Benchmarking the outsourcing factors of third-party logistics services selection: Analysing influential strength and building a sustainable decision model

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Revision Response

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for their insightful comments and suggestions.

The corrections incorporated are being highlighted in the revised paper with yellow colour respectively.

Dear Editor-in-Chief of Benchmarking: An International Journal

First, we would like to thank you and your esteemed reviewers for such insightful and constructive comments. In response, we have made the requested changes to our paper, which we believe have improved the quality of the manuscript. As per reviewers and your suggestions, the manuscript has been revised significantly and explained the motivation with additional value of the research. In the revised manuscript, the authors tried hard to present "Benchmarking the outsourcing factors of third-party logistics services selection: Analysing influential strength and building a sustainable decision model" which can be so significant for managers and decision makers.

We hope that you find the revised version to your satisfaction and to that of the reviewers. Finally, we thank you for your expeditious handling of the review process for our manuscript, and we look forward to your response.

Thank you in advance.

Yours sincerely,

Authors

Associate Editor

Comments to Author:

Please proofread your work.

Response: Thank you for your great suggestion. After applying all esteemed reviewers' comments, proofreading was conducted by an English native speaker to improve the language.

The revised manuscript as per Journal requirements is submitted for your kind consideration. We look forward to your positive response.

Thank you very much for your kind support.

Yours sincerely,

Corresponding author

Benchmarking the outsourcing factors of third-party logistics services selection:

Analysing influential strength and building a sustainable decision model

Abstract

Purpose: Outsourcings always affect crucial supply chain functions concerning flexibility and cost. During the decision to outsource and consider third-party logistics service (3PLs) provider selection, decision-makers need to pay more attention to certain critical outsourcing factors such as coordination, integration and cooperation as these key factors are essential to improve overall supply chain performance. The main purpose of this work is to identify the inter-relations among outsourcing decision factors to highlight the most important and influential factors that should be considered and carefully thought through when making outsourcing sustainable decisions.

Methodology: A two-phased methodology has been used in this study. In the first phase, outsourcing decision factors are identified from existing literature and validated by decision-makers from industry and academia. To understand the influential strength and build a sustainable model, the decision-making trial and evaluation laboratory (DEMATEL) method is employed. A courier company in the United Arab Emirates is considered for implementation.

Findings: All identified and validated factors are segregated into two categories (cause and effect). The result shows that the most influential factors are; developing strategic alliances, uncertainty and risk mitigation and deficiency of internal resources for a service.

Practical implications: There are several insights for industry managers and practitioners. The results of the study may help practitioners and logistics managers to make the logistics service sustainable and more efficient for businesses.

Originality/value: The originality of the study is that this study focuses on a courier company to understand the interdependencies among outsourcing decision factors; this is unique in this field of literature.

Keywords: Outsourcing decision; sustainability; outbound logistics; benchmark; DEMATEL; sustainable logistics

1. Introduction

To fulfil customer orders efficiently and effectively, it is essential to know the inter-relationships of all supply chain functions (Beamon, 1999; Khan, 2013; Szász and Seer, 2018; Salam and Khan, 2020). Ishtiaq et al., (2016) suggested that logistics and transportation play an important role in

any company's success and its outsourcing decisions play an integral part in the efficiency of the supply chain. Organizations are finding different ways of managing their supply chains to compete in this global environment as well as to be sustainable (Ali et al., 2018; Moktadir et al., 2019; Paul et al., 2020). Khan and Sawicka (2016) highlight the importance of innovation in the supply chain network and reduced logistics cost by redesign of the logistics process using outsourcing. Outsourcing is defined as *"the practice of hiring a third party from outside the company to provide goods and services that traditionally were performed in-house by the company's dedicated staff"* (Twin, 2019).

Most organizations and businesses around the world tend to regard outsourcing as a beneficial technique to use in their work. However, the question is why is it very important? How does this affect them and why is it preferred over using dedicated company employees? Outsourcing allows organizations to focus on their core businesses, as they outsource jobs such as computerized ways of entering data, marketing call centres, call centres; this frees up more time and attention to important activities, for example, marketing, sales, research and development and storing (Liu and Wang, 2014). This way, organizations will remain competitive by focusing on their core competencies.

Outsourcing also provides constant flexibility to companies with varying demands, as it gives the organization a chance to hire employees based on their needs and without worrying about hiring employees long-term (Keebler and Plank, 2009; Cagliano et al., 2017; Söderberg et al., 2017; Akbari, 2018). For example, for businesses involved in sales and marketing, tax season is a critical time of the year; therefore they need to hire extra accountants. Companies usually outsource an activity as a cost reduction measure as minimizing operational and recruitment costs is one of the most important aspects under consideration when a company makes decisions (Twin, 2019; Mangano et al., 2019).

Flexibility is an important factor in outsourcing as it gives organizations a chance to replace employees when unexpected actions occur e.g. when a worker becomes ill or an unexpected injury occurs to one of the staff. Having the chance to replace a key member of staff directly, positively affects the business as it does not prevent work and operations from meeting deadlines. All of these are interesting options for organizations to look at when deciding to outsource. It proves how much of a positive effect outsourcing has on companies, especially when finding the right outsourcing company that could help your organization bloom and become bigger as the years go by.

1.1 Problem context and objectives

We consider a courier company (details of the company can be found in Section 4.1 below) in this study who are currently facing problems in their logistics network with flexibility, accessibility and responsiveness. Therefore, the purpose of this study is to propose a framework and help this company by directing and providing them with decision factors that will help them in their sustainable outsourcing decision-making. This study focuses on the UAE courier company due to the following reasons. Firstly, this company is well established and well-known for its timely delivery, dedication and customer services. Secondly, the company shows continued growth in the number of shipments of e-commerce within their express transportation services while increasing operational efficiency. They are continuously expanding; therefore, they need a systematic procedure to select their 3PL (third party logistics) service provider. The proposed framework will also help them to prioritize important factors when making an outsourcing sustainable decision. This will provide competitive advantage at a supply chain level rather than an overall company level and will be available to use as benchmarking. This will also help managers and decision-makers in their strategic and operational outsourcing sustainable decision-making to achieve favourable outsourcing integration within the company. This will lead to improving the overall supply chain performance as well as increasing profitability. The specific objectives of this study are:

- Identify outsourcing decision factors of outbound sustainable logistics through literature review and experts' opinions
- Evaluate the inter-relations between outsourcing factors, then segregate these inter-relations into cause and effect categories to find the key influential factors to be considered and focused on when making outsourcing sustainable logistics decisions
- Rank the decision factors based on their weights and prominence to highlight the important factors

To achieve the desired goals of the research, an extended literature review was carried out to identify the factors involving outbound sustainable logistics decisions. Following the review, a set of key outsourcing decision factors of outbound logistics was identified and assessed via the DEMATEL technique. In this study, the DEMATEL technique was selected for its advantages in

finding interactions among decision factors which can help to make better decisions after considering causal and effect group factors.

This paper is organized as follows. Section 2 provides a brief overview of the literature related to outsourcing. Section 3 describes the proposed research methodology followed by case description and proposed methodology implementation in Section 4. The results and discussion of findings are presented in Section 5. Section 6 provides the managerial and practical implications of the finding. Finally, Section 7 concludes the paper.

2. Literature review

Barak and Javanmard (2019) worked on a case study to find and address the most strategic and important indicators that would help them build successful outsourcing alliances. The outsourcing factors or indicators they focused on were decreasing overall costs, improving technical abilities and implementing new technologies. Tian and Guo (2019) concluded that to remain responsive, it is essential to reconfigure manufacturing processes and supply chains to cater to constant and rising customer demands and to be able to fulfil the needs of customer customizations. To accomplish that, they need a "system-level optimization" that comprises factors such as outsourcing decisions, manufacturing tasks and different configurations in the supply chain. Examination was made of outsourcing factors such as reducing production costs, decreasing uncertainty and risks, competitive competencies and focusing on core competencies. The authors accomplished this task using a graph-based cost model (optimization model) as their method.

Grant (2019) combined two articles about classic industrial marketing management (IMM) to talk more about outsourcing integration and 3PL. A range of outsourcing factors were studied - increasing efficiency, concepts of cost transactions, organizational core competencies, establishing a competitive advantage and providing extra value for customers, reduced costs and improving service standards for a more beneficial logistical expertise. A wider geographical coverage for products and services was also looked at. Kavosi et al. (2018) applied a Delphi technique to explore factors that are influential in deciding on healthcare services outsourcing. The objective was to find the most important factors when making these decisions in this sector. The outsourcing factors they used in their study focused on the main function, utilizing resources for core activities; these were identified as "*improving flexibility*", "*sharing of risk*", "*improve service quality*", "*produce higher reliability and competency*", "*save management time*", "*reduction in management*

load", "*enhancing implementation speed*", "*enhance safety management system*", "*improve accountability*", "*need for specialized management*", "*function difficult to manage*", "*achieve flexibility with changing technology*", "*achieve innovative ideas*", "*complexity of function*", "*function integration and structure*", and "*save overall cost*".

Modak et al. (2017) carried out a performance evaluation of outsourcing decisions for the Indian coal mining industry using a combined method of Balanced Scorecard (BSC) and Fuzzy Analytic Hierarchy Process (FAHP). This study helps to determine the importance of the decision criteria by taking feedback from the decision-makers. The outsourcing factors of their study included "*profit variance*", "*operational cost*", "*reduction of penalties*", "*availability*", "*adherence to delivery schedule*", "*adherence to statutory norms*", "*production target achieved*", "*asset management*", "*training and development*", "*research and development*", "*employee satisfaction*", "*risk-sharing*" and "*leakage of confidential information*".

Hahn et al. (2016) developed a case study to select beneficial outsourcing techniques taking into consideration financial and statistical measures such as quality, risk, cost and services using Data Envelopment Analysis (DEA), Aggregate Production Planning (APP), MCDM and an optimization model. Criteria such as managing operational risks and quality issues, increased flexibility and cost efficiency as well as service improvements were explored. Bloem and Bean (2015), investigated the logistics function in a study in South Africa. This study objective was to provide a recommendation about outsourcing decisions. They applied the decision tree method and linear programming. The considered factors in this study were "*logistics costs*", "*associated risk*", "*long term strategy*", "*service provider fit*", "*degree of market growth achieved*", and "*service levels*".

Hassanain et al. (2015) presented an MCDM model to be used by managers for outsourcing maintenance services. Their objective was to develop a model using AHP (Analytic Hierarchy Process) that would prove useful to managers and decision-makers of Saudi Arabian universities in making outsourcing decisions. The AHP was introduced and applied first; the pairwise comparison method was then used to weigh the outsourcing factors. After scrutiny of published literature, they identified 38 factors that influence outsourcing decisions related to maintenance services. These identified factors were categorized into six main categories - *Strategic*, *Management*, *Technological*, *Economic*, *Quality*, *Function-characteristics*. Tjader et al. (2014) conducted a study on organization level outsourcing decision-making using a combination of BSC

and Analytic Network Process to determine the importance of IT outsourcing strategy. They considered outsourcing factors from BSC perspectives. Among the outsourcing factors they considered were "*availability of product/service*", "*customer database*", "*customer satisfaction*", "*price stability*", "*cash flow*", "*cost savings*", "*industry leadership*", "*profitability*", "*agility*", "*certifications*", "*core focus*", "*internal control*", "*quality*", "*employee competency*", "*employee satisfaction*", "*management know-how*" and "*technology RD*".

Lu et al. (2014) used a mathematical and optimization model to conclude whether it is better to have a company decide on whether they should outsource their supply chain activities or have them self-managed. They looked at outsourcing factors such as maximizing productivity and profitability, competitive strategies, cost savings, focusing on core competencies, as well as knowledge transfer and compliance effort. Cai et al. (2013) describe how they developed a model to characterize and filter the optimal decisions that each party should take in and work on to obtain a better supply chain. Their aim was to enable a fresh product manufacturer to supply goods to a distant market with the help of 3PL to preserve the quality of fresh products such as fruits, flowers etc. The outsourcing factors they considered were the geographical coverage regarding the separation of production base and target market, minimizing time cost and utilizing expensive transportation such as aircraft. Hsu and Liou (2013) discuss how outsourcing has become a critical need in most companies to boost growth and maximize their business performance. A study of airlines industries was made, looking at strategic moves on outsourcing their activities by considering outsourcing factors such as cost savings, increasing efficiency, analysing risks, organizational flexibility, maximize profits, customer satisfaction as well as improved competitiveness. They worked to accomplish these outsourcing factors using methods such as transaction cost theory (TCE), MCDM and most importantly, DEMETAL with the help of ANP, to be able to construct and weight the relationships of the outsourcing factors listed above.

Contador et al. (2012) conducted a study to build an approach to assess information technology outsourcing suppliers for the improvement and development of an existing system towards competitive advantage. To accomplish that, they used the model of Fields and Weapons of Competition (FWC) based on a range of outsourcing factors - minimizing costs, enhancing the quality of their services and competitive advantages.

This section aims to identify outsourcing factors where companies with similar (to the considered courier company) activities in logistics and supply chain depend on outsourcing decisions. To accomplish that, we have looked into 15 articles about outsourcing factors used in companies when outsourcing. We have conducted these searches using databases such as Science Direct and Google Scholar. We used "Outsourcing factors", "Outsourcing courier companies", "MCDM techniques", "MCDM + Courier" and "Outsourcing factors" as keywords in these searches.

After reading about the outsourcing decision factors and multi-criteria decision making (MCDM) techniques in the selected articles, we settled on the DEMATEL technique. We then made further literature readings on its applications in various businesses with similar purposes to our study. Scrutiny of eight articles was made regarding the use of DEMATEL applications in other pieces of research using keywords such as "DEMATEL applications", "DEMATEL methodology" and "DEMATEL in outsourcing decisions". This is further discussed in detail in this section.

After an extensive literature review, all outsourcing factors are listed in Table1.

Table 1. Outsourcing factors

Factors	Brief description	References
Cost reduction	Does outsourcing save overall cost by reducing labour, operating time, costs etc.?	Hahn et al., (2016); Hassanain et al., (2015); Kavosi et al., (2018); Woodall et al., (2009)
Flexibility and agility	Does a 3PL SP provide responsiveness to change or fluctuation in demand?	Hahn et al., (2016); Hsu and Liou (2013); Ramkumar et al., (2009); Hassanain et al. (2015); Woodall et al., (2009); Tjader et al., (2014); Kavosi et al., (2018)
Accessibility and Response time sensitivity	Is a 3PL SP easily accessible and responsive to any query within an agreed time?	Ramkumar et al., (2009)
Value addition	Does outsourcing add some value to the company?	Ramkumar et al., (2009)
Developing Strategic Alliances	Does forming an outsourcing contract with TPLs help you gain strategic alliances with outside firms?	Hassanain et al., (2015); Kavosi et al., (2018)
Competitive advantage	Will outsourcing help you gain a competitive advantage over others in the same field?	Contador et al., (2012); Ramkumar et al., (2009); Hassanain et al., (2015); Kavosi et al., (2018)
Enhance technical capabilities and achieve new technologies	To improve existing services and come up with new technologies that help with getting work achieved at a better place. Do you think this is possible with outsourcing TPLs providers? Will they help you keep pace with technology advancements?	Barak and Javanmard, (2019); Hassanain et al., (2015); Woodall et al., (2009); Modak et al., (2017); Kavosi et al., (2018); Tjader et al., (2014)

Uncertainty and Risk Mitigation	With outsourcing, risks and uncertainty might come in the way of your work. How predictable and controllable are the risks associated with outsourcing? Are they manageable?	Tian and Guo, (2019); Bloem and Bean, (2015)
Focus on core competencies	Core competencies are the firm's core functions. Does outsourcing help the firm focus on its defining strengths? Does it help with providing and supporting the foundations from which the business will grow?	Tian and Guo, (2019); Hassanain et al., (2015); Woodall et al., (2009); Tjader et al., (2014); Kavosi et al., (2018)
Improve service standards	Service standards are the most important aspects of achieving customer satisfaction. Do you think outsourcing will achieve a good service level in the eyes of the customers?	Grant, (2019); Ramkumar et al., (2009); Hassanain et al., (2015); Woodall et al., (2009); Kavosi et al., (2018)
Time cost	Does outsourcing save time and give you the chance to use this time to achieve the completion of other tasks and activities (time efficiency)?	Cai et al., (2013); Hassanain et al., (2015) Kavosi et al., (2018)
Maximize Utilization of expensive transportation	Save costs of transportation through outsourcing different delivery methods such as trucks, motors, aeroplanes etc. depending on delivery shipment type and size.	Cai et al., (2013)
Maximize productivity and profitability	Does outsourcing help the company produce more output than usual? Is it more profitable? Does it increase revenue?	Lu et al., (2014); Woodall et al., (2009); Tjader et al., (2014)
Function Complexity	Is the function difficult to accomplish, manage or control? Will outsourcing help with accomplishing, managing and/or controlling it?	Hassanain et al., (2015); Kavosi et al., (2018)
Lack of equipment and tool availability	Are the equipment and tools available in the firm or should they be deployed from outside to reduce costs and increase efficiency and effectiveness?	
Deficiency of internal resources for a service	The company might consider outsourcing resources when required to achieve the core service.	Hassanain et al., (2015); Kavosi et al., (2018)
Regulations governing the outsourcing practices	Are there any regulations that limit your outsourcing decision or outsourcing practices?	
Increase efficiency	Will outsourcing increase a firm's efficiency?	Hsu and Liou, (2013)
Performance	Can outsourcing improve the overall performance of the company or at least maintain it?	Bloem and Bean, (2015); Modak et al., (2017)
Financial returns	Will outsourcing incur better financial returns?	
Freeing resources for core activities	Does outsourcing help free a firm's resources for core activities rather than wasting them on secondary activities?	Hassanain et al., (2015); Kavosi et al., (2018)

2.1 DEMATEL application in literature

The DEMATEL method has been applied by Li and Mathiyazhagan (2018) to identify the influential factors of sustainable supply chain implementation in the automotive sector. The researchers focused on automotive components in small and medium-sized industries (SMEs) aimed at sustainable development (SD). They figured that the analysis of sustainable development indicators is essential to confirm SD in the auto-components manufacturing industry. Horng et al. (2013) used the DEMATEL application to investigate the important components of creativity by identifying and analysing different dimensions of "restaurant space design" based on an expert's opinion. This study presents a unique model of creativity assessment using the DEMATEL method. It identified six main dimensions of creativity - "*Novelty*", "*centrality*", "*importance*", "*affect*", "*interactivity*" and "*resolution*". They used both qualitative and quantitative surveys in several stages of data collection. They then used DEMATEL to identify the inter-relations and interactions among the six dimensions, revealing the dimensions with greater influence over others.

Chauhan et al. (2016) utilized the DEMATEL method along with ISM to analyse the barriers that hinder waste recycling in India. Overall, the amount of waste is causing problems for all nations across the globe, especially in countries like India. The theme of that study was to identify barriers that hinder the establishment of "waste recycling units" in India. After the barriers are identified, the study also identifies the most influential barriers by interpretive structural modelling (ISM) and DEMATEL.

Uygun et al. (2015) applied the DEMATEL approach along with fuzzy ANP to evaluate and select an outsourcing service provider in the telecommunication sector. Organizations improved their competitiveness by outsourcing. This study aimed to help decision-makers in demonstrating the inter-relationships among outsourcing factors and to take corrective actions based on their analysis. In this study, the integrated methodology i.e. DEMATEL and Fuzzy ANP, is used for the assessment and selection of an outsourcing provider for the telecommunication company.

In the present era, social media is all embracing; the capability of accessing it and the frequent usage of it has now become the norm. Researchers have discussed the possibility of highly addictive social media use (e.g. Kuss and Griffiths, 2017, Blackwell et al., 2017; Turel et al., 2018, Kırcaburun and Griffiths, 2018). Searching through and analysing these studies, their research suggests that such "addictive" behaviour is some sort of psychosocial disorder; this view is

supported by signs of emotional disturbance, withdrawal and interruptions and corruption of social relationships. This has supported a need for research into the broad area of influential factors and their relationships with each other. Using the DEMATEL method, some studies have revealed the relationships, inter-relations and interdependencies among factors, converted it into a cause and effect diagram, as well as highlighted the critical components in the system using impact relation diagrams (Dalvi - Esfahani et al., 2019; Raut et al., 2019).

In any decision-making problems, or any risk analysis situations, it is highly likely that the help of expert knowledge will be needed. Unfortunately for Kaya's case study, little data is available, leading to the use of the DEMATEL method to create Bayesian networks; this is recognised as a powerful framework that makes complex inferences based on decision-makers' knowledge (Fenton and Neil, 2019). This method helps in using surveys to evoke the confidence of both indirect and direct relations from several experts. The method also uses ranked nodes to help parameterize the BN and helps in more feasible decision support (Kaya and Yet, 2019).

The natural gas industry is a very critical yet important domain in our lives and depends on safe and reliable pipeline networks. However, as important as it is, it can also be quite risky in the event of any gas pipe leaks where it can escalate to major tragic events and result in the corruption of properties, and more importantly, loss of lives. Therefore, the goal of this study was to reduce any possible risk caused by a buried gas pipeline using the DEMATEL method to help with the theoretical accident analysis by representing a cause and effect diagram and identifying relationships among various potential accident-causing indicators; this helps the controller of the pipeline system to reduce the risks through security management resources (Li et al., 2019).

Heart failure is a global clinical issue that is of critical significance; it involves substantial resources and costs for treatment. Today, clinicians face a huge challenge in implementing the complex heart failure "self-care" process to come up with the best intervention for this issue. Therefore, they have decided to use the DEMATEL technique to examine critical success factors and to minimize the complication of the self-care process. Ten factors were identified as affecting heart failure self-care with a survey carried out to gauge their importance. Four experts were then asked to assess the direct link between influential factors in the heart failure self-care procedures to then analyse and visualize the direct and indirect relations between factors according to their type and severity (Mahmoudi et al., 2019).

2.1 Literature gaps and contributions

The literature on 3PL is vast and well established. However, the literature on outsourcing decision factors for the selection of 3PL in the context of the sector under study still has research gaps. That's why in this research we focus on smoothing and making efficient decision degrading 3PLP selection for this courier company. To do that, the literature review was used to extract outsourcing decision factors previously selected by many companies who had worked on them to come up with the decision to outsource. Extracted decision factors have helped us in creating a survey to elaborate on these with experts from our considered courier company to see if they match with their outsourcing decisions. We also looked into different MCDM techniques that were applied for similar purposes in various sectors and decided to proceed with the DEMATEL application. It has proved successful for evaluating the validated outsourcing factors and identifying the interdependencies and criticalities among them.

We chose the DEMATEL application because, compared with other MCDM techniques, we found it to be the most suitable and best fitting for our objectives; it is effectively able to find the inter-relationships among factors indicating cause and effect groups. Also, it helps decision-makers and managers to realize which factors have influence on one another. The main reason why we chose DEMATEL is that it can determine decision factors with ranking positions and how they show influence on each other. However, AHP can also be used to rank factors by finding weight but is unable to indicate the interactions among factors. After settling on the DEMATEL technique, we read and summarized companies' experiences using the DEMATEL application in their processes of MCDM for different organizational purposes.

3. Research methodology

To achieve our objectives set out in Section 1, we conducted a literature review (as mentioned in Section 2) to identify the potential factors and to decide on a suitable MCDM technique for our study. After identification, surveys and focus group discussions were conducted to validate the potential outsourcing decision factors and evaluate the inter-relations among them. The DEMATEL technique was then applied to identify the inter-relations, highlight the influential and autonomous factors and compute the importance weight rankings of the outsourcing factors (Sharma et al., 2016). Figure 1 below shows a summary of the steps undertaken in our proposed methodology.

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┌──────────────┐      ┌─────────────────────┐      ┌──────────────┐
│  Literature  │─────▶│ Identification of   │◀─────│ Discussion with│
│   Review     │      │ factors used to     │      │   Experts    │
└──────────────┘      │ outsource           │      └──────────────┘
                      └─────────────────────┘
                              │
                              ▼
                  ┌─────────────────────────┐
                  │ Survey sent to experts  │
                  │ to extract factors      │
                  │ used for outsourcing    │
                  └─────────────────────────┘
                              │
                              ▼
                  ┌─────────────────────────┐
                  │ Construct a direct      │
                  │ relation survey for     │
                  │ evaluations of          │
                  │ interrelations          │
                  └─────────────────────────┘
                              │
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                  ┌─────────────────────────┐
                  │ Application of DEMATEL  │
                  │ technique               │
                  └─────────────────────────┘
                              │
                              ▼
                  ┌─────────────────────────┐
                  │ Validation of results   │
                  │ of DEMATEL approach     │
                  └─────────────────────────┘
                              │
                              ▼
                  ┌─────────────────────────┐
                  │ Develop conclusions and │
                  │ recommend solutions     │
                  └─────────────────────────┘
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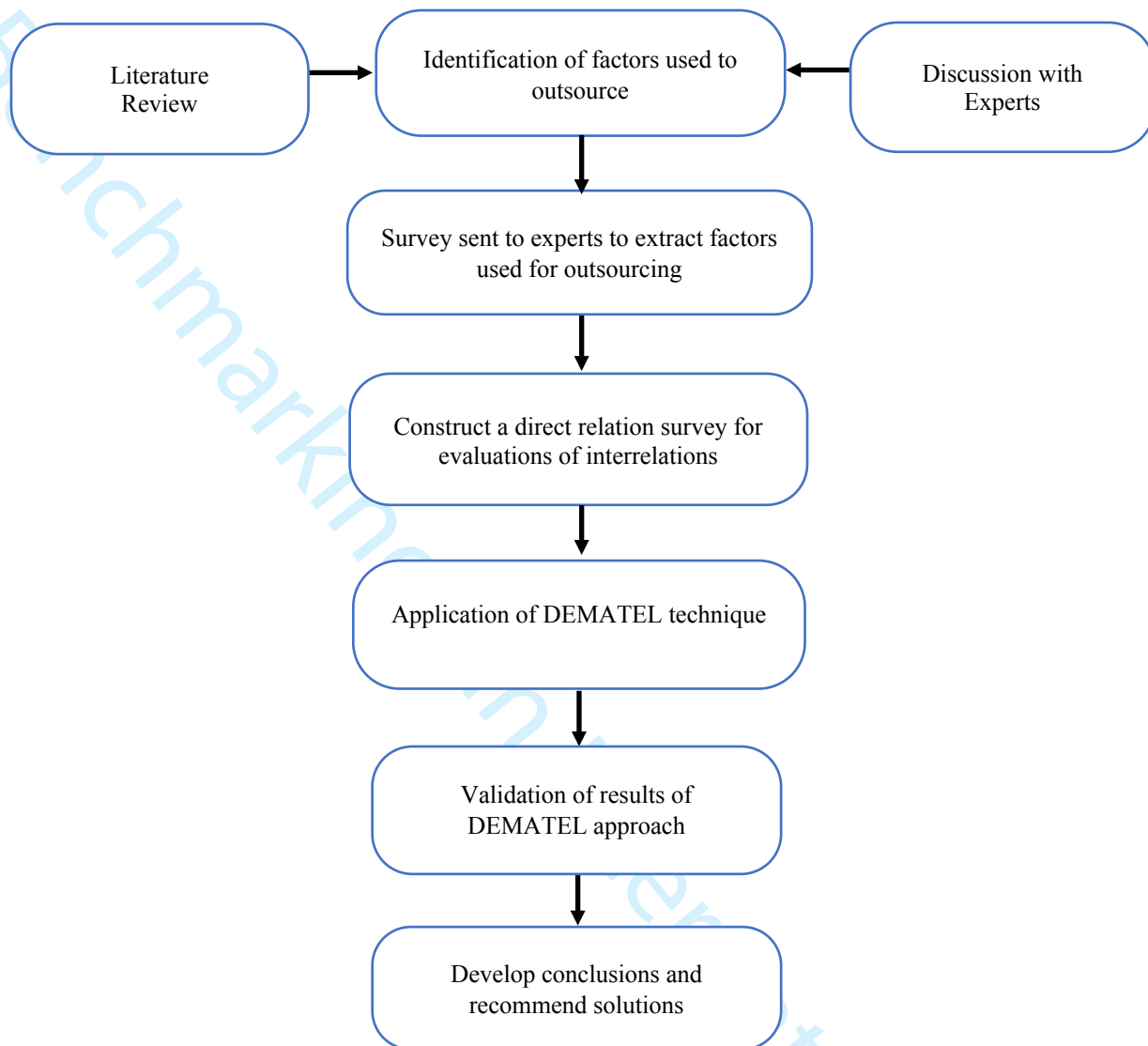
Figure 1: Proposed framework of our research study

3.1 DEMATEL process

DEMATEL is a widely used method to identify interactions among different factors (Kumar et al., 2018). It is a powerful structural model that envisions the structure of cause-effect relationships through matrixes and/or digraphs. It evaluates inter-relationships among factors and the inter-relations between them, identifying the critical ones through the graphic structural model (Nimawat and Gidwani, 2021). According to Batia and Srivastava (2018), "*DEMATEL technique can convert the interrelations between factors into an intelligible structural model of the system and divide them into a cause group and an effect group*". Therefore, it is an essential decision

modelling tool for analysing inter-relationships among different factors. In literature, it has been used by many researchers and decision-makers in several applications such as evaluating barriers to sustainable supply chains (Moktadir et al., 2018), demonstrating supply chain risk mitigation (Rajesh and Ravi, 2015), investigating GSCM practices (Govindan et al., 2015), social aspects in the sustainable supply chain (Khan et al. 2021), supplier selection (Chang et al., 2011) and many more. The mathematical steps of DEMATEL can be summarized as follows (Si et al., 2018):

1. Generate the direct relation matrix by gathering experts' opinions and calculating the average matrix Z by using a linguistic comparison scale as shown in Table 2 below:

Table 2. Linguistic comparison scale

Meaning	Linguistic value
No influence	0
Low influence	1
Medium influence	2
High influence	3
Very high influence	4

Take the average value based on the experts' and decision-makers' opinions about the influence of each factor over another and the inter-relationships between them.

$$Z_{ij} = \frac{1}{l} \sum_{k=1}^{l} z_{ij}^{k},$$ (1)

Where l= number of experts in the decision group, and Z= Z-matrix.

2. Establish the normalized direct-relation matrix X. For normalizing the matrix, each row will be summed up and then each value in the matrix will be divided by the maximum summation row

$$(X = \frac{Z}{s}),$$ (2)

Where s = maximum summation row.

3. Calculate the total-relation matrix T; this provides information on how one factor affects another, where

(3)

$$T = X(I - X)^{-1}$$

MATLAB interface will be used to obtain the total-relation matrix.

4.   From the total-relation matrix, a causal diagram will be produced where an IRM is produced. At this step, the vectors "R" and "C", denoting the sum of the rows and the columns, are defined by the following formulas:

$$R = [r_i]_{nx1} = \left[\sum_{j=1}^{j=n} t_{ij} \right]_{nx1} \tag{4}$$

$$C = [c_j]_{1xn} = \left[\sum_{i=1}^{i=n} t_{ij} \right]'_{1xn} \tag{5}$$

Where "R" denotes i^{th} row sum of total-relation matrix and "C" denotes the jth column sum of a total-relation matrix.

After vectors "R" and "C" are calculated, we calculate $(R + C)$ and $(R - C)$. Let $i = j$; the $(R + C)$ as the vector of horizontal axis called "prominence" shows the strength of influences that are given and received by the factor. It shows how much importance the criterion has. This means that $(R + C)$ indicates the degree of relation between each criterion with other outsourcing factors. The criterion with the highest $(R + C)$ value denotes that it is the most influential criterion since it has maximum inter-relationships with other outsourcing factors. The outsourcing factors with a higher value of $(R + C)$ have more relationships with other outsourcing factors. The outsourcing factors with a smaller value of $(R + C)$ have fewer relationships with other outsourcing factors. The vertical axis vector, called "relation," shows the net effect that the factor contributes to the system. It tells us about the kind of relation between outsourcing factors. When $(R - C)$ is positive, the outsourcing factors belong to the cause group; this is the 'dispatcher' group containing outsourcing factors that influence other outsourcing factors. When $(R - C)$ is negative, the outsourcing factors belong to the effect group; this 'receiver' group contains outsourcing factors that are influenced by other outsourcing factors.

5. Establish a threshold value (θ) to identify all the outsourcing factors which have a negligible effect over other outsourcing factors. That is, only elements of the total-relation matrix, whose influence level is higher than the threshold value, will be considered and converted into an IRM. If the value of the threshold is too low, many factors will be included and the IRM will be too complex to realize. At the same time, if the threshold is too high, very few factors will be considered and some important factors may be disqualified.

6. Create a causal (IRM) diagram using scatter plot in excel digraph. The IRM is a graphical representation of the inter-relations between outsourcing factors and explains the concept of a direct and indirect effect of various outsourcing factors over each other using the dataset of $(R + C, R - C)$.

7. Calculate the importance of weights for outsourcing factors. The weights of factors are calculated based on $(R + C)$ value by a normalizing process as follows:

$$w_i = \frac{r_i + c_i}{\sum_{i=1}^{n} r_i + c_i}, i = 1,2,...n.$$

(6)

4. Case description and proposed research methodology implementation

4.1 Case company background

The considered case company is a leading global courier company for logistics and transportation services; it is a member of both the "Global Distribution Alliance" (GDA) and the "World Freight Alliance" (WFA). It was established in the 1980s and rapidly evolved into a global brand. The company is recognized for its outstanding customized services and increased flexibility. Today it has around 11000 offices, 32000 vehicles and 65000 employees around the globe. The company has many strong global alliances making it a company with a strong worldwide reputation. It also entails a dynamic network of freight forwarding specialists that provide both sea and air freight services to their customers. Some services that are provided include "international and domestic express delivery", "freight forwarding", "logistics and warehousing", "documents management" and "online shopping services". The objectives of the company's logistics department are to facilitate on-time delivery to customers in both local and international markets at minimum cost.

The company gladly agreed to join in the study to outsource factors of third-party logistics services selection to understand and analyse the most influenced and influential factors.

4.2 Focus group formation and criteria validation

We started off our study with background research and a literature review (see Section 2) to gain further understanding of outsourcing and the possible outsourcing factors of influence in our case company. We also performed some research to gain an overview of the MCDM techniques and methodologies frequently used in outsourcing decisions to gain insight into which methodology will best suit our study and serve our purposes. Working through the literature review, we came up with 32 possible outsourcing decision factors and different MCDM methodologies that were used in similar decision-making processes in other studies with similar purposes. After extracting possible factors that influence outsourcing decisions from the literature review, we conducted a survey (as shown in Appendix 1) to validate and shortlist the 32 extracted outsourcing factors and to identify the factors among them that are applicable to our case study.

We gathered this information using a focus group consisting of four participants (operations team leader, supply chain leader, control tower leader and logistics operation supervisor), who all have a minimum of five years' experience in logistics and operations. As defined by Nyumba et al. (2018), "*the focus group discussion is a frequently used qualitative approach to gain a comprehensive understanding of a problem*". The aim of focus group discussion or survey is to acquire data from a specially selected group of individuals rather than a statistical sample of a larger population. The focus group survey resulted in shortlisting the outsourcing factors from 32 down to 21. These are considered in our study as shown in Table 1. Regarding the technique that we applied to our study, we performed further research among other methodologies extracted from the literature review and compared different techniques. The DEMATEL approach was found to best suit our case study.

4.3 DEMATEL application

Following up this survey, after the applicable outsourcing factors have been extracted, we conducted another survey (see Appendix 2) with the operations team leader to evaluate the inter-relations between the outsourcing factors by using the linguistic scale provided in Table 1 above. The Z matrix below (Table 3) was thus obtained.

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Table 3: Z-Matrix interrelations between outsourcing factors

i/j	OC1	OC2	OC3	OC4	OC5	OC6	OC7	OC8	OC9	OC10	OC11	OC12	OC13	OC14	OC15	OC16	OC17	OC18	OC19	OC20	OC21	Σ
OC1	0	0	4	3	2	4	3	4	3	4	3	4	4	1	0	3	0	0	1	4	0	47
OC2	0	0	3	2	3	1	2	3	4	2	0	3	2	3	1	0	4	1	2	3	0	39
OC3	1	2	0	1	1	4	0	0	2	1	0	3	4	1	2	2	3	0	2	2	1	32
OC4	3	0	0	0	1	2	3	3	3	3	2	1	4	3	4	3	3	2	3	2	2	47
OC5	3	0	3	2	0	0	2	3	4	3	3	4	4	4	4	2	2	2	0	1	3	49
OC6	0	1	0	3	3	0	0	3	1	1	2	3	4	3	3	2	1	1	2	0	2	35
OC7	4	2	2	0	4	0	0	0	0	1	3	3	0	1	2	1	4	1	3	4	1	36
OC8	4	3	2	4	4	2	2	0	4	3	3	2	4	2	3	4	0	4	4	2	0	56
OC9	0	0	3	3	4	2	0	1	0	0	0	4	3	4	3	2	0	0	4	3	1	37
OC10	4	3	1	3	0	4	2	0	0	0	0	4	2	2	2	4	1	2	1	0	2	37
OC11	1	0	2	4	2	0	0	0	3	3	0	0	0	0	0	2	2	0	1	1	0	21
OC12	3	0	0	4	2	4	0	0	0	1	3	0	2	2	4	0	3	1	4	4	0	37
OC13	1	2	0	4	0	2	0	0	0	0	0	2	0	1	1	2	0	2	0	0	0	17
OC14	3	0	3	2	2	2	1	3	0	0	2	4	4	0	3	4	2	0	2	1	1	39
OC15	0	0	2	4	4	0	0	3	4	4	1	0	1	0	0	1	3	2	1	4	0	34
OC16	3	0	2	2	3	0	0	3	0	0	0	3	2	0	3	0	4	3	0	1	0	29
OC17	0	0	4	3	4	3	3	2	0	4	0	0	0	3	3	2	0	2	0	0	0	33
OC18	2	0	2	1	0	0	4	2	4	0	0	3	1	0	0	4	0	0	3	1	0	27
OC19	1	3	2	4	0	3	1	3	0	3	2	4	0	0	1	3	2	0	0	0	0	32
OC20	0	1	2	0	4	3	0	0	0	0	3	1	2	0	3	0	0	3	0	0	0	22
OC21	1	3	0	1	0	0	2	1	0	3	3	2	4	0	1	3	4	4	1	0	0	33

In the last column of Table 3, we calculated the summation of each row, where we picked the maximum number for the summation, 56, to use for normalizing the matrix by dividing all elements in the matrix by 56. By doing this we obtain matrix X (Table 3) below. After normalizing the matrix, we used the program MATLAB interface to acquire the total relation matrix, T matrix. (Tables 4-5 below). This provides the influence rate of each outsourcing factor. The total relation matrix gives information on how one factor affects another. The relative importance of the decision factor is identified by determining vectors "R" and "C"; this will be shown in further detail.

Table 4: Normalized matrix X

i/j	OC1	OC2	OC3	OC4	OC5	OC6	OC7	OC8	OC9	OC10	OC11	OC12	OC13	OC14	OC15	OC16	OC17	OC18	OC19	OC20	OC21
OC1	0.000	0.000	0.071	0.053	0.035	0.071	0.053	0.071	0.053	0.071	0.053	0.071	0.071	0.017	0.000	0.053	0.000	0.000	0.017	0.071	0.000
OC2	0.000	0.000	0.053	0.035	0.053	0.017	0.035	0.053	0.071	0.035	0.000	0.053	0.035	0.053	0.017	0.000	0.071	0.017	0.035	0.053	0.000
OC3	0.017	0.035	0.000	0.017	0.017	0.071	0.000	0	0.035	0.017	0.000	0.053	0.071	0.017	0.035	0.035	0.053	0.000	0.035	0.035	0.017
OC4	0.053	0.000	0.000	0.000	0.017	0.035	0.053	0.053	0.053	0.053	0.035	0.017	0.071	0.053	0.071	0.053	0.053	0.035	0.053	0.035	0.035
OC5	0.053	0.000	0.053	0.035	0.000	0.000	0.035	0.053	0.071	0.053	0.053	0.071	0.071	0.071	0.071	0.035	0.035	0.035	0.000	0.017	0.053
OC6	0.000	0.017	0.000	0.053	0.053	0.000	0.000	0.053	0.017	0.017	0.035	0.053	0.071	0.053	0.053	0.035	0.017	0.017	0.035	0.000	0.035
OC7	0.071	0.035	0.035	0.000	0.071	0.000	0.000	0.000	0.000	0.017	0.053	0.053	0.000	0.017	0.035	0.017	0.071	0.017	0.053	0.071	0.017
OC8	0.071	0.053	0.035	0.071	0.071	0.035	0.035	0.000	0.071	0.053	0.053	0.035	0.071	0.035	0.053	0.071	0.000	0.071	0.071	0.035	0.000
OC9	0.000	0.000	0.053	0.053	0.071	0.035	0.000	0.017	0.000	0.000	0.000	0.071	0.053	0.071	0.053	0.035	0.000	0.000	0.071	0.053	0.017
OC10	0.071	0.053	0.017	0.053	0.000	0.071	0.035	0.000	0.000	0.000	0.000	0.071	0.035	0.035	0.035	0.071	0.017	0.035	0.017	0.000	0.035
OC11	0.017	0.000	0.035	0.071	0.035	0.000	0.000	0.000	0.053	0.053	0.000	0.000	0.000	0.000	0.000	0.035	0.035	0.000	0.017	0.017	0.000
OC12	0.053	0.000	0.000	0.071	0.035	0.071	0.000	0.000	0.000	0.017	0.053	0.000	0.035	0.035	0.071	0.000	0.053	0.017	0.071	0.071	0.000
OC13	0.017	0.035	0.000	0.071	0.000	0.035	0.000	0.000	0.000	0.000	0.000	0.035	0.000	0.017	0.017	0.035	0.000	0.035	0.000	0.000	0.000
OC14	0.053	0.000	0.053	0.035	0.035	0.035	0.017	0.053	0.000	0.000	0.035	0.071	0.071	0.000	0.053	0.071	0.035	0.000	0.035	0.017	0.017
OC15	0.000	0.000	0.035	0.071	0.071	0.000	0.000	0.053	0.071	0.071	0.017	0.000	0.017	0.000	0.000	0.017	0.053	0.035	0.017	0.071	0.000
OC16	0.053	0.000	0.035	0.035	0.053	0.000	0.000	0.053	0.000	0.000	0.000	0.053	0.035	0.000	0.053	0.000	0.071	0.053	0.000	0.017	0.000
OC17	0.000	0.000	0.071	0.053	0.071	0.053	0.053	0.035	0.000	0.071	0.000	0.000	0.000	0.053	0.053	0.035	0.000	0.035	0.000	0.000	0.000
OC18	0.035	0.000	0.035	0.017	0.000	0.000	0.071	0.035	0.071	0.000	0.000	0.053	0.017	0.000	0.000	0.071	0.000	0.000	0.053	0.017	0.000
OC19	0.017	0.053	0.035	0.071	0.000	0.053	0.017	0.053	0.000	0.053	0.035	0.071	0.000	0.000	0.017	0.053	0.035	0.000	0.000	0.000	0.000
OC20	0.000	0.017	0.035	0.000	0.071	0.053	0.000	0.000	0.000	0.000	0.053	0.017	0.035	0.000	0.053	0.000	0.000	0.053	0.000	0.000	0.000
OC21	0.017	0.053	0.000	0.017	0.000	0.000	0.035	0.017	0.000	0.053	0.053	0.035	0.071	0.000	0.017	0.053	0.071	0.071	0.017	0.000	0.000

Table 5: T-Matrix

i / j	OC1	OC2	OC3	OC4	OC5	OC6	OC7	OC8	OC9	OC10	OC11	OC12	OC13	OC14	OC15	OC16	OC17	OC18	OC19	OC20	OC21	R
OC1	0.071	0.038	0.132	0.152	0.117	0.145	0.092	0.128	0.110	0.132	0.111	0.162	0.162	0.079	0.021	0.133	0.068	0.059	0.085	0.133	0.029	2.158
OC2	0.058	0.031	0.113	0.119	0.125	0.084	0.074	0.106	0.119	0.092	0.05	0.132	0.113	0.108	0.098	0.071	0.127	0.066	0.093	0.107	0.024	1.910
OC3	0.057	0.058	0.043	0.087	0.073	0.119	0.028	0.046	0.071	0.062	0.036	0.112	0.129	0.060	0.095	0.086	0.098	0.039	0.076	0.075	0.035	1.485
OC4	0.120	0.037	0.071	0.102	0.101	0.105	0.098	0.119	0.111	0.121	0.091	0.110	0.156	0.108	0.153	0.138	0.119	0.094	0.115	0.098	0.059	2.226
OC5	0.124	0.037	0.123	0.141	0.856	0.077	0.081	0.117	0.132	0.123	0.111	0.160	0.165	0.129	0.159	0.124	0.108	0.095	0.070	0.088	0.078	3.098
OC6	0.055	0.044	0.050	0.132	0.112	0.052	0.035	0.104	0.066	0.072	0.079	0.121	0.139	0.098	0.120	0.100	0.073	0.065	0.084	0.048	0.055	1.704
OC7	0.117	0.060	0.938	0.076	0.134	0.059	0.037	0.052	0.049	0.076	0.099	0.121	0.067	0.062	0.100	0.078	0.124	0.060	0.096	0.120	0.037	2.562
OC8	0.150	0.092	0.118	0.188	0.164	0.120	0.090	0.083	0.147	0.132	0.118	0.151	0.177	0.106	0.154	0.169	0.084	0.135	0.147	0.113	0.032	2.670
OC9	0.054	0.028	0.103	0.132	0.132	0.094	0.032	0.072	0.047	0.054	0.049	0.143	0.127	0.116	0.126	0.099	0.059	0.046	0.119	0.102	0.040	1.774
OC10	0.124	0.078	0.070	0.131	0.066	0.127	0.073	0.059	0.048	0.053	0.047	0.145	0.109	0.082	0.104	0.134	0.079	0.081	0.071	0.055	0.055	1.791
OC11	0.051	0.016	0.068	0.115	0.072	0.037	0.024	0.032	0.080	0.085	0.024	0.046	0.045	0.033	0.045	0.076	0.068	0.027	0.047	0.046	0.016	1.053
OC12	0.100	0.025	0.054	0.149	0.099	0.127	0.037	0.057	0.502	0.077	0.099	0.068	0.104	0.080	0.137	0.066	0.104	0.062	0.115	0.116	0.022	2.200
OC13	0.044	0.045	0.024	0.106	0.031	0.061	0.020	0.030	0.026	0.026	0.021	0.069	0.036	0.041	0.052	0.066	0.029	0.057	0.027	0.026	0.010	0.847
OC14	0.109	0.029	0.107	0.122	0.104	0.097	0.053	0.108	0.052	0.061	0.084	0.144	0.145	0.048	0.126	0.376	0.095	0.051	0.087	0.072	0.038	2.108
OC15	0.052	0.027	0.088	0.141	0.131	0.057	0.038	0.100	0.118	0.120	0.058	0.070	0.088	0.050	0.070	0.083	0.100	0.082	0.066	0.114	0.023	1.676
OC16	0.970	0.02	0.082	0.101	0.107	0.049	0.035	0.097	0.047	0.050	0.038	0.109	0.094	0.040	0.110	0.055	0.112	0.092	0.042	0.062	0.016	2.328
OC17	0.578	0.028	0.120	0.123	0.130	0.104	0.088	0.086	0.050	0.120	0.043	0.073	0.073	0.099	0.121	0.101	0.056	0.079	0.049	0.048	0.025	2.194
OC18	0.077	0.022	0.076	0.075	0.052	0.045	0.093	0.072	0.101	0.037	0.035	0.110	0.069	0.034	0.053	0.115	0.043	0.032	0.095	0.061	0.013	1.310
OC19	0.069	0.078	0.081	0.143	0.061	0.107	0.052	0.101	0.046	0.104	0.075	0.134	0.067	0.047	0.084	0.111	0.090	0.043	0.050	0.048	0.020	1.611
OC20	0.280	0.031	0.065	0.046	0.105	0.079	0.019	0.030	0.035	0.031	0.076	0.058	0.075	0.027	0.090	0.037	0.031	0.077	0.028	0.028	0.013	1.261
OC21	0.064	0.076	0.047	0.085	0.053	0.047	0.070	0.060	0.041	0.098	0.084	0.095	0.121	0.038	0.071	0.108	0.117	0.109	0.059	0.041	0.014	1.498
C	3.324	0.900	2.573	2.466	2.825	1.792	1.169	1.659	1.998	1.726	1.428	2.333	2.261	1.485	2.089	2.326	1.784	1.451	1.6207	1.601	0.654	

Table 6 shows (R+C) and (R-C) values, also known as "prominence" and "relation" values. (R+C) shows the degree by which a factor influences another factor and the degree by which it is influenced by other factors. In other words, it shows the inter-relations between outsourcing factors; the higher the value of (R+C), the more inter-relation it has with other outsourcing factors. This also shows how much importance the criterion has, based on the inter-relation. (R+C) denotes the degree of relation between each criterion with other outsourcing factors. (R-C) divides the outsourcing factors into a cause group and an effect group, also known as "dispatcher" and "receiver" groups. When the (R-C) value is positive, this means that the outsourcing factors are influential; if the value is negative, then the outsourcing factors are being influenced. The outsourcing factors that influence are placed in the dispatched group while the outsourcing factors being influenced are placed in the receiver group. In addition, (R-C) shows the net effect that the factor contributes to the system. It tells us about the kind of relation between outsourcing factors.

Table 6: Prominence and relation vectors for all factors

Outsourcing factors	R+C	R-C	Outsourcing factors	R+C	R-C
OC1	5.4827	-1.165	OC12	4.533	-0.133
OC2	2.810	1.01	OC13	3.108	-1.414
OC3	4.058	-1.088	OC14	3.593	0.623
OC4	4.692	-0.24	OC15	3.765	-0.413
OC5	5.923	0.273	OC16	4.654	0.002
OC6	3.496	-0.088	OC17	3.978	0.410
OC7	3.731	1.393	OC18	2.761	-0.141
OC8	4.329	1.011	OC19	3.2317	-0.0097
OC9	3.772	-0.224	OC20	2.862	-0.34
OC10	3.517	0.065	OC21	2.152	0.844
OC11	2.481	-0.375			

Based on the (R+C) values, the threshold value (θ) can be determined by finding the average of the (R+C) values obtained from matrix T to filter out negligible effects as suggested by Dalvi-Esfahani et al. (2019). Only the factor of matrix T, whose influence level (R+C) is greater than the value of θ, is selected and converted into an IRM. To obtain the threshold value, we computed the average of the prominence (R+C) values obtained from the T matrix and used this as a threshold to compare the obtained (R+C) values against it. Our threshold value θ was calculated to be 3.758.

We used the threshold value to eliminate all of the outsourcing factors values of (R+C) that fall below 3.758. This helped to extract the outsourcing factors of high importance, which could give an even deeper insight of which outsourcing factors to focus on and help us to find out the weight of importance of each factor. Table 7 below shows the outsourcing factors that are above the threshold value and their corresponding prominence and relation values.

Table 7: Prominence and relation vectors for influential factors

Outsourcing factors	R+C	R-C
OC1	5.482	-1.1653
OC3	4.058	-1.088
OC4	4.692	-0.240
OC5	5.923	0.273
OC8	4.329	1.011
OC9	3.772	-0.224
OC12	4.533	-0.133
OC15	3.765	-0.413
OC16	4.654	0.002
OC17	3.978	0.410

We used the prominence and relation values to create two causal diagrams shown below in Figures 2 and 3, one for all the factors initially included in our study and one after eliminating factors with negligible effects compared to our threshold value.
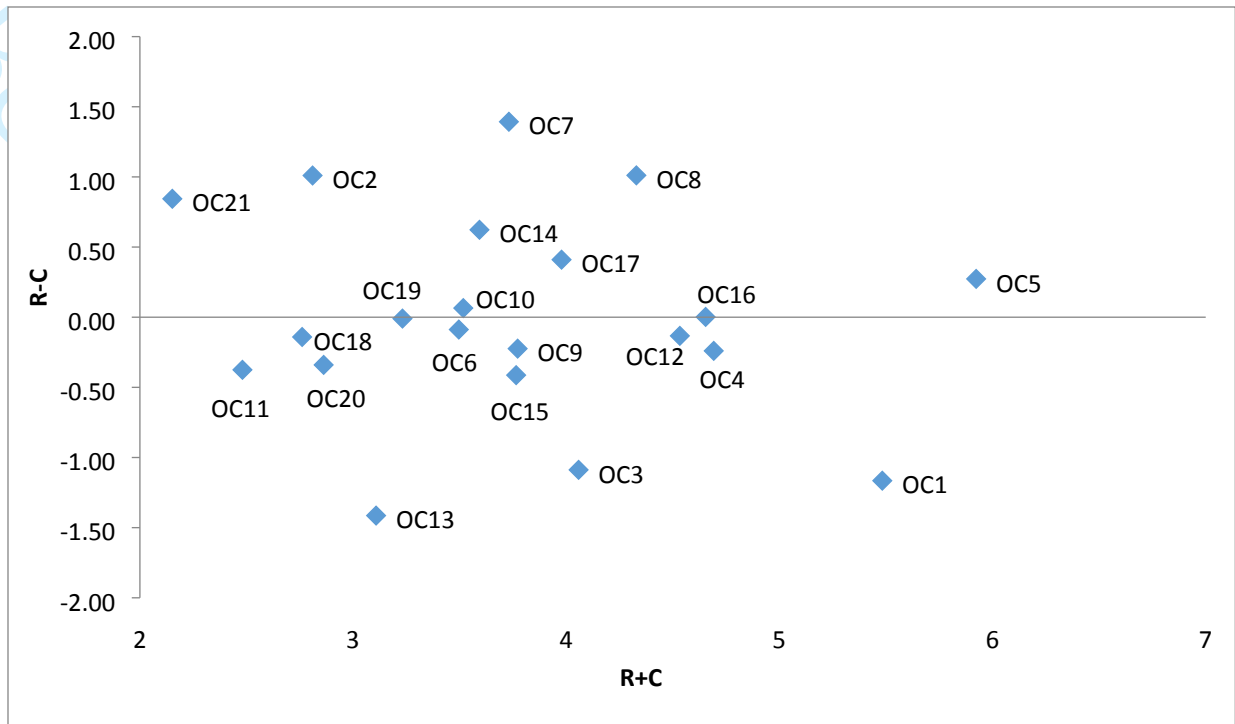
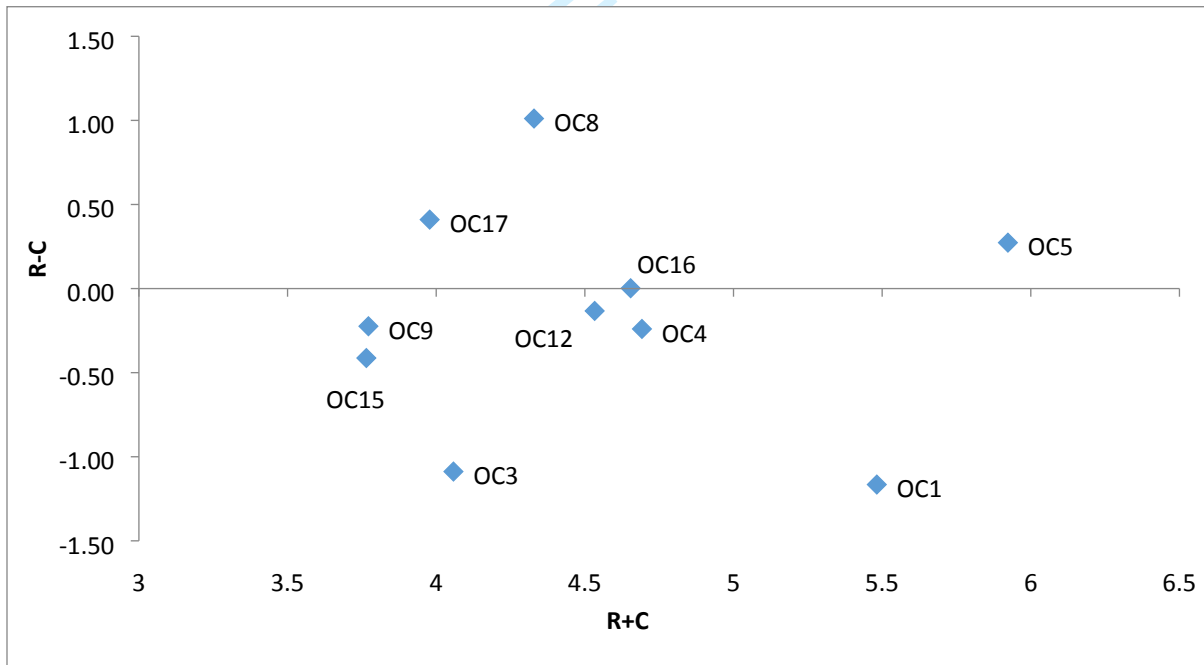**Figure 2:** Causal diagram with all factors

Figure 3: Causal diagram of influential factors (after applying threshold value)

Furthermore, the weights of influential outsourcing factors indicating the importance of the outsourcing factors is calculated based on the $(R + C)$ values, by dividing each $(R + C)$ value by

the highest number obtained in the summation of the inter-relations survey conducted previously, 56. This is shown in Table 8 below.

Table 8: Ranking and weights of influential outsourcing factors

Outsourcing factors	R+C	Wi	Rank
OC1	5.482	0.548	2
OC3	4.058	0.405	7
OC4	4.692	0.469	3
OC5	5.923	0.592	1
OC8	4.329	0.432	6
OC9	3.772	0.377	9
OC12	4.533	0.453	5
OC15	3.765	0.376	10
OC16	4.654	0.465	4
OC17	3.978	0.397	8

Based on the calculated weights in Table 8, the outsourcing factors are ranked in ascending order from the most important to the least, to emphasize each column.

After recording the results from the DEMATEL approach, we arranged a meeting with some case company experts to validate these results. The experts took a look at the inter-relations between outsourcing factors, the dispatcher and receiver values along with the ranking of weights based on their importance. A discussion took place on the potential changes this would make in their outsourcing decisions. The experts were happy to give us approval to proceed with our conclusions and recommendations as shown below.

5. Results and discussion

When we calculated the "prominence" $(R + C)$ values to determine the outsourcing factors with most inter-relations, outsourcing factor $OC5$ (developing strategic alliances) had the highest $(R + C)$ value; therefore, this shows the highest correlation with other factors. Next, cost reduction $(OC1)$ and value addition $(OC4)$ rank second and third highest respectively. These are the top three factors that should be considered carefully when the organization makes an outsourcing decision as shown in the IRM. Since they have the highest $(R + C)$ values, they have more relations with other outsourcing factors and hold more importance. This is crucial for outsourcing decisions as these factors have greatest impact. It is only from the prominence values that the weights can be calculated to rank the importance of the outsourcing factors.

5.1 Discussion of findings

This study seeks to address the existing gap in literature to benchmark the outsourcing factors of third-party logistics services selection by analysing influential strength and building a sustainable decision-making model in the considered case company. Based on the findings of the study, our discussion can be divided into three main sections. Firstly, the number of inter-relations between outsourcing factors based on prominence $(R + C)$ values. Secondly, the kind of inter-relations between outsourcing factors based on relation $(R - C)$ values and lastly the importance of outsourcing factors based on their relative calculated weights (Wi). Factors with high prominence values $(R + C)$ greatly affect other factors and are also affected by other factors. These are the factors that should be addressed and considered in the short term since they are considered as the central factors with highest importance and influence.

After the inter-relations between factors have been computed, based on the relation $(R - C)$ values, the kind of relations between outsourcing factors are established; the factors are divided into causal "dispatcher" groups and effect "receiver" groups. The factors developing strategic alliances ($OC5$), uncertainty and risk mitigation ($OC8$), deficiency of internal resources for a service ($OC16$) and regulations governing the outsourcing practices ($OC17$) fall under the causal group category. These factors are considered influential factors that impact other barriers and should be given the greatest attention; they should be considered first when making outsourcing decisions. Experts who make outsourcing decisions should carefully consider the impact of these factors on other factors and the whole organization. They have a more influential impact (R) than influenced impact (C) and therefore have a positive value. The higher the $(R - C)$ value, the greater the influence. As for the factors cost reduction ($OC1$), accessibility and response time sensitivity ($OC3$), value addition ($OC4$), focus on core competencies ($OC9$), maximize utilization of expensive transportation ($OC12$) and lack of equipment and tool availability ($OC15$), these fall under the effect group category. These factors tend to be easily influenced by other factors since they have more influenced impact (C) than influential impact (R); therefore their $(R - C)$ values are negative. Decision-makers should consider how these factors will be affected by other factors in the outsourcing decision-making process.

We have considered the prominence values, finding out which outsourcing factors are most inter-related, and how inter-related they are, as well as viewed the relations between each criterion by

using a causal diagram to support our theory. The last and essential part of our study, ranking outsourcing factors based on weights, was then undertaken. Weight of outsourcing factors is a critical factor in our study, as it is the final step of identifying the outsourcing factors that are most important when choosing to outsource. Through $(R + C)$, we were able to find the weights of the influential outsourcing factors, previously extracted through the threshold value, by dividing each of their $(R + C)$ value over the number of influential outsourcing factors. These results ranked our outsourcing factors from highest weight to lowest, showing the most important outsourcing factors to focus on when choosing to outsource. These are shown in order of highest to lowest in Table 8 - developing strategic alliances ($OC5$) is most important, followed by cost reduction ($OC1$) and then value addition ($OC4$).

6. Managerial and practical implications

6.1 Managerial Implications

Based on the study findings, numerous managerial implications can be offered for decision-makers and experts to improve the logistics services of businesses. The following managerial implications should be considered in the considered case company for improvement of their current practices:

a) **Developing strong strategic policy towards sustainable outsourcing decisions**: Study findings reveal that the factor 'developing strategic alliances ($OC5$)' came under the causal group factor, confirming its importance for outbound logistics decision making. Therefore, decision-makers and practitioners should make strong strategic policies towards outsourcing decision-making; this will help to improve the effective group factors simultaneously. The development of strong strategic policies should be considered first to ensure efficient logistics services throughout the supply chain networks.

b) **Developing pro-active, active and reactive risk mitigation strategies**: Decision-makers and practitioners should examine the risks involved in logistics services. They should build pro-active, active and reactive risk mitigation strategies for the confirmation of resilient logistics service facilities throughout the supply chain network. Also, study findings confirmed that the factor 'uncertainty and risk mitigation *(OC8)*' is a causal factor; this ensures that developing risk mitigation strategies can improve the logistics service by influencing effect group factors.

c) **Ensuring the sufficient logistics service facility**: From the study, the factor 'deficiency of internal resources for a service (*OC16*)' was ranked in third position in the causal group. However, the internal logistics facility should be high enough to meet customer demand timely with high efficiency. Therefore, decision-makers and industrial managers should give special attention to this factor to build a highly efficient logistics network. Also, logistics managers can improve the logistics service by enriching existing resources and service facility.

d) **Establishing strong regulations for outsourcing practices**: Decision-makers should establish effective regulations to ensure effective and desired logistics services. The findings also confirm that 'regulations governing the outsourcing practices (*OC17*)' comes under causal factors, indicating that other factors can be improved by improving this factor. Therefore, strong regulations towards efficient logistics network should be mandatory for business firms.

6.2 Practical implications

The findings of the research have some imperative and effective practical implications for industrial decision-makers and managers. Results have produced practical implications to inform decision-makers in the considered case company how to smooth supply chain activities. In this study, nine factors were identified as causal factors while twelve factors were listed as influential factors. The causal group factors can influence effective group factors. Therefore, the decision-makers should put greater focus on causal group factors for the improvement of logistics services. The findings may also help to identify those factors that should be implemented first to ensure improvement of services in the organization. The findings can also provide directions to make strategic goals for future improvement and strategy making. These results may also encourage management to make a sustainable policy for the continuous improvement of the logistics service facility; this is crucial for sustainable development of an organization. The proposed framework may assist decision-makers and logistics managers by considering the model as a benchmark for improving the current conditions of logistics services.

7. Conclusions and future research directions

In this study, we aimed to help maximize efficiency, as well as minimize costs for a case company in the most beneficial way possible. Knowing one of the case company's main dependent tasks for

their business is outsourcing, we decided to conduct a study on outsourcing factors relevant to the company with the help of a group of experts. Two surveys were prepared to help in validating outsourcing factors and evaluating inter-relations between the factors. We have extracted and ranked from highest to lowest the ten most important outsourcing factors that the case company should focus on when making the decision to outsource. These are shown in Table 8. These results will now help company managers to base their decisions on specific outsourcing factors without the risk of wasting time or financial costs on less important ones. Also, experts can assess the results of our study to cover any shortcomings or other outsourcing factors that were not considered in our study; this could be an important option to consider when outsourcing. We have applied the DEMATEL technique to address the three main objectives of our study - to identify the inter-relations, highlight the influential and autonomous factors and compute the importance weight rankings of the outsourcing factors. This allows us to construct the IRM to graphically represent the inter-relations computed between outsourcing factors so that it is clear which outsourcing factors are most important. These should be given a sizable amount of consideration during the outsourcing decision-making process. After the DEMATEL application, we were able to obtain the desired parameters to achieve our objectives with the help of a literature review and focus group discussions with the experts. Firstly, we obtained the validated outsourcing factors and evaluated the inter-relations among these outsourcing factors; this served as the basis for the start of our study. This enabled us to further compute the normalized matrix for the evaluated inter-relations so that the T-matrix can be obtained and used to compute the "prominence" values, the "relation" values and the importance weight rankings of the outsourcing factors. The "prominence" values were computed to identify the inter-relation weights between outsourcing factors to indicate which outsourcing factors have most inter-relations with other outsourcing factors and which have least; this gives the basis for ranking the importance weights. The "relation" values were computed to divide these inter-relations into causal "dispatcher" groups and effect "receiver" groups to determine which outsourcing factors are influential and which are autonomous. All these details are shown in the IRM as (R+C, R-C) points are plotted for each factor.

The last step was to compute the importance weights of the outsourcing factors using the "prominence" values to rank the importance of factors. Computing all these parameters enabled us to direct the organization with an accurate MCDM model to follow when making strategic and operational outsourcing decisions. During our time in the case company, we have also theorized

how this study could benefit operations even more. Due to time constraints, we have not had the chance to implement this. However, for future references, we recommend conducting a study on the outsourcing factors that each of their operations depends on. The DEMATEL technique could be implemented to extract outsourcing factors and list these from highest to lowest importance based on the need of each operation. This would help save time and money to learn which operation is in most need of outsourcing, and how this could be implemented.

To deepen this study, optimization formulas could be used to help find out the percentages that the company should work on when outsourcing; in other words, using optimization, the case company could figure out what percentage of outsourcing the company needs and how much outsourcing is needed for each operation.

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Appendix 1: Potential Outsourcing factors validation questionnaire

Potential Outsourcing factors Validation Questionnaire

Identification of relationship among outsourcing decision factors using DEMETAL

Company Position: _____   Date: _____

The purpose of this study is to conduct a study to investigate the different factors that play a role in the outsourcing decision made by logistic companies and use them to optimize the number of labour and activities to be outsourced to enhance performance and competitive advantage.

*Please take your time to tick the applicable outsourcing factors that are considered important in the outsourcing decision-making process.

	Outsourcing factors	Description	Validity Yes	No
1	Cost Reduction	Does outsourcing save the overall cost by reducing labour, operating, time costs, etc.?		
2	Flexibility	Does 3PLSP is responsiveness to change or fluctuation in demand?		
3	Safety in transportation	Does outsourcing guarantee transportation safety and decrease the liabilities associated due to accident damage?		
4	On-time delivery	On-time delivery is one of the main factors behind any decision making for logistics operation. Does outsourcing help with on-time deliveries?		
5	Accessibility & Response time sensitivity	Does 3PLSP be easily accessible and responsive to any query within the agreed time?		
6	Information Sensitivity & Confidentiality	How sensitive and confidential is the information? Is it safe and trusted to be given to outsourced parties?		
7	Need for reliability	Can you rely on third parties to do this job/task? Can outsourced companies be reliable?		
8	Value addition	Does outsourcing add some sort of value to the company?		
9	Developing Strategic Alliances	Does forming an outsourcing contract with TPLs help you gain strategic alliances with outside firms?		
10	Competitive advantage	Will outsourcing help you gain a competitive advantage over others in the same field?		
11	Enhance technical capabilities & achieve new technologies	To improve existing services and come up with new technologies that help with getting work achieved at a better place. Do you think this is possible with outsourcing TPLs providers? Will they help you keep pace with technology advancements?		
12	Uncertainty and Risk Mitigation	With outsourcing, risks and uncertainty might come in the way of your work. How predictable and controllable are the risks associated with outsourcing? Are they manageable?		
13	Focus on core competencies	Core competencies are the firm's core functions. Does outsourcing help the firm focus on its defining strengths? Does it help with providing and supporting the foundation from which the business will grow?		
14	Improve service standards	Service standards are of the most important aspects of achieving customer satisfaction. Do you think outsourcing will achieve a good service level in the eyes of the customers?		
15	Time cost	Does outsourcing save time and give you the chance to use this time to achieve the completion of other tasks and activities (time efficiency)?		
16	Maximize Utilization of expensive transportation	Save costs of transportation through outsourcing different delivery methods such as trucks, motors, aeroplanes, etc. depending on delivery shipment type and size.		
17	Maximize productivity & profitability	Does outsourcing help the company produce more output than usual? Is it more profitable? Does it increase revenue?		
18	Knowledge transfer	Does outsourcing help with bringing in new information and eases knowledge transfer between the firms?		
19	Function Complexity	Is the function difficult to accomplish, manage or control? Will outsourcing help with accomplishing, managing and/or controlling it?		
20	Lack of equipment & tool availability	Are the equipment and tools available in the firm or should they be deployed from outside to reduce costs and increase efficiency and effectiveness?		
21	Improving Quality	Will outsourcing help improve quality requirements and achieve a high quality of service for competitive advantage?		
22	Deficiency of internal resources for a service	The company might consider outsourcing resources when required for achieving the core service		
23	Risk Sharing	Are you willing to share risks with contractors or are the stakes too high?		

24	Regulations governing the outsourcing practices	Are there any regulations that limit your outsourcing decision or outsourcing practices?		
25	Agility	Firm's responsiveness to change (e.g.: new or changing demand). Does outsourcing still allow the firm to be agile?		
26	Control	Will the firm still be able to control all of its business processes and departments with outsourcing, or will it lose some sort of control?		
27	Information Loss	Can critical information be lost? How likely is it to happen and can it be prevented?		
28	Increase efficiency	Will outsourcing increase a firm's efficiency?		
29	Performance	Can outsourcing improve the overall performance of the company or at least maintain it?		
30	Financial returns	Will outsourcing incur better financial returns?		
31	Management	Will outsourcing save the management time, reduce the management load? Is there a need for specialized management? Will outsourcing increase the speed of implementation? Safety management, Consolidation or Decentralization?		
32	Freeing resources for core activities	Does outsourcing help free a firm's resources for core activities rather than wasting them on secondary activities?		

Appendix 2: Outsourcing factors Interrelations Evaluation

Outsourcing factors Interrelations Evaluation

Identification of relationships among outsourcing decision-making outsourcing factors using DEMETAL

Company Position: _____   Date: _____

The purpose of this survey is to evaluate the interrelations between shortlisted outsourcing decision-making factors to be used in our DEMATEL application.

*Using the below comparison scale and the key Table for the outsourcing factors, please take your time to evaluate the interrelations between outsourcing factors by rating the influence of outsourcing factors i on outsourcing factors j.

Comparison Scale

Numeral	Definition
0	No influence
1	Low influence
2	Medium influence
3	High influence
4	Very high influence

Key Table for Outsourcing factors

Key	Outsourcing factors
OC1	Cost Reduction
OC2	Flexibility

OC3	Accessibility & Response time sensitivity
OC4	Value addition
OC5	Developing Strategic Alliances
OC6	Competitive advantage
OC7	Enhance technical capabilities & achieve new technologies
OC8	Uncertainty and Risk Mitigation
OC9	Focus on core competencies
OC10	Improve service standards
OC11	Time cost
OC12	Maximize Utilization of expensive transportation
OC13	Maximize productivity & profitability
OC14	Function Complexity
OC15	Lack of equipment & tool availability
OC16	Deficiency of internal resources for a service
OC17	Regulations governing the outsourcing practices
OC18	Increase efficiency
OC19	Performance
OC20	Financial returns
OC21	Freeing resources for core activities

i/j	OC1	OC2	OC3	OC4	OC5	OC6	OC7	OC8	OC9	OC10	OC11	OC12	OC13	OC14	OC15	OC16	OC17	OC18	OC19	OC20	OC21
OC1																					
OC2																					
OC3																					
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