience level of each employee.

$C = [\text{Advanced, associate, intermediate, senior}]$ be the level of experience

$R = [0-5, 5 - 10, 10 - 20, 20+]$ be the set of years of experience.

$Z = [\text{CT, PT, ET}]$ be the set of time zones which each employee belongs to.

agile_cost, be the cost of an agile coach per week

time_cost, be the cost of team per time zone,

exp_cost, be the cost of team based on the level of agile experience in each team

product_cost, be the cost of the product owner in each team

et_cost, be the cost paid for employee working in j expertise, $j \in E$

DECISION VARIABLE

Let

$$x_{ij} = \begin{cases} 1, & \text{if worker_id } i \text{ belong to team } j, \\ 0, & \text{otherwise} \end{cases} \quad i \in W, j \in T$$

$$y_{jk} = \begin{cases} 1, & \text{if team } j \text{ belong to timezone } k, \\ 0, & \text{otherwise} \end{cases} \quad j \in T, \quad k \in Z$$

$$z_j = \begin{cases} 1, & \text{if team } j \text{ need a agile coach,} \\ 0, & \text{otherwise} \end{cases} \quad j \in T$$

$$c_{jk} = \begin{cases} 1, & \text{if team } j \text{ as a worker with } k \text{ expertise,} \\ 0, & \text{otherwise} \end{cases} \quad j \in T, \quad k \in C$$

$$f_{jk} = \begin{cases} 1, & \text{if team } j \text{ as a function } k, \\ 0, & \text{otherwise} \end{cases} \quad j \in T, \quad k \in F$$

$$a_j = \begin{cases} 1, & \text{if team } j \text{ as worker with agile experience as hands on experience,} \\ 0, & \text{otherwise} \end{cases} \quad j \in T$$

ALGEBRAIC FORMULATION

$$\min \quad agile_{cost} \sum_{j \in T} z_j + time_{cost} * \sum_{j \in T} \sum_{k \in Z} y_{jk}$$

$$+ exp_cost * \sum_{j \in T} \sum_{k \in C} (f s_{jk} + f m_{jk})$$

$$+ product_{cost} * \sum_{i \in W} \sum_{j \in T} x_{ij}$$

$$+ et_{cost} * \sum_{i \in W} \sum_{j \in T} x_{ij}$$

S.T.

$$\sum_{i \in W: E_i \neq \text{Scrum master}} \sum_{j \in T} x_{ij} = 1 \quad \{\text{allocation constraint}\}$$

$$\sum_{i \in W} \sum_{j \in T} x_{ij} \leq 10 + ts_j - tm_j \quad \{\text{team_size - constraint}\}$$

$$\sum_{j \in T} \sum_{k \in C} c_{jk} \leq 2.5 + fs_{jk} - fm_{jk} \quad \{\text{expertise - constraint}\}$$

$$\sum_{i \in W: F_i = "R"} \sum_{j \in T} x_{ij} \geq 1 \quad \{\text{owner - constraint}\}$$

$$\sum_{i \in W} \sum_{j \in T} x_{ij} = \text{function} + fps_{jk} - fpm_{jk},$$

$$k \in F: k \neq \text{Scrum} \quad \{\text{functional - constraint}\}$$

$$\sum_{i \in W: P_i = "Hands-on Experience"} x_{ij} \geq a_j, j \in T \quad \{\text{agile constraint}\}$$

$$\sum_{i \in W: P_i = "Hands-on Experience"} x_{ij} - 0.2 \sum_{i \in W} x_{ij} \geq -10(1 - ae_j), \quad j \in T \quad \{\text{2 hands - on experience constraint}\}$$

IMPLEMENTATION

The given optimization model has been implemented in python. Pyomo and Gurobi have been used as the solver in python. For more details, please refer to the jupyter file “Project_jaan_noora.ipynb” and excel sheet “Sample data.xls.”

RESULTS:

The following table shows the results after assigning the employees for team 20:

	A	B	C	D	E	F	G	H	I
1	Worker_ID	Expertise	Time_zone	Function	Experience	A.Experience	years_of_experience	Team	Y
4	103	Analyst	PT	Scrum	Associate	trained but no experience	10-20	20	
99	198	Network Professional	ET	Plan	Senior	hands-on experience	0-5	20	
163	262	Analyst	CT	Plan	Senior	hands-on experience	20+	20	
181	280	Product Owner	CT	Run	Senior	No experience/no training	5-10	20	
185	284	Scrum Master	CT	Scrum	Advanced	trained but no experience	0-5	20	
186	285	Developer	PT	Scrum	Intermediate	trained but no experience	5-10	20	
190	289	Developer	PT	Run	Associate	trained but no experience	20+	20	
193	292	User Acceptance tester	ET	Run	Advanced	No experience/no training	20+	20	
194	293	Analyst	PT	Build	Senior	No experience/no training	20+	20	
196	295	Architect	CT	Scrum	Senior	hands-on experience	10-20	20	
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The below table shows the worker id of each employee, grouped into the twenty teams with the total of ten in each teams and two hundred employees.

Members\Team	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	108	116	126	109	106	107	129	139	110	111	114	104	128	105	113	112	153	133	101	103
2	137	146	127	125	120	124	178	142	117	121	115	130	143	161	119	135	158	134	102	198
3	200	148	152	145	138	162	188	144	141	123	118	156	155	166	122	180	160	140	157	262
4	205	154	165	150	199	221	196	179	168	136	131	228	170	215	245	191	164	163	159	280
5	226	173	174	151	219	244	210	181	189	149	132	231	183	236	249	193	192	171	169	284
6	239	176	184	175	220	253	225	201	197	224	147	246	194	267	260	204	195	172	187	285
7	250	182	222	190	255	275	232	203	206	241	167	258	218	278	277	214	208	177	209	289
8	257	185	229	207	286	288	238	213	268	254	186	259	233	283	281	216	212	240	211	292
9	266	202	252	237	299	294	242	230	270	264	223	265	256	290	287	247	217	263	234	293
10	276	227	298	269	300	296	248	243	271	282	235	273	261	291	297	251	272	274	279	295

The below result shows that worker id has been assigned to at least one of the team:

```
x[101,19] =1.000000
x[102,19] =1.000000
x[103,20] =1.000000
x[104,12] =1.000000
x[105,14] =1.000000
x[106,5] =1.000000
x[107,6] =1.000000
x[108,1] =1.000000
x[109,4] =1.000000
x[110,9] =1.000000
x[111,10] =1.000000
x[112,16] =1.000000
x[113,15] =1.000000
x[114,11] =1.000000
x[115,11] =1.000000
x[116,2] =1.000000
x[117,9] =1.000000
x[118,11] =1.000000
x[119,15] =1.000000
```

CONCLUSION:

The optimization model has been implemented and the results could be seen in the codes. This shows that the method used was quite effective. We were able to get twenty teams with ten members each. The other constraints that affect the model were also analysed and no teams had more than one scrum master and product owner. All the team has members with more than one hands-on experience. Hence, we could say that there was no need for an agile coach on any of the team and the respective cost can be saved. This optimization model could be used by The Federal Reserve Bank of Richmond to analyse the functional groups of the department of Information technologies and assign the employees to each team with members with various expertise levels. The data regarding the constraints such as time zone, experience level, years of the experience do have impact on the assigning of the team members. As the bank does this change in the group every six months, the model used in this project could be helpful to reduce the cost and save the time.