

# **Operations Research: A Powerful and Versatile Discipline**

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This presentation will show through examples from work undertaken by the author, how operations research has been used successfully to address both operational and strategic issues within a firm; how local applications are extended to apply to global concerns; how various industry sectors can benefit from the techniques available; how service areas continue to be rich areas for OR applications; and how the public sector needs can equally be addressed by OR.

## **1 OR inside: an Operational System**

An OR-based operational application is one in use daily on the production floor of a carton plant to determine how to select the paper grade and size to use given what is available in inventory, and how to lay out the jobs to minimize the material wastage. A heuristic solution enabled material wastage reduction by 7%. Considering that 85% of the finished product is paper, this was a non-trivial outcome. A bigger system benefit is that the rules for the selection of the jobs to run and materials to use had previously been manually decided by a production scheduler who was scheduled to retire. Thus, a system was put in place that captures the decision rules used by the production scheduler, making the transition to a new scheduler much easier.

## **2 OR in crafting a Long Range Strategy**

Decisions affecting the company in the next 5 to 15 years are discussed in the board rooms of corporations. Expansions require millions in investments while closure of production facilities have far-ranging effects that need to be studied thoroughly. This example of an old ice cream plant that sits on a very prime property has been studied in detail using a mixed integer programming methodology. The model was formulated to answer the questions: Will it be beneficial to relocate the plant at the expense of higher distribution costs? If so, where? Given the demand for the next 10 years, is it better to put up several plants throughout the country? What equipment capacities will best be put in such plants? Should they be built and equipped at final capacity or just expanded in modules as needed? Would it make sense to put up two centralized facilities producing exclusively bulk ice cream and frozen products? If not, what mix of capacities is

best? This particular application has guided the expansion and eventual relocation of the ice cream plant from the city center to the suburbs.

### **3 Going beyond the Borders with OR**

The question of relocating, expanding and rationalizing operations does not only crop up within national boundaries but become especially complex where operations extend into the global arena. In this case, the model applied to the local scene was broadened to include unique characteristics of the specific areas affected by the long-term decisions. The example cited here starts with a situation where the rush to acquire shares in existing overseas beer brewing and bottling facilities in an emerging market has resulted in an over-capacity situation, with management mulling the various options by which it could rationalize its holdings. A mixed integer programming model that maximizes cash inflow for the company was formulated to consider the full range of options at any point in the 10-year planning period which include: the facilities to continue/ expand/ stop/scale down (implying full or partial divestment in joint venture holdings); equipment to transfer to/from existing plants; product lines and volumes to produce per facility per year; type of distribution modes and markets to serve; product lines to retain/discontinue; and the demand level to satisfy if cannot be fully met.

The model came out with the option that maximizes the inflow to the company but considerations about the plants that were chosen to be closed forced a lot of what-if analysis. In the end, management used the tool extensively to determine the level of company share in the joint venture that will prevent divestment of holdings in the plants chosen for closure. In the process, management gained deeper insights into the interaction of cost and revenue factors that helped them think of other possible options. The extensive "what if" analysis provided management with information on the optimal level of participation in the joint venture. Management went to the negotiating table armed with the maximum price per share to offer the partners as they negotiate for greater ownership in the joint venture.

### **4 OR power in other fields: Marketing and Insurance**

Not only has OR proven its use in manufacturing but also in marketing the end products. An OR application is used weekly to determine the TV shows in which to place advertisements for a given product. The mixed integer program provides the number of spots to place in a TV show that will minimize the cost to the advertiser but which ensures the advertiser that defined target audiences are reached. Alternatively, the OR program was run to determine the shows in which to advertise which will maximize the target audience that is reached but is constrained to be within the budget. Previous to the use of this system, the advertising agency just submits the advertising plan to the Marketing Department. These are reviewed and approved based on qualitative considerations, mostly with respect to the appropriateness of the shows to the company/product image and personal biases of the reviewer. The OR tool provided a quantitative basis for selecting programs other than those recommended by the advertising agency. A comparison of the agency

recommendations with the generated advertising placements showed a significant improvement in costs and target audience reach.

An OR tool likewise changed significantly the way in which insurance decisions are made within a company. Previously, the company insures all assets – manufacturing facilities, transport units, office space and equipment, plant inventory, items in transit, and personnel health insurance. The increase in premiums demanded by the insurance companies got management into turning to OR to determine whether such increases are acceptable. The use of decision analysis presented the company with options to self-insure especially on assets that have not had any history of losses. It also helped evaluate the budget proposals for programs that decrease the likelihood of fires, accidents, and sicknesses in the workplace. The costs of preventive measures were compared with the savings in premium payments and decisions to insure or self-insure were reached on the basis of the OR decision analysis tool.

## **5 OR serves the Service Sector**

The two applications discussed here have the theme of doing the same work with less people. The first one determines the minimum number of people to employ to do the servicing of equipment in restaurants and pubs. Scheduling is done weekly since there is a constant addition and reduction in the restaurants to visit. A significant reduction in the number of technicians to employ resulted from the application of a heuristic routing algorithm that ensures that service levels are met.

On the other hand, the use of simulation helped decrease the number of personnel in a document processing center while simultaneously decreasing in document processing time. Arrivals of customers were simulated and the number of document processors determined. The project also was aimed at minimizing the processor-customer interaction. Being able to expedite the transaction can mean a lot of savings in money and inconvenience for the customer, so the present set up sees a lot of customers giving processors “incentives” to finish their documents first. Re-layout of facilities and their simulated effect on the processing time gave the best layout, the minimum number of processors, the lowest response time to customers, and enforcement of a “first-in first-served” discipline.

## **6 OR goes Public**

It cannot be denied that the private sector has benefited a lot from the application of OR tools. The public sector is no exception. The example previously cited on the streamlining of customer service involves the importers as the customer and the processors, those within the government agency concerned with the keeping and releasing of imported goods and raw materials in government warehouses.

Energy is a key input in the pursuit of development and is especially vital for a developing country. OR has been used to determine from where power requirements will be sourced for a day. This situation came about as a result of a power shortage when power had to be rationed. The government stepped in to mitigate the situation and entered into a lot of power supply agreements with

independent power producers. The decline in demand in the ensuing years resulted in installed capacity being a lot greater than demand. There was now a need to prioritize the use of less-costly power sources. The OR tool used in this case is a mixed integer programming model that determines where the power requirements of the island that is home to more than half the country's population will come from. The model not only had to contend with the various plants and sources of energy (oil-based, hydro, geothermal, natural gas and coal), but also the costing arrangements with the independent power producers that varied with each producer. This was also a year-long model which made it impossible to take the full 24-hour pattern of energy consumption in a day. The tool came up with dispatching rules that were different from the current practice. However, upon explanation, the dispatchers and management obtained an insight into the interplay of the various cost factors. Additionally, by running the model without the transmission constraints, the model was able to identify the maximum investment that would justify easing of the transmission capacity constraints.

## **7 Underutilized Power and Versatility**

The success that has been achieved by OR – as has been demonstrated, in operational or strategic planning, in the production of goods or services, in the public or private sector, within the national or international arena - show the versatility of OR and its potential to be a powerful tool for development. However, at this point, the potential has not been fully realized. It is thus a challenge for OR workers to show how OR can be of help. This has been the objective of the International Federation of the Operational Research Societies.