GROUP 3

Emergency Department Physician Schedule Modelling

Final Group Project | OMIS 4000 R | Raha Imanirad | Friday April 9th, 2021.

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Executive Summary:

Upon reviewing the dataset showcasing information on shifts worked at a certain clinic, the optimization problem that our team investigated was how to best assign ED physicians to the different shifts of the day in order to maximize ED performance. Both primary and secondary research, in the form of interviews and case studies, were conducted and utilized to reach the decision to optimize both speed and quality when determining how to best maximize ED performance. Prior to constructing our optimization model, an extensive data analysis was conducted on the ED clinic dataset. With regards to how these metrics were deduced and evaluated, the 72-hour Rate of Return metric was used to analyze physician quality, and the Average Patient LOS metric was used to analyze physician speed. Using a scoring system, we combined the evaluations of the mentioned metrics for each physician by using average calculations and ranked the physicians through the coefficients in the objective function, with the highest value displaying the strongest overall performance measure and the lowest value displaying the weakest overall performance measure. Multiple other analyses were done to determine shift traffic, shift case severity, physician preference, and the number of physicians needed per day of the week and shift.

In terms of the optimization model used, the analysis was done using a binary integer programming model, with the decisions revolving around which and how many of the 28 physicians to assign to each of the 3 shifts over the 7-day horizon. When building our model, we also identified a group of constraints that needed to be considered. The first one demanded the process of scheduling physicians to shifts 1 through 3 on the basis of performance, since certain shifts experienced more critical cases along with traffic, therefore creating a higher demand for more skilled physicians. The next one dealt with the number of physicians that needed to be staffed per shift, and we addressed this by identifying how many physicians typically worked each shift and then allotted physicians accordingly. In addition, we also noticed that Sundays were less busy than every other day, so we reduced the number of physicians scheduled on Sundays. We also took physician preference into consideration by acknowledging which shifts they never worked and ensured that those physicians weren't scheduled for those shifts. Another important constraint that we implemented into our model was that no physician was to work two consecutive shifts either throughout the same day or overnight, which was done to prevent physician fatigue. Finally, the last constraint that we incorporated into our model was that every physician was to work at least one shift throughout the week since it was imperative that we didn't leave any physician without work.

The strengths and possible improvements of the model are also outlined. The key strengths of this model include the incorporation of the two most essential factors, as per our primary and secondary research (quality and speed), into the objective function while accounting for the mentioned constraints. The model also allows for easy adaptability to account for changes in needs, and it also considers 'fairness' to both patients and physicians by virtue of the formulation method. Some limitations such as the occurrence of exogenous events and omitted variables that might impact individual physician quality and speed ratings are discussed, followed by potential measures to address each limitation. The conclusion of the report highlights the summary of the model's results and insightful recommendations for the clinic's management team, while also discussing positive ethical and financial implications along with steps to curb undesirable social implications.

1. <u>Introduction:</u>

Within the healthcare system, emergency departments (ED) play a very critical role in the care and healing of many patients during some of the most life-threatening moments of their lives. Unlike medical clinics that have limited hours of operations, emergency departments are open 24 hours a day, 7 days a week[i]. This emphasizes the importance of effectively scheduling physicians in order to ensure patients are well cared for around the clock. The primary issue being investigated is how to best assign ED physicians to different shifts of the day in a way that maximizes ED performance in terms of physician speed and/or quality.

As a result of the various primary and secondary research that our team conducted, we decided to focus on the goal of maximizing both the speed and quality of ED physicians. We believe achieving this goal would help to minimize patient wait times while maximizing the number of patients served, along with ensuring patients are treated according to their needs in the most effective way possible.

In terms of primary research, interviews were conducted with nurses from both Sunnybrook Hospital in Toronto, Ontario and Health Sciences North Hospital in Sudbury, Ontario. Within the interviews, both nurses emphasized the importance of speed and quality in providing excellent patient care. One nurse stated, "*It is efficient to schedule for both speed and quality in my opinion. Speed is critical due to the fact that there can be urgent health issues to address in a timely manner and you do not want an overcapacity ER. Quality is also imperative to ensure a thorough assessment is completed to prevent patients from returning in a few hours or a few days.*" Similarly, another nurse stated that "*Speed is important because if you are quick to address and assess patients, you are able to increase the number of patients you serve. Quality is also very important as better-quality leads to better patient outcomes and reduces the amount of money spent fixing issues that could have been avoided while enhancing patient care*".

In terms of secondary research, our team came across an emergency medical case in which Dr. Anton Helman analyzes ED physician productivity and references Dr. David Petrie's perspective on the topic. Dr. David Petrie mentions how when considering patient per hour rates for individual emergency physicians, "it makes sense to optimize the speed in a way that maintains quality and safety for the individual patient, but also ensures that reasonable flow is maintained in the interest of those waiting to be seen"[ii]. As a result of these findings, we were motivated to optimize both speed and quality in solving this problem.

Additionally, in terms of company constraints, it is preferred that physicians are not scheduled on two consecutive shifts per day. The issue lies in ensuring that we are able to achieve our goal while also taking into account physician preference, physician priority, and the weekend effect.

The scope of this report will highlight the utilization of historical data in order to draw conclusions and apply insights gathered within our model to enhance its accuracy. Following the analysis, our report will go into depth on the structure of our optimization model, its outputs, along with its strengths and areas for improvement. Finally, relevant managerial implications and recommendations will be provided.

2. Data Analysis:

2.1 Validity & Significance Check

Analyzing raw data is important for any model to ensure results are relevant and accurate. For this reason, we first conducted a thorough analysis of potential outliers within the dataset OMIS 4000 Final Project Data.xlsx. In order to do so, we utilized a pivot table to analyze the count of physician shifts for each of the four years provided from 2013 to 2016.

The result of this analysis found that certain physicians such as Physician ID #3 & 20 have not worked a shift since 2013, and Physician ID #28 has not worked a shift since 2014. There could be a number of reasons as to why these physicians have not worked in a number of years. Instead of eliminating these physicians from our model, we have decided to include them given the patterns of Physician ID #4,14,16, & 19. Originally, these physicians were not working within the ED clinic, but later joined or re-joined the team. Another interesting finding from this analysis was that Physician ID #22 has not worked any shifts in 2016.

Count of Physician ID	Column Labels													
Row Labels	1	2	3	4	5	6	7	8	9	10	11	12	13	14
2013	121	132	113		119	142	21	145	119	123	36	140	30	5
2014	145	136			124	139	6	136	145	132	25	131	19	
2015	152	151		34	156	162	14	167	158	145	49	151	21	
2016	72	69		74	69	76	5	77	76	72	76	75	16	53
Grand Total	490	488	113	108	468	519	46	525	498	472	186	497	86	58

Row Labels	15	16	17	18	19	20	21	22	23	24	25	26	27	28	Grand Total
2013	95		115			13	48	93	87	84	150	96	101	10	2138
2014	91		136				40	101	83	107	143	108	119	78	2144
2015	122		157	11			62	76	106	127	152	118	109		2400
2016	58	22	67	7	16		30		11	54	73	56	52		1256
Grand Total	366	22	475	18	16	13	180	270	287	372	518	378	381	88	7938

Keeping in mind that the data set only contains seven months of data points for the year 2016, it was also decided to include Physician ID #22 in the data; assuming the physician is taking a leave of some sort. If given the opportunity, analysts would consult with the clinic in order to confirm such assumptions before creating the optimization model. In addition, we also ran regressions of all variables against both speed (Average Patient LOS) and quality (72-hr Rate of Return) to determine if any were directly correlated. We determined that none of the variables were significant and thus we excluded them from our model.

Count of Admission Rate	Column Labels											
Row Labels	1	2	3	4	5	6	7	8	9	10	11	12	Grand Total
2013	216	177	209	181	186	166	160	183	153	170	167	170	2138
2014	213	165	187	175	165	164	169	165	176	201	165	199	2144
2015	206	182	213	206	200	182	216	201	205	207	181	201	2400
2016	223	207	214	211	205	195	1						1256
Grand Total	858	731	823	773	756	707	546	549	534	578	513	570	7938

SUMMARY OUTPUT	
Regression Statistics	
Multiple R	0.31842878
R Square	0.10139689
Adjusted R Square	0.10071707
Standard Error	88.895326
Observations	7938

2.2 Maximizing Physician Speed and Quality

Once the initial data validity check was complete, the next step in our process was to determine a way to use the data in order to maximize physician speed and quality. The two important metrics within the data set that were utilized to do so included the 72-hr Rate of Return and the Average Patient LOS (minutes). The 72-hr Rate of Return metric was used to determine a physician's overall quality. This metric measures how likely each patient is to return to the ER clinic after being discharged. If the physician did a sufficient job with the diagnosis, treatment, and patient care, the patient should have a 72-hr Rate of Return of zero given no unforeseen circumstances occurred. The Average Patient LOS (minutes) measures how long a patient spent in the clinic from the time of their admittance to their discharge. Thus, this metric is used to measure a physician's speed.

In order to maximize both speed and quality, pivot tables were created to measure each physician's Average 72-hr Rate of Return and Average Patient LOS (minutes). The tables were then sorted from the lowest average 72-hr Rate of Return to the highest, and the lowest Average Patient LOS (minutes) to the highest. Of the 28 physicians, the fastest received a score of 28 and the slowest received a score of 1- the higher the score, the better. The same process was completed for the 72-hour rate of return metric where the physician with the lowest average received a score of 28 while the highest score received a score of 1. From there, the two scores were averaged together and an overall score of speed and quality for each physician was created. The physicians were then ranked from best to worst, or highest to lowest score. These scores were the basis of our mathematical objective function.

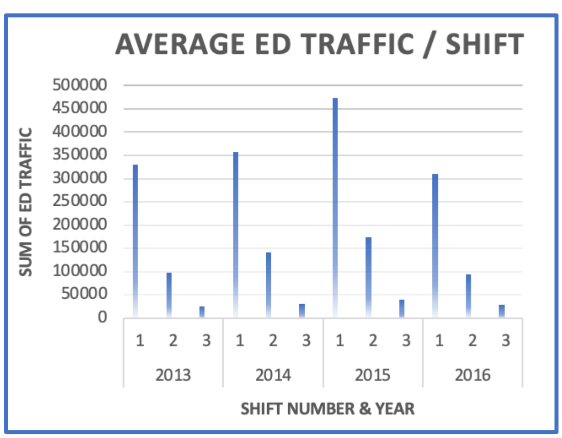
Row Labels	Average of 72-hr Rate of Return
19	0.005208333
3	0.008638854
18	0.009645062
16	0.013100115
20	0.013403263
23	0.013971365
13	0.014341259
14	0.014597655
9	0.016658616
10	0.017372928
2	0.017825958
7	0.019640046
24	0.019643012
5	0.021170489
17	0.021974986
26	0.022520554
21	0.022807863
6	0.022989786
11	0.023551957
28	0.023712222
12	0.023897326
27	0.024056559
4	0.024435937
25	0.026155535
8	0.026255517
22	0.029584636
1	0.030109243
15	0.035516505
Grand Total	**0.022588683**

Row Labels	Average of Average Patient LOS (minutes)
20	196.0182414
22	212.5641991
5	213.1456006
14	218.8450514
25	219.3610992
6	226.43425
24	234.6827651
27	235.6630056
15	236.5327757
21	237.0445469
13	237.0936761
26	238.1473376
28	240.3067071
1	243.3997
17	247.852337
9	248.8630117
11	252.1889376
4	264.4608535
3	267.0235145
7	268.2383513
12	269.0971786
23	270.0440887
2	272.6083774
10	276.1244772
19	278.3577188
8	283.0747259
16	283.8059537
18	293.404896
Grand Total	**246.8545091**

Rank	Physician ID	Average Score	Quality Score	Speed Score
1	20	26	24	28
2	14	23	21	25
3	5	20.5	15	26
4	13	20	22	18
5	24	19	16	22
6	3	18.5	27	10
7	6	17	23	11
8	9	16.5	20	13
9	19	16	28	4
10	21	15.5	12	19
11	22	15	3	27
12	23	15	23	7
13	26	15	13	17
14	25	14.5	5	24
15	17	14	14	14
16	27	14	7	21
17	16	13.5	25	2
18	18	13.5	26	1
19	7	13	17	9
20	28	12.5	9	16
21	2	12	18	6
22	10	12	19	5
23	11	11	10	12
24	15	10.5	1	20
25	1	8.5	2	15
26	4	8.5	6	11
27	12	8	8	8
28	8	3.5	4	3

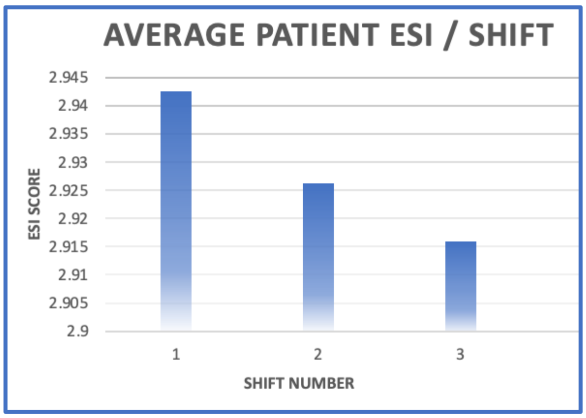
2. 3 Traffic per Shift

Another important aspect of our model was determining how many physicians to assign to each shift for each day of the week. The first analysis looked at ED Traffic to determine how busy each shift is. Across all 4 years, shift 1 consistently saw the most traffic, accounting for approximately 70% of the daily traffic. Shift 2 saw the next most amount of traffic, accounting for approximately 24% of the daily traffic. Finally, shift 3 saw the least amount of traffic, accounting for approximately 6% of the daily traffic.



2.4 ESI per Shift

The next analysis looked at determining which of the three daily shifts sees the most critical patient cases. This was determined by analyzing the Average Patient ESI metric. The Average Patient ESI, or Emergency Severity Index, is a metric that scores each patient admitted to the ER clinic on a scale of 1-4, with 1 being the least severe patient cases and 4 being the most severe. To determine which shift sees the most severe cases, the historical data was averaged across each shift over the 4 years. Shift 1 was determined to see the most critical cases with an average ESI of approximately 2.943. Shift 2 sees the next most critical cases with an average ESI of approximately 2.926. Finally, shift 3 sees the least most critical cases with an average ESI of approximately 2.916. The traffic per shift and average ESI per shift across the board verified that shift 1 sees the most patients and the most critical patient cases. This is then followed subsequently by shift 2 and shift 3.



2.5 Physicians Needed per Shift

In order to determine how many physicians to assign to each shift for different days of the week, our team examined the clinic's past scheduling history. To do so, a count of physicians per shift per day of the week across the 4 years was created. This count was then averaged to determine how many physicians were typically scheduled to each shift for every day of the week. This revealed that Sundays typically have fewer physicians scheduled compared to the rest of the week. Below is a chart of the minimum number of physicians required per shift per day of the week for the Python model.

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Shift 1	2	3	3	3	3	3	3
Shift 2	1	2	2	2	2	2	2
Shift 3	1	2	2	2	2	2	2

2.6 Physician Preference

The final step in the data analysis was a review of physician shift working preference. A count of the physician's past scheduling history across each shift was conducted. This analysis showed that some physicians in the past have never worked certain shifts. The reason for not working certain shifts may be due to preference, unavailability (such as working at another clinic), or any number of reasons. For example, Physician ID #3 never works shift 1. As a result, the insight gained from this analysis was to not allow the model to schedule these specific physicians to the shifts they have never worked.

Physician ID

Row Labels	1	2	3	4	5	6	7
1	265	510		232	1395	1716	287
2	149	242	3	116	595	786	35
3	76	224	336	84	350	612	
Grand Total	**490**	**976**	**339**	**432**	**2340**	**3114**	**322**

Shift Number

3. Model Methodology

In order to provide the best quality and speed of service to ED patients, a binary integer programming model was used.

The goal of this model was to maximize the speed and quality of ED physicians assigned to different shifts of the day over a one-week period. The speed and quality were reflected in the objective function coefficients as each physician was assigned a specific score, with the best physicians receiving higher scores (As explained in section 2.2). The construction of the objective function was based on which of the 28 physicians to assign to which of the 3 shifts over the 7-day horizon. We decided to schedule over a 7-day horizon due to the fact that within the interviews we conducted with the nurses, it was mentioned that they are normally scheduled over a one-week period. Additionally, the model assigns the highest quality physicians to the shifts which see the highest traffic and most critical cases (determined using ESI as explained in Section 2.4), allowing for all patients to receive the most rapid and best quality of care.

Please refer to Appendix A for an in-depth mathematical formulation of our optimization model. Please reference the Python file attached with this report for a closer look into the coding behind the model.

3.1 Relevant Constraints

When optimizing our model, there were a series of considerations we had to make and implement in order to fully encapsulate the reality of the problem. As mentioned in Section 2.3, after reviewing the data, we noticed that shift 1 tended to have much more traffic, as well as more severe cases than shifts 2 or 3. Subsequently, shift 2 had more traffic and severe cases than shift 3, but less than shift 1. This meant shift 3 had the least amount of traffic and severe cases. Knowing this, we decided to allocate the quality and speed mix of the physicians according to demand and case severity. The best physicians were allotted to shift 1, and the rest were to be scheduled in descending order, leaving the lowest scored physicians scheduled for shift 3. This way, the demand, and case severity are smoothed over the quality and speed of the physicians. This will ultimately result in improved medicinal operations since patients will be treated effectively according to their needs and traffic overflow in the clinic will be prevented.

Next, we looked at how many physicians typically work each shift of the day and set a lower and upper bound constraint specifying the number of physicians to work each shift of each day of the week. This was done to ensure no shift is understaffed so that patients can be treated both effectively and efficiently. Likewise, we did not want any shift to be overly overstaffed so that physicians are not idle and there are no unnecessary costs incurred by the clinic.

By analyzing the data, as well as performing secondary research[iii], we also noticed that Sundays are typically less busy than every other day of the week. Knowing this, we decided to allocate fewer physicians to work on Sundays compared to the rest of the week since this would smooth demand over the number of physicians working at a given time. This would maximize efficiency by preventing overstaffing or understaffing. As a result of this constraint, the number of physician working-hours cut on Sundays is then reallocated to busier days where they are more needed.

After reviewing each physician's work history, our team took a closer look at which shifts were rarely worked by each physician or not even worked at all. After we identified such shifts, we acknowledged them as ones that the physicians in question either could not attend or simply preferred not to work. With that in mind, we addressed that in our model by explicitly not scheduling physicians for shifts that they have a history of rarely working or not working at all. This way, we account for physician preference in our model and reduce the possibility of any potential inability for a physician to work their assigned shift.

Throughout our scheduling process, an important constraint that we also made sure to account for was that physicians were not to work two consecutive shifts on the same day. In addition, physicians who worked shift 3 at any point were to also not work shift 1 the following morning. The rationale behind both of those constraints is the same, and it is to prevent the issue of fatigue within ED physicians. Working one 8-hour shift can be exhausting enough, but working two 8-hour shifts back-to-back can be absolutely unbearable. The excessive hours would inevitably lead to a slowdown in efficiency as well as effectiveness within the ED clinic. Physicians will begin to work slower and lack the energy to perform a task up to the clinic's standards. Not to mention, physicians would also be more prone to making mistakes, hindering their quality of care, which can be remarkably detrimental to the clinic or patients. All in all, it is fair to note that for the reasons stated, these were some of the more critical constraints that our team felt the need to need to implement within the model.

The final constraint that we implemented in our model was that every physician needed to work at least one shift for the week. This was done primarily due to the assumption that all of the physicians in the provided dataset needed to be scheduled since, otherwise, they would not have been included. Since our scheduling is structured as a recurring weekly schedule, not including a particular physician in the scheduling process would also result in that physician not working at all, which would not make sense. In essence, since all 28 physicians are currently employed at the clinic, were included in the provided dataset, and our goal was to schedule these physicians in the most optimal manner, it was safe to assume that all physicians needed to be scheduled within the week.

3.2 Strengths and Opportunities of the Model

The key strength of this model lies at the core of its construction which determines the most desirable factors to be included in the objective function and accounts for multiple factors that affect scheduling such as shift order, availability, and preferences within the constraints.

It is important to note that our model currently assigns the best quality and speed physicians to shift 1 since it is in need of the most critical care compared to other shifts. However, any changes in terms of ED traffic or ESI per shift within the clinic can be easily accommodated by adjusting the model. Since Python assigns physicians to shifts in ascending order (ex. Shift 1, then shift 2, then shift 3), in order to incorporate any of these changes, all that would need to be adjusted is the mathematical formulation. For example, if shift 2 ends up seeing the most critical cases and becomes the busiest shift, followed by shift 3, and then shift 1, the formulation would be adjusted so that j = (2,3,1) = (shift 2, shift 3, shift 1). Therefore, the value of 0 in the Python code would represent shift 2,1 would represent shift 3, and 2 would represent shift 1. Preference constraints would also need to be modified accordingly. Alternatively, the constraint stating the minimum desired score for each shift could be adjusted, changing the right-hand side value to be a greater number for the desired shift. Both of these tests were conducted in order to assess the robustness of the model.

Additionally, the model incorporates fairness to patients by assigning physicians based on an equity method (needs of patients depend on the criticality of the shift), and fairness to physicians by accounting for their schedule preferences. Though the information was unavailable, a minimum number of shifts per week for each physician can also be incorporated to further improve fairness to physicians.

3.3 Limitations of the Model

A limitation of the model arises from the insufficiency of information provided as it only includes ED physicians, whereas other groups of professionals such as Trauma surgeons, ED nurses, and interns are also variables that interfere and factor into a physician’s quality and speed in any given shift. To account for these omitted variables, we suggest that individual physician characteristics are studied by possibly examining other data sets (same physician’s speed and quality at other hospitals) and running robustness tests, or examining data sets of other groups to detect any correlation.

Another improvement is that physician on-call schedule could be implemented into this model. Had we received information regarding on-calls they would have also been incorporated.

Finally, the model does not account for unpredictable exogenous events that might temporarily disrupt the effective implementation of the model. As explained in sections 3 and 3.1, the physicians are assigned to shifts based on a function that accounts for their respective ability, and constraints that take into consideration their availability and the corresponding criticality of the shift. However, emergency events such as large accidents or natural disasters might occur that spike the ESI for all shifts of the day, which would make the model ineffective until the ED situation returns to normal. To account for this limitation, we suggest either a separate model to accommodate such emergencies of different levels be built, or design a process to update the current model to work alongside emergency management software to accommodate such situations.

4. Recommendations and Implications:

Summarizing the approach as delineated in section 1, the model bases its construction on the optimization of both speed and quality, which was determined as the objective path by examination of primary and secondary resources. Since the model aims to maximize quality and speed as the top priority, it is designed to improve the physician scheduling system by aligning it with ethical principles most essential to the hospital - providing the required quality of care to patients, and delivering this impact to as many patients as possible.

The output of this model also shines a light on a unique managerial insight - whether the current availability of physicians can be planned and modified in such a way that the new availability constraints allow for even further maximization of quality and speed. Consequently, this method also optimizes the number of physicians working in each shift, which thereby enables optimization of financial savings in the long run by prevention of over-staffing or under-staffing situations.

An unfavourable social implication of this model would be that this scheduling might inhibit the transfer of technical and more importantly, tacit knowledge, from the higher to the lower quality physicians. This minimization of social interaction would arise as a result of their assignment to their corresponding criticality shift based on their quality (As explained in section 3.1, higher-quality physicians are assigned to shift 1, the most critical shift, and the lower quality physicians to shift 3, the least critical shift). This can be accounted for by adding 'observation days' for the lower quality physicians when the higher quality physicians are working during critical shifts.

The potential improvements supported by the results, the easy adaptability to changes in situations, and the ethical, financial implications provide a strong baseline for the ED to design their scheduling system and outweigh the potential pitfalls which can be addressed by the actions suggested following each identified limitation.

The following is the optimal ED physician schedule that is generated by our model. The numbers within the chart are representative of Physician ID #'s.

Physician Schedule	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Shift 1 (6:00 AM)	**18, 20**	**18, 19, 20**	**18, 20, 8**	**19, 20, 9**	**18, 19, 20**	**18, 19, 20**	**18, 20, 15**
Shift 1 (2:00 PM)	**27**	**13, 16**	**3, 7**	**13, 23**	**7, 16**	**12, 11**	**6, 25**
Shift 13 (10:00 PM)	**3**	**22, 4**	**1, 10**	**2, 28**	**3, 21**	**17, 26**	**3, 5, 24,14**

Appendices:

Appendix A: Model Mathematical Formulation:

Objective:

Maximize the speed and quality of ED physicians assigned to different shifts of the day over 1 week

Decision Variables:

X_{ijk} } 1, if physician i is assigned to shift j on day k where i = {1,….,28} = {Physician ID 1,…., Physician ID 28}, j = {1,2,3} {Shift 1, …., Shift 3}, and k = {1,2,3,4,5,6,7} = {Sunday,…,Saturday}
0, otherwise

Mathematical Objective Function:

Maximize $Z = 26X_{20jk} + 23X_{14jk} + 20.5X_{5jk} + 20X_{13jk} + 19X_{24jk} + 18.5X_{3jk} + 17X_{6jk} + 16.5X_{9jk} + 16X_{19jk} + 15.5X_{21jk} + 15X_{22jk} + 15X_{23jk} + 15X_{26jk} + 14.5X_{25jk} + 14X_{17jk} + 14X_{27jk} + 13.5X_{16jk} + 13.5X_{18jk} + 13X_{7jk} + 12.5X_{28jk} + 12X_{2jk} + 12X_{10jk} + 11X_{11jk} + 10.5X_{15jk} + 8.5X_{1jk} + 8.5X_{4jk} + 8X_{12jk} + 3.5X_{8jk}$

[i] Health Quality Ontario. (2016). Under Pressure - Emergency Department Performance in Ontario. Retrieved April 07, 2021, from https://www.hqontario.ca/portals/0/Documents/system-performance/under-pressure-report-en.pdf

[ii] Dr. Anton Helman. (2015, November 17). Emergency Physician Speed - Solutions to Physician Productivity. Retrieved March 22, 2021, from https://emergencymedicinecases.com/emergency-physician-speed-and-productivity-solutions/

[iii] Petch, J., Doig, C., & Dhalla, I. (2021, February 17). Fewer Hospital Staff on Weekends. Retrieved March 24, 2021, from https://healthydebate.ca/2013/08/topic/quality/fewer-hospital-staff-on-weekends-puts-some-patients-at-risk/?fbclid=IwAR3tPvrxelyB3cI5ruAzt3J7oPNYdWE4MaeRwFQf0vsMrMXuOJJoFS34a5k#:~:text=While%20most%20hospitals%20are%20open,would%20have%20on%20a%20weekday