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Use of Analytic Hierarchy Process (AHP) for Selection of 3PL Providers

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Abstract

Selecting a Third Party Logistics Provider for international business can be a complex undertaking. It is a multi-criteria problem, with alternative ways to weigh the importance of the chosen criteria. This paper describes a method applying the Analytic Hierarchy Process (AHP) to weigh the criteria based on surveying experts in the field of international logistics and merchandise exports. The weighted criteria are then multiplied with attribute score matrices to arrive at a ranking of the 3PL's under final consideration. Given our criteria, the weights and the attribute scores, it was found that two 3PL's ranked very closely in the top position. It was also found that a simple ranking of the criteria can produce very similar aggregate weights provided the number of experts is high enough. The paper contains an extensive literature review on the usage of AHP and related methods in a logistics context.

Introduction

There comes a point when any merchandise exporter will have to seriously consider the degree of outsourcing of its logistics operations. Most export sales transactions, of course, involve some type of external service providers, as exporters normally don't have the transportation equipment or expertise needed to provide door-to-door service completely on their own. Transportation firms and customs brokers are integral and indispensable pieces of the global trade picture. While all exporters customarily outsource activities such as transportation and documentation, it takes a more strategic decision to enter into a more tight-knit and long term relationship with a third party logistics provider (3PL). This paper will use a mathematical procedure called Analytic Hierarchy Process (AHP) to help in the selection of not just a contending 3PL's, but also in the choice and weighing of the selection criteria that go into such a decision making process. The paper will show how six criteria were chosen, how ten logistics experts were asked to help weigh these criteria, how data were gathered on the four 3PL finalists, and how the criteria weights and finalist data were combined to arrive at a recommended decision of which provider to choose. We will also compare how the decision using AHP might differ from a process where the experts were asked to just provide a simple, straight ranking of the six criteria.

When exporters grow, they have greater needs than just occasionally contracting with freight firms and brokers regarding their logistics needs. Despite globalization and "free trade", the

whole process of international supply chain management is complex enough that many exporters need more hand holding than the local freight company can give. In this paper the segment of supply chain management that we are concerned with is logistics operations, including transportation. Combined with greater overall complexity and compliance requirements, the trend towards a "smaller" global market means that the sales transactions are not completed as soon as the finished products leave the local warehouse. The fact that manufacturers and exporters have to deal with overseas assembly, modifications, storage, warranty repairs and reverse logistics means that the range of logistics needs are now potentially much greater than just a few years ago. In addition to the physical flow of goods come the flows of papers and electronic documentation, both for internal and external purposes.

Large 3PL providers can essentially provide anything you can think of within the area of logistics management. Transportation and related documentation are naturally what first springs to mind, but various inventory related tasks – such as warehousing, picking and packing, light assembly, customization, labeling and order processing – are gaining greater prominence as outsourced activities. 3PL's can also get involved in more customer oriented operations, such as order taking, replenishment, invoicing and showroom management. At a price, anything can be outsourced. Nevertheless, any exporter needs to find a smart balance of what to perform in-house and what to hire outside providers to do. For the purposes of this paper, we will assume that the exporter has undergone a process of strategic assessment to determine to what degree it makes sense to utilize 3PL's. That means this paper can focus on the process of refining the decision criteria and developing a systematic method for choosing the most suitable provider.

To summarize, this table lists the most common services provided by 3PL's [Mangan et al]:

Transportation, both inbound and outbound	**Warehousing, incl. receiving and placement**	**Pick and pack; order fulfillment**
Light manufacturing and assembly	**Vendor managed inventory**	**Documentation, compliance and customs clearance**
Trade financing, incl. currencies	**Managing reverse logistics**	**Critical parts distribution (spare parts and accessories)**
Inventory management and replenishment		

When the company has decided on which functions it wants the 3PL do perform, it is wise to have a process for choosing the criteria and prequalifying the candidate providers. Before we explain our methodology we will discuss the interesting information we found by when we did a thorough literature review.

Discussion and Literature Review

Academic and trade journals routinely contain a multitude of articles and advice dealing with how to select logistics providers. We have tried to focus on material that applies various systematic and somewhat scientific tools to arrive at informed management decisions. The better informed decision makers are able to avoid mistakes, provide better customer service and save their companies money in the long run.

The concept of "Total cost of Ownership" (TCO) weighs heavily in the logistics field. It is easy to make suboptimal purchasing decisions that eventually will cost more or result in lower revenues because of customer dissatisfaction. Well informed and equipped logistics managers keep the big picture in mind, yet pay attention to the many small details that are necessary for success in supply chain management. Modern decision tools can make the clutter a bit more manageable, and perhaps shift the balance of logistics management more from an art to a science. TCO is typically used in the purchasing field and used to assess the total cost of owning and maintaining an asset over time, but the concept can easily be modified to take into account the ongoing total cost of purchasing service products, such as 3PL services. For the purposes of logistics management, we may rephrase TCO as the "Total cost of Outsourcing" [Mangan et al].

TCO is a broader concept than "total landed cost", which according to Coyle et al. is the total cost of a product once it has arrived at the buyer's door, including the original cost of the item, all brokerage and logistics fees, complete shipping costs, customs duties, tariffs, taxes, insurance, currency conversion, crating costs, and handling fees [Coyle et al.]. The landed cost pertains to the transportation part of logistics, while logistics services such as warehousing and inventory management have different and often more complex cost structures.

Donald Bowersox wrote an article for CSCMP's Supply Chain Quality in 2007, [Bowersox] which was later reprinted in the 2008 textbook *Global Logistics and Supply Chain Management* [Mangan et al.]. He stressed six imperatives that combine to create the supply chain discipline: 1) customer-centricity; 2) operational excellence; 3) integrative management; 4) real-time responsiveness; 5) network leveraging; and 6) collaboration. Sophisticated companies with equally sophisticated international customers should aim to select 3PL providers on an equal philosophical and operational level and that can live up to Bowersox's six imperatives.

a) Selection of 3PL providers

We have reviewed two classes of papers that deal with provider selection. The first category suggests what factors to look for, and the second category of papers deal with how to use mathematical techniques to aid in the decision making. In a 2002 paper, Kee-hung Lai et al. refer to what is called the SCOR model, where the focus is on both customer facing and internal facing supply chain processes [Lai et al.]. The customer facing processes (such as reliability,

flexibility and responsiveness) center around what we might call effectiveness measures, or "doing the right things" for the customers. The internal-facing processes (such as costs and assets) are efficiency-gauges, and focus on "doing the things right" to run a cost-efficient and lean operation. Inherent in the relationship between customer focus and internal focus is the old and inevitable trade-off between customer service and cost. Lai et al.'s study presented transportation practitioners (survey respondents) with a 26-item measurement instrument for evaluating supply chain performance in transport logistics. The 26 items were divided into three distinct categories; 1) service effectiveness for shippers; 2) operations efficiency for transport logistics service providers; and 3) service effectiveness for consignees. The latter category is important and often somewhat neglected by the shippers who hire and pay the logistics provider. The supplier is often partially judged based on the performance and behavior of the logistics provider, and keeping the consignee (customer) happy is crucial for a long term relationship.

It is likely that transportation is the costliest element of the various logistics processes, especially in international trade where the merchandise travels long distances and is subject to customs fees and surcharges. Freight transportation used to account for 7-8% of GDP, although it is slightly lower today [Coyle et al., p. 42]. It is the author's experience that the total freight cost in international trade can easily amount to 30-40% of the value of the product. The examples we show later in this paper will also illustrate the dominance of transportation costs over the other logistics costs considered. A 2006 study found that transportation cost is of paramount importance (Supply Chain Systems Lab.]. The transportation expense as a proportion of the value of the product will vary tremendously between industries. One of this paper's authors has experience from the horticultural industry, where the transportation cost can be extremely high. Other industries with light, high value products may find that the relative transportation costs is low, and other logistics expenses (such as inventory management) may dominate. Regardless of the internal makeup of the total logistics cost, we will find that total cost is regarded one of the top two criteria in the selection of 3PL's.

An instructive 1997 paper outlines a managerial framework for the acquisition of third-party logistics providers [Sink & Langley]. They caution the decision maker of the internal role of politics, power and chance, as well as the individual, organizational and environmental variables. The authors present a systematic 3PL buying process, with the following five steps: 1) Identify need to outsource logistics; 2) Develop feasible alternatives; 3) Evaluate and select supplier; 4) Implement service; and 5) Ongoing service assessment. This paper deals primarily with steps 2 and 3 on this list. Sink and Langley stress that candidate selection begins with the establishment of selection criteria. Their top evaluation criteria are quality, cost, capacity and delivery capability. After an initial or preliminary screening to prequalify or eliminate unsuitable suppliers, the company can focus on those which seem the most appropriate for the

final selection. In this paper we have followed this principle by reducing the candidate pool from several dozen potential contenders down to only four finalists, before applying the decision vector on the final four. Through their research, Sink and Langley found that typical logistics teams evaluate 6-8 candidates using both quantitative and qualitative tools, before seriously considering 2-3 finalists. A combination of criteria weights and formal Requests for Proposals (RFP's) are often used. The authors state that references from trusted professional colleagues and current clients of the finalists are the most important information sources to members of the logistics buying team. This is similar to the approach we are taking in this paper, where ten experts in logistics and exports were surveyed to come up with appropriate criteria weights.

According to the Supply Chain Council (owners of the SCOR – Supply Chain Operations Reference – model), effective supply chain management is all about delivering the right product in the right quantity and in the right condition with the right documentation to the right place at the right time and the right price [Supply Chain Council]. As they point out, this sounds easy but is very difficult without a proper organizational framework that links business processes, metrics, best practices and technology into a unified structure.

Patrick Sedlak points out the importance of developing a comparison matrix of the various cost components offered by potential 3PL's [Sedlak]. Common measurement units are needed when price quotations come back in different units. He stresses the importance of understanding the offers, doing the math and getting the numbers right. John Fitzgerald writes about six essential strategies for selecting a global 3PL [Fitzgerald]. Outsourcing to 3PL's is a process fraught with pitfalls, and in considering what he calls "total supply chain costs", he recommends weighing and analyzing the following criteria: 1) Cultural alignment;, 2) Company infrastructure (physical resources and presence); 3) IT capabilities; 4) Ease of doing business (e.g. flexibility, customization); 5) Metrics (costs and other measurables); and 6) Partnership intangibles ("global collaboration").

Martin Murray makes the obvious point that the decision to use a 3PL depends on a variety of factors that differ from business to business [Murray]. He is right in stating that the growth of global 3PL companies (perhaps close to a $400-billion industry according to Fitzgerald) is driven by the need for business to become leaner, reduce assets, and focus on core business processes. By outsourcing large portions of the logistics activities, chunks of assets can be taken off the balance sheet (like warehouses, transportation and packaging equipment) and turned into a variable rather than a fixed annual cost. Murray suggests a four-step process: 1) Make a strategic decision to outsource; 2) Begin the search for the right 3PL provider; 3) Issue detailed requests for quotations (RFQ's); and 4) Evaluate the bids using a multi-discipline team and a predefined set of criteria. He subsequently lists ten possible criteria, most of which are

quantifiable enough for making valid comparisons between the candidates. One of the criteria, "Is the 3PL a good cultural fit?", will be hard to quantify and in our view the decision team needs to be very disciplined in limiting the parameters and scope of such an open-ended question. Unfortunately, most companies cannot assess whether a cultural match was good or bad until several months or years into the contract. Perhaps the best one can hope for here is detecting obvious red flags of possible mismatches in advance. Murray concludes his short article by suggesting the assignment of scores and weighing of the criteria. This is exactly what we intend to do.

Perhaps the most influential article for us in coming up with suitable criteria was CapGemini and Georgia Institute of Technology's annual "State of Logistics Outsourcing" [Langley, 2009]. We used the 2009 edition to guide us in our search for measurable criteria, and although many of the criteria that CapGemini uncovered through its annual survey were of qualitative nature (like "openness, transparency and good communication", and "continuous, ongoing improvements"), many were concrete enough to be of use when putting numbers to them. Their report warns against typical disappointments that can happen if the selection process is faulty. The four main complaints and problems identified in the survey were: 1) Lack of continuous, ongoing improvements and achievements in offerings; 2) Service level commitments not realized; 3) Information technology capabilities not sufficient; and 4) Cost reductions not realized. It is no doubt difficult to guard against such disappointments in the selection process, although steps can be taken to reduce the possibility of let-downs (for example, clearly spelling out expectations and "who does what", having clearly communicated metrics and benchmarks, and providing enough internal training in the new systems and procedures). The CapGemini report listed two other desirable criteria that we eventually chose to include in our list: global capabilities and industry-specific knowledge.

The 2010 version of CapGemini's study confirmed most of the findings from the year before [Langley, 2010]. It stated the interesting finding that companies devote an average of 11% of their sales revenues to logistics, and that 42% of that is now outsourced. The consulting firm also found that shippers continue their tendency to outsource transactional, operational and repetitive activities, and less so those that are strategic, customer-facing and IT-intensive in nature. Overall, the CapGemini studies seem very useful for any company developing a list of relevant selection and evaluation criteria.

Two contemporary logistics and transportation management textbooks were also useful in scouring for suitable criteria. We found material in Coyle et al.'s 2011 edition of "Transportation – A Supply Chain Perspective" [Coyle et al.] and Mangan et al.'s 2008 edition of "Global Logistics and Supply Chain Management" [Mangan et al.] to be especially helpful.

b) Technical methodologies

Several research papers have been published on various related methodologies for screening and picking 3PL's. Many of them describe multi-criteria, hierarchical processes, such as ANP ("analytic network process") and AHP ("analytic hierarchical process"). Some of the papers introduce what might seem like overly complicated analytical processes, such as fuzzy logic and a concept called TOPSIS ("Technique for Order Preference by Similarity to Ideal Solution"). We suppose only the limits of the imagination can delimit what parametric and non-parametric tools can be applied, but it seems important that the sophistication and complexity of these match the internal skills and capabilities of the analysts and managers who shall use them and make decisions base on them. The AHP process that we are applying in this paper seems to have just the right level of complexity and sophistication to be understandable and learnable by most managers with a calculator and a spreadsheet package. We will briefly mention some of the techniques we found in the nine technical papers we considered.

In a 2008 paper, Pravin Kumar walks the reader through a relatively accessible procedure of using AHP to assign weights to criteria and TOPSIS to determine the order of preferences of the alternatives. Matrix multiplications and normalizations are used to arrive at the highest scoring candidates [Kumar]. We are not sure whether the TOPSIS process actually adds much to the value of a more traditional AHP process, but his paper is a great source of inspiration for how to do the calculations. It also contains a useful table summarizing many researchers' suggestions for criteria for selection of 3PL's. The first two criteria suggested in this table (cost of service and quality of service) happens to match two of the six criteria in our final list.

Aïcha Aguezzoul provides a thorough literature review in a paper he presented in 2008 [Aguezzoul]. He labels the supplier selection a multi-criteria, complex process, because it involves a variety of universal and customized factors around the issues of price, quality and delivery. The main utility of this paper is his comprehensive listing of 3PL evaluation methods, ranging from linear weighing models, artificial intelligence, statistical approaches, and mathematical programming models. AHP is a linear weighing model, placing a weight on each criterion and arriving at a total score for each 3PL by summing up the performance on the criteria multiplied by their associated weights. AHP, ANP and fuzzy TOPSIS all fall under the linear weighing model category. Aguezzoul makes the important statement that different criteria are used depending on the logistics activity outsources and the industry sector studied. Obviously the shoe has to fit. In our case it also means that the experts asked to rank the decision criteria have to be right for the industry under consideration.

Although the concept of adding fuzziness to the equation may be appealing from a theoretical standpoint, it may add too much complexity unless it can be reliably computerized and automated. Mahmoodzadeh et al. have written an interesting paper that takes the vagueness

of human thought into consideration [Mahmoodzadeh]. We believe introducing fuzzy ranges around qualitative data (e.g. subjective rankings such as good – medium – poor) may be useful if the number or respondents (experts) is low. The fuzzy technique tends to soften the sharp divisions among discrete (categorical) answers, but with a larger response base it seems to us that such gradations will become apparent regardless, and be accommodated through the calculations used with the pairwise comparisons in the AHP method.

Eleonora Bottani and Antonio Rizzi also discuss fuzzy TOPSIS in their 2006 research paper [Bottani]. The authors provide a thorough discussion of as many as 12 major decision criteria, and point out the benefits of the multi-layered decision trees, where the importance/rating (weights) against one criterion depends on the importance/rating given to a few criteria at the tier below. Such sub-criteria can obviously be evaluated and weighted through a pairwise comparison procedure, just as with the main criteria. The benefit of TOPSIS is said to be the reduction of cumbersome pairwise comparisons at many levels, with the inherent risk of inconsistencies, and TOPSIS is a system that scores alternatives on the perceived closeness to either a Positive Ideal Solution (PIS) or a the Negative ideal Solution (NIS). Getting the input data for a good TOPSIS analysis requires the availability of a well structured body of knowledge about the potential 3PL candidates. In other words, instead of relying on expert advice, TOPSIS needs good data from the preliminary RFQ process. Chan, Kumar, Tiwari, Lau and Choy also offers a recent (2008) paper on using the fuzzy AHP approach for global supplier selection [Chan et al.]. Again, our feeling is that with a large enough pool of experts, a fuzzy approach may not be needed to extract any aggregate nuances in the response set. The distribution of many crisp responses can be seen to create a triangular (or at least a Gaussian) pattern, which is the aim of fuzzy set analysis. However, with a limited number of responders and many comparisons of a qualitative nature, it seems that bringing fuzziness to the analysis can add some value.

The analytic network process (ANP) approach is covered in detail by the authors Sanjay Jharkharia and Ravi Shankar in a 2005 paper [Jharkharia]. This approach seems to require a greater degree of prescreening and obtaining detailed information from the candidates before the real analysis can take part. Many pairwise comparisons are still used, however, and the whole ANP process seems to generate an army of matrices and even a “super-matrix”. The authors point out that the results of the analysis are valid only for the case company in its own decision environment, and should not be generalized to establish the superiority of one 3PL over the others. That is not too unlike the AHP process, we suppose, where certain criteria will obviously tend to weigh higher in some industries than others.

Thomas Saaty teaches in a 1990 paper that in AHP, the paired comparisons are performed throughout the hierarchy with the exception of the alternatives (candidates) themselves [Saaty]. For example, you would not ask experts to compare UPS against FedEx by assigning

weight scores. The alternatives are simply rated as to what category in which they fall under each criterion. For example, if one criterion is price of service, each alternative will have a composite dollar amount (or a normalized value) assigned to them (based on research, as we will see). Laura Meade and Joseph Sarkis call the ANP technique a general form of the AHP [Meade]. Nevertheless, the usage and solving of a possibly enormous super-matrix in ANP is somewhat disconcerting to us, especially when these authors talk about raising a 24 x 24 matrix to the 64^{th} power to attain convergence of the final set of priority weights. With modern computing power this is not a daunting task, however. The authors were more concerned with the many pairwise comparisons that had to be made to be able to produce the initial super-matrix. We can sympathize with the concern that going back and asking the same experts over and over could be a less than ideal way of gathering information.

So, Kim, Cheong and Cho present a very concise AHP procedure in their 2006 paper addressing the service quality of 3PL service providers [So et al.]. They studied five service quality dimensions (dubbed Tangibles, Reliability, Responsiveness, Assurance and Empathy), and obtained 89 responses to the pairwise questionnaires they sent out to logistics managers. It would be interesting to know whether having that many experts do the comparisons actually add much value. The value of AHP and the pairwise comparison method is that you can have very few experts make the comparisons (sometimes as few as one or two, although we would not recommend that few), and it would be interesting to know at which point the aggregate weights start to stabilize. In statistics, and with normally distributed samples, the threshold value for a fairly valid analysis is a minimum sample size of 30, but in AHP it is certainly lower than that. Our team obtained comparisons from ten experts, and the aggregates seemed to stabilize after 8 or so responses. For a serious pairwise comparison in a complex industry, we do not believe any credible weights could reliably be attained with only a few respondents. You will need at least a half a dozen or so to "stabilize" the matrix.

Both Dundar Kocaoglu's paper on "A participative approach to decision making" [Kocaoglu, 1983] and Buckingham and Ra's study of using AHP and MAU ("multi-attribute utility" theory) in selecting Alaskan airports [Buckingham] were useful for us in developing this paper. The conversion of raw data and the normalization to utility curves in connection with the Alaskan project were helpful for us in considering how to treat the data obtained on the four logistics providers we evaluated.

Decision Hierarchy and Methodology

In a hierarchical structure (see figure 1), it is important to focus on what the goal of the project is. Our hierarchy has the goal of "selecting a 3PL provider" on top, with the criteria and sub-criteria on the next levels, and ultimately the four finalists on the bottom rung.

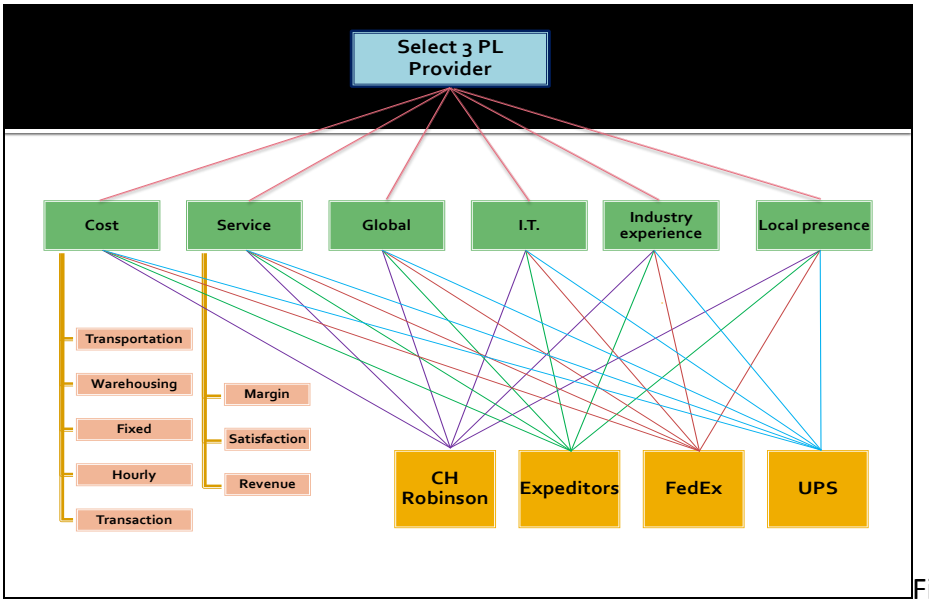

Figure 1

Four decisions now have to be made:

1) Deciding on the proper criteria
2) For some of the criteria, deciding on the proper sub-criteria
3) Choosing the right experts to ask for criteria weightings
4) Deciding on which 3PL's to consider

We will briefly discuss these in order:

1) Criteria:

The literature review revealed some of the criteria that it seems appropriate to include. Our team spent considerable time and effort on considering and vetting possible criteria before deciding on the six we eventually picked. We did not have the luxury of a specific industry perspective, so our criteria had to be somewhat broadly applicable. A team working in a specific industry would naturally want to choose decision criteria that closely fit important strategic and practical concerns for its business. Arriving at between five and seven criteria seems about right. The pairwise comparison necessitates asking the experts to weigh every dual combination of the criteria, which means that there will be (n * (n-1) / 2) combinations to ask. In the case of six criteria, this produces (6 * 5 / 2) = 15 paired questions, which is manageable from a

questionnaire standpoint. If, for example, you decided to include as many as 12 criteria, the number or questions to ask (comparisons to make) would be 66, causing responder fatigue and confusion, which again could cause the responses to be overly inconsistent. Another factor to consider when choosing appropriate criteria is whether you will be able to find good answers and data to support them. Reliable numerical data are easy to use, and even qualitative responses (like "good – medium – bad") can be converted to numbers and normalized, but we are more concerned with obtaining trustworthy data on questions that are hard to quantify prior to entering into a supplier relationship. This team did not have the opportunity to issue RFP's, so we were not able to ask pointed questions from the 3PL candidates. This, however, is practically a must in a vendor selection process, and care must be taken to ask questions that are answerable. (You would hardly obtain an answer to a question like "How is your customer service?" with "Oh, it's pretty bad, actually.") Although you could ask the candidates questions about on-time performance and other metrics – and perhaps hope for relatively truthful answers – it seems clear to us that such information might be better obtained from secondary industry sources and just asking around. This whole process of developing strong criteria and vetting providers could be resource and time consuming, but obviously the more effort the analysts can put into it, the more pinpointed the set of criteria and the final candidate pool can be.

After deliberations and a thorough literature review, the team selected the following selection criteria (with the sub-criteria the second lines):

We felt that we would be able to find relevant supporting data to rank these criteria for each of the four candidate finalists. Some of the data are approximations and proxy measures. We had to rely on published information, including the candidates' websites, while ideally and in reality some of this can be asked directly of the candidates, as discussed above. As for the last item (strong Pacific Northwest presence), it should obviously be changed if your company is not located in that area. The "rating system" listed to under the fourth and fifth criteria refer to a way of converting non-numerical observations into a ranking order. For example, if the provider's IT system would adapt to the client's system, the score is higher than if the client had to adapt to the provider's system.

2) Sub-criteria

The sub-criteria can be scaled and weighted using the pairwise comparison process. We only used pairwise comparisons to weigh the main six criteria. For the "cost of service" item, we let the numbers to the talking: it turned out that in our example the transportation costs were so dominant that they amounted to about 90% of the five sub-criteria considered. For many exporters, though, it may be that the transportation portion plays a lot smaller role. The three sub-criteria under "service level" consisted of percentages, ranking scores and dollar amounts (one third weight each), so these three had to be normalized before plugged into the score matrix.

3) Choosing the right experts

This paper is not industry-specific, although the 16 experts we contacted were all somehow actively involved with the export business. The ten experts who submitted responses were all former colleagues or business acquaintances (or colleagues thereof) of one of our team members, and combined it is likely that they have hundreds of years of experience from the exports and logistics fields. The following two tables list who the experts are and the initial questionnaire that was given them.

Name	**Title**	**Company**	**Industry**	**Function**
Fred Pursell	Product Manager, Worldwide Licensing & Pricing	Microsoft Corp.	Software and computer game products	Exporter and importer
Dan Chevalier	Trade Compliance Manager	Gardner Denver Inc	Industrial Machinery (compressors, pumps, blowers)	Exporter and importer

Jesper Damgaard	Branch Manager	DSV Air & Sea Inc	Transportation & Logistics	Logistics expert
Bob Deane	International Trade Specialist	U.S. Department of Commerce	Government agency	Trade expert
Mark Ferguson	Director of Logistics	Supervalu International	Groceries and Supplies	Exporter and importer
James Foley	Director	Illinois SBDC International Trade Center	Government agency	Trade expert
Larry Kvidera	Manager, Marketing & Trade	Port of Tacoma	Government agency	Logistics expert
Tobias Mayer	Marketing Manager	Veterinary Transplant Services	Animal tissue bank	Exporter
Stephen Newby	Export Manager	Sam's Club	Groceries & Supplies	Exporter and importer
Johnathan Tucker	Shipping Supervisor and Customs Control Officer	Philips Healthcare	Medical devices	Exporter and importer

The fifteen paired questions were randomized and sent to experts who provided answers to the questionnaire. (Appendix A)

4) Deciding on which 3PL's to consider

If we put ourselves in the shoes of a major exporter or merchandise, there are some definite minimum requirements that can be asked at the outset. As much as your local trucking firm now wants to label itself as a sophisticated 3PL provider, it is clear that an ambitious exporter has to somehow prequalify the candidates that should be considered as finalists and be subject to our AHP methodology. Buckingham and Ra call this an initial screen for feasibility, or "feasibility screen" [Buckingham]. Mangan et al. use the term "order qualifiers", which are minimum requirements for being accepted into the more limited potential "order winners" category for further consideration [Mangan et al]. Our team started out with considering two dozen potential candidates, and through a combination of previous industry knowledge and discrimination based on size, we pared this down to eight viable candidates (originally nine, before we realized that DHL had acquired Exel):

- C.H. Robinson
- DB Schenker
- DHL
- Expeditors International
- FedEx
- Kuehne & Nagel
- Menlo Worldwide Logistics
- UPS

We originally considered running the numbers on all eight candidates, but soon realized that we did not have enough resources, and that our study really would not gain anything by having as many as eight 3PL's considered. We would get our (and the methodology's) point across by cutting this number in half. There are some benefits to evaluating more than four candidates, especially if one wants to uncover strengths that were not initially apparent, and also if one wants to use the AHP method to narrow the search down to two or three finalists for further interviewing and screening. In our case, we decided to narrow the search to the four providers that are publicly traded on an American stock exchange (presumably making data gathering somewhat easier). The four finalists were therefore C.H. Robinson, Expeditors International, FedEx and UPS. These are all large operations with global networks of services.

AHP Pair Wise Comparison

The pairwise responses from the ten experts (figure 3) were fed into a rudimentary software program called PCM. What this program essentially does is averaging the response data and running it through a sequence of matrix calculations and normalizations to arrive at average weight allocations for the six criteria that we considered. Figure 2 shows how PCM displays the output.

Relative Weights

Project Title: 3 PL Provider

Users	1	2	3	4	5	6	Incn
Deane	0.11	0.23	0.17	0.21	0.13	0.15	0.008
Kvidera	0.27	0.25	0.14	0.14	0.12	0.08	0.044
Damgaard	0.28	0.22	0.10	0.14	0.18	0.09	0.009
Ferguson	0.35	0.14	0.20	0.09	0.08	0.14	0.027
Newby	0.21	0.21	0.15	0.13	0.09	0.21	0.013
Tucker	0.10	0.32	0.24	0.17	0.14	0.04	0.064
Pursell	0.25	0.21	0.12	0.20	0.10	0.12	0.035
Mayer	0.11	0.59	0.18	0.06	0.01	0.04	0.042
Person 11	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Mean	0.22	0.26	0.17	0.15	0.10	0.10	0.076
Min	0.10	0.14	0.10	0.05	0.01	0.04	
Max	0.35	0.59	0.24	0.29	0.18	0.21	
Std Dev	0.09	0.12	0.04	0.07	0.04	0.05	

Figure 2

	Industry Experts:				Exporters:						Overall:		Experts:		Exporters:	
PAIRWISE:	Foley	Deane	Kvidera	Damgaard	Ferguson	Newby	Chevalier	Tucker	Pursell	Mayer	Average	Std. dev.	Average	Std. dev.	Average	Std. dev.
Cost of service (achieving cost reductions)	30	30	60	60	80	40	60	25	60	20	47	20	45	17	48	23
Service level performance and quality (on-time, accuracy, reliability)	70	70	40	40	20	60	40	75	40	80	54	20	55	17	53	23
Comprehensive global capabilities	30	40	30	40	75	50	75	50	20	70	48	20	35	6	57	21
Information Technology capabilities and integration	70	60	70	60	25	50	25	50	80	30	52	20	65	6	43	21
Service level performance and quality (on-time, accuracy, reliability)	80	60	60	60	75	60	80	75	70	99	72	13	65	10	77	13
Expertise and experience specific to your industry	20	40	40	40	25	40	20	25	30	1	28	13	35	10	24	13
Strong local (Pacific NW) presence and capability	30	40	25	40	50	60	20	25	50	20	36	14	34	8	38	18
Comprehensive global capabilities	70	60	75	60	50	40	80	75	50	80	64	14	66	8	63	18
Cost of service (achieving cost reductions)	60	40	60	75	70	60	55	25	60	20	53	18	59	14	48	21
Comprehensive global capabilities	40	60	40	25	30	40	45	75	40	80	48	18	41	14	52	21
Service level performance and quality (on-time, accuracy, reliability)	80	60	80	70	50	50	90	95	60	90	73	17	73	10	73	21
Strong local (Pacific NW) presence and capability	20	40	20	30	50	50	10	5	40	10	28	17	28	10	28	21
Expertise and experience specific to your industry	70	40	40	70	25	30	20	25	30	10	36	20	55	17	23	8
Comprehensive global capabilities	30	60	60	30	75	70	80	75	70	90	64	20	45	17	77	8
Information Technology capabilities and integration	65	60	30	30	25	30	30	50	40	30	39	14	46	19	34	9
Cost of service (achieving cost reductions)	35	40	70	70	75	70	70	50	60	70	61	14	54	19	66	9
Strong local (Pacific NW) presence and capability	50	60	50	30	50	70	15	25	50	80	48	20	48	13	48	25
Expertise and experience specific to your industry	50	40	50	70	50	30	85	75	50	20	52	20	53	13	52	25
Cost of service (achieving cost reductions)	75	40	80	70	70	50	95	75	70	80	71	16	66	18	73	15
Strong local (Pacific NW) presence and capability	25	60	20	30	30	50	5	25	30	20	30	16	34	18	27	15
Comprehensive global capabilities	75	40	30	30	60	40	40	50	40	20	43	16	44	21	42	13
Service level performance and quality (on-time, accuracy, reliability)	25	60	70	70	40	60	60	50	60	80	58	16	56	21	58	13
Information Technology capabilities and integration	75	60	50	60	40	40	90	75	60	60	61	16	61	10	61	20
Strong local (Pacific NW) presence and capability	25	40	50	40	60	60	10	25	40	40	39	16	39	10	39	20
Service level performance and quality (on-time, accuracy, reliability)	60	50	70	60	60	60	80	50	60	90	64	13	60	8	67	15
Information Technology capabilities and integration	40	50	30	40	40	40	20	50	40	10	36	13	40	8	33	15
Expertise and experience specific to your industry	20	60	40	40	25	30	20	75	30	10	35	20	40	16	32	23
Cost of service (achieving cost reductions)	80	40	60	60	75	70	80	25	70	90	65	20	60	16	68	23
Information Technology capabilities and integration	90	60	50	50	50	60	65	50	60	80	62	14	63	19	61	11
Expertise and experience specific to your industry	10	40	50	50	50	40	35	50	40	20	39	14	38	19	39	11
STRAIGHT RANKING:																
											RANK:					
Cost of service (achieving cost reductions)	2	4	1	1	1	1	1		1	4	1.8	1.3	2.0	1.4	1.6	1.3
Service level performance and quality (on-time, accuracy, reliability)	1	1	2	2	3	2	2		2	1	1.8	0.7	1.5	0.6	2.0	0.7
Comprehensive global capabilities	4	2	3	6	4	4	3		5	2	3.7	1.3	3.8	1.7	3.6	1.1
Information Technology capabilities and integration	3	3	5	3	2	5	4		3	3	3.4	1.0	3.5	1.0	3.4	1.1
Expertise and experience specific to your industry	5	5	4	4	5	6	5		6	5	5.0	0.7	4.5	0.6	5.4	0.5
Strong local (Pacific NW) presence and capability	6	6	6	5	6	3	6		4	6	5.3	1.1	5.8	0.5	5.0	1.4

Figure 3

In figure 2, the row labeled “Mean” shows the average weights given the six criteria:

1) Cost of service (achieving cost reductions) 22%
2) Service level performance and quality (on-time, accuracy, reliability) 26%
3) Comprehensive global capabilities 17%

4) Information Technology capabilities and integration 15%
5) Expertise and experience specific to your industry 10%
6) Strong local (e.g. Pacific NW) presence and capability 10%

We had a feeling that the two first criteria (cost and service) were going to come out strong, as what we had read in the literature confirmed this general pattern.

Two of the ten respondents had "inconsistency" scores (last column of figure 2) of 0.124 and 0.170. This is more than a threshold of 0.10, which is regarded high enough to justify going back to the respondent to ask for clarification. What this means is that the answers did not show enough transitivity (logical coherence). Our team did not go back to these two experts, but we excluded them from the PCM calculation of aggregate weights (the outcome did not change by removing them, which is a benefit of having a relatively large sample). In a real situation it is may be worth going back to the experts with high inconsistencies, especially if the number of experts is relatively low. Some writers will accept inconsistency scores up to 0.10 [Saaty] & [So et al.], while others [Kocaoglu] specify a limit of 0.016 as an upper inconsistency level, which in our case would "disqualify" all but two of the respondents. With many questions (15 in this case) it is not surprising that this would happen, and our feeling is that we are perfectly OK with as many as 8 to 10 responses.[1]

The resulting weight vector is therefore **{0.22 0.26 0.17 0.15 0.10 0.10}** This will be multiplied with the normalized attribute score matrix (figure 8) to find the highest scoring provider.

a) Assigning the Scores

Now that we have extracted average scenario weights from the expert panel, it is time to join this vector of weights with the matrix of attribute scores on the four candidate providers. For each criterion, we obtained various scores from researching the websites of the four finalists, as well as other publicly available information from stock analyst websites. For the cost scores, prices were randomly assigned to the four finalists[2] based on the comparison in figure 4 (the

[1] One of our team members played around with answering the questionnaire a second time to try to improve the inconsistency score. The result was that the score actually got worse the second time. It can, therefore, be risky to go back to a respondent and ask to have the whole questionnaire done over again. It would be better to try to pinpoint exactly which pairs of answers were inconsistent, and then ask the respondent to address those again. This is a possible weakness with the pairwise comparison approach (especially with many questions). There is a limit to how often you can go back and re-probe the experts.

[2] It is important to note that actual price information was not obtained from the four providers. This would have been practically impossible without a formal RFP.

underlying and detailed worksheet is shown in Appendix C). Figures 5 and 6 show the attribute score matrices for criteria 2 (service level) and 4 (IT integration). The attribute score matrices for criteria 3, 5 and 6 are not shown. The combined attribute score matrix (figure 7) needs to be normalized before we multiply it with the weight vector that we found above. This is done in figure 8.

Attribute scores for criterion 1 (costs):

Cost Element:	C H Robinson	Expeditors	FedEx	UPS	Of total
Fixed costs	$45,000	$25,000	$14,000	$14,400	1%
Transportation costs	$2,064,000	$2,287,500	$1,784,500	$1,935,000	96%
Warehousing costs	$38,400	$37,188	$34,800	$33,000	2%
Hourly fees	$14,500	$17,500	$9,875	$11,250	< 1%
Transaction fees	$2,375	$1,875	$3,750	$3,125	< 1%
Total	$2,164,275	$2,369,063	$1,846,925	$1,996,775	
Normalized	0.26	0.28	0.22	0.24	
Utility (inverse)	3.85	3.57	4.55	4.17	
NORMALIZED	**0.24**	**0.22**	**0.28**	**0.26**	

Figure 4

Attribute scores for criterion 2 (service level):

Service level performance and quality	C H Robinson	Expeditors	FedEx	UPS
Margin	6.71%	9.50%	5.20%	6.70%
Employee Satisfaction	2.8	2.9	3.5	3.1
Revenue per Empl	1229.6	477.3	175.94	114.83

Figure 5

Attribute scores for criterion 4 (IT integration):

C H Robinson	Expeditors	FedEx	UPS
• Built in-house • Flexible tech • Connects to customer's TMS • Can create custom tech solutions • CFRWOnline Summary: Provider adapts to customer	• Built in-house • "Book Ship Track": Proprietary "expo" internet tracking and reporting system, incl. 8 modules • Order mgmt also part of expo Summary: Customer adapts to provider	• Built in-house • "My Global Trade Data" is a systems suite • Includes new Warehouse Management System program • "Global Order Logistics" web based system Summary: Customer adapts to provider	• Built in-house • Several tracking systems, incl. Flex Global View, Gemini, MyFreight • Systems integrate with customer' EDI and existing IT systems Summary: Provider adapts to customer
Rating:			
High (5)	Medium (3)	Medium-High (4)	High (5)

Figure 6

The attribute score matrix before normalization:

	C H Robinson	Expeditors	FEDEX	UPS
Cost of service (achieving cost reductions)	0.24	0.22	0.28	0.26
Service level performance and quality (on-time, accuracy, reliability)	0.39	0.28	0.17	0.17
Comprehensive global capabilities	304	348	1900	1033
Information Technology capabilities and integration	5	3	4	5
Expertise and experience specific to your industry	5	2	3	4
Strong local (Pacific NW) presence and capability	8	3	5	4

Figure 7

Normalized score matrix and the weight vector:

CRITERION:	C H Robinson	Expeditors	FEDEX	UPS	PCM Weights
Cost of service (achieving cost reductions)	0.24	0.22	0.28	0.26	**0.22**
Service level performance and quality	0.39	0.28	0.17	0.17	**0.26**
Comprehensive global capabilities	0.08	0.10	0.53	0.29	**0.17**
Information Technology capabilities and integration	0.29	0.18	0.24	0.29	**0.15**
Expertise and experience specific to your industry	0.36	0.14	0.21	0.29	**0.10**
Strong local (Pacific NW) presence and capability	0.4	0.15	0.25	0.2	**0.10**

Figure 8

By multiplying the normalized score matrix (the four middle columns of figure 8) with the PCM weights column, we arrive at aggregate weighted preference scores for the four contenders. Using our numerical assumptions and the criteria weights derived from the experts, the highest scoring provider in this example is C.H. Robinson, with a score of 0.29. FedEx is very close behind, however, with a score of 0.28. Unless management wants to make a decision based on this, the two companies seem prime candidates for further discussions and comparisons in the form of management meetings and further negotiations. It is probably to the company's advantage that the scores were so close in this case, as it creates suitable fodder for price and service negotiations with both of the leading providers. The following graph is a summarized way of looking at the outcome of the AHP comparison:

Figure 9 clearly shows that C H Robinson excelled in service level, which more than compensated for FedEx's higher scores on global capabilities and cost. Other examples, with other numerical assumptions and perhaps more focused on specific industries, will exhibit different rankings. Out purpose here is to illustrate an example that could have been close to reality if more accurate attribute numbers had been used. The most realistic part of this study was the criteria weights that we obtained from the real life international logistics experts.

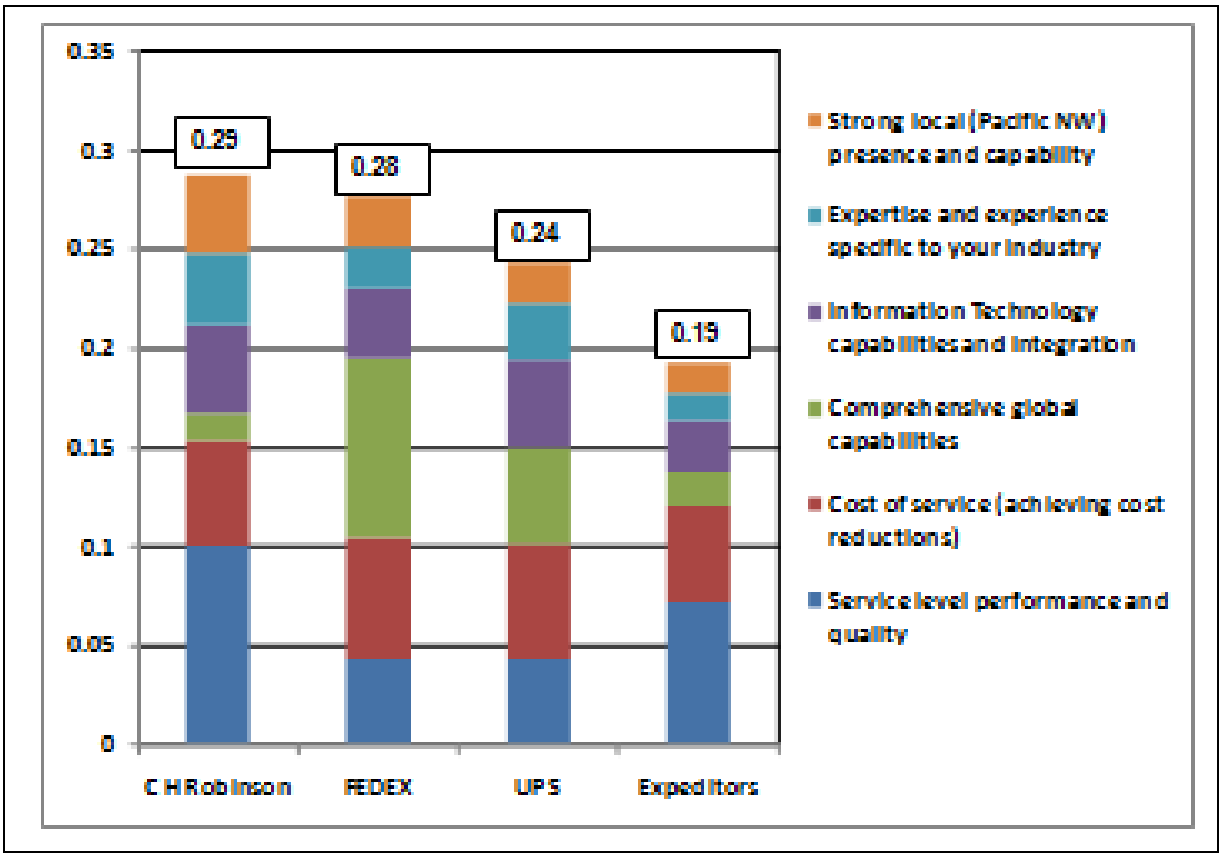

Figure 9

b) Simple rankings

As shown on page 16, we did a quick follow-up questionnaire to the ten experts who answered our first pairwise questionnaire (Appendix B). Our hypothesis with so many experts was that perhaps a simple ranking (from 1 to 6) would roughly provide the same criteria weights, in the aggregate.

CRITERION:	Overall:		Experts:		Exporters:	
	Average	Std. dev.	Average	Std. dev.	Average	Std. dev.
Cost of service (achieving cost reductions)	1.9	1.3	2.0	1.4	1.8	1.3
Service level performance and quality (on-time, accuracy, reliability)	1.7	0.7	1.5	0.6	1.8	0.8
Comprehensive global capabilities	3.5	1.4	3.8	1.7	3.3	1.2
Information Technology capabilities and integration	3.5	1.0	3.5	1.0	3.5	1.0
Expertise and experience specific to your industry	5.0	0.7	4.5	0.6	5.3	0.5
Strong local (Pacific NW) presence and capability	5.4	1.1	5.8	0.5	5.2	1.3

Figure 10

By inverting and normalizing the overall average and comparing the resulting column to the PCM scores arrived at from AHP, we get the following comparison table:

Criterion:	Normalized	vs. PCM
Cost of service (achieving cost reductions)	**0.25**	**0.22**
Service level performance and quality (on-time, accuracy, reliability)	**0.28**	**0.26**
Comprehensive global capabilities	**0.14**	**0.17**
Information Technology capabilities and integration	**0.14**	**0.15**
Expertise and experience specific to your industry	**0.09**	**0.10**
Strong local (Pacific NW) presence and capability	**0.10**	**0.10**

Figure 11

As can be seen, the normalized scores from the simple ranking are within striking distance from the scores obtained from the considerably more complicated AHP procedure. The general magnitude and order of the rankings are practically the same.

c) Experts vs. Exporters

We divided the ten respondents into two groups: the four logistics and trade experts and the six exporters. The former group works for service organizations such as governmental support agencies, ports and freight forwarders, while the managers in the latter group all currently hold positions with American exporters. Even though the sample sizes are awfully small, we wanted to check if there were discernable differences in the way the two groups weighed and ranked the six selection criteria.[3] Figure 10 deals with the simple rankings, and we can see that the experts gave more weight to service than cost (an average ranking of 1.5 vs. 2.0), while the

[3] Other cross-comparisons could also be performed. For example, one could study whether the exporters engaged in the shipment of refrigerated merchandise (in this case three of them) would prioritize differently than the exporters engaged in supplying industrial supplies/capital goods (in this case two of them). However, we hesitate to draw inferences based on such a low sample base.

exporters assigned equal weight to the two criteria. Does this mean that the exporters are more cost conscious or under greater pressure to save money?

We also compared the AHP weighted scores for the four experts versus the six exporters. Figure 12 shows the outcome of this comparison, compared to the overall weight scores we used in the calculations:

Criterion:	Experts	Exporters	Overall
Cost of service (achieving cost reductions)	0.20	0.22	**0.22**
Service level performance and quality (on-time, accuracy, reliability)	0.24	0.26	**0.26**
Comprehensive global capabilities	0.14	0.20	**0.17**
Information Technology capabilities and integration	0.19	0.13	**0.15**
Expertise and experience specific to your industry	0.10	0.09	**0.10**
Strong local (Pacific NW) presence and capability	0.10	0.09	**0.10**

Figure 12

While the two top ranked criteria are the same (service and cost), the order of the global capabilities and IT capabilities (the yellow cells) were the opposite between the two groups. The exporters found comprehensive global capabilities to be more important than IT, and almost as important as the cost of service.

Conclusions

The Analytic Hierarchy Process (AHP) is a very appealing and thorough method to weigh selection criteria and apply the weights on attribute scores matrices with information distilled from the 3PL providers being considered. One huge benefit is the reliance on just a few topical experts. The deliberate and pairwise method of asking similar comparison questions in a repeated pattern assures fairly consistent rankings, especially when more than just a couple of experts are consulted. In our hypothetical example - which contained real selection criteria,

but attribute data and scores on the four finalists that were guesstimates - we were able to come up with a very realistic weighting vector and a workable attribute score matrix that we used to develop a pro forma ranking of the four candidate providers. In this example, the provider with clearly the highest service scores (C H Robinson) came out ahead of the least expensive provider, FedEx. The proximity of these two providers should encourage further negotiations with both of them. For example, the fact that FedEx is breathing C H Robinson down the neck can be used to negotiate further price concessions from C H Robinson. To strengthen such arguments, there is nothing preventing the project team from performing various types of sensitivity analyses on the data to check the impact of the final rankings if certain attribute scores were tweaked. For example, we did a quick calculation and found that C H Robinson would gain another 2 points (from 0.29 to 0.31) by dropping their prices 10%. Such comparisons can be useful in close situations.

It was interesting to see that using just simple rankings (asking the experts to rank the six criteria from 1 to 6) provided a very similar ranking order and weights. This was not unexpected, given our sample of as many as ten experts. Call this the quick and dirty way to arrive at a weight vector.

By having ten willing experts we were able to compare the priority weightings of two distinct groups of them. The logistics experts (service providers) assigned slightly different aggregate weights from the exporters, but not enough to be worrisome. Any project team should aim to ask a diverse group of experts, as long as these experts have relevant experience with the industry and type of logistics services required. In the case of global trade, it would be essential to have both criteria and experts that relate to the complexities of international logistics and supply chain management.

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- Also: http://www.logisticslist.com/largest-3pl-companies-2010.html; http://www.logisticslist.com/biggest-logistics-companies.html#ixzz1JzqOspy6; http://www.3plwire.com/2009/05/05/top-25-global-3pls-2008/; http://tradeinservices.mofcom.gov.cn/en/i/2008-05-12/35491.shtml

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Appendix A: Questionnaire (sample of cover letter and form)

"…[we are] writing a paper on which decision criteria are used by exporters when choosing a Third Party Logistics Provider (3PL), and how such criteria might be weighted.

With your knowledge of exporting and logistics (even though you may or may not currently be utilizing 3PL's), could you put yourself in the shoes of someone who tries to assign weights to various selection criteria and assign scores to the following pair-wise comparisons? For this method we have chosen six plausible criteria that a decision maker might use, and then ask you to compare each one of them against each of the others, in random order. Each comparison must add up to 100.

For example, if you compare A and B, and think that B is considerably more important than A, then you could assign a score of 30 to A and 70 to B (other plausible splits could be 0/100, 10/90, 20/80, 40/60, 50/50, 60/40, 70/30, 80/20, 90/10, 100/0, or any other number combination in between as long as it adds up to 100).

Each pair-wise comparison should be considered on its own merit. Erase from your memory the earlier comparisons and just assign your subjective importance scores to the pair you are currently considering. There are 15 pairs, and it should only take a few minutes to score them.

It is easy to complete this pair-wise scoring:

Use the reply button, which will enable you to write your scores into the boxes, for ***example,*** *if you consider apples three times more important than oranges:*

Apples	*75*
Oranges	*25*
Total	*100*

When finished with the 15 comparisons, just push the send button, and that's it. (I am attaching a word version of the questionnaire that you can use in case your e-mail browser messes up the formatting).

The six criteria we chose should be self-explanatory. They are all typical factors that exporters evaluating 3PL's would consider…….

PLEASE ASSIGN IMPORTANCE SCORES TO THE FOLLOWING 15 COMPARISONS:

Cost of service (achieving cost reductions)	
Service level performance and quality (on-time, accuracy, reliability)	
Total	*100*

Comprehensive global capabilities	

Information Technology capabilities and integration	
Total	*100*

Service level performance and quality (on-time, accuracy, reliability)	
Expertise and experience specific to your industry	
Total	*100*

Strong local (Pacific NW) presence and capability	
Comprehensive global capabilities	
Total	*100*

Cost of service (achieving cost reductions)	
Comprehensive global capabilities	
Total	*100*

.....etc. (15 iterations total)

Appendix B: Follow-up questionnaire for simple rankings

"... We added one little interesting test to the project: whether a straight ranking of the criteria would give us approximately the same aggregated results (the beauty of pair-wise comparisons is that it gives us weights, but with many respondents we may achieve the same effect by just asking for a straight ranking – much simpler, of course).

If you were to just rank the six criteria in order of importance (with respect to choosing a third-party logistics provider), what would your preferred order be? (Just reply to this e-mail and fill in the six numbers from 1 to 6 in the empty cells; ***1 is the most important, 6 is the least****):*

Cost of service (achieving cost reductions)	
Service level performance and quality (on-time, accuracy, reliability)	
Comprehensive global capabilities	
Information Technology capabilities and integration	
Expertise and experience specific to your industry	
Strong local (e.g. Pacific NW) presence and capability	

Appendix C: Price Comparison Matrix

Possible Price Comparison Matrix (a composite of elements of importance to a particular customer):

Element:	UPS	FedEx	Expeditors	CH Robinson
Fixed (lumpsum) up-front setup costs?	$12,000	$40,000	$5,000	$0
Monthly fixed fees?	$1,000	$500	$2,000	$3,750
= 5-year fixed cost	$72,000	$70,000	$125,000	$225,000
Sample transportation costs (for representative point-to-point moves of typical commodities):				
a) Air shipment	$225	$199	$250	$238
b) LTL (e.g. 1 pallet)	$395	$445	$375	$490
c) TL (e.g. 1 x 40' container)	$3,250	$2,925	$3,950	$3,400
Straight sum (no weights)	$3,870	$3,569	$4,575	$4,128
Warehousing and order fulfillment fees:				
a) Fixed	$750	$1,200	$999	$1,500
b) Variable (e.g. per pallet, per shipment, per carton, per area occupied, etc.)	$3 per move + 50 cents per cubic yard per month	$2.50 per move + 45 cents per cubic yard per month	$3.10 per move + 55 cents per cubic yard per month	$2.00 per move + 70 cents per cubic yard per month
Per month with 500 moves,	----------	----------	----------	----------

average 1,000 cubic yards	$2,750	$2,900	$3,099	$3,200
Hourly service fees for additional services	$22.50	$19.75	$35.00	$29.00
Transaction fees (documentation, handling, etc.)	$0.25 per transaction	$0.30 per transaction	$0.15 per transaction	$0.19 per transaction

This leads to a normalized comparison matrix:

Element:	UPS	FedEx	Expeditors	CH Robinson
5-year fixed cost	.15	.14	.25	.46
Transportation	.24	.22	.28	.26
Warehousing/Fulfillment	.23	.24	.26	.27
Hourly services	.21	.19	.33	.27
Transaction fees	.28	.34	.17	.21
Average w/equal weights	**.22**	**.23**	**.26**	**.29**