PARAMETERS AFFECTING OUTSOURCING PERFORMANCE IN REVERSE LOGISTICS USING TISM APPROACH

A DISSERTATION

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR

THE AWARD OF THE DEGREE OF

MASTER OF TECHNOLOGY

IN

PRODUCTION ENGINEERING

SUBMITTED BY

ANKITA SINGH

ROLL NO. - 2K17/PIE/02

Under the supervision of

PROF. RANGANATH M. SINGARI

DEPARTMENT OF MECHANICAL ENGINEERING

DELHI TECHNOLOGICAL UNIVERSITY

(Formerly Delhi College of Engineering)

Bawana Road, Delhi-110042

JULY, 2019

DELHI TECHNOLOGICAL UNIVERSITY
(Formerly Delhi College of Engineering)
Bawana Road, Delhi-110042

CANDIDATE'S DECLARATION

I, ANKITA SINGH, hereby certify that the work which is being presented in this thesis entitled "PARAMETERS AFFECTING OUTSOURCING PERFORMANCE IN REVERSE LOGISTICS USING TISM APPROACH" being submitted by me is an authentic record of my own work carried out under the supervision of **Professor. Ranganath M. Singari, Department of Mechanical, Production and Industrial Engineering, Delhi Technological University, Delhi .**The matter presented in this thesis has not been submitted in any other University/ Institute for the award of M.Tech. degree.

Place: Delhi **(ANKITA SINGH)**

DELHI TECHNOLOGICAL UNIVERSITY

(Formerly Delhi College of Engineering)

Bawana Road, Delhi-110042

CERTIFICATE

I hereby certify that the project Dissertation titled "PARAMETERS AFFECTING OUTSOURCING PERFORMANCE IN REVERSE LOGISTICS USING TISM APPROACH" which is submitted by [ANKITA SINGH], Roll No. 2K17/PIE/02 [Department of Mechanical Engineering], Delhi Technological University, Delhi in partial fulfillment of the requirement for the award of degree of Master of Technology, is a record of the project work carried out by the student under my supervision. To the best of my knowledge this work has not been submitted in part or full for any Degree or Diploma to this University or elsewhere

Place: Delhi

Date : 08/07/2019 **(Prof. RANGANATH M. SINGARI)**

Department of Mechanical,Production and Industrial Engineering

Delhi Technological University,

DELHI-110042

ACKNOWLEDGEMENT

It is a matter of great pleasure for me to present my dissertation report on "PARAMETERS AFFECTING OUTSOURCING PERFORMANCE IN REVERSE LOGISTICS USING TISM APPROACH". First and foremost, I am profoundly grateful to my guide Prof. Ranganath M Singari, Department of Mechanical, Production and Industrial Engineering, Delhi Technological University, Delhi for his expert guidance and continuous encouragement during all stages of thesis. I feel lucky to get an opportunity to work with him. I am thankful to the kindness and generosity shown by him towards me, as it helped me morally complete the project before actually starting it.

Last, but not the least, I would like to thank my family members for their help, encouragement and prayers through all these months. I dedicate my work to them.

Place: Delhi **(ANKITA SINGH)**

Date: 08/07/2019

ABSTRACT

Development is the need of the hour so is the taking care of the environment as development means increase in the number of industries working for the development .Due to the growing environment concern , corporate social responsibility the Reverse Logistics have become widely accepted by the industries all over the globe . As implementing reverse logistics network is not an easy process so firms are outsourcing the tasks to be performed in the RL .

From collection of EOU products from different customers to disposition methods various activities like sorting, inspecting, redeveloping, reusing, recycling and many other are outsourced by the industries to the firms that ca perform particular activities .This provides an efficient flow of process.

But many parameters are to be concerned by the industries before finding appropriate outsourcing firm . In this study some parameters and their significance over the industries are studied so that industries can achieve the most appropriate outsourcing firm and can achieve better performance. The methodology used for finding which parameters are driving while others drive is the TISM model .i.e, Total Interpretive Structural Modelling.

This study can help increasing the performance efficiencies of the industries outsourcing the activities in the process of reverse logistics.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

Table 2.1

The identified parameters affecting the performance of outsourcing during disposition of EOU products.

Tables 3.

NOMENCLATURE

PARAMETER	DESCRIPTION
RL	Reverse Logistics
EOU	End Of Use
SCM	Supply Chain Management
CLSC	Closed Loop Supply Chain
RSC	Reverse Supply Chain
3PL	Third Party Logistic
TISM	Total Interpretive Structural Modelling

CHAPTER 1

1.1 INTRODUCTION

Development is the need of the hour so is the taking care of the environment as development means increase in the number of industries working for the development , the increment in number of the industries is directly proportional to the waste produced and that effecting the natural resources, the human life and climate change ,etc .Due to the growing environment concern , corporate social responsibility the Reverse Logistics have become widely accepted by the industries all over the globe .

RL process has attracted not only firms but also the researchers, which are studying the issues of the RL since past 10-20 years, and they refined Reverse Logistics as 'the process of controlling backward flows of raw materials and planning and implementing of in-process inventory, finished goods and packaging, from a distribution and manufacturing or use point, to a point of disposal or point of proper recovery'

1.2 REVERSE LOGISTICS

Reverse Logistics is the method in which end of used products or customer rejected products flow back in the reverse order to the industries or firms for the purpose of remanufacture, reuse, recycle or dispose of the products. The industries coverts those products received as a raw material in the same supply change or the other production change and the products which cannot be reused as a chain, are then goes under various disposition methods required .

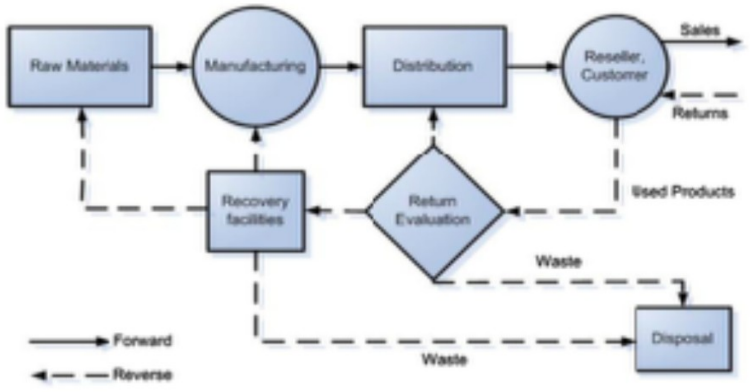


Figure 1. Genetic form of reverse / forward logistics (Govidan et al. (2015)

Industries are now implementing the integrated environmental strategies that can improve the their business model in the competitive market and can do the profit making from the recovery an reuse of the EOU products .

Government has also introduced various legislations for the industries just in order to prevent environment and to limit the waste generated and keep the check on the environment affected reasons by the industries. As it is understood by many that RL is the necessity for sustainable competitiveness.

In Reverse Logistics the first process in the storage of the EOU derivatives and then inspection of the products for the sorting in various areas. Further method is the disposition of the EOU products for recycling, repair, reuse, remanufacturing or final trash scrapping depending upon the choice made that is either for re-evaluating cost or scrap it

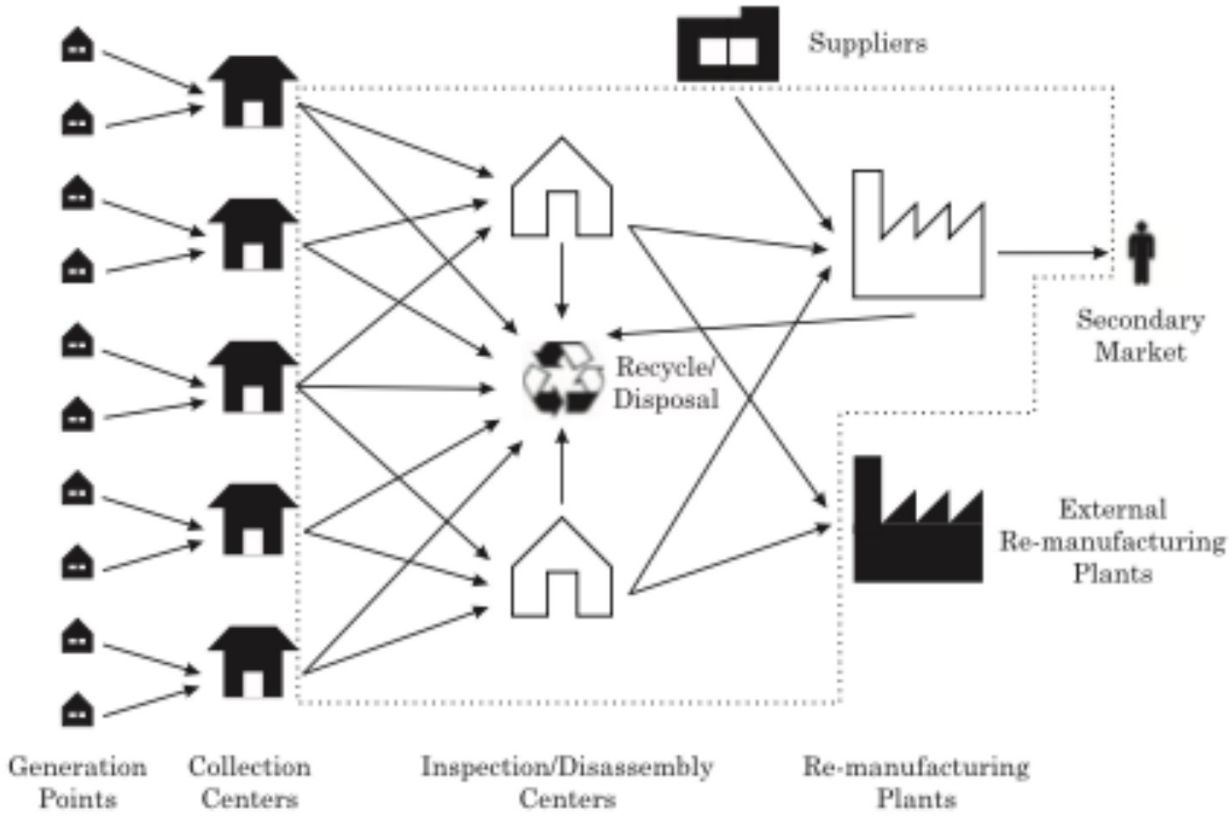


Figure 2. Network of reverse logistics (Almur et al. 2012)

1.3 KEY PROCESSES USED IN RL

The key processes used in RL are discussed briefly

1. Acquisition of Products

Acquisition of acquired parts and products from end customers for post-processing. Acquisition of products is very critical process for establishing the reverse logistics. It is mainly a set of methods which are performed by the retailer for identifying the acquired parts which are installed back into the branch and returned to the customer after solving the problems. For e.g. if customer is not satisfying with the product value then retailer thinks should the part must be sent for further proceedings or returned to the consumer. This settlement of decision is termed as Gate keeping.

2. Collection Units

The customer rejected parts are collected after gate keeping and transferred to the maintenance units for sorting, inspection and temperament. A company which holds the possession of the returned parts is called collection facilities, mainly three collection methods are used by manufacturers .According to some authors, first step in collecting the product is to return products in which company exercise no control for returns on the other hand, second method is to collect individually which gives full control over returns by the side of manufacturer.

3. Inspection and Sorting

Return of the products may be for the returns for the use of them commercially, service returns, distribution returns or EOL returns. Because the products rejected by customers may differ greatly in condition, and the reason known by customers of the return may be known or not known by them.so every item is required to inspect and sorted differently. The products are such evaluated that the state of the products and the constituting elements can be known.

4. Disposition

After the sorting and inspection of the customer rejected products the next steps is to take the decision about the disposition method need to be applied on the products . There are three key disposition alternatives to choose from for the products; reuse , recovery and waste management .

Industries mainly use one of 5 alternatives for recovery of the product that are either selling it as new product **,** repackaging and repairing it and then selling it as a new, repairing and repackaging it

and selling it as a used one, selling it in a lower price to salvage and selling it by weight to salvage house.

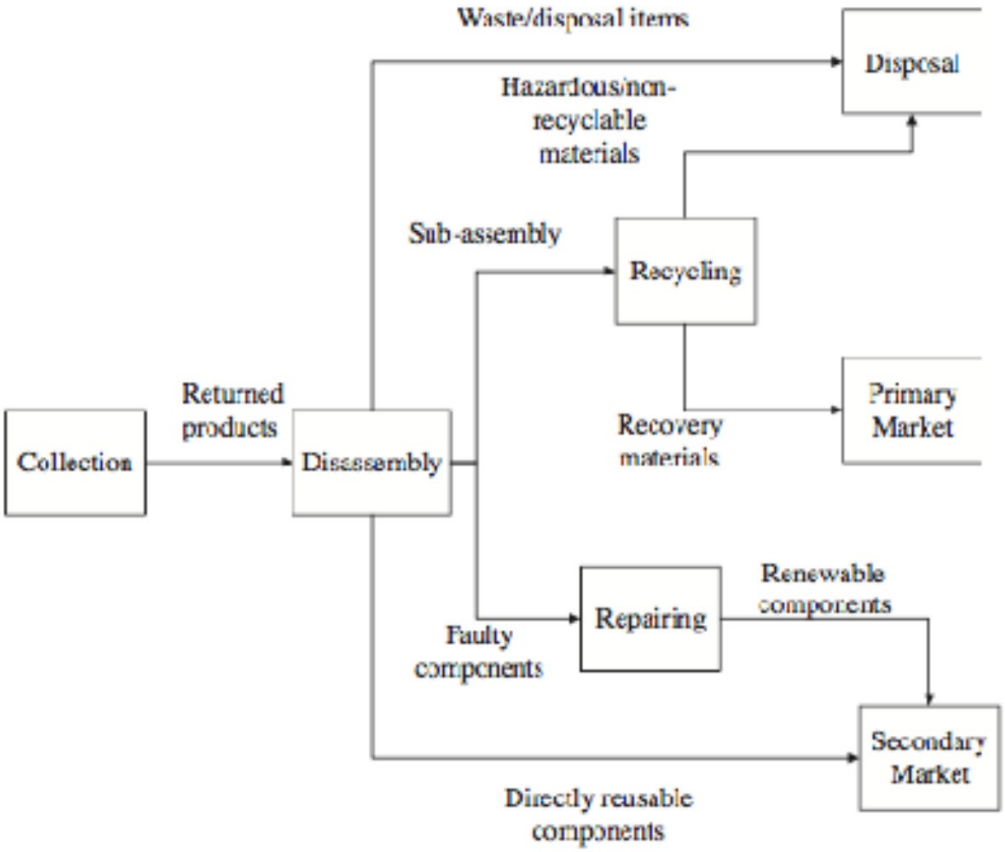


Fig 3.Flow of products in RL network (dat et al., 2012)

1.4 OUTSOURCING

Numerous retailers are contracting outsider suppliers to execute turn reverse logistics projects intended to hold an incentive by acquiring the parts back in the fast way, so that it can be expediently redistributed to clients for prompt service.

Kmart realized between $5 - $6 million in savings per $1 billion in sales by outsourcing RL as it saves in-house expenditure.

Our focus is made on the discussion how to select third party provider as an outsourcing firm.

Parameters are discussed which can affect the outsourcing performance , the internal parameters and the external parameters between the firm providing the outsourced facilities and the firm getting the work done by the outsourced industries.

Partnering could be happen from the point of view of a outsourced temporary administration work, also a long haul alliance, or a vital or restrictive partnership. The determination of the procedure will essentially have a few similitudes with standard merchant choice, however it might likewise have outside issues engaged with the choice, for example, regardless of whether there exists a minimum amount for items or segments that can be presented through the RL network and the higher inconstancy of product returns related with RL network.

The RL process has certain characteristics which requires unique facilities/demands. The RL has a basic function that is to collect product from many different sources and locations., secondly from economic view point there is critical mass issues. Third, there is typically greater supply variation in RL networks reasons are uncertainties of the life span , return rates and availability of the products. Fourth, what technique is to applied on the product once received, i.e., reuse , reclaim, recycle, remanufacture and dispose.

A decision network hierarchy is shown in fig.5 though a graphical image , defining general factors affecting the decision taken for the selection of the outsourcing firm that can perform RL for the industry

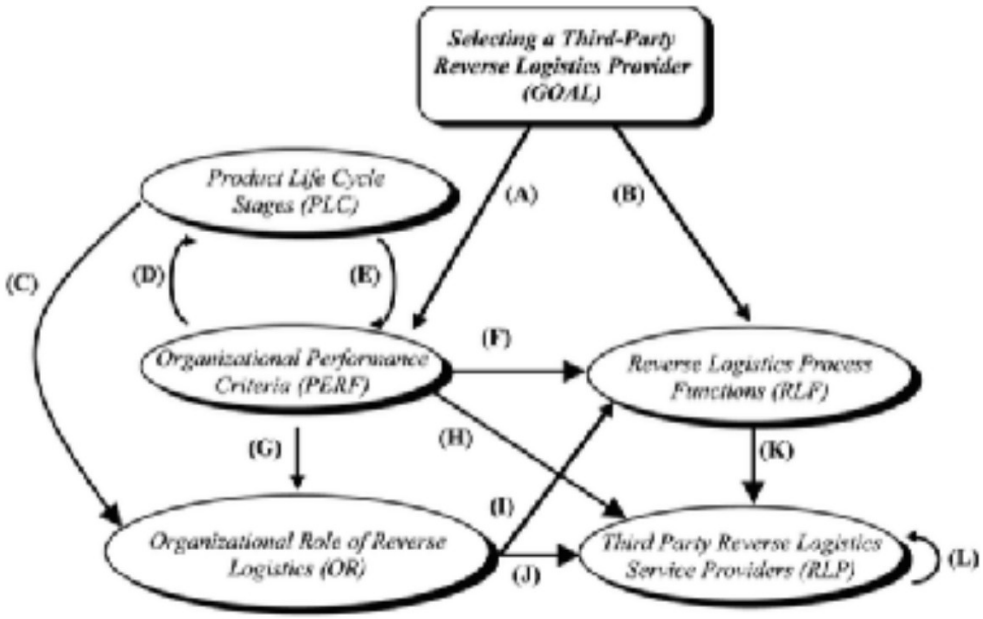


Fig 4.Graphical representation of the factors influencing the selection of the outsourcing firm

1.5 GROUPINGS AFFECTING DECISION FOR THE SELECTION OF OUTSOURCING FIRM

Mainly there are four groupings affecting the decision for the selection of outsourcing firm.

1. **Product life-cycle**

The parts situation in the product lifecycle will have an effect. As it were, the situating of the product or part family in the presentation, development, or decrease level will affect the choice; a vital issue looked by the association, where products in the beginning times of the lifecycle may not require as critical a capacity issue but rather would need to create collection mechanism.

2. **Organization Structure Performance**

Centrality is the hierarchical presentation that comprise of customary vital authoritative measurements, for example, cost, quality, time, and adaptability.

3. **Reverse logistics process function.**

It consists of functions like collection, sorting, inspecting, packaging, processing, and final delivery.

4. **Organizational role of RL**

It consists of functions like**:**

- recover, where the sole reason for existing is to recover the item for capacity, reuse, or different exercises that may not be dealt with by the RL provider
- remanufacture, where the design is to remanufacture an item around a reusable centre
- recycle, where the object is to change the physical or potentially substance make-up of the item;
- reuse, which is to reuse the item with minimal extra creation necessity;
- take back, products which are in warranty and serviced
- disposal to trash

CHAPTER 2

LITERATURE REVIEW

A considerable studies have researched the reverse logistics challenges in different industries, and analysing them by using different approaches. These studies have been discussed below briefly.

Sergio et al. (2014) analysed the concept of reverse logistics and its implications for supply chain management by analysing some of the opportunities and challenges that reverse logistic implies for SCM through Simulation of data on decision making Manufacturing industry and was focused to discover recovery of EOU products as a business opportunities. With future scope of study being the strategic aspects of the CLSC.

Navid et al. (2018) conducted a study on topic a novel multi objective model for the green forward and reverse logistics network design which was aimed at Designing & planning for the green forward & reverse logistic network foe the aim of minimising the cost of operation, process, transportation & fixed cost of establishment as well as reducing the amount of CO2 emission by adopting a model of mixed integer linear programming Epsilon constraint method in a home appliance industry. This study draws a conclusion of understanding the effects produced due to changes in demand cost & rate of return of used product on the objective function values with further scope of study of uncertainty in the quality of the returns of the used products other objective can be included such as social responsibility & community welfare.

Saurabh et al. (2015) studied reverse logistics for the objective of filling the gap existing in the literature review made on an outline the future directions based on the research gap. Main goal of the research was the building of legislation, corporate imaging, environmental factors, economic benefits, and sustainable competitiveness are forcing firms not only to adopt RL but also to make them efficient and effective by methods of Forecasting and Material collection, Descriptive analysis, Category selection and Material evaluation in Industries. Insights the research on the issues like adoption and implementation, product return, RL networks from secondary market perspective, forecasting, outsourcing and disposition decisions, other issues like marketing, financing and information technology can be taken for further studies.

Kannan et al. (2014) have reviewed recently published papers in reverse logistics and closed loop supply chain with objectives to find new research for understanding RL/CLSC and reconstruct the new literature review to get the view of future generation. Forecasting, Material collection, Descriptive analysis, Category selection and Material evaluation methods were built in Industries to find the future directions and opportunities of research in RL/ CLSC.

Debadyuti et al. (2015) focusses on the investigation of reverse supply chain management in consumer electronics based on an Indian perspective to find out the planned motive of an institution to undertake reverse supply chain management activities with the main goal of analysing RSCM activities in terms of cost incurred, time taken and study of return streams based on design of surveys in Electronics industry. Major searchings were motivating parameters of consumer electronics firms to pursue RSCM functions and EOL return stream is ranked 1 (commercial returns from customers: warranty returns). Issues relating to sample size, size of organised and unorganised samples must be taken for further research.

Mohd et al. (2017) examined the extent to which product returns motivate manufacturing firms for adopting CLSC activities that influences the effectiveness of RSC by calculating importance of product returns in adaptation of CLSC activities. This research was done by sampling approach and Empirical test for structural equation in manufacturing industry and for understanding the effects of changes in cost of demand &rate of return of used product on the objective function value and Uncertaintly in the quality of the returns of the used products, some other objectives can be included like social responsibility ,community welfare etc.

Liwen et al. (2017) focusses on the investigation the pricing and reverse channel choice decision issues in a CLSC to find the best suited collection model of used products and to make channel effective by using Game theory Xerox in cannon corporation and communication industry. Research figured out that Optimal reverse channel, Repair and maintenance model is best suited. For considering asymmetry information for example consider the case here consumers have different willingness to pay for two kind of products is scope for further research .

Bente et al. (2018) focusses on the Examination of how RSC in electronics industry which influences the governance mechanism and culture of the social, ecological and economic

performance in supply chain. Principal agency logic apparatus was used in Norwegian electronics industry to gain understanding for productive management of RSC, and monitoring and inter-firm collaboration act as governance mechanisms which can increase the inter-firm culture can lead to heightened triple bottom line performance. The utility of the model and results can be extended by examining the inter-firm culture operating in some other industries which have been adopted circular economy strategies.

Muhammad et al. (2012) studied theoretical based RL models and identified RL barriers for understanding the similarities and differences of the RL barriers among the MNC's and domestic firms and also investigating sample study of literatures of the companies in Chinese manufacturing industry. Low commitments and absences of RL experts in the business management levels constituted major barriers of the RL implementation in the manufacturing. Valuable insights have to be gained through studying the effects getting affected by firm size, efficiency of the firm and performance on RL implementation to firm with various hypotheses assumed in every sector for deeper and clear understanding of reverse logistics.

Sibel et al. (2012) proposed a profit of maximisation modelling framework for reverse logistics network design problems and suggested a multi commodity formulation & uses a reverse billing of materials in order to get component commonality among different products for having the flexibility to take in all the plausible sources for tackling of the product returns using mixed integer linear programming formulation and Case studies. Manufacturing (washing machines and tumble dryers) in Germany reveals demonstrated that there can be profits by using of a multi period model comparing to a static one. Further scope can be addressed a multi stage decision making problem with correlated decisions.

Saman et al. (2012) gave a model of closed loop supply chain network that examined manufacturer, disassembly process, refurbishing, and disposal sites to search out the optimal number of samples and products in CLSC network. Multi objective programming and Fuzzy theory model was used in manufacturing supplier selection and order allocation in the closed loop supply chain configuration in single period model. Further studies can investigate application of supplier selection methods in the CLSC configuration also Multi period model can be examined.

M. Mendi et al. (2005) focusses on the competitive value of service management activities, particularly repair services as well as the importance of supporting role of effective reverse logistics operations for the successful and profitable execution of repair service activities also taking profit of effectiveness and profitability by achieving a rapid cycle time goal for repair service while minimizing total capital and operational costs by various studies. Major international medical diagnostics manufacturer was investigated in case study, revealed that repair cycle times significantly longer than 6 hours created unacceptably low customer satisfaction while repair cycle times significantly shorter than 6 hours moved out of the realm of feasibility. The reliability of the service supply chain by eradicating the possibility of multiple domiciles coverage that would be taken advantage of the post-hoc analysis, conducted frequently by the firm.

Luu Quoc et al. (2012) proposed a model which minimizes the total processing cost of multiple types of WEEPs and focused on determination of the optimal facility locations and the material flows in the RL network. Mathematical programming model was used in Electrical and electronics industry. The result reveals that transportation cost plays a crucial role in the cost structure of the recycling pro- cesses. Therefore, the most effective way to remove the system's total cost is to cut down the transportation cost, also each type of waste goes through different recycling process based on its properties . Extending this model to include forward logistics in the recycling network to make the model more powerful and closer to reality.

Yung-Hsiang et al. (2010) investigating of the importance of reverse logistics services requirements, but also in selecting an appropriate (3PL)THIRD PARTY LOGISTIC PROVIDERS by providing a valuable references for the manufacturers concerned with the service requirements for outsourcing. Analytic network process analysis in TFT-LCD sector in Taiwan was researched. This valuable research significantly will be contributing to the efforts of the 3PLs in process in evaluating whether they may comply with potential of the customer requirements based on their service capabilities. Considering wider variety of firms when taking the outsourcing of reverse logistics functions can be of enough help.

Feng et al. (2007) addresses the analysis of reverse logistic networks that deal with the returns having repair services. A bi -objective subject proposing one related to total cost and other to customer satisfaction Scatter search using the dual simplex method and the constraint method and last computational analysis in Manufacturing industry. The cost related factors, such as installation

cost and transportation cost, can mostly influence the outcomes and the time related parameters, such as transportation time and customer's expected cycle time heavily influences the result. Other social and environmental parameters can be considered for future study work.

Ivan et al. (2018) introducing qualitative comparative analysis (QCA) in the field of supply chain management. A better understanding of RL helps for appropriate use of QCA and how to apply this methodology was proposed by Multi step analysis in manufacturing industries. The existence of multiple sufficient configurations for customer satisfaction indicates equal-finality because multiple alternative solutions leading to the same result. QCA dealing with large sample sizes need further development.

Ravi et al. (2013) four segments of manufacturing industries in India were investigated to get the status of RL in paper, food and beverage, auto and electronics. With respect to Indian context the tactical and operational issues at different segment of Reverse supply chain is studied thoroughly. Furthermore, it was suggested that managers could formulate strategies for successful implementation throughout completely reverse supply chain. Questionnaire based survey of Indian manufacturing industry was conducted. Further work can be done in different sectors of industries practicing functional dissimilarities in reverse logistics operations

Michael et al. (2010) researched Grounded theory approach, which was focused in Retail industry, which gave conceptual paradigm for handling retail RL supply chain operations. Through this framework total number of products, being retuned in volume can be optimized through lowering operational costs and practitioners by increasing values of assets being recovered. Further quantitative data with grounded theory can be applied in future works for improved research. Since multi-faceted operations are there, so there is need to manage at operation level of reverse supply chain. The three important dimensions are

- Operation performance
- Management control
- Organization integration

Qian et al. (2015) studied network design of RL supply chain to optimize the location of factories, Third Party Logistics Company and online retailers in accordance with ecommerce market

sector .Mixed-integer linear programming and mathematical model along with case studies in Electronic commerce industries helped in Identifying the further application of RL supply chain network. Aspects like penalty cost and second market business can be considered for future work.

Mario et al. (2012) analysed the impact of RL supply chain network in inventory change for single echelon SC for various amplification of order and inventory. Furthermore the given order policy was considered to one of most fought over management tool for improving the functionality of whole reverse supply chain network. It can help to reduce variability of orders and inventory in supply chain network via suppliers in RL chain. General review of literature and mathematical approach for modelling and analysing in manufacturing sector were studied. In a closed loop Supply chain the variability of reverse flow is grown considering the inventory variance. Moreover the proper design for RL supply chain network can only depend on new policy named RAPIOBPCS, which is used considerably for Reverse supply chain network.

S. Tibben (2002) studied that Reverse logistics supply chain is important for any company considering the reverse flow of products managing which is very crucial according to most of the online retailers in market. In this study, the reverse supply chain is studies based on sales of product throughout product life cycle. Study of literature in manufacturing industry gave the idea that generally when shifting from one part to another sector of life cycle for one model is considered much easier than when whole class of product move from one level to another.

Laura et al. (2002) researched for third party logistics provider in market for optimizing the reverse supply chain network. This was achieved by laying out various factors on which the working of TPL providers depends. Analytical network process model in manufacturing industry gave a clear idea how a decision making model can help in improving the management of overall supply chain. Sensitivity analysis was done was checking the factor hypothesis for third party logistics provider so that robust model can be generated for reverse supply chain network.

Yi-Chun et al. (2015) focuses on the investigation of the reverse logistics supply chain network in Taiwanese computer, consumer and communication electronics so that the impact of task environment can be figured out for organizational performance benefits. Analysis of the factors for decision making to be implemented during Reverse logistics network using Hierarchical regression analysis in retail industry of Taiwan. To increase the variance in task environment of RL chain the level of influence on the Firms network of reverse supply chain also improves. In addition, it was indicated that the salient task environment also affects the performance of reverse supply chain

network. Task for future can be considering the internal factors along with bottleneck external factors using hierarchical regression analysis in different sectors or in different industries.

Umberto et al. (2014) studied the reverse logistics supply chain network for various challenges and opportunity in context of HL. In humanitarian logistics sectors it is seen that the broad range of RL network is increasing causing humungous change in management of supply chain within commercial sectors. In addition, the impact is very limited based on commercial sectors. Findings indicate that, the Reverse logistics supply chain is very limited in commercial sector within HL. In future work the commercial reverse supply chain network can be implemented in aid agencies, governments host and most crucially for affected populations.

Michael et al. (2002) demonstrated the qualitative methods to analyse the reverse network problems in supply chain also to further analyse the economics variance of overall system using Qualitative methodology in Computers manufacturing sectors. The research methodology being adopted was thoroughly applied in the study to improve the performance of network and to collect Industry sensitive data that is needed to analyse economic variance of system which are designed to refurbish EOL computers. Further research can be implemented on further collecting data on factors being influenced/driven by other variables in reverse supply chain network.

Rudrajeet et al. (2016) studies the major RL deign aspects being optimized in clothing chains so that challenging factors necessary for value creation can be found. Using the method of exploratory study in clothing industry factors having high influence on clothing reverse supply chain can be studied to create a high value system with least complexity. The main enablers and factors, which influence the supply chain, is rigorously optimized to form a devising strategic solution for the current problem. Empirical insights for correlation of various value factors in clothing sectors were provided amongst which crucial factors were formulated and modelled using strategic communication and collection of data. The product, process and supply chain design aspects can be explored using a 3- dimensional concurrent engineering (3- DCE) framework to propose solutions for higher value creation and its manifestation

Joseph et al. (2012) identified the critical challenges faced by reverse supply chain management professionals in today's markets. These factors were then compared and optimized using vast research of literature review. Delphi method was used in manufacturing industry to direct better a scope for future work with current managerial issues in supply chain network. The seven key issues being targeted in paper are

- Customer support
- Communication
- Cost
- Formalization
- Operation time
- Issues of environment
- Support of Top management

Although the extensive hints are provided in paper for future work, critical areas or bottleneck situation can also be considered.

Sushmita et al. (2013) presented a study for the RL supply chain network for complex interactions of variables. Pharmaceutical supply chain is studied based of thinking and modelling methodology for complexities in network. The study analyses Indian pharmaceutical network based on system thinking approach incorporated with stakeholder analysis model to clarify loops of feedbacks in operating network of supply chain. The research suggest strong connection between reverse logistics network design along with key variables of management cells for more complex data based on industry with national level interaction.

Liz Ritchie et al. (2000) evaluated and improved the recycling and disposal of pharmaceutical products to find out where the NHS can save money which can be deployed and where it can demonstrate a continuing and proactive commitment for delivering the money by removing waste without in any way diminishing the level of care and resources devoted to patients by Data analysis in Manchester royal infirmary pharmacy. The results suggested that there are significant financial and advantages to the NHS, and other organisations, in developing of effective reverse logistics processes.

S.K. Sharma et al. (2014) focusses on a the topic for robust group decision device making for selecting the best alternative for product recovery also providing insight into the metrics that have been used in monitoring and controlling RL processes. The findings can help firms in identifying

loopholes and than choosing the metrics that they can employ to RL processes with firm giving goals in using Content analysis in Defence industry. Research identifies specific categories of goals, challenges & metrics. Most of the themes emerges from the work, that includes customer service, disposition activities, costs related, and efficiencies of the process. Other parameters like social and environment can be considered for further study.

Mclvor et al. (2008) studied reverse logistics outsourcing parameters and manufacturing functions using multi phased strategical model to determine parameters by conceptual study of both strategic and economical parameters in reverse logistics. The scope of future study was evaluation using software and internet tools for better optimization

Mehta et al. (2015) formulated a research on core competency for outsourcing parameters in pharmaceutical firms based on risk losing opportunity to improve innovation. Also it concluded that strength and capabilities that can give edge in the global market to the company based on outsourcing decisions of disposition strategies.

Rogers et al. (2012) studied modelling and analysis of reverse logistics to apply modelling methodologies to manage reverse logistics problem and issues. Here an overview of opportunities to provide benefits to supply chain professional. Thus parameter cost associated with outsourcing was determined for research as it depends on expenditure made.

Kremic et al. (2006) was responsible for determining risk associated with outsourcing parameter and researched the risk associated with outsourcing mainly as they fall onto four general categories

- For controlling loss
- For innovation loss
- For firm trust loss
- Higher of the expected transaction costs

Research was two fold. The first step was to provide a review of the major amount of outsourcing which has been accumulated in the past decades by using a decision making support of framework. The second step is to analyse the statistical outlines in the work to find the commonalities and gaps in order to support the directions for future research.

Lieb et al. (1993) researched third party logistics services based on American and European manufacturers using 500 largest industrial firms in regions mentioned. This study was responsible for determining coordination with third party service provider being a constant link and also having knowledge of the work action of third party. Potential future research topic is the use of third-party service providers by global companies in their home market versus other markets.

Jena et al. (2016) studied critical success parameters for smartphone manufacturing industries ecosystem in India using TISM modelling for 15 critical factors in smartphone industry to develop a conceptual framework for different critical factors and develop relationships among them. Results can be used to promote framework in smartphone manufacturing in India. Further factors can be explored and assessed to improve the drivers of framework

Neetu et al. (2015) researched about TISM model for project, managing the telecom service providers using TISM modelling of 17 critical links responsible for drawing framework for telecom service providers. The study shed lights on strategic parameters relating to the performance from subscriber and enterprises opinion. Research be considered as milestone move in research relating to telecom industries in Indian opinion.

Table 2.1 The identified parameters affecting the performance of outsourcing during disposition of EOU products.

SR.NO	PARAMETERS	DESCRIPTION	SOURCES
1	Specificity	Specifying/hiring the third party service provider for outsourcing that is capable for particular manner of disposition	Mclvor (2008); Loh (1994); Ordoobadi (2009);
2	Core competency	Strength and capabilities that can give edge in the global market to the company based on outsourcing decisions of disposition strategies	Mehta and Peters, 2015; DiRomualdo and Gurbaxani, 1998; Harris and Giunipero, 1998; Muscato, 1998;
3	Cost associated with outsourcing	Expenditure made on having certain. Job function done outside a company instead of having an in-house department handling them	Loh (1994); Kremic etal 2006; Rogers etal ,2012;

4	Risk associated with outsourcing	Risks that we accompany while outsourcing mainly fall into four general categories: loss of control, loss of innovation, loss of organisational trust , and higher than expected transaction costs	Kremic etal 2006; Liao and Ho, 2014; Gibler and T.black, 2004;
5	Profit associated with outsourcing of action	Benefits an organisation gains from the outsourcing work like cost savings, increased quality, augmented staff and many more	Kremic etal 2006; Jumah and wood, 2000; Lieb etal ,1993;
6	Lack of internal expertise	Lacking of basis of credibility of a person who is perceived to be knowledgeable in an area of subject matter in an in-house of a organisation	Mclvor (2008); Weight and Sarkar, 2011, Zobler and Hatcher, 2003;
7	Coordination with the third party service provider	Being in constant link with the third party and also having knowledge of the work action of third party	Lieb etal ,1993; Delfmann etal,2002; M.Wagner and Sutter, 2012;
8	Infrastructural facilities	Since in-house facilities like machinery floor space etc not available for a work than outsourcing is better option than making heavy investment on infrastructural facilities	Bouzan etal 2014; Jain and Natrajan ,2011; Agarwal etal ,2018;

9	Flexibility in outsourcing agreement	Terms and conditions and kind of partnership of outsourcing companies and organisation is a need to concern of an organisation to work smoothly	Beulen ans Ribbers , 2002; Zuniga (2005);
10	Social and environmental aspects of outsourcing	Satisfaction of human building upon trust and loyalty and deplecting environment to less as possible	Gunawardana (2018); Agarwal etal 2018; Schoenherr etal ,2015;

2.1 STUDY THE IMPORTANCE OF THESE PARAMETERS IN FIRMS OBTAINING OUTSOURCING AND FIRMS PERFORMING OUTSOURCING IN RL.

Several parameters descried in the table 2.1 affects the outsourcing performance and thus it is required which factors have high impact or the less impact on the performance meter. So that high impacting parameters can be taken with higher concern as each and every parameter cannot be taken with equal importance as there is no perfect service providers that can assure 100% performance. So depending upon the firms the selection can be made on the parameters taken in concern which are the driving parameters and which are the driven parameters . So that max performance efficiency can be aimed .

This study of finding driving parameters and driven parameters are made by applying the TISM methodology and data is collected by the experts .

CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

In this chapter TISM methodology has been discussed. The TISM methodology is Total Interpretive Structural Modelling (TISM).

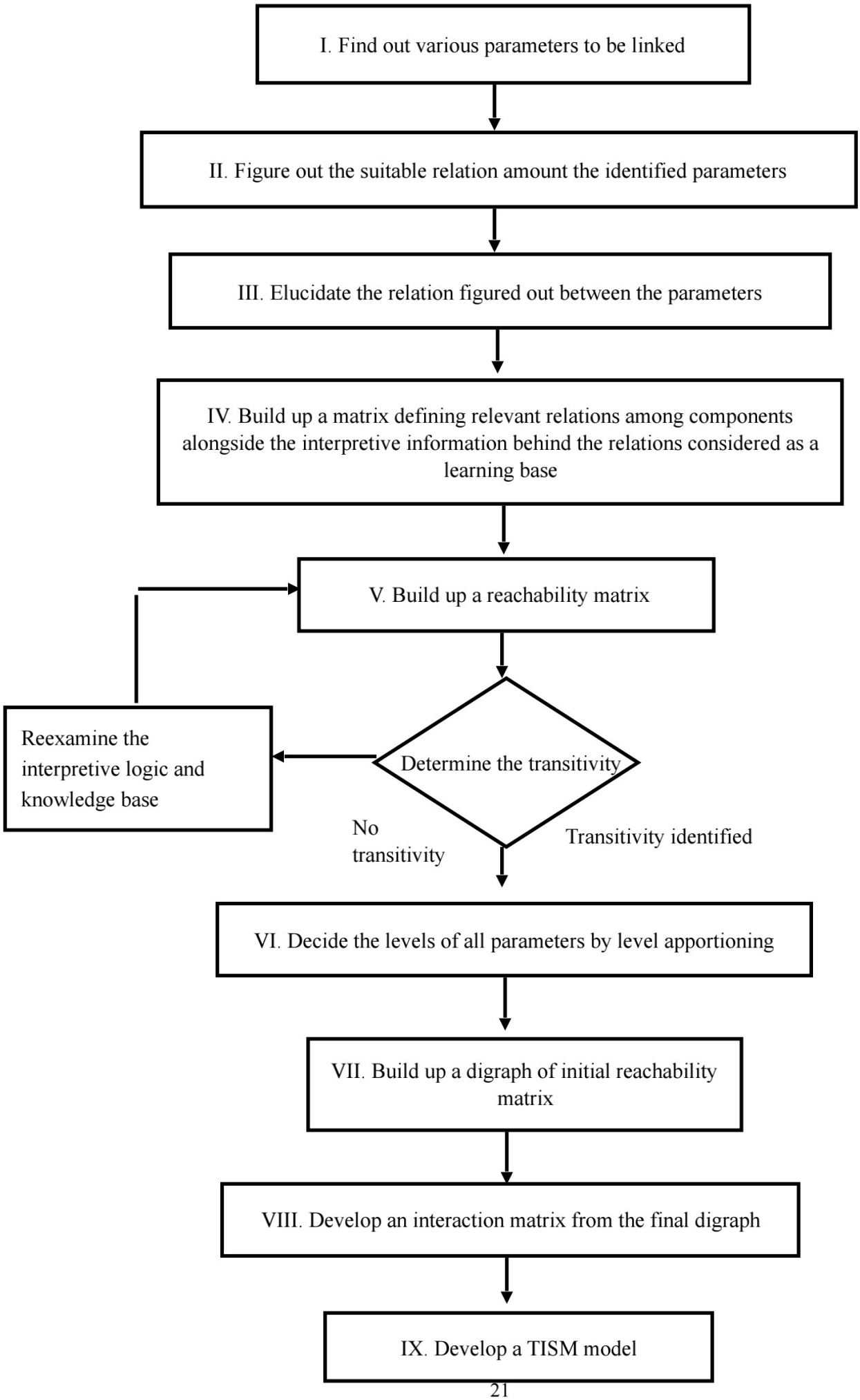
TISM is pair examination strategies to advance various levelled connections among a lot of components. This technique help to change over poorly organised mental models into well-explained models that go about as base for conceptualisation and hypothesis building.
Over the ongoing decade, numerous examinations have been done on the use of TISM and a wide range of variations have been advanced in the writing.

3.2 FLOW CHART OF RESEARCH METHODOLOGY

This fig 3.1.1 explains about the steps followed in series in this research methodology. The steps have been discussed later the flow chart. Various steps have been followed to apply this research methodology .

The very first step is to find out the parameters to be linked . Then suitable relationship is identified around the parameters on the basis of expert opinion. Next step is to develop the questionnaire done with the help of google form for collecting the data based on expert opinion. Later the questionnaire is send to various experts of the industries send through messenger, mails and personally visiting the experts to complete this step of the process. Fourth step is the analysis of the data, that is reliability analysis of factor analysis (relationships among parameters).

The software used to complete the process is Microsoft Excel. After the parameter analysis the very next step is to implement the TISM approach in which gradually it is applied in order to conclude the result. Digraph is used for finding the result and final conclusion .



3.3 Total Interpretive Structural Modelling (TISM)

Total interpretive structural modelling (TISM) technique is an extension of Interpretive structural modelling (ISM). It was proposed by Honorable Professor Sushil (IIT Delhi, India).

The TISM strategy is utilised to build up the various leveled relationship among the factors of interest. The focal instrument of ISM, for example reachability matrix and its partitions is embraced as it is a part of TISM technique. The TISM technique is a nine-step procedure, the brief description is presented below:

Step 1: Identify the parameters

The parameters in the study for the modelling which affects the outsourcing performance of the disposition in the RL are identified through literature and study.

Step 2: Define dependent relationship

To build up the structure, it is basic to characterise the logical connection between the factors/ variables of interest. Here, the relevant relationship distinguished between the vital variables is "Factor A will impact or improve Factor B". A model might be "Government approaches will impact or upgrade furious challenge".

Step 3: Understanding of relationship

This progression gives TISM an edge over conventional ISM, as the previous looks for an understanding of the connections. With regards to this study , the understanding will be "How factor A will impact or improve factor B?". It will help accomplish inside and out learning express.

Step 4: Interpret logic of pair-wise examination

An "Interpretive Logic-Knowledge Base" can be made for pair-wise examination of the parameters; the response for every correlation might be Yes (Y) or No (N). In the event that the appropriate response is Y, further interpretation is fundamental done by the experts to understand the the reason of the relationship among two parameters. The views of the experts are used to develop an interpretive logic knowledge base.

TABLE 1 STRUCTURAL SELF-INTERACTION MATRIX (SSIM)

Code	*F10*	*F9*	*F8*	*F7*	*F6*	*F5*	*F4*	*F3*	*F2*	*F1*
F1	X	X	V	O	V	V	V	O	O	1
F2	A	O	V	V	O	O	V	A	1	
F3	O	A	O	V	O	O	V	1		
F4	O	A	O	X	X	A	1			
F5	X	V	V	O	V	1				
F6	A	O	A	X	1					
F7	O	A	A	1						
F8	A	O	1							
F9	A	1								
F10	1									

TABLE 2 RULE FOR TRANSFORMING SSIM TO REACHABILITY MATRIX

(i-j) Entry	(i to j) Relation	(i to j) Relation
X	1	1
O	0	0
V	1	0
A	0	1

Step 5: Forming of reachability matrix and transitivity check

The interpretations of the identified relationship set up in Step III have been utilised as a premise to reachability matrix. It is acquired by entering 1 or 0 in the I-j cell of the network (where I is line and j is section) instead of 'Y' or 'N', individually. At that point the network is tried for transitivity. Transitivity exists if a backhanded relationship exists among variables which means if factor A prompts factor B and factor B prompts factor C, at that point factor A will likewise prompts factor C.By embeddings transitivity in the reachability matrix, a last reachability matrix has been acquired.

Transitivity adding in the initial reachability matrix is an iterative process. For every transitivity link, the initial reachability matrix is updated and 'N' entry is altered to 'Y' entry. Finally, 'transitive' has been written in the interpretation column.

TABLE 3 FINAL REACHABILITY MATRIX FOR CRITICAL SUCCESS FACTORS

	F1	*F2*	*F3*	*F4*	*F5*	*F6*	*F7*	*F8*	*F9*	*F10*	***DRIVING POWER***
F1	1	0	0	1	1	1	1	0	1	1	**7**
F2	0	1	0	1	0	0	0	1	1	0	**4**
F3	0	1	1	1	0	0	0	1	0	0	**4**
F4	0	0	0	1	0	0	1	1	0	0	**3**
F5	0	0	0	1	1	1	1	0	1	1	**6**
F6	0	0	0	1	0	0	1	1	0	0	**3**
F7	0	0	0	1	0	0	1	1	0	0	**3**
F8	0	0	0	0	0	0	1	1	1	0	**3**
F9	1	0	1	1	0	0	0	1	0	1	**5**
F10	1	1	0	0	1	1	1	0	1	1	**7**
	3	**3**	**2**	**8**	**3**	**3**	**7**	**7**	**5**	**4**	

Step 6: Level partitioning of reachability matrix

The reachability set and the antecedent set have been identified for each parameters from the initial reachability matrix. When both the intersection set and the antecedent set are similar, a level has been assigned to each parameter. Once the level is allocated to a factor, it is not considered in the next iteration. This procedure is repeated until levels of all the parameters are identified as shown in Table IV and Table V.

TABLE 4 ITERATION 1

PARAMETER	Reachability Set	Antecedent Set	Intersection	Level
1	1,4,5,6,8,9,10	1,9,10	1,9,10	
2	2,4,7,8	2,3,10	2	
3	2,3,4,7	3,9	3	

4	**4,6,7**	**1,2,3,4,5,6,7,9**	**4,6,7**	**I**
5	4,5,6,8,9,10	1,5,10	5,10	
6	**4,6,7**	**1,4,5,6,7,8**	**4,6,7**	**I**
7	**4,6,7**	**2,3,4,6,7,8,9**	**4,6,7**	**I**
8	6,7,8	1,2,5,8,10	8	
9	1,3,4,7,9	1,5,9,10	1,9	
10	1,2,5,6,8,9,10	1,5,10	1,5,10	

TABLE 5 ITERATION 2-7

PARAMETER	Reachability Set	Antecedent Set	Intersection	Level
1	1,5,8,9,10	1,9,10	1,9,10	**VII**
2	2,8	2,3,10	2	**III**
3	2,3	3,9	3	**IV**
5	5,8,9,10	1,5,10	5,10	**VI**
8	8	1,2,5,8,10	8	**II**
9	1,3,9	1,5,9,10	1,9	**V**
10	1,2,5,8,9,10	1,5,10	1,5,10	**VI**

TABLE 6 VARIABLE AND RESPECTIVE LEVEL

S. No.	Factors	Code	Level in TISM
1	Risk Associated with outsourcing	F4	I
2	Lack of internal expertise	F6	I
3	Coordination with the third party service provider	F7	I
4	Infrastructural Facilities	F8	II
5	Core Competency	F2	III
6	Cost associated with Outsourcing	F3	IV
7	Flexible in outsourcing agreement	F9	V
8	Profit associated with outsourcing of action	F5	VI
9	Social and environmental aspects of outsourcing	F10	VI
10	Specificity	F1	VII

Step 7: Digraph formation

A digraph is formed consisting of nodes and arrows. Each node represents parameters and each arrow represents direction of relationships between two parameters. Every parameter is arranged in the digraph as per the level obtained during level partitioning. The directions of relationships have been established as per the reachability matrix. Indirect relationships have also been shown in the final digraph with the dotted line.

Step 8: Interaction matrix

A binary matrix is formed by translating the final digraph. In this matrix '1' is used to indicate direct and significant transitive links. It is further developed as an interpretive matrix by providing the relevant interpretation from the knowledge base

TABLE7 REPRESENTS THE TRANSITIVITY LINKS BETWEEN THE FACTORS

Variable	*F1*	*F2*	*F3*	*F4*	*F5*	*F6*	*F7*	*F8*	*F9*	*F10*
F1	-	0	0	1*	1*	1*	1*	0	1*	1*
F2	0	-	0	1*	0	0	0	1*	1*	0
F3	0	1*	-	1*	0	0	0	1*	0	0
F4	0	0	0	-	0	0	1*	1*	0	0
F5	0	0	0	1*	-	1*	1*	0	1*	1*
F6	0	0	0	1*	0	-	1*	1*	0	0
F7	0	0	0	1*	0	0	-	1*	0	0
F8	0	0	0	0	0	0	1*	-	1*	0
F9	1*	0	1*	1*	0	0	0	1*	-	1*
F10	1*	1*	0	0	1*	1*	1*	0	1*	-

Step 9: Forming TISM model

The final step, a TISM based framework has been developed using digraph and interpretive matrix. In this framework, the interpretation of each relationship of parameter is mentioned. This framework clearly showcase the driving power as well as the dependence power of each parameter affecting the outsourcing performance in RL.

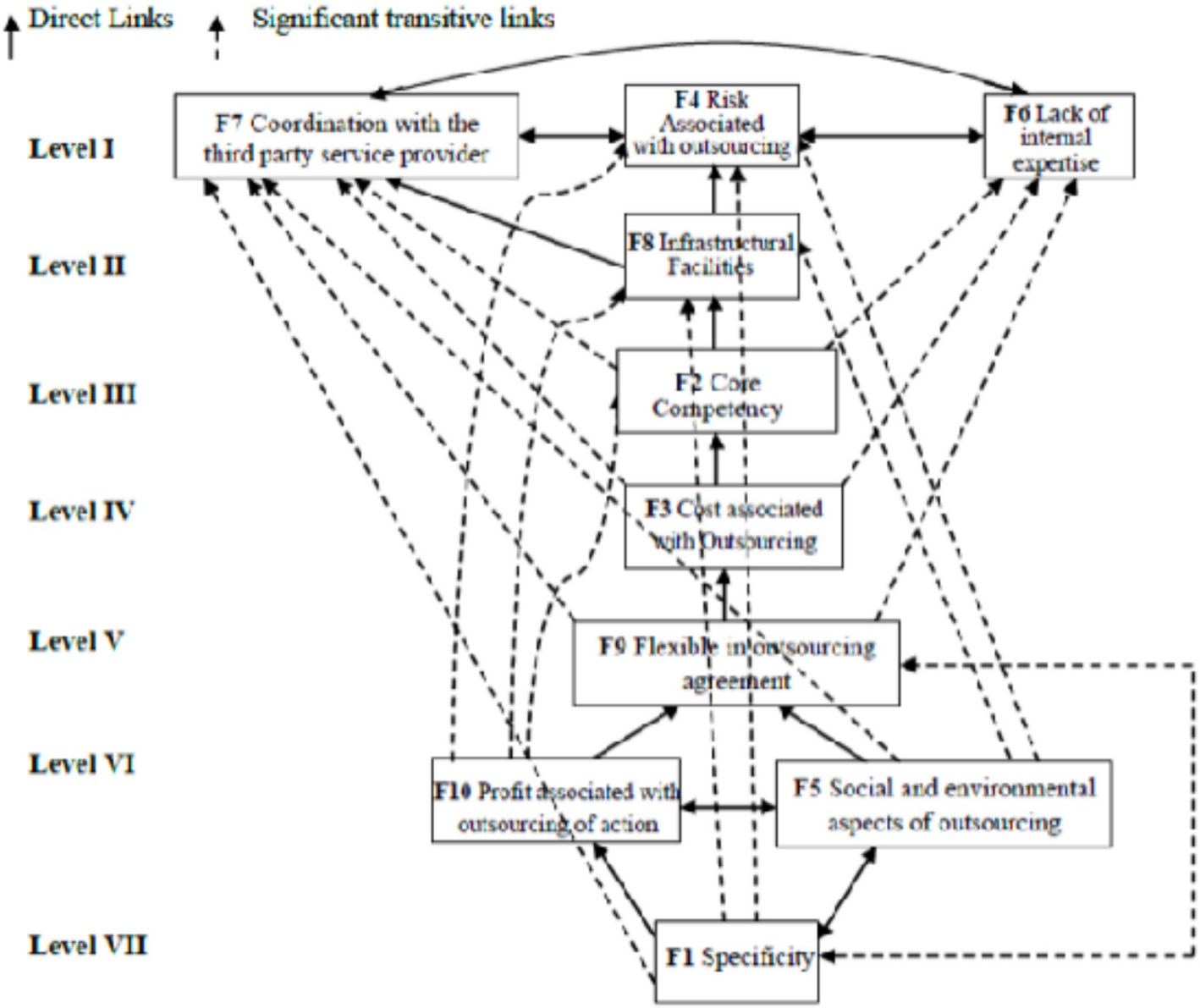
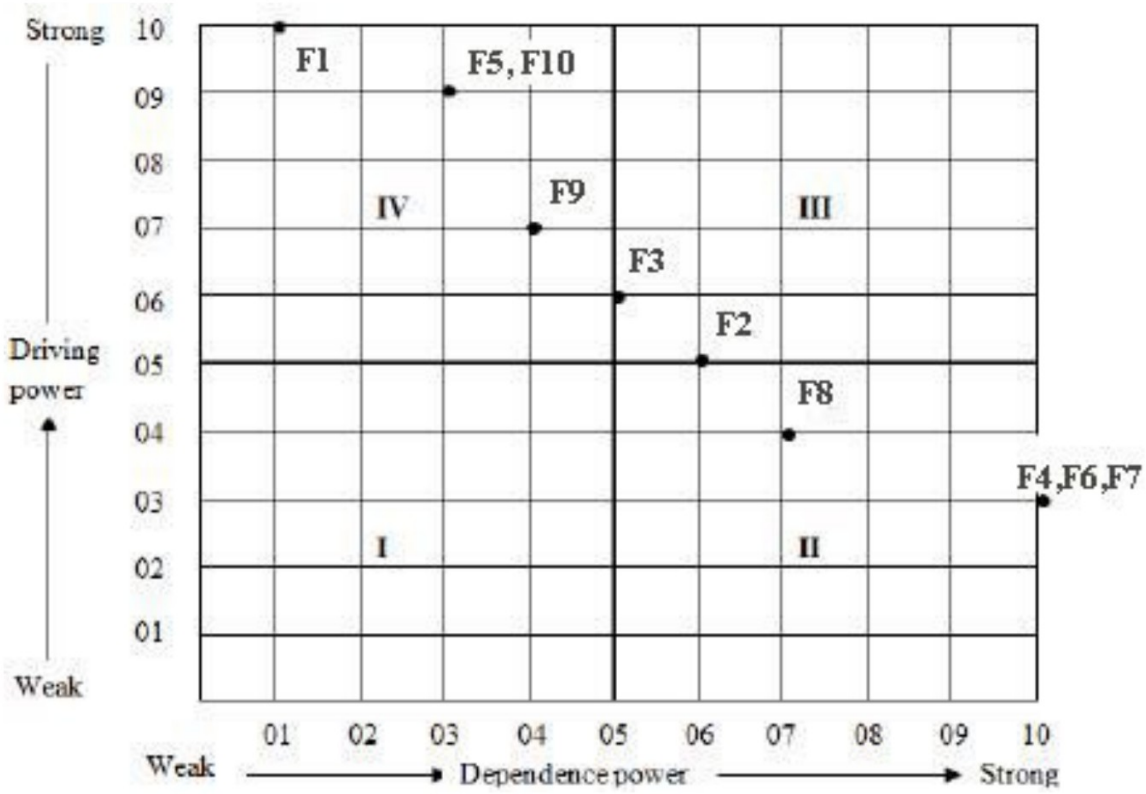


Fig 6. Digraph representation of links and nodes

CHAPTER 4

RESULT

4.1 Graphical representation of driving and dependence power of each Parameter



Parameters present in IV cluster needs to be given maximum attention as they are more strategic in nature, parameters in II cluster ,without these parameters working well result won't be achieved sufficiently. Direct and significant links with all other factors of reverse logistics have been implemented and shown in Table 7 transitivity links between factors, it shows the interaction matrix in diagraph matrix format and direct link and significant transitive link is represented by * in the table. Quadrant 1 represents autonomous variable, Quad 2 shows the dependent variables, Quad 3 represents linkage variables and Quad 4 shows independent variables, which are also called driver variables.

Flexible in outsourcing agreement (F9), Profit associated with outsourcing of action (F5), Social and environmental aspects of outsourcing (F10) and Specificity (F1) comes under the IV Quadrant,

which means the factors have weak dependence power and are independent variables with strong driving power. As seen in figure Quad III means independent variables factors with strong dependence power as well as driving power. These factors are consider dynamically unstable and any actions on these factors creates a direct or indirect impact on the other factors as well as on themselves. Thus, managers are required to pay special attentions on these factors as they can invite major changes Cost associated with Outsourcing (F3) lie on borderline of Quadrant IV and Quadrant III. Additionally Core Competency (F2) comes under borderline of Quadrant III and Quadrant II. In Quadrant II lies independent variables with strong dependence power and weak driving power. These factors lie above the central section of ISM hierarchy model. Risk Associated with outsourcing (F4), Lack of internal expertise (F6), Coordination with the third party service provider (F7) and Infrastructural Facilities (F8) is represented in Quadrant 2.

Through this research study, following suggestions can be drawn to prevent ill effects of occurrences of variables affection reverse logistics supply chain. Since specificity has been seen with highest driving power and weakest dependence power, the SCM managers should Specifying/ hiring the third party service provider for outsourcing that is capable for particular manner of disposition. As far as possible Profit associated with outsourcing of action should be focused upon to increase cost saving, quality of service and other things as well as Social and environmental aspects of outsourcing should be taken care of environment in RL chain to build trust and loyalty towards fellow human race and prevent depletion of environment. Terms and conditions and kind of partnership of outsourcing companies and organisation is a need to concern of an organisation to work smoothly to effectively overcome Flexibility in outsourcing agreement. As seen in diagram two variables lie in centre of hierarchy Core Competency which can be used to Strengthen the capabilities that can give edge in the global market to the company based on outsourcing decisions of disposition strategies and Cost associated with Outsourcing Expenditure made on having certain Job function done outside a company instead of having an in-house department handling them are related to one another as weak driving power and should be correlated when managing the RL supply chain. Risk Associated with outsourcing can occur due to Lack of internal expertise and Coordination with the third party service provider. Some other factors can also be Infrastructural Facilities. It is observed that the base factors of the diagraph are related to organisational management whereas the top variables are direct Supply chain related. This shows that problems and issues at organisational level affect the productivity of Reverse logistics supply chain.

CHAPTER 5

CONCLUSION AND FUTURE SCOPE

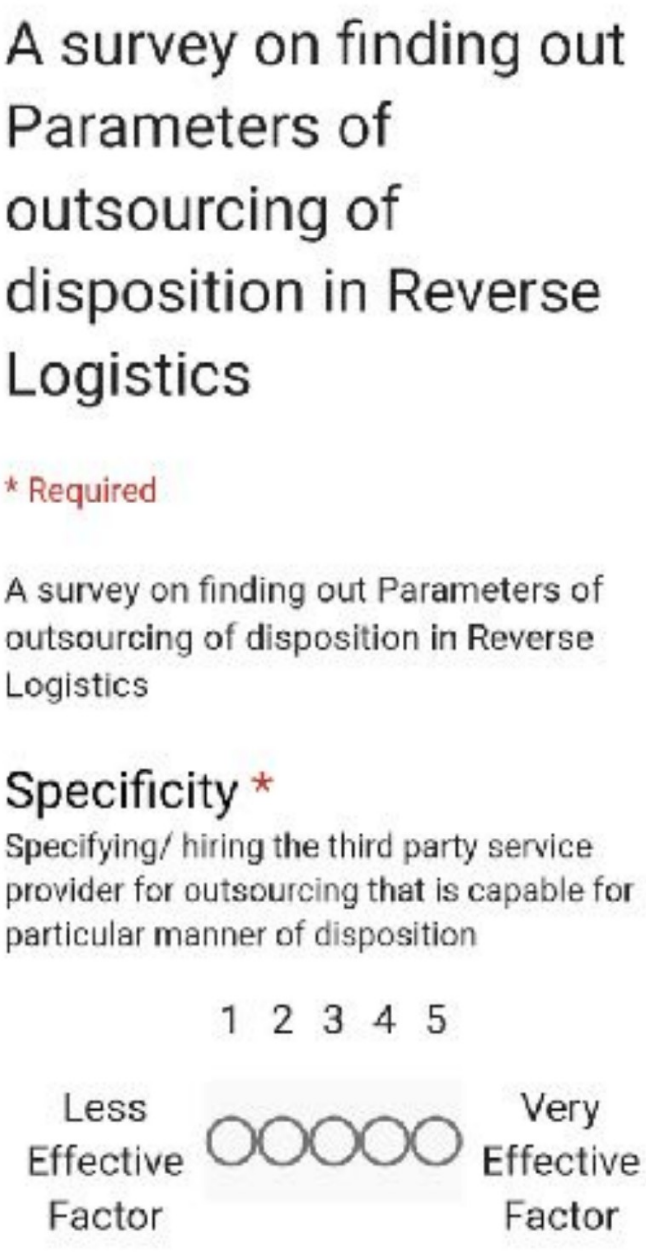
Several parameters are studied that are need to be considered while modelling of outsourcing of disposition strategies by an organisation. So that the organisation can be able to make 'cash from trash' and considering it important for environment. Reverse logistics supply chain issues have not been thoroughly explained. In this research study 10 variable, which can affect supply chain in direct or indirect manner, are explained here and links between these factors were drawn based on literature review and TISM model for correlating parameters. Application of TISM model is here considered a crucial method as directly able to link/understand the high driving power and weak dependence between variables is easily understood to help focus upon the crucial variable only in Supply chain. The limitation of study is that since the data collection is done based on limited responses of some supply chain based companies the study cannot be generalised to whole industry reverse supply chain as of now. In addition, the are 10 factors only which are limiting in nature as modern supply chain is huge with many factors affecting in bottleneck situations. Therefore, there is scope of further research with more extensive factors to proper generalise the result. Further research can be carried out to statistically validate the model with the help of structural equation modelling. In addition, TISM model can be implemented to areas where number of attributes contribute towards a problem.

APPENDICES

QUESTIONNAIRE DEVELOPMENT

The questionnaire was developed on the google forms for collection of the experts views about the rating of the performance of particular parameter in their firms.

Survey is conducted and the data is developed for the TISM model.



Core Competency *

Strength and Capabilities that can give edge in the global market to the company based on outsourcing decisions of disposition strategies

1 2 3 4 5

Cost associated with Outsourcing *

Expenditure made on having certain Job function done outside a company instead of having an in-house department handling them

1 2 3 4 5

Risk Associated with outsourcing *

Risks that we accompany while outsourcing mainly fall into four general categories: 1) loss of control 2) loss of innovation 3) loss of organisational trust 4) higher than expected transaction costs

1 2 3 4 5

Less Effective Factor ○○○○○ Very Effective Factor

Profit associated with outsourcing of action *

Benefits an organisation gains from the outsourcing work like cost savings, increased quality, augmented staff and many more.

1 2 3 4 5

Less Effective Factor ○○○○○ Very Effective Factor

Lack of internal expertise *

Lacking of basis of credibility of a person who is perceived to be knowledgeable in an area of subject matter in an in-house of a organisation

1 2 3 4 5

Less Effective Factor ○○○○○ Very Effective Factor

Coordination with the third party service provider *

Being in constant link with third party and also having knowledge of the work action of third party

1 2 3 4 5

Less Effective Factor ○○○○○ Very Effective Factor

Infrastructural Facilities *

Since in-house facilities like machinery floor space etc not available for a work than outsourcing is better option than making heavy investment on infrastructural facilities

1 2 3 4 5

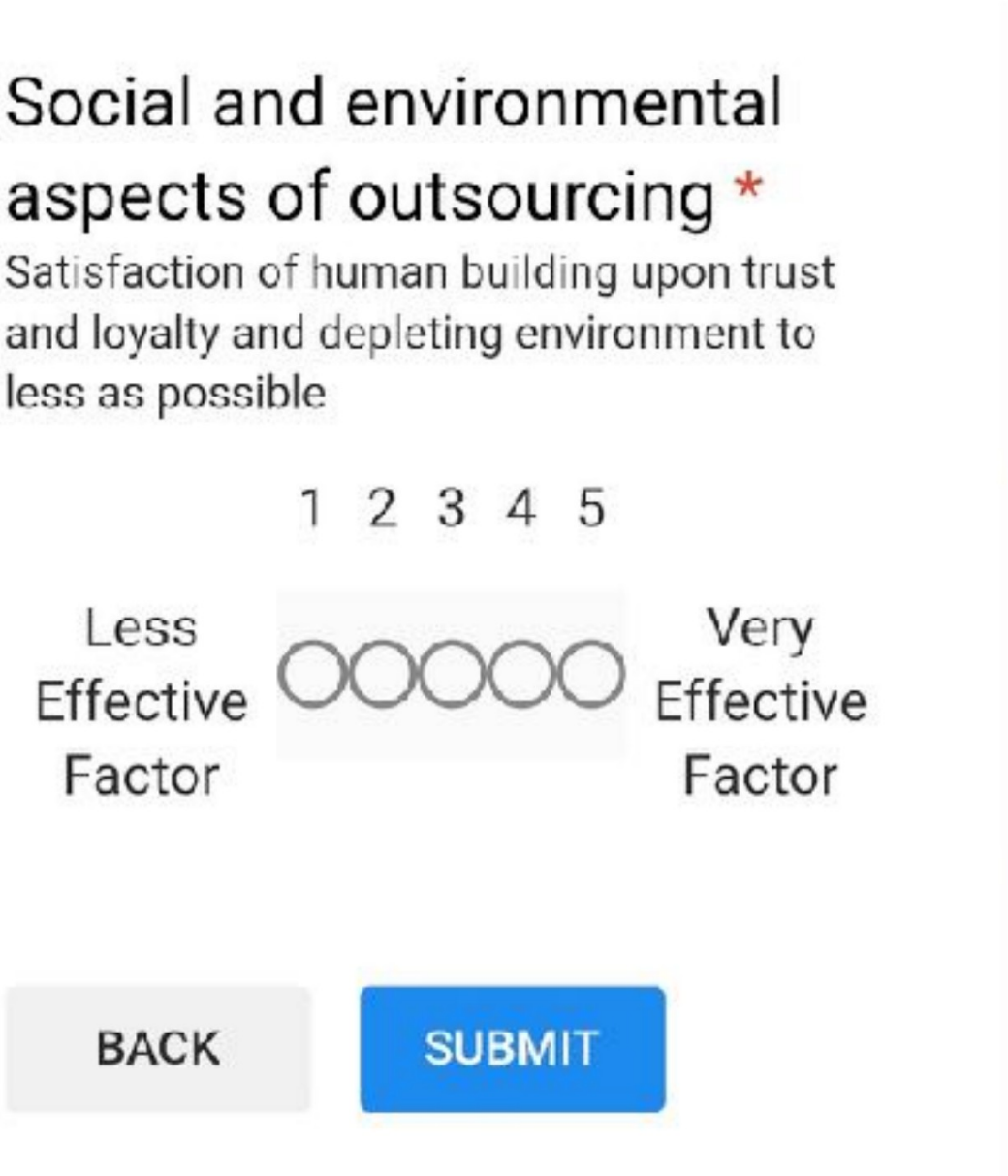
Less Effective Factor ○○○○○ Very Effective Factor

Flexible in outsourcing agreement *

Terms and conditions and kind of partnership of outsourcing companies and organisation is a need to concern an organisation to work smoothly

1 2 3 4 5

Less Effective Factor ○○○○○ Very Effective Factor



REFRENCES

1. Agrawal, S., Singh, R. K., & Murtaza, Q. (2015). A literature review and perspectives in reverse logistics. Resources, Conservation and Recycling, 97, 76-92.

2. Abdulrahman, M. D., Gunasekaran, A., & Subramanian, N. (2014). Critical barriers in implementing reverse logistics in the Chinese manufacturing sectors. International Journal of Production Economics, 147, 460-471.

3. Alumur, S. A., Nickel, S., Saldanha-da-Gama, F., & Verter, V. (2012). Multi-period reverse logistics network design. *European Journal of Operational Research*, *220*(1), 67-78.

4. Amin, S. H., & Zhang, G. (2012). An integrated model for closed-loop supply chain configuration and supplier selection: Multi-objective approach. *Expert Systems with Applications*, *39*(8), 6782-6791.

5. Amini, M. M., Retzlaff-Roberts, D., & Bienstock, C. C. (2005). Designing a reverse logistics operation for short cycle time repair services. *International Journal of Production Economics*, *96*(3), 367-380.

6. Bernon, M., Rossi, S., & Cullen, J. (2011). Retail reverse logistics: a call and grounding framework for research. *International Journal of Physical Distribution & Logistics Management*, *41*(5), 484-510.

7. Cheng, Y. H., & Lee, F. (2010). Outsourcing reverse logistics of high-tech manufacturing firms by using a systematic decision-making approach: TFT-LCD sector in Taiwan. *Industrial Marketing Management*, *39*(7), 1111-1119.

8. Das, D., & Chaudhari, R. (2015). Reverse supply chain management in consumer electronics: an Indian perspective. International Journal of Logistics Systems and Management 16, 20(3), 348-369.

9. Dat, L. Q., Linh, D. T. T., Chou, S. Y., & Vincent, F. Y. (2012). Optimizing reverse logistic costs for recycling end-of-life electrical and electronic products. *Expert Systems with Applications*, *39*(7), 6380-6387.

10. Du, F., & Evans, G. W. (2008). A bi-objective reverse logistics network analysis for post-sale service. *Computers & Operations Research*, *35*(8), 2617-2634.

11. Flygansvær, B., Dahlstrom, R., & Nygaard, A. (2018). Exploring the pursuit of sustainability in reverse supply chains for electronics. Journal of Cleaner Production, 189, 472-484.

12. Govindan, K., Soleimani, H., & Kannan, D. (2015). Reverse logistics and closed-loop supply chain: A comprehensive review to explore the future. European Journal of Operational Research, 240(3), 603-626.

13. Huang, Y. C., Rahman, S., Wu, Y. C. J., & Huang, C. J. (2015). Salient task environment, reverse logistics and performance. *International Journal of Physical Distribution & Logistics Management*, *45*(9/10), 979-1006.

14. J. Hall, D., R. Huscroft, J., T. Hazen, B., & B. Hanna, J. (2013). Reverse logistics goals, metrics, and challenges: Perspectives from industry. *International Journal of Physical Distribution & Logistics Management*, *43*(9), 768-785.

15. Jena, J., Fulzele, V., Gupta, R., Sherwani, F., Shankar, R., & Sidharth, S. (2016). A TISM modeling of critical success factors of smartphone manufacturing ecosystem in India. *Journal of Advances in Management Research*, *13*(2), 203-224.

16. Knemeyer, A. M., Ponzurick, T. G., & Logar, C. M. (2002). A qualitative examination of factors affecting reverse logistics systems for end-of-life computers. *International Journal of Physical Distribution & Logistics Management*, *32*(6), 455-479.

17. Kremic, T., Icmeli Tukel, O., & Rom, W. O. (2006). Outsourcing decision support: a survey of benefits, risks, and decision factors. *Supply Chain Management: an international journal*, *11*(6), 467-482.

18. Liu, L., Wang, Z., Xu, L., Hong, X., & Govindan, K. (2017). Collection effort and reverse channel choices in a closed-loop supply chain. Journal of cleaner production, 144, 492-500.

19. Lieb, R. C., Millen, R. A., & Van Wassenhove, L. N. (1993). Third party logistics services: a comparison of experienced American and European manufacturers. *International Journal of Physical Distribution & Logistics Management*, *23*(6), 35-44.

20. Meade, L., & Sarkis, J. (2002). A conceptual model for selecting and evaluating third-party reverse logistics providers. *Supply Chain Management: An International Journal*, *7*(5), 283-295.

21. McIvor, R. (2008). What is the right outsourcing strategy for your process?. *European management journal*, *26*(1), 24-34.

22. Mehta, S., & Peters, L. S. (2007). Outsourcing a core competency. *Research-Technology Management*, *50*(3), 28-34.

23. Narayana, S., A. Elias, A., & K. Pati, R. (2014). Reverse logistics in the pharmaceuticals industry: a systemic analysis. *The International Journal of Logistics Management*, *25*(2), 379-398.

24. Peretti, U., Tatham, P., Wu, Y., & Sgarbossa, F. (2015). Reverse logistics in humanitarian operations: Challenges and opportunities. *Journal of Humanitarian Logistics and Supply Chain Management*, *5*(2), 253-274

25. Pal, R. (2017). Value creation through reverse logistics in used clothing networks. *The International Journal of Logistics Management*, *28*(3), 864-906.

26. Rubio, S., & Jiménez-Parra, B. (2014). Reverse logistics: Overview and challenges for supply chain management. International Journal of Engineering Business Management, 6, 12.

27. Russo, I., Confente, I., Gligor, D., & Cobelli, N. (2018). A roadmap for applying qualitative comparative analysis in supply chain research: The reverse supply chain case. *International Journal of Physical Distribution & Logistics Management*.

28. Ravi, V., & Shankar, R. (2015). Survey of reverse logistics practices in manufacturing industries: an Indian context. *Benchmarking: An International Journal*, *22*(5), 874-899.

29. R. Huscroft, J., T. Hazen, B., J. Hall, D., B. Skipper, J., & B. Hanna, J. (2013). Reverse logistics: past research, current management issues, and future directions. *The International Journal of Logistics Management*, *24*(3), 304-327.

30. Ritchie, L., Burnes, B., Whittle, P., & Hey, R. (2000). The benefits of reverse logistics: the case of the Manchester Royal Infirmary Pharmacy. *Supply Chain Management: An International Journal*, *5*(5), 226-234.

31. Rogers, D. S., Melamed, B., & Lembke, R. S. (2012). Modeling and analysis of reverse logistics. *Journal of Business Logistics*, *33*(2), 107-117.

32. Shaharudin, M. R., Govindan, K., Zailani, S., Tan, K. C., & Iranmanesh, M. (2017). Product return management: Linking product returns, closed-loop supply chain activities and the effectiveness of the reverse supply chains. Journal of cleaner production, 149, 1144-1156.

33. Turrisi, M., Bruccoleri, M., & Cannella, S. (2013). Impact of reverse logistics on supply chain performance. *International Journal of Physical Distribution & Logistics Management*, *43*(7), 564-585

34. Tibben-Lembke, R. S. (2002). Life after death: reverse logistics and the product life cycle. *International Journal of Physical Distribution & Logistics Management*, *32*(3), 223-244.

35. XiaoYan, Q., Yong, H., Qinli, D., & Stokes, P. (2012). Reverse logistics network design model based on e-commerce. *International Journal of Organizational Analysis*, *20*(2), 251-261.

36. Yadav, N. (2014). Total interpretive structural modelling (TISM) of strategic performance management for Indian telecom service providers. *International Journal of Productivity and Performance Management*, *63*(4), 421-445.

37. Zarbakhshnia, N., Soleimani, H., Goh, M., & Razavi, S. S. (2019). A novel multi-objective model for green forward and reverse logistics network design. Journal of Cleaner Production, 208, 1304-1316.