THE GEORGE WASHINGTON UNIVERSITY

TRUCKING INTO TOMORROW

A DECISION ANALYSIS FOR LEHIGH PORTLAND CEMENT'S
TRUCK TRANSPORTATION NEEDS

FUNDAMENTALS OF DECISION SYSTEMS AND COMPUTATIONAL METHODS

EXECUTIVE MASTER OF BUSINESS AND PUBLIC ADMINISTRATION PROGRAM

SCHOOL OF BUSINESS AND PUBLIC MANAGEMENT

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Introduction

Portland cement, a combination of limestone and other ingredients, is produced in rotary kilns operating at over 2,800° Fahrenheit. The resulting product is ground into a very fine, dry powder. The cement is then transported either by rail or truck to consumers. Upon its arrival, the cement, along with sand, stone and water, is mixed into a product called concrete. This material in its "wet" or plastic state is placed into innumerable types of forms where it goes through a chemical process know as hydration causing the material to cure into a rock-like substance known as concrete. Frequently, the finished product – concrete - is incorrectly referred to as cement. For the record, cement is the bonding agent that holds the mass of sand and stone together.

Lehigh Portland Cement is one of the nation's largest producers of portland cement with a major production facility in located in Union Bridge, MD. Currently, that facility is undergoing the largest expansion in the company's history and one of the largest expansions in the history of the portland cement industry. `The scope of the project is enormous, as are its implications for both the company and its many stakeholders. Plans for the project call for a complete rebuild of most of the plant with state of the art manufacturing technology. The price tag for these improvements is $275 million. This represents the largest capital expenditure in Lehigh's 103 year history as well as the largest expenditure in the 127 year history of Heidelberger Zement, Lehigh's parent company. Annual cement production will double from one to two million tons when the facility is completed late in 2001.

A project of this scope presents many challenges as well as opportunities for improvements in various plant processes. Efficient and timely transportation of the material to the end user is particularly important and is the subject of the decision analysis that follows. Transportation is critical for many reasons, particularly since it is the most common interface between the customer and Lehigh. Lehigh ships approximately 28,000 truck loads of cement from Union Bridge annually.

Decision Analysis – Trucking into Tomorrow

Current State

Currently, Lehigh contracts out all of it cement transportation requirements with several local trucking firms. One, Hahn Transportation, is the firm's primary hauler. In addition to Hahn, several other truckers deliver product to Lehigh customers daily. Employing several haulers in addition to the Hahn has, for the most part, worked well. Recently, however, this traditional way of dealing with transportation has come under examination.

One segment of the Union Bridge modernization involves an analysis of all transportation related issues. This analysis includes rail traffic in and out of the plant, the delivery of raw materials into the plant as well as Lehigh's methods of delivering cement to its customers. A prime motivator for this review is the installation of a highly automated truck weighing and loading system for outbound cement. The traditional methods of loading, which have remained essentially unchanged for the past 30 years, will undergo radical change within the next year. Change is seldom easy and out trucking vendors will be asked to deal with substantial amounts of it.

It is important to remember that the amount of cement that must be hauled from Union Bridge will double in the next 18-24 months. In practical terms, this means that peak delivery periods in the year 2001 will require over 250 trucks per day. At current levels, there are days when adequately meeting customer demand for deliveries is difficult. This doubling of deliveries adds a powerful imperative to accurately evaluating Lehigh's transportation vendors with a keen eye on the future requirements of both Lehigh and its customers.

Desired State

Ideally, Lehigh would like to minimize its day to day involvement in the trucking business. Numerous examples of cooperative efforts between manufacturers and transportation companies exist. One example is found in the relationship between Roadway Logistics Systems and the Ford Motor Company, where Roadway takes "full responsibility for an operation, and delivers a guaranteed result."[1] Lehigh, in the long run, would like to achieve a similar result. The immediacy of the company's needs, however, preclude such a substantial restructuring. With a huge expansion underway, a very tight timetable for completion of all projects, including evaluating trucking vendors, a more modest plan has been adopted.

In the final analysis, this writer will make the recommendations on which company or companies Lehigh's should use for its trucking needs. As mentioned earlier, the trucker is a critical link between Lehigh and its customers. Late or inadequate deliveries are one of the most often heard complaints. The increase in sales volume could well cause those complaints to increase. The purpose of this decision analysis to determine Lehigh's best course of action relative to truck transportation issues in both the short and long haul.

The Decision Making Process and AHP

A primary role of most managers in business today is to make the best decisions they can to assure both the immediate and long term viability of their operations. In a world of increasing complexity and change, this can be a daunting task. In far too many cases, change comes as result of a crisis within a business and equally too often the changes that occur as the result of that crisis do little to clearly identify and resolve the underlying problem. This phenomena is sometimes called BOGSAT – A Bunch of Old Guys/Gals Sitting Around Talking. Without proper tools to define and evaluate a problem, BOGSAT is likely since "the

[1] Michael Treacy and Fred Wiersema, The Discipline of Market Leaders, New York: Addison-Wesley Publishing,. p. 124.

human brain is limited in both its short-term memory capacity and its discrimination ability . . . to about seven things."[1]

A method to better understand the decision making process and in turn make better decisions is suggested by Nobel laureate Herbert A. Simon. Simon suggests the following model for successful decision making:

- Intelligence
- Design
- Choice[2]

In this decision analysis, we shall use Simon's model in conjunction with the Analytic Hierarchy Process (AHP) and Expert Choice software. AHP was developed by Thomas Saaty while at the Wharton School of Business and allows complex business decisions to be broken down into a series of more manageable and understandable components. AHP shows the relationship between:

- A goal
- Objectives
- Sub-objectives
- Alternatives[3]

AHP uses three basic principles to determine the relative importance of various factors involved in the decision making process. Those principles are:

- Decomposition
- Comparative judgments
- Synthesis of priorities

In explaining AHP, authors Forman and Selly note:
The decomposition principle is applied to structure a complex problem into a hierarchy of clusters, sub-clusters and sub-sub clusters and so on. The principle of comparative judgments is applied to construct pairwise comparisons of all combinations of elements in a cluster with respect to the parent of the cluster. These pairwise comparisons are used to derive 'local' priorities of the elements in a cluster with respect to their parent. The principle of hierarchic composition or synthesis is applied to multiply the local priorities of elements in a cluster by the 'global' priority of the parent element, producing global priorities throughout the hierarchy and then adding the global priorities of the lowest level elements (the alternatives).[4]

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[1], Ernest Forman and Maryann Selly, Decision By Objective, p. 6.
[2] Ibid, p. 18.
[3] Ibid,. p. 43.
[4] Ibid., p.51.

These concepts are embodied in the Expert Choice software which is employed in this analysis.

Intelligence

As a first step, all current trucking vendors have been evaluated by this writer in conjunction with other Lehigh employees. Face-to-face meetings with vendors to discuss future plans, visits to their offices and garages, discussions with Lehigh customers and evaluation of pertinent data about the truckers have been conducted. Specific, quantifiable data available for evaluation includes items such as delivery prices to typical locations, number of trucks and trailers, availability of storage blimps as well as location and condition of garages and other real property. Less easily quantified items evaluated include the vendor's attitude toward service to Lehigh and its customers, vendor willingness and ability to handle the increased volume of business and the likelihood that the trucker could someday take over some of the logistics issues that are now the responsibility of Lehigh.

Design

With the intelligence step complete, a goal for this decision analysis was established - Select the trucker best able to meet LPC's delivery needs. Subsequently, objectives and sub-objectives for the goal were established. Both quantitative and qualitative objectives were defined for this analysis. Two quantitative objectives were established:

- Physical Assets
- Pricing Structure

Four qualitative objectives were established:

- Logistics Acumen
- Management Capabilities
- Service
- Willingness to grow with Lehigh

Finally, alternatives, in this case four trucking companies, were identified as well. Alternative truckers include:

- Cheetah Trucking
- Hahn Transportation
- Schwerman Trucking
- Silfes Trucking

Choice

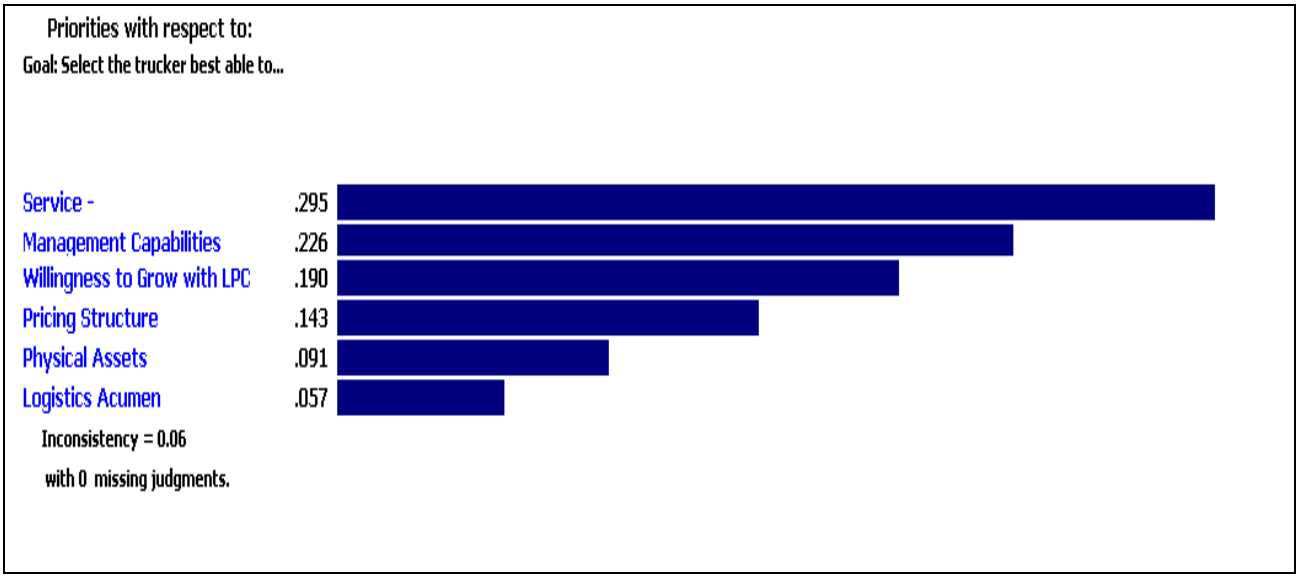
Using the Expert Choice software enables a decision to be made using the principles of AHP described earlier. With the goal for this decision analysis established – Select the trucker best able to meet Lehigh's delivery needs – as well as objectives and sub-objectives related to that goal, decomposition of the problem was accomplished. Next, the principle of comparative judgments was used to produce pairwise relative comparisons of all objectives and sub-objectives. The pairwise comparison process "enables decision-makers to *derive* ratio scale priorities or weights as opposed to arbitrarily *assigning* them."[1] Pairwise comparison "can be performed using words, numbers or graphical bars, and typically incorporates redundancy, which results in a reduction of measurement error as well as producing a measure of consistency of the comparison judgments."[2]

Priorities with Respect to Goal

Figure 1 shows the relative importance of the six objectives with respect to the goal of selecting the best truck transport company for Lehigh Portland Cement. Service and management capabilities both received very high rankings and collectively have a weight of .52. This result comes as no major surprise since excellence in the eyes of Lehigh's customers is primarily judged by the service they receive in terms of timely delivery and related issues. Management qualifications of the vendors are another key component, as Lehigh's management team clearly places strong emphasis on the trucker's ability to handle its affairs both today and into the future.

[1] Ibid., p. 41.
[2] Ibid., p. 45.

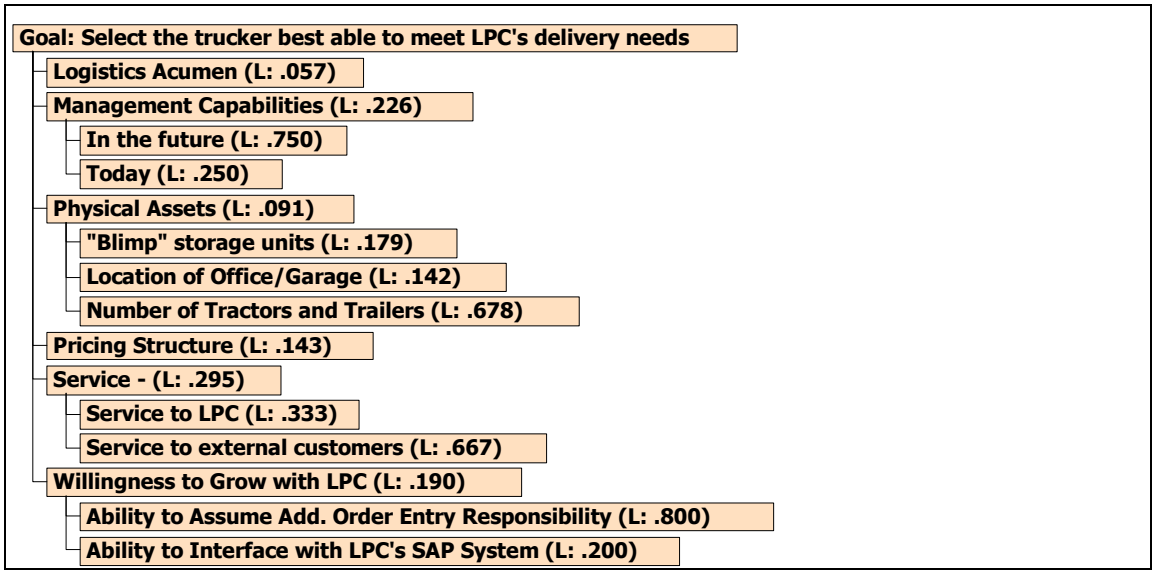
Figure 1. – Priorities with Respect to Goal – The Best Trucker for Lehigh



One surprising result is the priority derived for price. Price is an issue of major discussion both by Lehigh and its vendors. Lehigh often pushes for a lowering of prices and truckers use lower prices as a way to gain business. It is interesting to see that in the context of this analysis, price was judged to be only approximately half as important as either service or management. Collectively, service and management are rated as 3 ½ times as important as price.

Four of the six objectives identified were also assigned sub-objectives. These too were prioritized using pairwise judgments as shown below:

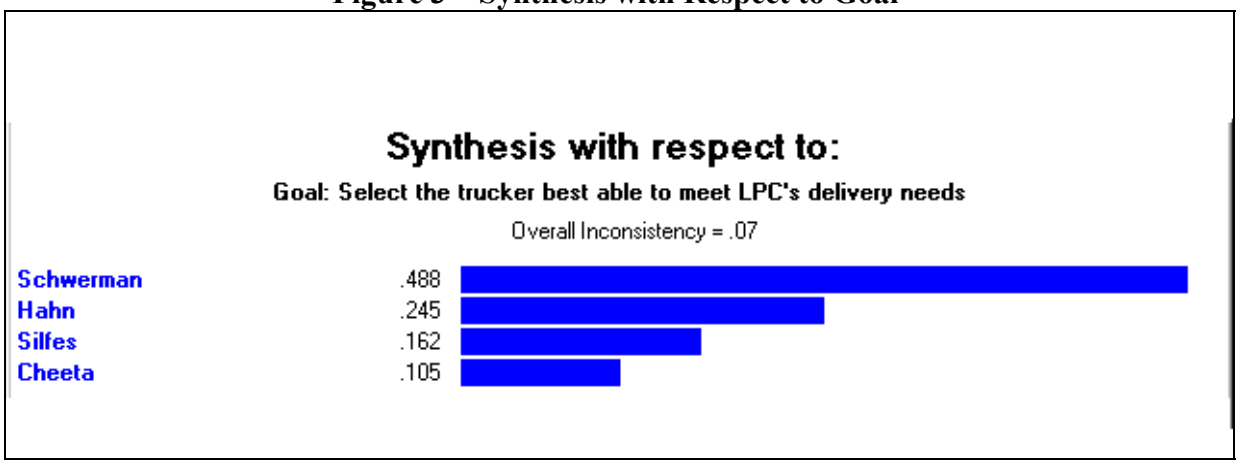
Figure 2. – Objectives and Sub-objectives with Respect to Goal



Synthesis

With the pairwise comparisons for the decision analysis complete, the next step is to synthesize that information to produce a ranking of alternatives in relation to the goal of this analysis. Figure 3 provides the details.

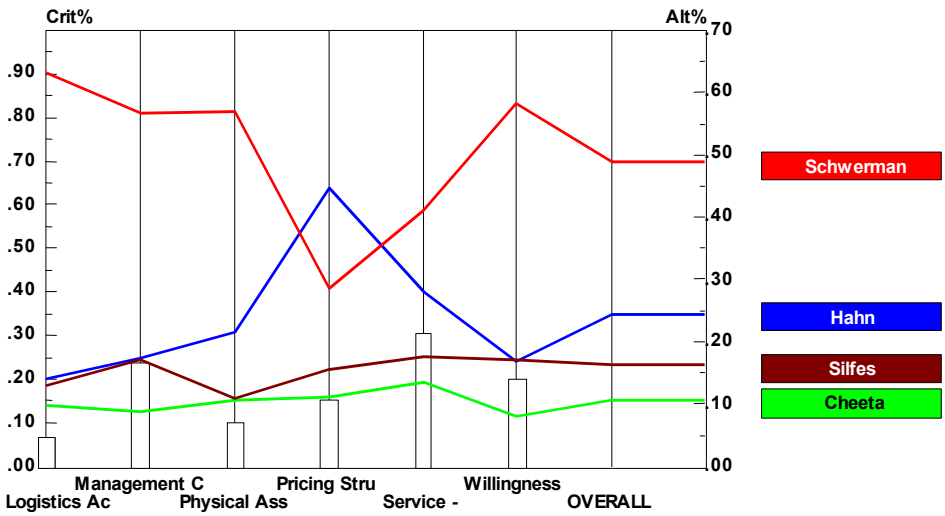
Figure 3 – Synthesis with Respect to Goal



This synthesis shows that for this decision analysis, Schwerman Trucking proves to be the vendor with the best combination of services for Lehigh. This conclusion is very enlightening, since the comments of several Lehigh personnel interviewed in preparation for this analysis showed a subtle bias towards Hahn. In retrospect, those opinions are easily understood. Hahn has been a part of Lehigh's operation for many years and does a good job. What this analysis shows is that there are better options available to Lehigh.

In order to better understand the results of this analysis, a performance sensitivity graph is included on the next page. This graph is a useful in gaining an overview of how the alternatives considered relate to the goal's objectives. In addition, in Appendix A, a Dynamic Sensitivity graph is included to provide the reader with another method of understanding the synthesis with respect to both objectives and alternatives.

Figure 4 – Sensitivity Analysis



Objectives Full

Logistics	Logistics
Management	Management
Physical	Physical
Pricing	Pricing
Service	Service
Willingnes	Willingness to Grow

Alternatives Full

Hahn	Hahn
Schwerm	Schwerm
Cheet	Cheet
Silfe	Silfe

In Figure 4, the bars represent the objectives established for the goal. The objectives are expressed as ratio scale priorities, meaning that "not only do the priorities show order, but differences and ratios are meaningful as well."[1] This is significant, because if the relative importance of the objectives should change, then the preferred alternative might change as well. Expert Choice includes the option of adjusting the relative values of the objectives if the user wishes to examine the impact of such changes on the alternative selected.

Conclusion

In the case of this decision analysis, there are several revelations. As mentioned, Schwerman would not have been the likely choice as the preferred alternative trucker if there had been only conversation among Lehigh managers, instead of the synthesis provided by AHP and Expert Choice. In addition, if there had been only conversation, it is very likely that the importance of price would have been considered a larger factor than the pairwise comparisons showed it to be in the analysis.

This analysis has already had an impact on the decisions that Lehigh Portland Cement is making on the issue of its future truck transportation needs. The understanding of the relative importance of the objectives to the goal means the firm is looking at transportation in a different and more balanced way.

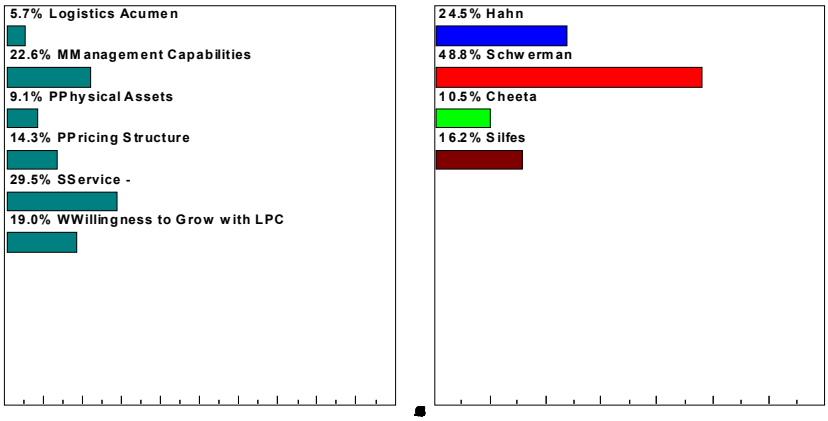
As a result, the decisions made in the near future regarding trucking will be subject to regular revaluation using the AHP concepts embodied in Expert Choice. The concept of incremental improvement[2] has great merit for issues regarding Lehigh's future truck transportation needs

[1] Ernest Forman and Mary Ann Selly, Decision By Objective, p. 81.
[2] Ibid., p. 113.

Appendix A

Dynamic Sensitivity Analysis

Dynamic Sensitivity for nodes below: Goal: Select the trucker best able to meet LPC's delivery needs



Objectives Full Names

Logistics Ac	Logistics Acumen
MManagement	MManagement Capabilities
PPhysical As	PPhysical Assets
PPricing Str	PPricing Structure
SService -	SService -
WWillingness	WWillingness to Grow with LPC

Alternatives Full Names

Hahn	Hahn
Schwerman	Schwerman
Cheeta	Cheeta
Silfes	Silfes

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Treacy, Michael and Wiersema, Fred, The Discipline of Market Leaders, New York: Addison-Wesley Publishing, 1995. p. 124.