ISSN: 2513-2520

R4TLI Conference Proceedings 2017
Paper Reference: *R4TL (17) – D32*

Literature Review of Analytical Techniques Used in Solving Logistics Problems

R N Liyanage
University of Moratuwa, Sri Lanka

Amal S Kumarage
University of Moratuwa, Sri Lanka

1. Introduction

Optimising the use of resources is critical for efficiency and pricing in the logistics industry. Analytical techniques (AT) play a decisive role by providing solutions such as optimisation. This paper is a review and classification of the different ATs which are the most widely-used in solving common logistics problems (LP). The objective of this research is to evaluate the most-used ATs.

2. Methodology

The review is based on a search of resources including journals, books and websites based on the keywords such as 'analytical techniques', 'freight logistics', 'distribution', 'optimisation', 'decision making', 'forecasting', 'performance evaluation', 'logistics problems' and so on regarding logistics and ATs. Fifty-six recorded researches and case studies published within the 2008 - 2017 period have been used to classify the ATs according the LP they were used to solve. These 56 articles were then classified according to their research nature as empirical and theoretical. 42 articles (75%) were empirical while only 8 articles (14.29%) represented theoretical studies and the other 6 (10.71%) articles are review-based. Among the empirical studies, 36 articles are case studies conducted in different geographical regions that are Europe with 17 (47.22%), Asia with 14 (38.88%), and USA and Brazil with 5 (13.9%) as well as 6 articles are survey based.

3. Analysis

3.1. Different Types of Logistics Problems (LPs)

The total of 31 recorded LP cases in research papers and case studies could be classified in to seven categories that have been identified and elaborated as:

- Location Selection - the selection of the best location, such as for a logistics hub, distribution centre or warehouse.
- Transport Mode Choice - the selection of the better mode of transport for freight distribution.

- Design of Network–selection the features for an optimal reverse and forward logistics network.
- Selection of Logistics Partners - the selection of logistics partners such as suppliers, vendors and third-party logistics (3PL) partners when evaluating partnership strategy.
- Logistics Benchmarking and Performance Evaluation - the discovery of what would be the best performance that can be achieved by a particular company, competitor or by an entire logistics industry.
- Vehicle Routing Problem (VRP) - finding the optimal route for delivery or collection of material or people.
- Demand forecasting –means of predicting future demand on the basis of past events and prevailing trends.

3.2. Different Types of Analytical Solutions (ATs)

A classification of ATs by Aguezzoul (2014) compiled for the performance measurement of 3PL identified multi-criteria decision-making (MCDM) techniques, mathematical programming models, artificial intelligent, statistical approaches and integrated approaches. MCDM is a methodological framework that aims to select the best solution from a finite set of alternatives evaluated using multiple criteria. The mathematical programming models consist of an objective function optimised as opposed to a set of constraints faced by the decision maker. Integrating qualitative factors and human expertise in the selection process is called artificial intelligence. Statistical approaches use correlation and refer to data gathered from empirical studies. Combining two or more techniques to select the better solution is called an integrated approach.

Most forecasting methods which can be included belong to mathematical programming and statistic approaches. But research in forecasting techniques classify them in different ways. Table 1 shows them classified as quantitative and qualitative methods, with the latter further divided as casual and time series extrapolation (Ghiani & Laporte, 2004).Therefore, forecasting techniques have been classified as another category here.

Table 1: Classification of forecasting techniques

Category	Techniques	Comparison
Quantitative Casual	• Regression • Econometric models • Input– Output models • Life-cycle analysis • Computer simulation models • Neural networks	• Difficult to implement, even for larger companies. • Difficult to identify any causal variable having a strong correlation with future demands. • Difficult to find a causal variable that leads the forecasted variable in time. • In practice, only single or multiple regression is used for logistics planning and control.
Quantitative Time series extrapolation	• Elementary technique • Moving averages • Double moving average method • Exponential smoothing techniques (Brown method) • Revised exponential smoothing method • Holt method • Winters method • Decomposition approach • Box–Jenkins method	• Easier to understand and explain. • Winter's method can be used whenever there is a linear trend and a seasonal effect. • In a business context, complex forecasting procedures seldom yield better results than simple ones.
Qualitative	• Sales Force assessment • Market research • Delphi method	• To estimate the influence of political or macro-economic changes on an item demand.

Note: Adopted from Ghiani & Laporte, 2004.

Of the 56 cases investigated in this research, 49 can be categorized in to the six ATs as discussed above and shown in Figure 1 with the balance falling within review.

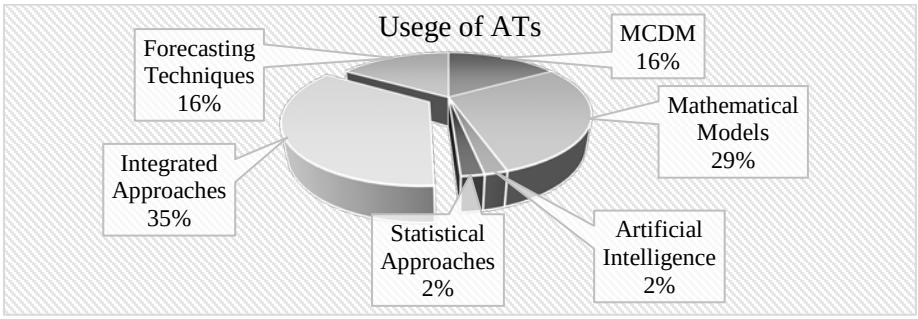

Figure 5: Distribution of ATs Used in LPs

Majority of researchers have used two or three techniques together to make the decision due to greater effectiveness than using one technique. Most of time MCDM techniques such as Analytical Hierarchy Process (AHP) have been used with mathematical programming and Fuzzy sets. Table 2 shows examples of how ATs have been used in referred papers.

Table 2: Integrated approaches

	MCDM	**Mathematical model**	**FUZZY**
MCDM	AHP/TOPSIS AHP/ DEMATEL AHP/SCOR model TOPSIS/ BWM	AHP/MILP AHP/ Gravity model DEA, TOPSIS / LP	PROMETEE/ FUZZY ANP/ FUZZY AHP/ FUZZY TOPSIS/ FUZZY ANFIS/ FUZZY ARAS/ FUZZY AHP,Delphi / FUZZY

AHP can be used to structure a complex problem into a hierarchy of simpler clusters using the decomposition principle. The major limitation of AHP is the subjectivity of the decision criteria used (Alam & Jonsson, 2013). Analytical Network Process(ANP) and TOPSIS also have been used as MCDM techniques. ANP is a powerful tool due to ability to analyse both quantitative and qualitative and multiple dimensions of information into the analysis and advance version of AHP (Çelebi, Bayraktar, & Bingöl, 2010). Analysis using fuzzy numbers could improve accuracy in many real-world decisions. As such integrated systems use a combination of MCDM techniques with fuzzy sets. Furthermore, Gary system theory, DEMATEL, DEA, SWOT analysis, ANFIS and ELECTRE methods are different MCDM techniques used in Selection Processes. Genetic Algorithms (GA) and Savings Method are heuristic approaches which yield near-optimal results very quickly. They are used to solve VRP.

3.3. Mapping of Typical ATs used for Solving Different LPs

Table 3 shows the instances where the different ATs were used in solving different LPs.

Table 3: Frequency of AT Usage in Literature for Solving LP

	MCDM			Mathematical Models										
	AHP	ANP	DEA	Integer programming	MILP	robust model	GA	Saving Algorithm	MOPSO	Statistical approaches	Artificial intelligence (Data mining)	Integrated Approaches	Forecasting techniques	Discussion of ATs
Location selection												3		1
Mode choice												1		
Design network					5		1					2		
Selection of logistics partner	1	1										7		3
Logistics Benchmarking /performance evaluation			2									2		
VRP (Vehicle routing problem)				3			1	1			1			
Demand forecasting													8	
Set of LPs	2					2			1	1		2		5

4. Conclusion/Recommendation

This review has classified logistics problems into seven categories and major analytical techniques into five major categories. There are different techniques which can be used within the major techniques and integrated solutions where several techniques are put to combined use.

5. References

[1] Aguezzoul, A. (2014). Third-Party Logistics Selection Problem: A Literature Review on Criteria and Methods. Omega. https://doi.org/10.1016/j.omega.2014.05.009

[2] Alam, S. A., & R. Daniel Jonsson. (2013). Evaluation of the potential locations for logistics hubs: A case study for a logistics company. KTH Royal Institute of Technology.https://www.diva-portal.org/smash/get/diva2:604876/FULLTEXT01.pdf

[3] Çelebi, D., Bayraktar, D., & Bingöl, L. (2010). Analytical Network Process for logistics management: A case study in a small electronic appliances manufacturer. Computers and Industrial Engineering, 58(3), 432–441. https://doi.org/10.1016/j.cie.2009.09.002

[4] Ghiani, G., & Laporte, G. (2004). Introduction to Logistics Systems Planning and Control. https://doi.org/10.1002/0470014040

***Keywords**: analytical techniques, optimisation, forecasting, logistics, logistics problem*