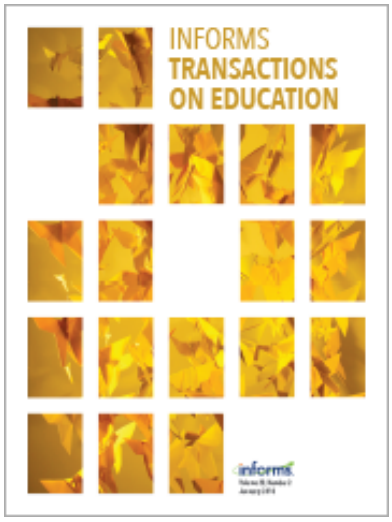

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Case Article

Three Mountain Communications: Fairness Considerations for Workplace Task Allocation

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Abstract. The case study has two primary objectives: incorporating fairness considerations in managerial decision making and introducing task allocation using an optimization model. The case focuses on a call center that faces the issue of daily task allocation. The current self-selection-based allocation protocol has created friction among employees. To enable employee satisfaction and boost team morale, the call center needs to develop an allocation model that is perceived to be fair by employees. The case tends to elicit enthusiastic participation from students, especially on the theme of workplace fairness and the role of gender and individual constraints on employees' ability to excel at the workplace. Overall, students believed the case was challenging and that it provided them skills to combine (i) optimization modeling and (ii) qualitative considerations for workplace fairness that they studied in management and leadership courses.

Supplemental Material: The Three Mountains Student Shell Excel spreadsheet is available at https://doi.org/10.1287/ited.2023.0044ca. The Teaching Note and the Three Mountains Solution Final Excel spreadsheet are available at https://www.informs.org/Publications/Subscribe/Access-Restricted-Materials.

Keywords: task allocation • fairness • integer programs

1. Introduction

This case study is based on an actual industry project on task allocation at call centers. It considers Three Mountain Communication (TMC),[1] a regional vehicle insurance firm with an annual revenue of $18 million. TMC operates call centers to process insurance claims. Insurance claims vary significantly in scope. They range from fender benders that could be repaired at local shops to total-loss vehicles that need replacements. The founder of TMC was a first-generation student. He established the business in the area near his home in the hope to provide employment opportunities to Native Americans and others in less-developed regions. When customers call their insurance provider regarding a claim, the call is routed to TMC. The customers have the choice of either waiting in line for representatives or leaving a callback number to have a call center representative call them back the next day. When customers choose the callback option, the callback number and related information are recorded and sent to the Pocatello Call Center. The Pocatello Call Center has one team lead and three employees. The four workers handle an average of 20–40 calls daily.

The team lead believed in providing flexibility to the team and implemented a self-selection–based allocation protocol. Each day, when employees arrive at the office, they sign up for the calls they would like to take, conditional on taking at least five calls per day. In a recent visit to the Pocatello center by the TMC founder, friction among employees emerged, especially around how the calls were allocated or claimed by individuals. The situation warranted a visit from a process manager to improve the process to allocate calls to individual employees. The process manager collected data through employee interviews and found dissatisfaction with the current self-selection based allocation protocol. This allocation protocol was perceived as unfair, ignoring the different difficulty levels between various calls (e.g., short call for payment versus long call for repair condition), and with a lack of career/skill development opportunities. To better understand the tasks handled by the Pocatello center, the process manager collected data

Table 1. Average Call Duration (in Minutes) by Each Employee for Each Type of Call

	Call type													
Employee	I-R	I-M	I-N	C-R	C-P	C-I	N-Q	N-Pcr	MI	MC	MN	AD1	AD2	AD3
Erica	38	7	18	93	143	17	60	76	36	68	25	46	42	55
Robin	53	10	40	89	122	19	64	70	76	86	23	58	57	30
Washakie	25	15	22	80	90	20	68	60	35	67	16	47	30	40
Dan	51	14	42	120	175	17	59	72	12	74	27	45	30	53

regarding the average call duration by each employee for each type of call (Table 1) and the list of different types of calls (Table 2). Raw data for Table 1 are available separately in the student shell file.

Table 1 demonstrates that some calls are more time-consuming than others. For example, coordination purchase (C-P) calls tend to be the longest, and insurance money payment (I-M) calls are the shortest. The variance across employees for the same type of call demonstrates that there may be differences in how each person handles the same type of call. For example, Washakie needs only 90 minutes for a C-P call and Dan processes this call in 175 minutes. The case focuses on the development of a model that helps the Pocatello call center better allocate calls by mitigating employee dissatisfaction.

The rest of the article is organized as follows. Section 2 contains a review of related academic literature. Section 3 includes a discussion of the teaching plan for the case. Section 4 discusses classroom experience, and Section 5 contains the conclusion.

2. Literature

Workplace task allocation is a complex endeavor that involves well-known computational challenges, but it also provides opportunities for managers to balance their employees' workload, provide intellectual stimulation, and inspire team effectiveness. Several academic articles have studied various aspects of managing this process, and this area of research has evolved with industry practices. There are two streams of literature that are relevant to the case: (1) call-center operations and (2) fairness in workplace task allocation.

Table 2. Call Type Code and Description

Code	Description
I-R	Insurance replace-vehicle
I-M	Insurance money payment
I-N	No action
C-R	Coordination repair
C-P	Coordination purchase
C-I	Coordination insurance
N-Q	New customer quote
N-Pcr	New customer purchase
MI	Miscellaneous insurance
MC	Miscellaneous coordination
MN	Miscellaneous new customer
AD	Administrative

Labor allocation in a call-center is typically an operational problem with a time horizon of only a few days or less. There are four phases in the process of labor allocation: (1) workload prediction, (2) staffing, (3) shift scheduling, and (4) rostering. It is important to find a good match between the predicted workload and the scheduled workforce. An inadequately sized or skilled workforce can lead to low service levels, such as long waiting times. This can be avoided by scheduling a sufficiently large number of employees. However, it is undesirable to schedule too many employees because 60%–70% of operating costs in call centers are because of personnel (Gans et al. 2003). Among others, Avramidis et al. (2010) study how call centers handle several types of calls distinguished by the required skills for delivering service and how training agents to handle all call types is not cost-effective. Typically, the integration of the four phases described above results in intractable models. This stream of literature extensively focuses on computational developments to expedite the solution time for the complex integrated formulations.

Of salient interest to us is the second stream literature on fairness in workplaces. The term "fairness" is a manifestation of distributive justice, which involves balancing two competing aspects: equality and equity. "Equality" means providing the same opportunity and resources to all, whereas "equity" involves providing opportunities and resources to employees based on their skills and individual characteristics such that they can make meaningful contributions to the firm. Of prior practice-driven articles that are relevant to the case, Rea et al. (2021) study two intertwined issues in this regard in a hospital staffing setting. (i) How can the tradeoff between equity and equality be represented in an optimization model in a way that is both useful and objectively fair from a manager's perspective? (ii) Can a process that prioritizes meritorious employees to the detriment of others still be perceived as subjectively fair? They use an optimization model to generate solutions on the Pareto frontier of equality and equity. For the employee-staffing situation at a large hospital their model implementation shows that inequality, if transparently reflective of equity, can be perceived as fair and can improve employees' satisfaction. In a similar paper, Anderson et al. (2019) show how firms can use optimization models to best use a limited sum of money to adjust individuals' salaries with

the objective of minimizing gender pay gap at commercial firms. Their optimization-based framework has two parts: (1) a semilogarithmic regression that controls for job type and performance characteristics to isolate the effect of gender on salaries and (2) an optimization model that allocates sums of money toward individuals with gender pay gaps. Bertsimas et al. (2013) study the problem of allocating donor kidneys to waitlisted patients in a fair and efficient (optimal) way. They develop allocation policies that are based on point systems. Under these policies, patients are awarded points according to some criteria, and patients are then prioritized by the number of points awarded. They identify the challenges in designing a point system, specifically, the relative emphasis put on each criterion and finding the right balance between efficiency and fairness.

On the theory dimension, Bertsimas et al. (2012) address the problem of designing objectives that account for the tradeoff between efficiency and fairness for resource allocation problems. They identify a notion of fairness, the "α–fairness," that is well documented in the welfare economics literature. That notion of α–fairness provides a family of objective (welfare) functions that encompass (1) the utilitarian allocation, (2) the min-max fair allocation, and (3) the proportionally fair allocation (or Nash bargaining). These functions also allow the decision maker to select their attitudes toward fairness and efficiency by choosing the value of a customized parameter. Hooker and Williams (2012) discuss combining conflicting objectives of equity and utilitarianism (which maximizes the total-good irrespective of differences between individuals for social policy making) using a mathematical programming model. To this end, they use the maximin principle where one seeks to allocate goods to maximize the welfare of the worst-off. As an example, they discuss healthcare allocation decision where the worst-off patients should receive the highest priority until this requires a disproportionate sacrifice from others.

Although this body of work provides a rigorous analysis of fairness considerations in the workplace, our focus via the case is to present the problem in a more accessible fashion to train practitioners. The case also focuses on the importance of contextual details, such as the average call duration (in minutes) by each employee for each type of call and on developing a model that helps the Pocatello call center determine a better allocation that resolves employee dissatisfaction and fulfills company goals.

3. Teaching Plan

3.1. Salient Features and Questions

The intended audience for this case comprises MBA and undergraduate students enrolled in modeling-focused courses. Other potential audiences include industrial engineering, applied math, or data analytics/data science students with a foundational knowledge of integer programming. The case addresses the use of optimization models to inform workplace fairness in task allocation and is therefore also suited to students majoring in operations management and managerial leadership. A knowledge of Excel Solver or any other integer programming software is necessary to solve the case. In curricula where Excel modeling is part of core courses this case can be used to illustrate and discuss fairness considerations for students for all majors. The suggested case questions are as follows:

1. If the Pocatello Call Center wants to minimize the total time spent on calls, what is the optimal allocation of tasks?

2. What are some strengths and weaknesses of this allocation from the workers' perspective? From the firm's perspective? How can it be improved?

3. (Advanced) The companion spreadsheet also provides raw data collected from calls handled by the employees. Using these data, simulate the total duration of call time for the schedule developed in question 2 above. Report the variability in total call times for all four employees and the 2.5th and the 97.5th percentiles.

3.2. Teaching Plan

We typically encourage students to read the case before the session and come to the classroom prepared with initial task allocation solutions using the Excel shell (available online), along with some justification. The preparation is helpful in several ways. Some students recognize the similarities between the task allocation model and the transportation optimization model in terms of limited resource capacity (time available of each employee daily) and demand (number of calls of each type) that needs to be met. Many of them build an initial solution based on the intuition from the transportation model: They use a greedy heuristic in which they identify the longest task (C-P), assign all calls of this type to the fastest worker, then move to the next longest call, and so on. Some others start with a specific fast worker, assign the longest calls to him, exhaust all their time, and then move to the next fastest worker. Some others use ad hoc ways to allocate calls. We often revisit all these initial solutions at the end of the solution development to quantify the suboptimality in their intuition-based solution.

We start the classroom discussion by asking students to share their initial models. This discussion leads to setting up a model with the three parts of optimization: (i) objective function from the firm's perspective, (ii) decision variables, and (iii) constraints. After using Excel Solver (or any other optimization software) to solve the task allocation model, we ask students to share their observations of the strengths and weaknesses of the initial model. Some students recognize

that the allocation determined by the optimization routine appears unfriendly or unfair to some employees. Some prodding nudges them to conclude as a group that this outcome is not surprising because the objective function was articulated from the firm's perspective. As a result, the solution obtained is best for the firm and may not perform well from an employee welfare perspective.

A major takeaway from this discussion is that many times objective functions capture the preferences of only one stakeholder. In situations where one must develop solutions that are informed by the welfare of more than one stakeholder and their interests are not aligned, one must explicitly represent their individual preferences and welfare in the optimization model. Although we mention the use of a weighted objective function to jointly model the firm's and workers' welfare, we focus on using constraints to steer the solution in a desirable direction. This discussion highlights that in industry applications it is common for managers to use constraints to drive solutions toward a specific direction. In our context, students articulate that the original solution is not fair to all workers. We do not go into further the details of this part of solution in this article because it is meant for open access. These details are in the Teaching Note. The student body at this point is energized; students discuss different ways in which fairness can be measured and how these metrics could be used to evaluate various candidate solutions provided by a modified optimization routine.

After this discussion, we update the initial model incorporating constraints that would promote fairness in call allocations. We usually perform the updates through multiple iterations based on student feedback and discussion. After each model update, we ask students to study the changes in the solution and the possible managerial implications of the change. Students usually also notice the tradeoff between minimizing the total call time and promoting fairness in work allocations. This discussion captures the multifaceted nature of decision making and the importance of incorporating all perspectives to align with the ultimate business objectives. Further discussions beyond the optimization model also arise when students recognize other long term business objectives that are relevant to task allocation and workplace fairness but could not be directly captured with the available data and model.

The discussion usually concludes with three items. First, we revisit the initial models provided by the students at the beginning of the session. We then revisit the multiple iterations of the model that incorporate fairness considerations to see how they perform in comparison with the initial solution. The improvement in workplace fairness of task allocation provided by the model stems from the managerial decision of explicitly representing fairness in the optimization model. Furthermore, there is a cost for the firm to incorporate employee-fairness considerations in call allocations. We discuss the various ways to incorporate multiple business objectives in the optimization model and the different implications arising from the update of the model. Finally, we encourage students to identify other managerial considerations that are not yet explicitly included in the analysis. Students often identify different considerations that could help the firm's long-term success such as potential benefits of cross training employees.

For advanced classes, we also provide the raw data used to calculate the average call times reported in Table 1. Students can use these data to determine the variability in the total call time for each employee for the schedule selected for each employee. We have used both variants of this analysis: one where bootstrap samples are drawn to determine the distribution of total call times for all employees for the plan developed in class and one where students first estimate the parametric distributions for call times for each employee (for each employee-call time combination) and then simulate from these estimated distributions. At a practical level, this analysis quantifies the likelihood that an employee will be able to finish all assigned calls within a workday of 480 minutes. At a conceptual level, this analysis emphasizes that employees will still have different total call times on account of innate variability in the time spent on individual calls.

4. Classroom Experience and Student Reception

We have used the case in an MBA elective course over four years with more than 150 students. The typical class size is around 20 students. As discussed above, we typically ask students to come to class with an initial solution and its justification, working either individually or in pairs. We also assign Anderson et al. (2019) as a reading. The students who take the elective usually belong to two polar opposite groups: students who are math savvy and would like to develop an expertise in quantitative methods and students who are focused on using communication and management leadership skills at workplace but would like to be able to understand quantitative analysis–based discussions. Both groups of students have different but positive reactions to the case as it unfolds in the class.

The model building with the software execution is led by the instructor while incorporating classroom discussion. During the class, the students usually watch the instructor implement the model and replicate the work on their computers. During the discussion of the first optimization-based solution and its inability to provide a fair work allocation, quantitatively focused students tend to express a vexation that the notion of

fairness is not crisply defined when compared with, say, profit maximization from a standard transportation problem or an assembly problem. A representative comment from this discussion:

> "How can we optimize something when each one of us has a different definition of it?"

In contrast, the leadership-focused students express apprehension that human values such as fairness could be quantified:

> "Can we ever completely capture a human feeling such as fairness using cold numbers?"

A starting point for subsequent discussion is to identify specific numbers or outputs (e.g., the total call time allocated to each employee) that suggest that the first solution is unfair. We then encourage students to articulate the changes they would like to see in these numbers that would address their fairness concerns. These desirable changes are then translated into constraints in an iterative manner. As the session progresses through various iterations of the model with different constraints added to obtain a fairer call allocation, both these groups of students appear to absorb specific learnings, towards a point of convergence. The quantitatively focused students appreciate that although mathematical models may never capture the entire problem at hand (e.g., accurately quantify fairness with its nuances), they might be useful in identifying solutions that are managerially sufficient to support decision making.

> "I now understand that the point of optimization is not to find the best solution. It's not even clear what is the best solution for this situation. But all of us agree that this new set of solutions is better than the first solution."

The leadership focused students recognize that, although completely capturing human dimensions such as fairness may not be possible, even a first-order attempt may help firms quantify and improve them.

> "Fairness as a societal idea is complex, but I can see now how one can use math models to advocate for a better work environment."

In some informal comments, students noted that, although they understood before the session that fairness can be costly for a firm, they now had a better understanding for measuring this tradeoff.

Both groups also converged to the notion that mathematical models can be useful in helping managerial discussions move forward by providing a what-if analysis by trying alternate (call allocation) solutions with corresponding performance metrics (e.g., total time, individual buffer-time, variability in workload). Finally, students appreciated the reading in Anderson et al. (2019) as it primed them for the session using the context of gender wage gap: a fairness issue that many firms are actively trying to address as described in the article.

5. Concluding Remarks

This case was developed to introduce students to fairness issues in workplace task allocation. The focus was specifically on the use of optimization models to approach task allocation problems. The case text provides the workplace context using historical performance data and employee interviews. The mathematical modeling focus is on incorporating multiple business objectives into a single optimization model that can be solved by Excel Solver or other standard optimization software. Overall, the case provided an opportunity to students to develop skills in using optimization models to inform multifaceted managerial decision making.

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Endnote

[1] For confidentiality reasons, we do not use our industry partner's name in the case.

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