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Operations Management Service Learning Case Study: Using Optimization to Increase the Effectiveness of the SIFE Student Care Package Program

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The Student Care Package program is a fundraising project conducted by a local chapter of Students in Free Enterprise (SIFE) at a private university in the southern United States. The most arduous aspect of the program is determining which products to purchase to meet demand requirements, while minimizing purchasing costs. To reduce the amount of time and effort, and to develop a sustainable process, SIFE students utilized computer optimization software. Incorporation of the Microsoft Excel add-in What'sBest! by LINDO Systems enabled students to reduce the time spent calculating materials and develop more efficient purchasing plans. Optimization is initially presented to students in a sophomore quantitative methods business course. Through optimization software, SIFE members are able to achieve higher levels of efficiency, sustainability, and profitability for the Student Care Package program.

The international organization Students in Free Enterprise (SIFE) encourages students to seek ways to apply business lessons in the real world. Each SIFE chapter brings business professionals and university student leaders together through work on various projects. These projects give student leaders opportunities to further explore the ideas they have encountered in their formal instruction and private study. With the help of seasoned business professionals, students plan and implement projects to improve their community, especially the lives of people in need. The students present reports on their chapter's successful community outreach at a series of regional and national conferences, which recognize students for developing creative and beneficial projects and for presenting their results effectively and professionally (http://www.sife.org/).

SIFE projects fall into the realm of service learning, and this paper presents a case study in which SIFE members applied mixed-integer linear programming to develop purchasing plans for their annual fund raising program. Below, relevant literature is summarized and focuses primarily on the nature and benefits of service learning in business schools. Service learning in business schools is gaining popularity; however, a gap exists in the field of operations management. Following the literature review, the problem is presented, followed by the solution. A key part of the solution is its reproducibility for future SIFE members. Additionally, other organizations can use to teach students operations management techniques, while benefiting the organization. Finally, a reflection section discusses that students learned the appropriate modeling techniques by applying the techniques in later courses.

LITERATURE REVIEW

The literature supports the premise that service learning pedagogy is beneficial. Service learning is an instructional method used by academic disciplines to enhance students' involvement in the community by providing them with several opportunities to complement classroom instructions (Kenworthy-U'Ren and Peterson, 2005). Opportunities in the form of service learning projects not only enhance students' abilities in applying academic learning to community issues, but in several instances the projects also address unmet needs in communities (Anderson-Butcher, 2004; Peebles-Wilkins, 2004). Service learning programs contribute towards improving the educational and social fabric of a community (Anderson-Butcher, 2004).

Additionally, business schools have begun embracing service learning (Govekar and Rishi, 2007). Service-learning pedagogy that supports community involvement values and promotes leadership development offers more effectiveness and efficiency for management educators interested in incorporating real-world learning into their courses than traditional internships and cooperative education (Godfrey and Grasso, 2000). Real-world education in the business school classroom is based on imparting

"learnings that are dynamic, emergent, context-sensitive, and holistic" (Billimoria, 1998: 266). Some business school applications found are in the areas of marketing (Hagenbuch, 2006; Jakus, 1990; Chapman and Avila, 1991); management (Andrews, 2007); entrepreneurship (Shuman and Hornaday, 1975); finance and banking (Govekar and Rishi, 2007).

Still, service learning is still limited or seemingly nonexistent in certain business disciplines (Gujarathi and McQuade, 2002). Specifically, little evidence exists for the application of quantitative operations management in service learning activities. Since operations management overlaps with industrial engineering, some evidence was discovered in service learning in engineering (Dukhan et al., 2008) and computer science (Dahlberg, 2010). Neither offer a strong use of powerful analytics often used in planning and scheduling.

Experiential learning research does exist for operations management. Notably, MIT's Beer Game is often used to study the bullwhip effect in supply chains (Tiger et al., 2006). Other simulation games exist such as the strategic Capstone by Capsim (http://www.capsim.com). However, none of these offer the benefits of service learning activities, which address unmet needs in communities.

The SIFE Chapter

The SIFE chapter operates out of a private university in the southern United States and has a rich history of activity. Each year, this chapter implements projects both on campus and in the local community. The chapter itself consists of business students as well as students studying other subjects, such as art and nursing. The university offers a unique opportunity for students to earn college credit through involvement in the chapter's projects. Since 1993 when the chapter was established, its members have won awards at SIFE regional conferences fifteen times. The main reason for the consistent success of the chapter is that it is involved in numerous service projects each year.

A major focus of SIFE is teaching concepts and principles of business to children and young adults. The chapter maintains a strong presence in the community's elementary and secondary schools. Through its Kids Count financial literacy program, SIFE students teach second graders the importance of saving money. In the chapter's World at Play program, sixth graders learn about product development and the free enterprise system by creating a business model from start to finish. The chapter's Roadmap to Success program teaches high school students - mainly the ones who are at-risk - valuable skills necessary to acquire their first job. Back on the university campus, the SIFE chapter's Freshman Financial Seminar teaches freshman basic financial management skills.

The Student Care Package Fundraising Project

SIFE programs are free to the participants. Rather than charging "tuition" fees for its programs, the chapter must finance its projects and conference trips in other ways. There are approximately seventy student organizations at the university, all competing for adequate funding through fund raising efforts on campus. Because the groups often vie for the same dollars, effective fundraising can be difficult. SIFE has taken a unique approach. Many other student groups sell goods and services to other students. In fact, projects that sell t-shirts or holiday grams to students have become so common that they are now considered to be staples of the student center on campus. The SIFE chapter recognized that students' family members are often overlooked in many fundraising attempts by campus organizations. This is understandable since students' parents, grandparents, uncles, aunts, etc., are seen on campus far less than students themselves. This realization led the SIFE chapter to focus its fundraising efforts off-campus.

One such effort is the Student Care Package project, which gives parents whose children attend the university the opportunity to send their sons and daughters a care package prepared by the chapter. Students receive their care packages during finals week - a stressful time when encouragement is most needed. Since the project's inception in 2004, SIFE has generated almost $60,000 in revenue. The Student Care Package project is valuable for several reasons. Parents can show love to their children in an easy way. The SIFE chapter raises money so that it can provide Kids Count, World at Play, Roadmap to Success, and Freshman Financial Seminar. The profits enable chapter members to attend regional and

national conferences. Having one lucrative fundraiser allows the chapter to give greater focus to the true purpose of the organization, rather than being distracted by the ongoing need for money making projects throughout the year.

Perhaps the greatest benefit of the Student Care Package project is the real-world experience that it provides to the chapter members who are involved with it. Through the project, students apply the knowledge they have learned in their classes. Granted, this application is limited and takes place within a controlled setting; nevertheless, students have the opportunity to use the principles of marketing, management, economics and accounting that they may have previously only grasped in theory.

The project coordinator is exposed to a variety of business situations and is expected to make decisive decisions. Marketing the Student Care Packages begins months before assembly of the packages. To market the care packages, the project coordinator must determine the best way to reach the target market. He or she must commission and later approve the design of promotional materials, such as postcards and flyers. These tasks demand that the coordinator apply knowledge learned in his or her marketing courses.

This student is also responsible for selecting the items to be included in the care packages. Such a decision calls for the project coordinator to price materials and analyze the benefits and costs of adding new items to the packages. To maximize fundraising dollars, the chapter must seek the right balance of quality and cost for the items in the care package and put a reasonable price on its product. The project coordinator must plan the production and assembly of the care packages carefully to ensure efficiency and consistency. Other tasks include scheduling workers and communicating with care package recipients. The project coordinator and the other workers must rely on many aspects of their business education to successfully raise funds for the chapter. Organization and communication skills are vital.

While the project coordinator has ample opportunity to employ his or her knowledge and gain practical experience, the students in other positions have similar possibilities. For instance, students who input information about customer orders use various software programs, and students who handle consumer questions use customer service skills. Students who prepare the Student Care Packages must follow a standardized production plan to assure that their work is consistently high quality. During distribution, students can develop communication skills as they interact with the recipients of the care packages.

The Problem

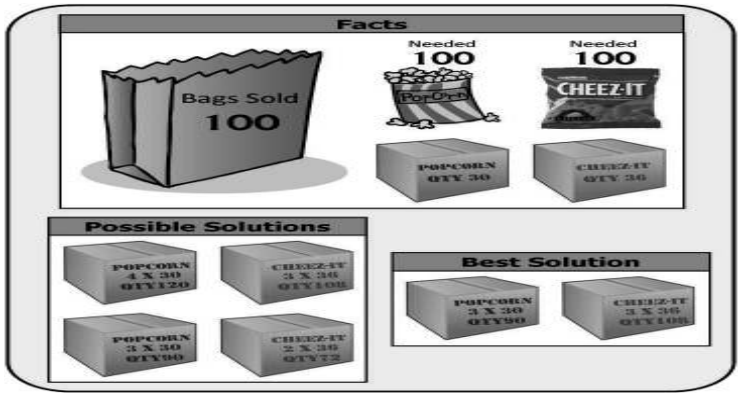
From one semester to the next, the Student Care Package project's success has varied. Turnover of students due to graduation can create challenges. Of all the project coordinator's responsibilities, the acquisition of input materials is generally the most arduous task. He or she must calculate the quantity of materials required to fulfill each order, while also considering the profit margin. Prior to using computer optimization, these calculations were performed by hand, and a student can expect to spend more than five hours working them.

Calculating the cost of raw material takes so much time for two reasons. The first is that input materials are purchased in bulk at a wholesaler such as Costco or Sam's. The second is the variety of care packages offered. The fundraiser offers four types of packages - known as Standard, Premium Standard, Healthy, and Premium Healthy. Each care package contains 25 to 30 items. Some items, such as Animal Crackers and Kraft Easy Mac, are included whether the package is non-Healthy or Healthy. Other items, such as trail mix and Nerds Rope, are only included in the Healthy and non-Healthy packages respectively. Since the items are purchased in bulk at wholesale prices to minimize expense, the number of items purchases may not match the quantity required to fill the orders. This leads to a materials surplus.

For example, as shown in Figure 1, assume that 60 Standard Packages and 40 Premium Packages have been ordered. Bags of popcorn and Cheez-It crackers are in both packages; therefore 100 bags of popcorn and 100 bags of Cheez-It crackers are needed to fill the orders. Popcorn is purchased in 30-bag bundles and Cheez-It crackers in 36-bag bundles. When purchasing popcorn, one can acquire four bundles (120 bags in total) or three bundles (90 bags in total). The first option results in an excess of 20 bags; the second option results in a shortage of 10 bags. In this example, the better solution is to simply purchase

more popcorn than required to ensure that each package has the right one bag. When purchasing Cheese-It crackers, the same problem exists. The orders call for 100 bags, but an excess or a shortage is the result of the two best purchasing options available. But if the popcorn could be substituted for the Cheese-It crackers in 20 packages, then the overall waste could be reduced. The problem arises in complexity due to the many different items that are used to assemble a packages and the allowance of equivalent substitutions.

Figure 1: Equivalent Substitution Example



The Solution

Part I: Using Optimization to Minimize Purchasing Costs

In an undergraduate sophomore-level "Quantitative Methods for Business" course, SIFE chapter members first considered using computer spreadsheets to model their project. Such tools can help with purchasing decisions that yield the maximum output or profit, or minimum cost, waste, or production time (What'sBest!, User's Manual, 2005). Computer optimization modeling traditionally uses linear programming to find the optimal solution to a problem. The students hoped the program would achieve three main goals: reduce the time spent calculating, increase the profit margin, and establish consistent decision-making approach to ensure continuity for new project coordinators in the future. The SIFE chapter was directed to use the Microsoft Excel add-in What'sBest! by Lindo Systems for the Student Care Package program.

In math modeling, there are three kinds of inputs. Sometimes called the ABCs of modeling, these kinds of inputs are known as decision variables, the objective function and constraints. In What'sBest! nomenclature, these three inputs are called the ABC's of modeling and are the adjustable cells, best cells, and constraints. Table 1 lists the decision variables; Table 2 lists the objective function and constraints; and Table 3 lists the inputs. The What'sBest! model is available upon request.

Table 1: Decision Variables

Decision Variables	Location (Cell Range)	Variable Type
bulk packages to purchases	=Main!M4:M103	integer
individual items used in each final product	=Main!N4:N103	continuous, naturally integer
equivalent substitutions matrix	=Substitutions!C4:CW103	continuous, naturally integer
logic variables forcing substitutions to be only given or taken, not both	=Substitutions!DA4:DA103	binary

Table 2: Objective Function and Constraints

Item	Location (Cell Range)	Description
Objective Function	=Main!AC1	minimize total purchasing costs
Constraint	=Main!AB4:AB103	meet demand (either through product or equivalent substitutions)
Constraint	Main!U4:AA103	Minimum quality, i.e., all products cannot be replaced by the cheapest substitute
Constraint	=Substitutions!DB4:DD103	Supporting binary variables which force substitutions to be either givers or takers

Table 3: Inputs

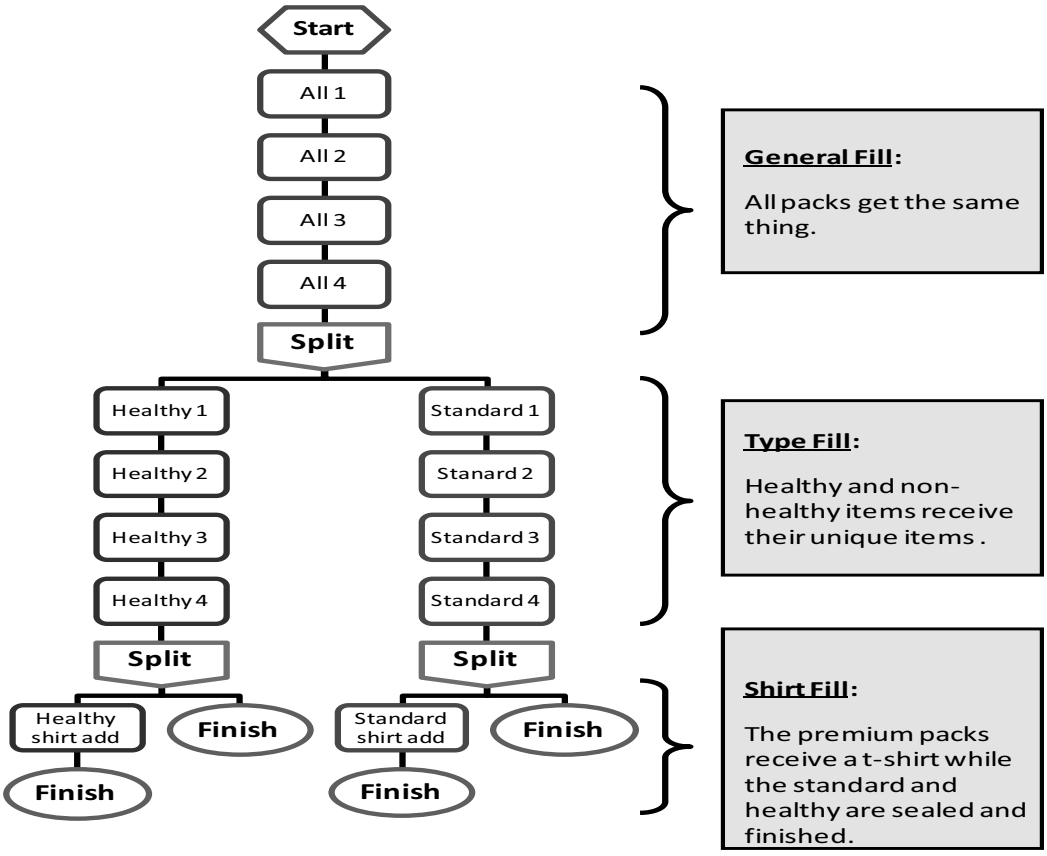
Input	Location (Cell Range)
List of bulk products to purchase	=Main!B4:B103
Quantity per bulk package	=Main!C4:C103
Cost per bulk package	=Main!D4:D103
Bill of materials	=Main!I4:J103
Product demand	=Main!I1:J2

Currently, each Care Package contains 29 different products. In anticipation of future demand for additional items, the optimization model was built to accommodate up to 50 different products per Care Package. If 21 more items were added to the Care Packages, the model would have over 10,000 adjustable cells, and about 500 constraints. With a platform for expansion, the Student Care Package program is positioned to continue meeting the needs of students.

Part II: Care Packages Assembly

Once the orders have been received and the optimal mix of materials has been determined, the materials are purchased and assembly begins. To accommodate the different types of Student Care Packages, SIFE utilizes a three stage production process known as general fill, type fill, and shirt fill. See Figure 2.

Figure 2: Care Package Assembly Plan



All types of Care Packages contain some of the same items such as a bottled drink and animal crackers. In the first stage of production known as general fill, the packs are filled with items that are common to all Care Packages. At the end of this stage, the identical Care Packages are divided into two groups, “healthy” and “standard”. In the second stage of production known as type fill, the healthy items

are placed into the "healthy" packs, while the "standard" packs are filled with standard items. Packs from both groups are then designated as premium (Premium H and Premium S) and segregated to enter the third processing stage known as shirt fill. In this stage, each premium pack receives a t-shirt and is sealed. The packs which are not designated as premium (Standard and Healthy) do not include shirts and only need to be sealed in the third stage of production.

Approximately 16 SIFE students work together to assemble the Student Care Packages. In each of the three stages of production (general fill, type fill, and shirt fill), there are several stations where SIFE members place about three items in each Care Package. Each SIFE member follows a detailed production plan that provides instructions regarding the type and quantity of items to be placed in each Care Package. Included in the detailed production plan are the equivalent substitutions instructions.

CONCLUSION

The Realized Benefits of the Working Model

Before the final model was ready for operation, there were seven versions created, tested, and edited. Building a spreadsheet optimization model as complex as this one takes time. The development process was validated by comparing model solutions to solutions generated by experts, including the current project coordinator.

After validation, the SIFE students realized some of the benefits of their efforts. For instance, the easy-to-use model could make calculations and recommend a purchasing plan in mere seconds; whereas, the students spent hours with pencil, paper, and calculator arriving at similar results. Furthermore, the computer optimization approach could be used in future projects, bringing some consistency to the work of all project coordinators - present and future. In theory, the model's optimized purchasing plan should increase the project's profit margin. However, it is difficult for the chapter to determine whether this actually happened this semester because some of the SIFE chapter's records from past fundraising projects were not available. But thanks to the spreadsheet optimization model, the chapter can maintain better records in the future.

Reflection

The Student Care Package project has given SIFE students the opportunity to utilize some of the concepts they have learned in the classroom. They identified a problem that involved purchase calculations, and with the assistance of faculty, they found a solution using the optimization model. Students were active participants in developing this solution, rather than being passive observers. Such participation reinforces what they have learned in the classroom.

In addition to improving the Student Care Package project, the successful use of the software program has also inspired students to utilize it in other areas. In general, it encourages students to apply what they have learned in class to solve real life problems using business models before they graduate from college. Of all the fundraisers implemented by student groups, the Student Care Package project is uniquely complex. SIFE has been motivated to incorporate advanced technology to solve the problems that arise in making and selling a product with variable and multiple components. Successful utilization of optimization software demonstrates the members' degree of competency and commitment to excellence in business.

REFERENCES

Anderson-Butcher, D. 2004. Transforming schools into 21st century community learning centers. *Children & Schools*, 26: 248-252.

Andrews, C. 2007. Service learning: Applications and research in business. *Journal of Education for Business*, 83: 19-26.

Billimoria, D. 1998. From classroom learning to real-world learning: A diasporic shift in management education. *Journal of Management Education*, 22: 265-268.

Chapman, J., & Avila, R. 1991. Sales training for students: An experiential approach. *Marketing Education Review*, 1: 54-59.

Dahlberg, T., Barnes, T., & Bean, K. 2010. Applying service learning to computer science: Attracting and engaging under-represented students. *Computer Science Education*, 20: 169-180.

Dukhan, N., Schumack, M., & Daniels, J. 2008. Implementation of service-learning in engineering and its impact on students' attitudes and identity. *European Journal of Engineering Education*, 33: 21-31.

Godfrey, P., & Grasso, E. 2000. Introduction. In P. Godfrey, & E. Grasso, (Eds.), Service-learning in the disciplines: Management (1-10). Washington, D. C.: American Association for Higher Education.

Govekar, M., & Rishi, M. 2007. Service learning: Bringing real-world education into the B-school classroom. *Journal of Education for Business*, 83: 3-10.

Gujarathi, M., & McQuade, R. 2002. Service learning in business schools: A case study in an intermediate accounting course. *Journal of Education for Business*, 77: 144-150.

Hagenbuch, D. 2006. Service learning inputs and outcomes in a personal selling course. *Journal of Marketing Education*, 28: 26-34.

Jakus, J. 1990. The use of client-sponsored projects in university professional salesmanship classes. In D. Good, (Ed.,), Professional sales and sales management practices leading towards the 21st century. Paper presented at the 1990 Pi Sigma Epsilon and Mu Kappa Tau Annual Conference in Sales Management, Dallas, TX.

Kenworthy-U'Ren, A., & Peterson, T. 2005. Service-learning and management education: Introducing the "WE CARE" approach. *Academy of Management Learning & Education*, 4: 272-277.

Peebles-Wilkins, W. 2004. The full-service community school model. *Children & Schools*, 26: 131-133.

Shuman, J., & Hornaday, J. 1975. Experiential learning in an entrepreneurial course. *Collegiate News and Views*, 29: 5-9.

Tiger, A., Benco, D., & Fogle, C. 2006. Teaching the importance of information, supply chain management, and modeling: The spreadsheet beer-like game. *Issues in Information Systems*, VII: 108-113.

What'sBest! User's Manual. 2005. Chicago, IL: LINDO Systems.

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