MASTER

Analyzing the added value of 3PL partners in chemical logistics

Bharatheesha, S.

Award date:
2014

Link to publication
Analyzing the added value of 3PL partners in chemical logistics

by

Suhas Bharatheesha

Bachelor of Engineer(BE) Industrial Engineering and Management-MSRIT,India 2012
Identity Number: 1MS08IM051

in partial fulfillment of the requirements for the degree of
Master of Science
In Operations Management and Logistics

Supervisors:
dr. Emrah Demir
prof.dr.Tom van Woensel
Mr. Ronald Giesbers
TU/E School of Industrial Engineering

Series Master Thesis Operations Management and Logistics

Subject headings: Outsourcing, consolidation, transportation
Analyzing the added value of 3PL partners in chemical logistics

Thesis Report

Suhas Bharatheesha

Supervisors:

dr. Emrah Demir
prof. dr. Tom van Woensel
Mr. Ronald Giesbers

Eindhoven, August 2014
Preface

This report marks the conclusion of my Master thesis project and is the final jigsaw piece of my MSc study in Operations Management and Logistics. The last 7 months have been a real test for me; both as a student and as a professional at the company.

I would like to thank my supervisor Emrah Demir for guiding me during the course of the project. From the start of the project, he has been a great guide and the numerous meetings with him have proved extremely beneficial. He has motivated me on several occasions which pushed me to do more. I thank him for that. I would also like to thank Tom van Woensel for his continued support during the project.

Furthermore, I would like to thank The Dow Chemical company for providing me the opportunity to conduct my thesis project at a reputed company. Thanks to Ronald Giesbers for giving me the freedom to explore options for the project, providing opportunities to interact with other company professionals and providing exposure in the field of supply chain operations. Though we were not located in the same region, he has always ensured to provide me with contacts to support my study. I would also like to thank Rudy Milliau who has provided me with valuable information and helped me getting in touch with right people to provide me with information I needed. Special thanks to the Supply chain department at Dow for their various contributions to this project.

I would like to thank all my friends and colleagues at the university who have been of great support to me. I would like to specially thank my friends at Terneuzen with whom I stayed during the course of the project.

I cannot thank my family enough for always being there for me. Without my parents and my brother I would not have reached this far. I will always remain grateful to them. Suhas Bharathee-
Abstract

Obtaining regular services from 3PL partners requires assessment of the added value of such partnerships. The assessment of added value results in careful study of the current processes taking place in the network of shipper and 3PL. This enables to improve and address the gaps in relationships. This project was aimed at addressing these issues and analyzing the alternate solutions involving Information Technology, such as Transport Management System. The project was conducted at The Dow Chemical company to study the scenario of Road transportation of packed goods. One of the observed gaps being absence of order consolidation was addressed in the form of a Decision Support System to provide visibility of outbound LTL shipments. DSS indicated the opportunities for added value services, highlight the capabilities of IT and provide gateway to the improved use of TMS software package. Combination of contract clauses and suggestions from the tool indicate a possible savings for outbound LTL shipments.
Management Summary

Introduction

The Dow Chemical company has established partnerships with various 3PL providers to obtain logistic services. Dow is now determined to analyze the added value of such relationships, ascertaining the existence of possible gaps in the relationships and addressing them. The research questions below were formulated to address these goals

(1) What is the added value of 3PL partners in road logistics (for chemical goods) offered for Dow chemicals?

(2) How can the gaps in the current 3PL relation be addressed with the use of technology thereby providing visibility in the supply chain?

Analysis

These research questions are based around Dow’s activities carried out in association with its 3PL providers. To make a sound analysis of the scenario, it is quintessential to understand the current practices at Dow supply chain operations. The use of MFWP at Dow provides department specific information leading to the operations involving interactions between Dow and its 3PL partners. Aspects like added value and gaps in current relations are observed. It is stated that a value which can be differentiated and considered superior than that of the competitor can be considered as added value. Focus is also given on these operations to find the possible gaps in the current relation and ways to address it. While studying the order entry and order dispatch data, an interesting pattern was observed. There were repetitive instances where a particular customer had requested for multiple consignments to be delivered on the same day. This provided a lead in indicating that an order consolidation system was not in place and at the same time served as a motivation to build a consolidation model that can assist Dow in reducing the cost associated with multiple shipments.

Methodology

The first attempt to analyze the added value and also to evaluate for possible gaps revealed significant findings. Due the magnitude of outbound shipments from Dow, the possible benefits of order consolidation are considerable and hence the main focus was given to this. The motivations to build a DSS are shown in figure 1.

Ability to contribute to the added value of the relationship as well as being identified as an in-house product were the main motivations to consider the DSS. It employs a mathematical model whose construction progressed from a basic model to an NLP model employing piece-wise concept. The pricing strategy based on different weights enabled to think about the piecewise function. The motivation behind this is the similarity in the nature of the piecewise function.
Figure 1: Ishikawa diagram showing the need for a DSS

and the first challenge. A piecewise function is characterized by a common functional notation whose body has an array of functions and associated sub-domains. Comparing this with the model requirements, the array of functions explain the different cost structure for varying weight bands. A piecewise linear function is one where the array of functions are linear in nature. The following steps explain the model building process. The mathematical model is supported by a database which stores the forecast data being used at Dow. At the same time, GUI is built to facilitate the tool’s ease of use. The GUI was built keeping in mind the necessary flexibility and compatibility with the solver engine used to solve the mathematical model. The methodology process is shown in figure 2

Figure 2: Methodology

The DSS requires a user created database for a particular carrier/set of carriers but needs to be pre-defined. Based on different selections made by the user, the model checks for possible order consolidations. If any such exist, then the solver engine is made use of to determine the optimal combination and the resulting output is shown. The tool was implemented in Microsoft Excel utilizing the built-in solver as the engine for solving mathematical model built whereas the Visual
Basic for Application()VBA) was made use for linking the different parts of the tool as well as creating a user friendly interface.

Results

The main results are listed below:

- The tool provides a view of the possible order consolidation opportunities for each carrier. Historical data indicates that there are significant LTL shipments which are dispatched from Dow. However, the possibilities for order consolidation are overlooked.

- The tool provides a new dimension to look into the future orders(based on Country/Region/GI etc..,) An opportunity to do a detailed data analysis is provided.

- One common tool can be used to keep a track of orders being dispatched via multiple 3PL partners.

- CSRs constitute the gateway for orders which are entered into the Dow database. It was often mentioned that due to different business classification of CSRs and magnitude of data, CSRs are not in a position to discuss and consolidate the orders by themselves. The tool provides a common platform for CSRs to take a look at possible future shipments and make use of consolidation opportunities.

- Based on Case study for Carrier 1, the extra-payment constitutes 24.5% of the total payments made. At the same time, for Carrier 2, 15% of the payment already made constituted for extra payment.

Conclusions

Given that logistic operations is not the core-competency of Dow Chemical company, outsourcing of these operations eliminates investment in fixed assets and the need for expertise in this field. One of the added values of such relationship is the flexibility to reduce logistic costs or improve supply chain efficiency. In Dow Chemical company’s scenario, the strategic operations are held by Dow due to the presence of multiple 3PL partnerships. The control on strategic operations enable Dow to analyze the trade-off between logistic costs and supply chain efficiency. The intention of the tool built was mainly to show the opportunities for order consolidation thereby not only improving supply chain efficiency, but also reducing the logistic costs with no further investments. The tool was tested on historical data. An average of 20-30% extra payment provided an opportunity to optimize this part of the supply chain process.
### Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3PL</td>
<td>THIRD PARTY LOGISTICS</td>
</tr>
<tr>
<td>4PL</td>
<td>FOURTH PARTY LOGISTICS</td>
</tr>
<tr>
<td>BPSC</td>
<td>BUSINESS PROCESS SERVICE CENTER</td>
</tr>
<tr>
<td>CSR</td>
<td>CUSTOMER SERVICE REPRESENTATIVE</td>
</tr>
<tr>
<td>DSS</td>
<td>DECISION SUPPORT SYSTEM</td>
</tr>
<tr>
<td>DTS</td>
<td>DISPATCH TYPE SEQUENCE</td>
</tr>
<tr>
<td>ECC</td>
<td>ENTERPRISE CORE COMPONENT</td>
</tr>
<tr>
<td>EH&amp;S</td>
<td>ENVIRONMENT HEALTH AND SAFETY</td>
</tr>
<tr>
<td>ERP</td>
<td>ENTERPRISE RESOURCE PLANNING</td>
</tr>
<tr>
<td>ISCP</td>
<td>INTEGRATED SUPPLY CHAIN WORK PROCESS</td>
</tr>
<tr>
<td>ISM</td>
<td>INTERPRETIVE STRUCTURAL MODELLING</td>
</tr>
<tr>
<td>LHS</td>
<td>LEFT HAND SIDE</td>
</tr>
<tr>
<td>LLP</td>
<td>LEAD LOGISTIC PROVIDER</td>
</tr>
<tr>
<td>LSC</td>
<td>LOGISTIC SERVICE COORDINATOR</td>
</tr>
<tr>
<td>LSP</td>
<td>LOGISTIC SERVICE PROVIDER</td>
</tr>
<tr>
<td>MFWP</td>
<td>MATERIAL FLOW WORK PROCESS</td>
</tr>
<tr>
<td>MOT</td>
<td>MODE OF TRANSPORT</td>
</tr>
<tr>
<td>MT</td>
<td>METRIC TONNES</td>
</tr>
<tr>
<td>NEA</td>
<td>NEW ENTERPRISE ARCHITECTURE</td>
</tr>
<tr>
<td>NL</td>
<td>NETWORK LANE</td>
</tr>
<tr>
<td>OTC</td>
<td>ORDER TO CASH</td>
</tr>
<tr>
<td>RFP</td>
<td>REQUEST FOR PROPOSAL</td>
</tr>
<tr>
<td>RHS</td>
<td>RIGHT HAND SIDE</td>
</tr>
<tr>
<td>RSM</td>
<td>ROAD SHIPMENT MONITOR</td>
</tr>
<tr>
<td>SAP</td>
<td>SYSTEM ANALYSIS AND PROGRAM DEVELOPMENT</td>
</tr>
<tr>
<td>TMS</td>
<td>TRANSPORT MANAGEMENT SYSTEM</td>
</tr>
<tr>
<td>D&amp;MSC</td>
<td>DESIGN AND MODIFY SUPPLY CHAIN</td>
</tr>
<tr>
<td>RFQ</td>
<td>REQUEST FOR QUOTATION</td>
</tr>
<tr>
<td>RFP</td>
<td>REQUEST FOR PRICE</td>
</tr>
</tbody>
</table>
## Contents

Preface iii  
Abstract iv  
Management Summary v  
Abbreviations viii  
Contents ix  
List of Figures xi  
List of Tables xiii

### 1 Introduction
1.1 The Dow Chemical company 1  
1.2 Overview of Logistic Operations 2  
1.2.1 Selection of LSP 2  
1.2.2 Logistic Operations 3  
1.2.3 Responsibility of LSP 3  
1.3 Problem Statement 5

### 2 Literature Study
2.1 Who is a Logistic Service Provider? 6  
2.2 Origin and classification of LSP 7  
2.3 What are the motivations for Outsourcing 11  
2.4 3PL in Europe 14  
2.4.1 Vertical Logistics Alliance 14  
2.4.2 Horizontal Logistics Alliance 14  
2.5 Strategic Development in 3PL 14  
2.5.1 Consolidation among 3PL providers 15  
2.6 Selection of 3PL provider 18  
2.6.1 Customized tool with tabu search technique 18  
2.6.2 Fuzzy analytic network methodology 18  
2.6.3 LP model focusing on reduced delivery fees 18  
2.6.4 Customer satisfaction model 18  
2.6.5 Interpretive structural modelling 19  
2.7 Designing Transportation Contracts 21  
2.8 Pitfalls in Logistic Partnerships 21  
2.8.1 Failure to reach an understanding 22  
2.8.2 Promises that cannot be fulfilled 22  
2.8.3 A desire to failure 22  
2.8.4 A money losing contract 22

Analyzing the added value of 3PL partners in chemical logistics ix
## CONTENTS

3 Research Design ........................................... 23  
3.1 Underlying Questions .................................... 23  
3.2 Scope .................................................. 24  
3.3 Deliverables ............................................ 24  
3.4 Methodology ............................................ 24  

4 Analysis ..................................................... 26  
4.1 Dow’s Supply Chain Operation ........................... 26  
  4.1.1 Outplant Operations .................................. 28  
  4.1.2 Transportation Activities ............................... 28  
4.2 Definition of Added Value .................................. 31  
4.3 Transportation Management System (TMS) ............... 32  
  4.3.1 Capabilities of TMS .................................. 33  
  4.3.2 TMS at Dow ......................................... 33  
  4.3.3 Insight into Transwide TMS solutions ............... 34  
4.4 Motivation ............................................... 35  

5 Methodology .................................................. 37  
5.1 Data Collection ........................................... 37  
5.2 Choice of Database ......................................... 38  
5.3 The model ................................................ 39  
  5.3.1 Model 1 ................................................ 39  
  5.3.2 Model 2: Cost minimization model-NLP .............. 42  
  5.3.3 Model 3: Cost minimization model-LP ............... 45  
5.4 Graphical User Interface (GUI) ............................. 45  

6 Implementation ............................................... 47  
6.1 Choice of Software ......................................... 47  
6.2 Design and User Interface .................................. 47  

7 Results ........................................................ 49  
7.1 Model Assumptions ......................................... 49  
7.2 Case Study A .............................................. 49  
7.3 Case Study B .............................................. 53  
7.4 Limitations ............................................... 54  

8 Conclusion ..................................................... 56  
8.1 Conclusions ............................................... 56  
8.2 Recommendations ......................................... 57  

References ....................................................... 59  

Appendix .......................................................... 63  
A Dispatch Type Sequence ..................................... 63  
B Introduction .................................................. 65  
C Literature Study ............................................. 68  
D Results ....................................................... 70  

Analyzing the added value of 3PL partners in chemical logistics
List of Figures

1. Ishikawa diagram showing the need for a DSS .................................................. vi
2. Methodology ........................................................................................................ vi

1.1 Steps in Strategic Sourcing Process ................................................................. 2
1.2 Basic product classification ............................................................................ 3
1.3 Product and information flow for transportation via truck ............................ 4
1.4 Percentage share of LSPs in Dow’s businesses ............................................. 5

2.1 Consumer supply chain .................................................................................. 6
2.2 Role of LSP in Supply chain .......................................................................... 7
2.3 Interactions between 3PL and other parties ................................................... 10
2.4 Interactions between 4PL and other parties ................................................... 10
2.5 Framework for Evaluating Logistics Outsourcing Decisions ....................... 12
2.6 Decision Support Framework for Logistic Sourcing Strategies .................. 12
2.7 Trends in the service provider-customer relationship .................................. 13
2.8 Classification of 3PL ..................................................................................... 15
2.9 Classification of 3PL providers based on customer adaptation and problem solving ability ................................................................. 16
2.10 Logistics growth market .............................................................................. 17
2.11 Role of key criteria in the selection of 3PL providers .................................. 20

3.1 Project overview linking different chapters .................................................... 24

4.1 Sub-processes of ISCWP .............................................................................. 27
4.2 Flow chart highlighting different ways of meeting customer demands .......... 29
4.3 3PL activities within ISCWP ....................................................................... 30
4.4 The Order Life-cycle ..................................................................................... 31
4.5 TMS interaction with SAP and WMS ............................................................ 35
4.6 Transwide Platform ....................................................................................... 35
4.7 Ishikawa diagram showing the need for a DSS ........................................... 36

5.1 Methodology ................................................................................................... 37
5.2 Data collection hierarchy .............................................................................. 38
5.3 Parameters influencing an order .................................................................... 39
5.4 Selection requirements for orders to be considered for consolidation .......... 41

6.1 Design and operation of the Tool ................................................................... 48
6.2 A screenshot of the tool’s GUI ....................................................................... 48

7.1 Order Classification ....................................................................................... 50
7.2 Extra payment classification ........................................................................ 50
7.3 Percentage extra payment with Carrier 1 ..................................................... 51
7.4 Relation between Input parameters and Output display .............................. 51
7.5 Display Area of the Tool .............................................................................. 52
LIST OF FIGURES

7.6 Output Display showing the possible savings ............................................. 52
7.7 Order Classification for Carrier 2 ............................................................. 53
7.8 Percentage extra payment with Carrier 2 .................................................. 54
7.9 Solution Methodology ............................................................................... 55

A.1 Bulk liquid transportation ........................................................................... 63
A.2 Packed full truck load ................................................................................. 63
A.3 Bulk Granules .............................................................................................. 64
A.4 Bulk liquid intermodal transport ................................................................. 64
A.5 Packed full truck intermodal ....................................................................... 64

B.1 Logistic operations hierarchy ....................................................................... 66
B.2 A snapshot of outbound truck operation MFWP ......................................... 67

C.1 Flow chart showing ISM methodology for 3PL provider identifying criteria. . . 69

D.1 Major LTL destinations for shipments departing Ternezuen ....................... 70
## List of Tables

2.1 Activities associated with LSPs .............................................. 8
2.2 A classification of functions of LSP .................................. 9
2.3 Types of LSPs based on the type of customization offered .......... 9

4.1 Global work process .......................................................... 27
4.2 Dimensions of TMS ............................................................. 33
4.3 Comparison of OTM with TMS dimensions .......................... 34

7.1 Model Execution Scenario-Carrier 1 .................................. 49
7.2 Model Execution Scenario 2 ................................................. 53
7.3 Sample data showing model discrepancy ............................ 54
7.4 Unit Cost Discrepancy ......................................................... 55
7.5 Model Capacities ............................................................... 55

A.1 Dispatch Type Sequence codes ........................................... 64

D.1 Case Study A: Specific Scenario- Germany ..................... 71
D.2 Case Study B: Specific Scenario- Italy ............................... 71
Chapter 1

Introduction

This chapter contains a brief description of Dow Chemicals and the operations carried out at Terneuzen site. Main attention is given to the Logistic Operations carried out and a detailed classification of the processes is performed. The last section of the chapter describes the problem statement which serves as an information provider for formulating research question. Chapter 2 publishes the literature review carried out in the 3PL field to give an idea about the nature of this industry. Continuing with the process, Chapter 3 establishes the research question which helps in setting the focus point that needs to be addressed as well as stating the scope of the project. A pictographic description of various chapters and their relations is provided which gives a clear approach to the project. Chapter 4 describes the analysis conducted based on the problem statement and research questions that were established. The analysis looks at current operations being carried out at Dow and serves as a means to set background for the Methodology phase. In the mid-way of the report, Chapter 5 explains the methodology employed to address the research questions formulated in the previous chapter. A detailed explanation of the requirements and reasoning behind the methodology to be used is provided. The details of the methodology form a key input to the implementation phase described in Chapter 6. This chapter mainly focuses on the steps taken to realize the methodology so as to provide a tangible output. Chapter 7 highlights the results obtained via case studies performed at The Dow Chemical company where the tool was tested and also lists the possible benefits. Chapter 8 concludes this project. The main conclusions of the project are listed giving way to recommendations and future research.

1.1 The Dow Chemical company

Established in 1897, the Dow Chemical company has spread its reach across the world in becoming one of the leading chemical industries. Employing over 54,000 employees with more than 188 manufacturing sites across the globe, the company recorded sales of $56.8bn in the year 2012 through their six operating segments.1 Dow was a proud partner of the recently concluded Sochi Olympics and actively participated in reducing the carbon footprint. Dow visions to be the most valuable and respected science company through integrity, respect for people and protecting the planet. Dow Benelux was first established in the year 1955 and has grown to become one of the key contributors to the Dow chemical company. The site in Terneuzen with 18 plants and approximately 1,800 employees is the heart of Dow in the Benelux and also its headquarters. It is the biggest manufacturing location outside the United States of America. The site also has one of the biggest Research and Development centres and a Business Process Service Centre (BPSC) which serves the businesses in Europe, Middle East and Africa (EMEA).

1Electronic and Functional Materials, Coatings and Infrastructure solutions, Agricultural Sciences, Performance Materials, Performance Plastics and Feedstocks and Energy
1.2 Overview of Logistic Operations

Dow presently does not perform transportation operations. All the logistic activities are outsourced to Logistic Service Providers (LSPs). However, Dow closely works with its LSPs to keep track of the activities and assist them when required. In the following paragraphs, we take a brief look at the selection of LSPs, transportation operations.

1.2.1 Selection of LSP

Based on historical data and critical planning, Dow creates various Network Lanes (NL) which define the route and/or Medium of Transport (MOT). This NL is the first step in setting up a long term logistic network with the LSPs. Dow makes use of a custom built step-by-step process to aid them in selecting LSPs. This process is referred to as Strategic Sourcing Process (SSP). A preview of the steps constituting SSP is shown in Figure 1.1

![Figure 1.1: Steps in Strategic Sourcing Process](image)

We now simplify the aforementioned steps and briefly describe the processes taking place in the selection process:

- **Creation of NL:** the responsibility of creating NL and selection of LSP falls to Logistics Purchasing department. With the help of past data, the purchasing department creates various lanes based on demand and type of the product being served. In most of the cases, it is essential to create cluster of networks for granules and independent focused lane for liquid goods. These lanes provide a bird’s eye view of the route to be taken from the source to the destination.

- **Business leader interaction:** the purchasing department then contacts various business leaders to receive an update on various requirements. These requirements can vary from addressing a new customer/product demand or the means of satisfying an existing customer. Each business leader has the freedom to inform the purchasing department about the needs of his department. The leader may request for a LSP who has exceptional service capabilities and is not concerned about the costs. On the other hand, the leader may request for a LSP who is known for his economical services by performing the operations for a low cost. The purchasing department needs this information before they move on to the next step.

- **Market research:** once they have the information regarding the needs of the business leader, the purchasing department conducts an extensive market research to gather information of carriers. In this phase, information concerning the capabilities, performance, cost measures etc., are collected. A short-list of various carriers is created from the market research data.

- **Negotiation and Selection of LSP:** these short-listed carriers are then invited for meetings where they are provided with an opportunity to do a presentation. After carefully going through various details of carriers and the input from the meeting, the Purchasing department proposes a suitable candidate for a particular business to the concerned business leader. The selection of the LSP depends on the decision of the business leader. A green
light from the leader indicates that the purchasing department can now work on preparing the contract. The contract usually lasts for 2-3 years and has information ranging from ownership of products to delivery terms.

1.2.2 Logistic Operations

Before we look into the detailed logistic operations, we will first take a look at the classification of products to simplify our understanding.

![Basic product classification](image.png)

As can be seen in Figure 1.2, the products are classified into different sub-levels. The classification is performed based on the scope of the project. It provides a good means to classify products during the data collection stage. Products belonging to each category are referred by their business groups. A business group refers to a collection of different end products which have the same source or belong to the same category of chemicals. These products are referred to as Value-centres. It is important to have an understanding of these terminologies and classification since an order ticket contains information about all the above mentioned aspects.

It then becomes the responsibility of Dow personnel to ensure that the ‘Order to Cash’ process is executed smoothly. These Dow personnel are referred to as Logistic Specialists. A logistic specialist is handed the responsibility of different business groups (in most cases more than two business groups) and it is their responsibility to take necessary measures for the smooth process. Whereas Logistic specialist take care of long term planning, Logistic Service Coordinator (LSC) is responsible for day to day activities. This means that all exceptions (problems) raised which are of lower importance (such as insufficient safety measures, truck container is not clean etc..) is handled by LSCs. A flow chart indicating the break-down of product category and responsibility is shown in Figure B.1. During the course of the project, we will be focusing on the logistic operations of packed goods. Each of these levels may play an important role in determining the type of transportation container used. (If possible, describe the type of products which constitute packed granules or packed liquids etc.)

The various types of classifications can be found below.(insert the picture and description of DTS)

1.2.3 Responsibility of LSP

As described earlier, an LSP is assigned to a particular NL (please note that one LSP may be assigned to multiple NL as well) and is responsible for delivering orders dedicated to that particular line. Whenever there is a customer order, the computer system recognizes the associated NL and triggers an order request to the LSP. This request contains all the details of the product, lead

---

2In our context, an end product refers to the product which is ready to be shipped. This may not always be the final product. A semi-finished product can also be considered in this category.
CHAPTER 1. INTRODUCTION

time, necessary measures to be carried out by the LSP before arriving for pickup and so on. A simple depiction of this process is shown in Figure 1.3.

![Figure 1.3: Product and information flow for transportation via truck](image)

The steps to be carried out on arrival, the loading process, unloading is described by Dow in what is known as a Material WorkFlow Process (MFWP).

MFWP is a hierarchical setup created by Dow which is characterized by different levels each indicating processes associated with the superior ones. These functions depict the step by step process required to complete the task and provide the output to upper level functions. MFWP can be considered as the backbone of all the Work processes involved in the Dow chemical company. We will focus our attention towards MFWP in the area of Integrated Supply Chain. (a figure indicating different levels-ISC network) MFWP is an important part since it is required by the LSPs to carry out all the activities based on the steps described in the MFWP. Some of the example include that of the steps to be carried out when the truck enters the Dow plant, loading operations, Outplant operations etc. Based on this, detailed MFWP are designed for Inbound truck operations, Outbound truck operations and Outplant operations. A sample MFWP is shown in Figure B.2.

Once the order is assigned and the LSP has collected the order from pickup point, it becomes their responsibility to ensure the product is delivered to the customer in the correct order and on time. In most of the scenarios, the LSPs make use of Outplants which can be closely related to that of a consolidation centre, the only difference being that here outplants operate in the reverse way. Outplants may be used to collect orders from various pickup points and delivered to one customer. These outplants are again maintained and operated by third party.

At each stage of the described MFWP, employees of both BPSC and Dow keep a track of the ongoing process to ensure smooth flow. They are responsible to handle unexpected problems arising on a daily/monthly basis and to plan for future improvements. The type of product being shipped and the MOT (in this case, the possibility of inter-modal transport is taken into consideration) determines the type of container/trailer attached to a truck.

---

3 An outplant refers to a storage unit maintained and operated by a third party

4 Analyzing the added value of 3PL partners in chemical logistics
CHAPTER 1. INTRODUCTION

1.3 Problem Statement

Dow has made strategic decisions in the past to engage the services of Third Party Logistic providers (3PL) in Road logistics in the various geographies. Dow Europe ships over 9 million tons of product via Road/Intermodal and well over one-half million shipments annually. In some cases Dow’s reliance on these 3PLs has become significant. In Europe alone, the level of dependency on 3PLs can be seen with five 3PL operators servicing close to 80% of the Dow operations. With this extent of reliability on the 3PLs, we can make various considerations:

- 3PL partnerships have advantages, but obscure the view of the logistics market
- Potentially 3PL partnerships prevent the active pursuit of different logistics options, outside the partnership
- There is a lack of transparency of the true added value provided by the 3PL partners
- Dow is implementing a new SAP system (ECC) which enhances the possibility to consider standard modules such as Transport Management Systems (TMS) that can be easily integrated with SAP.

![Figure 1.4: Percentage share of LSPs in Dow’s businesses](image)

Dow is interested in knowing the added value of its 3PL partners. Keeping in mind the extent of Dow’s reliance on external parties for its Logistic needs (Dow’s reliance on 3PL providers is shown in Figure 1.4), they expect more from 3PLs than just transportation of the goods. In other words, they are interested in knowing:

- If their 3PLs are doing more than just transporting the goods (i.e., added value)
- If yes, what is the added value. If no, why is it not being done/how can it be done?

There might be situations where the customer feedback can be very valuable to the company and Dow expects its 3PL providers to gather these type of information. At the same time, there might be various factors which can hinder or improve a process carried out by 3PL operators and it becomes their responsibility to observe these changes rather than carrying out the process in a text-book fashion.

As Dow has embarked on its Transformational Strategy and is in the process of transitioning to SAP ECC, it is opportune to determine whether the current strategy (3PL) provides the highest added value, or whether an alternative solution could potentially be the best value proposition that long-term will provide the required service at the right cost.
Chapter 2

Literature Study

This chapter is designed to cover the topics of Logistic Service Providers which includes Third Party Logistics and Fourth Party Logistics from the available scientific sources. An attempt has been made to cover the existing practices as well.

2.1 Who is a Logistic Service Provider?

![Diagram of Consumer supply chain]

**Figure 2.1: Consumer supply chain**

*Source: Lummus et al. (2001)*

We will first focus on defining Logistics and then provide a brief description about LSPs. As stated by Lummus, Krumwiede and Vokurka (2001), “logistics profession involves planning, implementing and controlling efficient, effective flow and storage of goods and services from the beginning point of external origin to the company and from the company to the point of consumption for the purpose of conforming to customer requirements”. The council of logistics management define logistics as addressing primary activities like planning, implementation and control of the flow of goods, services and related information. Not to confuse with supply chain management,
logistics is the implementation of just how this flow in a supply chain is accomplished Lummus et al. (2001). Figure 2.1 shows the entire supply chain and the part of logistics in accomplishing the tasks. LSPs can be characterized as companies who perform logistic activities on behalf of others Delfmann, Albers and Gehring (2002). This is expected to be achieved by using their expertise in performing delivery activities and intelligent use of logistic partnerships. In addition to the above mentioned activity, the focus of the LSP is expected to be on adding value to the customers existing process whenever possible. Figure 2.2 shows the role played by LSP in Supply chain.

![Figure 2.2: Role of LSP in Supply chain](source: Banomyong (2010))

### 2.2 Origin and classification of LSP

Though there is no clear cut classification stating the evolution of LSP, Papadopoulou and Macbeth (1998) try to map the progress based on the services offered by LSPs over the past 40-50 years. The five categories by Papadopoulou and Macbeth (1998) are:

- **Single services**: The third party can provide only haulage or transportation or warehousing services
- **Separated services**: The third party can provide either hauling or warehousing services
- **Integrated services**: The third party can provide a combined haulage or warehousing services
- **Combined services**: The third party can provide extra services on top of the equipment, warehousing, transportation functions such as trade administration and planning services
- **Complex combined services**: The third party can provide a network of different services, such as planning, equipment, handling, yard management, warehousing administration and information and transportation functions.

Analyzing the added value of 3PL partners in chemical logistics
The authors observe various economical, political and military situations and place the above mentioned categories into specific period ranging few years each:

- **Introductory period (1900s-1950s):** The concept of 3PL is in its infancy. Companies are still hesitant about 3PL and are willing to consider the option only if the 3PL can prove to be significantly cost advantageous.

- **Awareness period (1950-1960):** The concept of 3PL gains popularity. Companies consider this as an alternative solution.

- **Necessity period (1960-1970):** Concept begins to be adopted by the companies. Significant market changes and legal changes increase the distribution complexities which results in relying upon 3PL.

- **Integration period (1970-1980):** The concept of 3PL interest more companies. Internationalization forces companies to shift to 3PL.

- **Differentiation period (1980-1990):** 3PL is considered as a differentiation in the companies competitive position. The globalization and need for partnerships and alliances necessitate 3PL even more.

In the field of LSPs, a common and widely accepted typology has not yet been established. However, Sink, Langley Jr and Gibson (1996) provides a simple classification based on the functions LSPs typically perform (based on a survey among buyers of logistic services). Table 2.1 shows the classification:

<table>
<thead>
<tr>
<th>Function</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transportation</td>
<td>Shipping, forwarding, (de)consolidation, contract delivery, freight bill payment/audit, household goods relocation, load tendering, brokering</td>
</tr>
<tr>
<td>Warehousing</td>
<td>Storage, receiving, assembly, return goods, marking/labelling, kitting</td>
</tr>
<tr>
<td>Inventory management</td>
<td>Forecasting, location analysis, network consulting slotting/layout design</td>
</tr>
<tr>
<td>Order processing</td>
<td>Order entry fulfilment</td>
</tr>
<tr>
<td>Information systems</td>
<td>EDI/VANS, routeing/scheduling, artificial intelligence, expert systems</td>
</tr>
<tr>
<td>Packaging</td>
<td>Design, recycling</td>
</tr>
</tbody>
</table>

Table 2.1: Activities associated with LSPs

Source: Sink et al. (1996)

Delfmann, Albers and Gehring (2002) adapts the classification of Sink, Langley Jr and Gibson (1996), Engelsleben and Delfmann (1999) and Niebuer (1996) to provide two new typologies. Table 2.2 shows one of the classification based on clustering of the functions into two groups: services directly related to physical flow of goods and services which are not directly related to physical flow of goods. The second classification, arguably the most interesting for company scenarios, was developed by Niebuer (1996) (As stated in the article by Delfmann, Albers and Gehring (2002)). The classification is based on the degree of customization offered by the LSPs (Table 2.3).

- The first group consists of LSPs offering standardized logistic services like transportation and warehousing.
CHAPTER 2. LITERATURE STUDY

Table 2.2: A classification of functions of LSP

Source: Delfmann et al. (2002); Engelsleben and Delfmann (1999)

- The second group consists of companies which combine standardized services to bundles of logistic services based on the customer’s request. An example of a bundle is transportation activity combined with simple assembly or quality control activities.
- The third group is completely customized as per customer’s wish. A tailor-made service is provided by the LSPs.

<table>
<thead>
<tr>
<th>Standardizing</th>
<th>Bundling</th>
<th>Customizing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standardized</td>
<td>Disposal by the customer</td>
<td>Individual, complete logistics solutions for specific customers</td>
</tr>
<tr>
<td>Disposal by the customer</td>
<td>Combination of isolated services and coordination by the LSP</td>
<td>Responsibility for important customer logistics functions</td>
</tr>
<tr>
<td>Optimization and offering of singular logistics services</td>
<td>Optimization of the bundle of logistics services</td>
<td>Administrative and disposal tasks</td>
</tr>
</tbody>
</table>

Table 2.3: Types of LSPs based on the type of customization offered

Source: Delfmann et al. (2002); Niebuer (1996)

We now shift our focus to two commonly referred names belonging to the LSP group: Third Party Logistics service provider (3PL) and Fourth Party Logistics service provider (4PL). In the following paragraphs, we take a look at the functioning of 3PL and try to understand the difference in functionalities of a 3PL and a 4PL.

decamargo Junior et al. (2012) explain the functioning of the 3PL as shown in Figure 2.3. A 3PL firm receives the outputs from a focal firm, perform its activities and delivers its outputs to the clients of this focal firm. As can be seen from the figure, 3PL connects different horizontal layers.
CHAPTER 2. LITERATURE STUDY

The performance of 3PL can improve or complicate the vertical flows associated with the focal firm which makes it important to have a good understanding between the focal company and the 3PL. According to de Camargo Junior et al. (2012), the main difference between a 3PL and a 4PL is the change in focus. Whereas a 3PL is responsible for logistic operations, 4PL does this service and the development, implementation and maintenance of logistics projects for a given supply chain. A 4PL can contract and evaluates 3PL and other service providers and it performs management services such as financial services, payments, insurance and activities for end customers. According to Chapman, Soosay and Kandampully (2003), 4PL is nothing but redesigning of 3PL structures and relationships that enables the creation of a knowledge chain that facilitates and improves data, communication, coordination and planning. These companies (4PL) should synchronize activities between the agents of the supply chain, building strong relationships amongst the participants and developing the flexibility to deal with supply and demand uncertainties (Win, 2008).
If we reconstruct the same figure and analyze the interactions of 4PL with various horizontal levels, we can see that a 4PL needs to maintain strong relationships with almost all actors in the chain, serving as a hub to all participants (refer to Figure 2.4). In this case, even 3PL firms are represented as a new layer due to the fact that it is one of the responsibilities of 4PL to interact with 3PL companies, hiring and managing their services.

Focusing on the functions of 3PL, Belman and White (2005) categorize 3PL providers based on the kind of services provided by them. The categories include transportation-based, warehouse/distribution-based, forwarder-based, shipper/management-based, financial based, and information-based. We will give a short description of Transportation and Warehouse based categorization.

- Transportation-based: Transportation-based suppliers who provide leveraged services (use of assets of other companies) and non-leveraged services (utilizing the transportation-based assets of the parent organization)

- Warehouse/Distribution based: The firms belonging to this category are the ones who have already been involved in logistics activities such as inventory management, warehousing, distribution, etc. The author also indicates that these facility-based operators transition to integrated logistics has been less complex compared to transportation providers. It is also stated that many firms emerge out of large corporate logistics organizations (such as Caterpillar Logistics Services) who make use of their significant experience in managing logistics operations.

2.3 What are the motivations for Outsourcing

Rao and Young (1994) identified three main characteristics of shippers business profile that drive their logistics outsourcing behavior and influence the formation of a favourable or unfavourable climate for outsourcing. These include:

a) Network complexity, referring to both the geographic dispersion of the firms trading partners as well as the intensiveness of transactions with selected trading partners

b) Process complexity, referring to time and task compression in the logistics process

c) Product complexity, relating to the special circumstances required by products and materials due to complexity of the environment governing their transportation, storage and handling.

Understanding the reason for a company's decision to outsource is as much important as knowing what implications the decision has on the supply chain operations of 3PLs. The implicit reason being that depending on what an organization decides to outsource, it will restrict the involvement of 3PLs in the organizations logistics operations to minimum (Bolumole, 2001). The author provides an example of the decision of petrol retailers in UK to outsource their logistics operations.

As can be seen from Figure 2.5, the decision to outsource or perform in-house largely depends on the fact whether Logistics is a core competency and if Logistics is an industry critical success factor. In general, the author notes that the main reason for outsourcing was a realization of the lack of, and subsequent need for, in-house logistics expertise required to manage centralized distribution operations. Some of the drivers of outsourcing were:- Complex supply chain, increasing volume of product returns, maintaining high service levels, cost reduction etc.

Focusing now on the factors influencing the role of 3PLs, Bolumole (2001) identifies four main factors:

- Managements main reasons for outsourcing and their subsequent perception of 3PLs function within the logistics strategy

- Organizations strategic focus and orientation

Analyzing the added value of 3PL partners in chemical logistics
CHAPTER 2. LITERATURE STUDY

Figure 2.5: Framework for Evaluating Logistics Outsourcing Decisions.

Source: Bolumole (2001)

Figure 2.6: Decision Support Framework for Logistic Sourcing Strategies.

Source: Bolumole (2001)
• The extent to which the logistics process is outsourced.

• The nature of the client-3PL relationship

The strategic orientation refers to the focus of organizations competitive strategies and the effect this has on the nature of the logistics strategy. The motives for outsourcing by the retailers largely influence the retailers perception of, and the nature of retailer-3PL relationship. As an example, the motive for outsourcing might be to reduce the logistics costs as opposed to improving supply chain efficiency. It was observed that internal strategic orientation was designed for firms to focus on strategic activities which lead to internal profit making at the expense of supply chain optimization. The client-3PL relationship was observed to range from adversarial arms length to fully collaborative partnerships. It was observed that though the term partnership was used, upon further analysis, it was revealed that the client held full control of strategic level functions and responsibilities while 3PLs, acting as contractors were in charge(under the constant supervision of retailers) were in charge of operational level duties. Social exchange theory suggests that the exchange process (i.e., the transition from arms length relation to actual partnership) evolves over time as organizations mutually and sequentially demonstrate greater levels of trust. Figure 2.7 provides a picture of the evolution of the relation between service provider and customer.

![Trends in the Service Provider/Customer Relationship](source: Bolumole (2001))

over time. Another reason influencing the extent of logistic outsourcing is the firms reasons for outsourcing influenced by its perception of 3PLs abilities. This refers to the way in which 3PLs job functions are defined and their capabilities are perceived based on the retailers underlying reasons for outsourcing. This helps to position the firms expectations and influences its understanding of how 3PLs are able to contribute to logistics strategy. The extent to which individual activities within the overall logistics process are being outsourced, managed in-house or shared between retailer and 3PL, has the greatest impact on the role of 3PLs. the extent of outsourcing is categorized into operational level, tactical level and strategic level.
CHAPTER 2. LITERATURE STUDY

2.4 3PL in Europe

According to Datamonitor (2000), 3PLs play a critical role in logistics provision contributing to about 26% of total logistics across the European Union (EU). The market for third-party logistics was estimated at 40 billion euros in 2001 (IDC, 2001). Carbone and Stone (2005) examine the strategic behavior used by 20 leading European 3PLs in the past decade to keep up with the market challenges. These strategies could be vertical alliances which involves alliance among customers and 3PLs (vertical alliance) or different 3PLs (horizontal alliance) Some of the strategies used by the 3PLs are discussed below.

2.4.1 Vertical Logistics Alliance

According to Cooper et al (1998), a vertical alliance includes planning and overseeing the inbound and outbound freight flows in the nodes of the logistics network. Improvements to the service levels, inventories management and order processing are looked for. Bagchi and Virum (1996) state that firms in UK, Scandinavia and Netherlands have used vertical alliances for many years. They also state that the reason behind this is due to re-structuring as part of re-localization of production sites and the outsourcing of logistics. Overall, it was also observed that more vertical alliances were used in sectors which incorporated developed SCM approach.

2.4.2 Horizontal Logistics Alliance

Carbone and Stone (2005) state that horizontal logistics alliances are key for 3PL to expand internationally. They state that horizontal alliances enable cross-border expansion and further globalization. This kind of alliance allows to spread costs or/and risks and at the same time increasing the scope of the services. Some of the reasons for alliance were:

- To enlarge and strengthen the geographical network concerning a specific business
- To penetrate new markets, in terms of services
- To penetrate new geographical markets, dominantly beyond Europe

2.5 Strategic Development in 3PL

Hertz and Alfredsson (2003) analyze the strategic development in 3PL which attracted many new firms to enter into the field of third party logistics business. The importance is given to the general problem solving capability and the degree of customer adaptation. At the same time, the authors focus on the reasons which has also driven the customers to look into more advanced and complex services (such as 4PL) The authors list out the factors which make a service provider to be classified as 3PL provider. They state that balancing between customer adaptation and problem solving is what makes a 3PL provider. This indicates that as part of the strategic development by 3PL, they have to keep in mind of this balance. However, it is not a mandatory requirement. Some small firms have been noted to focus on only one of the two factors and thereby making it their core competence. The small size of the organization makes them appropriate to master in one aspect. The classifications as indicated by Hertz and Alfredsson (2003) is shown in figure 2.8

Further focusing only on the 3PL firms, they are divided into 4 categories (figure 2.9) which are now explained in detail.

- The standard 3PL provider can be seen as supplying standardized 3PL services like warehousing, distribution, pick and pack, etc. These firms offer these services as a side service to their normal business
- A 3PL as service developer is one who offers advanced value-added services. This could involve differentiated services for different customers, forming specific packaging, cross-docking, track and trace, offer special security systems, etc. An advanced service packaging
often involves several sets of more standardized activities turned into modules that could be combined according to each customer demands.

- Customer adapter can be described as the 3PL firm taking over customers existing activities and improving the efficiency in the handling but actually not making much development of services. This usually happens when a 3PL provider takes over the customers warehouses and logistics activities and relies only on few customers

- The final category is in accordance to customer developer classification. This is the most advanced and difficult to form. This involves a high integration with the customer often in the form of taking over its whole logistics operations. Such a firm is sharing the risk and rewards of the logistics management with the customer.

### 2.5.1 Consolidation among 3PL providers

There is a new trend developing in the 3PL market which intends to change the face of 3PL. Gordon (2003) suggests in his article that there is a developing trend for consolidation among 3PL service providers. As can be seen in Figure 2.10, the logistics market is growing at the rate of 15-25% annually. However, this growth is accompanied with high fragmentation which makes the logistics industry ripe for consolidation. The fragmentation provides a breeding ground for consolidation of small companies which will be essential to meet the varied market demands. Based on the above mentioned observation, the author identifies three main consolidation drivers:

- Shippers quest for LLPs: shippers need for greater control over their outsourced activities has given rise to LLP\(^1\). Some of the expectations required to be met by LLPs include multimodal expertise, powerful technology, financial resources, geographic scope and so on. To meet these expectations, the smaller 3PLs resort to consolidation else they face the possibility of finding themselves out of shippers consideration.

\(^1\)Lead Logistic Provider offers a wide range of outsourcing services through a single point of contact. In short, they rely on a network of smaller 3PL subcontracors to deliver these services
• Game-Changing technologies: growing number of shippers expect their 3PLs to use sophisticated and costly technology solutions. These sophisticated technologies can require an investment of up to $10 million.

• Money Rich Logistics acquirers: There have been examples in the recent past where prominent 3PL players were acquired by the big boys (Deutsche post buying Danzas for $1.2 billion). Money rich organizations in Europe tend to buyout companies in US and other continents to reach out to new markets and expand their geographic market.

Keeping these things in mind, it can be said that the reasons send out certain implications for 3PL users. They have an added responsibility of addressing some key questions like business needs of the organization, will it be better served with LLPs, can the current 3PL can keep up with the new technology and so on. It is important that the shippers realize the importance to analyze the existing situation and identify the developing trends.

Source: Hertz and Alfredsson (2003)
The Logistics Market Today:
High-Growth but Extremely Fragmented

Figure 2.10: Logistics growth market.

Source: Gordon (2003)
CHAPTER 2. LITERATURE STUDY

2.6 Selection of 3PL provider

This section provides a list of tools to assist organizations with the selection process of 3PLs.

2.6.1 Customized tool with tabu search technique

Once the decision to choose the services of 3PL is made, it is important to have a strong structure which will aid in selection of a 3PL provider. In the paper by Schittekat and Sørensen (2009), the authors discuss optimization techniques for the selection of 3PL providers taking the example of an automotive industry. A specific tool is designed with the sole purpose of aiding the organization in the selection of the best LSP from the set of available ones. The tool makes use of tabu search meta-heuristic to solve the location-routing problem. The tool generates a set of high-quality solutions which provides an opportunity for the parent organization to analyze the different available options. At the same time, it also helps guide the organization in swiftly switching between different transport networks in case of an unexpected error. As an added advantage, the tool also has provision to integrate with a commercial vehicle-routing solver. This can be beneficial to integrate with an existing LSP or can be used in the future by the organization if they decide to carry out the operations by themselves. In practical scenario, this tool has already been integrated with commercial routing solver SHORTEC. Overall, this tool has the potential in aiding a selection of a 3PL and corresponding transport platform.

2.6.2 Fuzzy analytic network methodology

Wong (2012) discusses the possible techniques to assist parent organization in selecting a 3PL provider. The aim is to take into consideration flexible resources and interaction among providers. It is proposed that Fuzzy Analytic Network Process overcomes the shortcomings of traditional mathematical programming. This method is primarily aimed at organizations who intend to outsource partial or whole logistics operations. The general selection criterions which the companies are expected to know are: globalization considerations, relationship building and integration competencies, operational performance, quality, finance and finally information technology.

2.6.3 LP model focusing on reduced delivery fees

It is important for a parent organization to make sure that the LSP is not billing excessive prices for their services. It is not an easy task for the organization either to determine the exact cost. To address this issue, Balakrishnan, Natarajan and Pangburn (2000) describe a linear programming model which is capable of deciding the delivery fees to be paid to distributors. The model applies to manufacturer-distributor partnerships where distributors are compensated using fee values that depend on delivery weights and distances. Factors like stochastic demands are considered to cover the aggregate distribution costs for each distributor. Since manual selection of acceptable fee values is difficult, the model developed by the authors promises to minimize the total expenses for the manufacturer meanwhile ensuring that the distributors are adequately compensated.

2.6.4 Customer satisfaction model

Coltman, Gattorna and Whiting (2010) take up an interesting task of identifying the specific service attributes which are valued by the customers with respect to the buying experience through third-party logistics. This can be a crucial finding as this can be promising in realigning the service concept of an organization. The development of the model is based on quantitative The service concept is defined as “total bundle of goods and services sold to the customer and the relative importance of each component to the customer (Sasser, Olsen & Wyckoff, 1978). The statement can be interpreted as stating that it reflects the way an organization would like its services to be perceived by customers. This means that the organization should pay special interest to the service concept which can be a key strategic decision in improving their customer satisfaction.
With this viewpoint, the model mentioned by the authors can be useful to help the organization realize what are the key services valued by the customers which enables them to re-define the strategies to meet these service requirements.

2.6.5 Interpretive structural modelling

Qureshi, Kumar and Kumar (2008) propose an integrated model for assessment and selection of 3PL service providers which uses Interpretive Structural Modelling (ISM) and FMICMAC analysis. The model classifies various criteria into four different categories based on their importance. The classifications dependent criteria, independent criteria, autonomous criteria and linkage criteria are made based on driving and dependence power, deduced from fuzzy reachability value. The model promises to assist logistical managers in selecting the right criteria for the selection of 3PL providers through identification and classification of key criteria.
CHAPTER 2. LITERATURE STUDY

Figure 2.11: Role of key criteria in the selection of 3PL providers.

Source: Qureshi et al. (2008)
As shown in figure 2.11, the step by step process includes collection of data, defining the required specifications, requesting for proposal (RFP), evaluation and confirmation. Some of the important criteria as identified by the authors include Quality of Service, Quality of fixed assets, Information technology capability, Information sharing and trust, Operational performance etc. The entire list considered by the authors is provided in table 1. The ISM model is applied to show the interrelationships among the various selected criteria. The benefit is from the fact that ISM helps to identify the key criteria as it depicts the direct and indirect relationship among the criteria identified for the selection of 3PL service providers. The detailed steps involved in the ISM methodology is shown in figure C.1.

The ISM methodology infuses experts opinion through brain storming to develop contextual relationship among various criteria.

2.7 Designing Transportation Contracts

Alp, Erkip and Gülli (2003) discuss about designing of Transportation Contracts between a manufacturer and a transporter. Before we discuss about the designing of contracts, it would be beneficial to know the importance and contents of a transportation contract. Generally, the manufacturing organization outsources transportation and warehouse activities (basic 3PL operation). The transportation company (LSP) is selected via a bidding mechanism that requires all the conditions of the contract to be met. The manufacturing organization should follow the bidding structure, but has flexibility of preparing the contract. The contract has details concerning the face value of the job, quantities needed, due dates, and unit penalty costs. Keeping this in mind, the authors aim to present a methodology for identifying a set of possible bidders who would be economically eligible for undertaking the contract. Now focusing on functioning of the model, it provides the manufacturer with ability to estimate average transit lead-time, average values of vehicle hiring cost etc., by approaching via three sub-problems: Contract Value Problem (CON), Vehicle Dispatching Problem (VEH) and Inventory Control problem (INV). Each sub-problem is analyzed by observing various parameters influencing them. VEH plays an important role as the two main outcomes from this sub-problem (Transportation Cost and Delivery Schedule) are used to further analyze CON and INV sub-problems respectively. The final evaluation phase consists of collecting information from the above mentioned sub-problems and is checked for consistency and compared against acceptance standards. If proved to be satisfactory, the result is generation of a contract involving terms such as Order amounts and dates, Penalty costs, Contract value etc.

2.8 Pitfalls in Logistic Partnerships

Until this section, we have looked at various aspects of 3PL performance, methods of 3PL selection, present trend in outsourcing and strategic developments in the functions of 3PL service providers. Now, we take a look at possible pitfalls in the logistic partnerships, try to reason why they occur and consequently understand the ways of preventing it. Ackerman (1996) refer to this issue and list out few reasons why a logistics relation might fail.

- The buyer and seller have not reached a realistic understanding about the job to be done.
- The seller has over-promised and is unable to deliver on that promise.
- Managers at the buyers company do not want to make the relationship work.
- The seller has discovered that he/she is losing money in the relationship.
- Services failures has become intolerable for the buyer.
- An orderly procedure for separation is not specified in the agreement.

Each of the above mentioned reasons are analyzed in detail to provide information on ways to prevent the fallout of the logistics partnerships.
2.8.1 Failure to reach an understanding

The author suggests that a failure to have a true meeting of the minds is the most frequent case for the collapse of logistics partnerships. One of the common reasons for this to happen is either an accidental or deliberate failure on the part of the buyer to describe properly the job which must be done. This scenario usually begins with a discovery that the seller cannot perform the job without incurring a substantial loss. It might also be the case that seller lacks the resources to handle all the complexities of the job to be done and therefore they cannot maintain adequate service and sustain the volume of work within the required schedule.

2.8.2 Promises that cannot be fulfilled

At times the complexity and/or volume of the job to be performed exceed the capabilities of the seller. This can take place when the information system requirements are beyond the capabilities of existing systems used by the seller.

2.8.3 A desire to failure

Unfortunately there are some managers who believe that outsourcing of logistics is a threat to their own job security. They view the logistics contract as a development which could eliminate the need for the positions they hold. They feel that they have nothing to lose and everything to gain if a logistic partnership fails.

2.8.4 A money losing contract

Because of the communication failures described above, some vendors fail to create a realistic fee schedule for the logistics contract. When the losses are substantial the seller may lack the ability or the courage to renegotiate the agreement. Also, renegotiation might not be feasible if the buyer has submitted a budget based on the offered price.
Chapter 3
Research Design

The problem statement described in the previous section highlights the key areas of interest to Dow. We try to cover these aspects by addressing the research question:

(1) What is the added value of 3PL partners in road logistics (for chemical goods) offered for Dow chemicals?

(2) How can the gaps in the current 3PL relation be addressed with the use of technology thereby providing visibility in the supply chain?

3.1 Underlying Questions

We now list several sub-questions which will assist us in addressing the two main research questions.

Addressing Research Question 1:-

1. What are the current practices carried out by the 3PL partners?
   • How satisfied is Dow with the current practices?

2. What are the practices available for 3PL partners in the market?

3. What is the extent of involvement of Dow in the logistic operations?

4. What are the expectations of Dow from their 3PL partners?

Addressing Research Question 2:-

1. What are the areas where the visibility is required?

2. What type of Information Technology system can help in improving the supply chain visibility?

3. What are the possible ways in which TMS can contribute to Dow operations?

4. What is the adaptability of existing Information systems to new softwares?

The approach taken in the project is shown in Figure 3.1 which also indicates the link between different chapters and their purpose.
3.2 Scope

The scope of the project will be limited to European geographical area excluding Russia and Turkey domestic transport. The mode of transport under consideration will be Road transport and all intermodal transport with one section involving road transport. The focus on type of products will be limited to packed goods (the majority being packed granules). This will significantly assist in simplifying the data for future use.

3.3 Deliverables

A list of expected deliverables is provided in this section. The list is created with the intention of addressing the various sub-questions supporting the main research questions and hence the main research question itself.

- Review and summary of expected logistics market development (3PL, 4PL, insourcing)
- Evaluation model for considering each model (i.e., outsource vs insource transport management) from a chemical industry perspective
- Identification of the added value delivered by 3PLs in the market (best-in-class)
- Review and verify potential benefits for insourcing TMS

3.4 Methodology

The aim of the project is to determine the added value of 3PL partners in road logistics. At the same time, it is also required to assess the performance of the 3PL partners with other possible alternative solutions. This can very well belong to the category of Unstructured or semi-structured problem. As stated by Keane (1980) and Sprague (1980), Decision Support System (DSS) is a tool to facilitate organizational processes and possess the characteristic of combining the use of models
or analytical techniques with traditional data access to address less well structured and underspecified problem Keen (1980) Sprague (1980). Though our requirement is clear, the problem seems to be unstructured and hence the aim of the methodology will be to build a DSS to assist the upper management. To build a DSS, we need to understand the three fundamental components of a DSS architecture Haag, Cummings and Dawkins (1998):

1. the database(or knowledge base)
2. the model
3. the user interface

To determine the requirements for the first step, we start looking back from our final requirement: database. The first task in our methodology would be to create a database of required knowledge. It is quite difficult to objectify the required knowledge at this point in time and hence we approach it from a subjective viewpoint. Going one step back, it is essential to know what database is to be created and consequently what kind of data is to be mined for. To proceed in assessing the added value of the 3PLs, it is important to understand the way things are carried out in the current scenario. Data collection of the current activities would be the ideal start. At the same time, it is also important to look into the market scenario’s for some possible benchmark performances which can be used as a reference point. This would further lead to analyzing the collected data which is expected to yield performance results. After keenly observing the problem statement and the research question, we can confidently say that there seems to be lack of transparency between Dow and its LSPs regarding the expectations and deliverables. This situation indicates the existence of a possible hinderance between the two parties and it is essential to locate the problem. One of the possible ways in locating the problem would be to conduct semi-structured interviews with both Dow and its LSPs. In this way, the understanding of each other’s expectations will become clear and helps to identify the pivotal problem. This opens up a possibility to make use of Ishikawa diagram (Cause and Effect diagram). This tool assists in identifying the potential causes for a particular problem. In our case, we can refer to the tool in an attempt to identify the possible causes resulting in the hinderance between Dow and its LSPs over each other’s expectations. After conducting a preliminary interview with Dow, it was also told that Dow is keen in knowing the functionalities of a Transport Management System(TMS). The basic question they are interested to find answer to is “What is the capability of a TMS from the perspective of Dow operations?”. This requires conducting a detailed literature study in the field of TMS software packages and further analyzing them to determine its compatibility.
Chapter 4

Analysis

The research questions formulated in the previous chapter are based around the activities carried out at Dow in association with its 3PL providers. To make a sound analysis of the scenario, it becomes quintessential to understand the current practices at Dow supply chain operations.

4.1 Dow’s Supply Chain Operation

It is essential to be familiarized with the supply chain process of Dow to get a clear picture of the operations and help in addressing the three questions listed above. Dow makes use of “Work Processes” to define all its activities. A work process is a set of steps or activities that transforms an input to an output. It is a defined process with recognized roles, responsibilities, steps, step descriptions (including rules), implementation best practices, process measures, competencies and skill requirements, and enabling tools; usually described with flowcharts which indicate steps, who does what, relative time sequence and dependent events. In total, there are 9 global work processes and each work process is further explained in 6-7 levels. The 9 global work processes are:

- Lead People
- Plan and Allocate Resources
- Innovate Commercial Offering
- Integrated Supply Chain
- Procurement
- Market/Sell
- Produce Product
- Record and Report
- Manage Information

Table 4.1 describes the purpose of different levels.

Of the 9 global work processes, ISC and Procurement are the two which deal with operations involving the 3PL partners.

In recognition of the important role that Purchasing plays in driving business results and supporting strategic growth, the Procurement work process was elevated from a sub-process within the Integrated Supply Chain work process to a Level 1 global work process in 2008. This change aligns Dow to industry best practices and underscores the importance of Procurement as it joins the ranks of the nine (9) global work processes within The Dow Chemical Company. The process spans from strategic procurement through payment of invoices.
Table 4.1: Global work process

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 0</td>
<td>The Dow Chemical Company</td>
</tr>
<tr>
<td>Level 1</td>
<td>Nine global work processes</td>
</tr>
<tr>
<td>Level 2</td>
<td>Global sub-process of a global work process (concepts, description and scope)</td>
</tr>
<tr>
<td>Level 3</td>
<td>Next level of sub process or global major process steps within a sub process.</td>
</tr>
<tr>
<td>Level 4</td>
<td>Global process steps within major steps (Rummler-Brache maps, roles, steps, inputs, outputs)</td>
</tr>
<tr>
<td>Level 5</td>
<td>Global task level (inputs, outputs, methods, tools), may be specific to function/discipline.</td>
</tr>
<tr>
<td>Level 6/7</td>
<td>Local implementations</td>
</tr>
</tbody>
</table>

- It sets strategic direction and lays the foundation for procurement excellence and compliance across the organization.
- It defines strategic sourcing across Dow businesses and functions.
- It defines transactional work sub-processes that are highly integrated across Dow functions such as Finance, Supply Chain, Produce Product, etc.

The work process facilitates effectiveness and efficiency to maximize value creation, competitive advantage and Dow success.

As described earlier, procurement is oriented towards purchasing the services of a 3PL which includes functions like RFQ handling, RFP handling and so on. They are not related to processes taking place at the operational level. ISC work process is the one which deals with various supply chain operations.

The Integrated Supply Chain is the major work process(Figure 4.1) covering the Design & Modification of Supply Chains through to the transactional process of Sales and Operations Planning processes and the entire Order To Cash cycle. It is highly cross functional in nature and involves the Controllers, Manufacturing & Engineering, Purchasing, EH&S and Commercial functions. It is also highly integrated with other work processes including Produce Product, Market Sell, EH&S, Procurement, Record & Report and Manage Information. Its major purpose is to enable the businesses to Design & Modify Supply Chains and execute the transactional processes and enabling tools, in order to provide quality service to our customers and the lowest cost to serve. The main sub processes are: Design & Modify Supply Chains, Planning, Order To Cash and Procurement.

![Figure 4.1: Sub-processes of ISCWP](image)

ISCWP has 3 sub-processes associated with it.
• **Design & Modify Supply Chain:** The Design and Modify Supply Chain (D&MSC) work process is designed to support the efficient and effective design of new, or modification of existing, integrated supply for lowest cost to serve and maximum business value and customer service. The scope of these supply chain design projects ranges from new very large natural supply chains to existing small local modifications.

• **Balance Demand & Supply Work Process:** The Balance Demand and Supply work process is the set of cross functional planning work processes which enables a business to generate, balance and execute demand, supply, inventory and financial plans at optimum value. It links high level strategic plans with day-to-day operations and integrates business financial. The Balance Demand and Supply work process is the ongoing work process that a business will use to operate with a demand driven mentality.

• **Order to Cash Work Process:** The Order To Cash Work Process involves decisions and processes necessary for the transfer of the ownership of goods and services to customers after they are made available for sale. It begins with a request from the customer and ends with the conversion of material or service into a recognized revenue and accounts receivable, then ultimately into cash.

All the activities associated in performing D&MSC and Balance Demand and Supply Work processes are performed internally as these are process optimization and network optimization of Dow’s supply chain process. Presently, these processes do not involve 3PL partners. The main transportation activities performed by 3PLs are part of the the Order to Cash (OTC) sub-process in the ISCP. Dow currently ships about 1.5MM Tons of goods annually via Road Packed Transportation. The logistic operations involved in transporting these goods can be categorized into two sets: a) warehouse operations-involving shuttling activities to inplant and outplant, operating and maintaining outplants. Figure 4.2 shows possible ways of meeting a customer demand for packed goods.

4.1.1 Outplant Operations
Dow outsources all operations related to Outplants. This includes transportation activities from the manufacturing sites to the Outplant as well as operating and maintaining the Outplant. In most of the cases, the products are transported in bulk to an outplant and later packed based on the requirements. The transportation activity is referred to as Shuttling operation and is mostly outsourced to the same party which is responsible for outplant operations. However, these two operations are out of scope and the main focus will be on the 3PL involvement with transportation activities to customers.

4.1.2 Transportation Activities
The Transportation activities in this context refers to the operations involved in moving the goods from the source to destination (customer). This requires frequent interactions between Dow and 3PL providers to exchange information regarding product specifications, pickup location, date and time which are usually communicated via SAP platform. (sometimes by fax). It is during this phase that there is significant communication and information sharing between the parties and hence more focus will be given to it. This phase falls under the domain of Integrated Supply Chain Work Process (ISCWP) of Dow. Detailed explanation of ISCWP is given below highlighting the locations within ISCWP where the 3PL intervenes. This provides a medium to record the activities performed by the 3PL and compare it against practices of 3PL carried out in the logistics market.

Figure 4.3 shows the 5 sub-processes in the Level 3 of OTC process where the Dow processes have significant involvement of 3PL partners. These are:

1 Outplants are third party managed warehouses, bulk liquid terminals, and rail-to-truck transfer terminals, handling both liquid and dry products.
CHAPTER 4. ANALYSIS

Figure 4.2: Flow chart highlighting different ways of meeting customer demands
• **Order Readiness**: provides proactive connectivity between OTC sub-processes and businesses.

• **Order Receipt and Handling**: facilitates the creation of an order through the collection of data representing a request for a specific goods in a defined quantity from a customer on a specific date to a specific location.

• **Outbound Material Flow**: defines the on-site and off-site activities associated with the movement and storage of products and raw materials.

• **Create and Send Invoice**: sub-process which includes the creation and distribution of the invoice.

• **Payment Receipt and Handling**: monitors receipt of payment from customers and resolves any issues associated with it.

The 5 sub-processes are summarized below by highlighting the main functions taking place in each step.

A customer contacts a Customer Service Representative (CSR) to place an order with Dow. The CSR enters the requirements in the computer system and is tagged as Customer Order. The SAP tool, commonly referred to as ECC (Enterprise Core Component) then analyzes the customer order and calculates the desired inventory level to satisfy the demand. If the desired inventory is available, the system continues with the next step by finalizing on the agreed lead time. However, if the desired inventory level is unavailable, then the system adds the production lead time to the total lead time and checks if the total lead time is in compliance with the customer requirements. An appropriate note is attached to these orders in the computer system. The function described above belongs to the Order Readiness and Order Receipt & Handling sub-processes. Order Readiness provides proactive connectivity between OTC sub-processes and businesses.

The system then proceeds to create Delivery note for each successful Customer Order creation. The delivery note is the final confirmation of an order which is one of the key inputs to be given to a carrier. In addition to Delivery Note, Shipment notifications are also created. Based on the amount of delivery note per carrier per day, the shipment notifications can contain one or more delivery notes. This leads to creating a carrier notification which confirms a customer order and is an indication to the carrier that they need to make arrangements to pick-up and deliver the
product to customer. It is important to note that no customer order is finalized until the creation of shipment number and carrier notification meaning that until this point in time, the customer has the freedom to modify/cancel the order placed earlier. The carrier notifications are dispatched one day prior to the Transport Allocation date.

Transport allocation date is the beginning of a certain time frame which is agreed beforehand between dow and the carrier. It is the time allocated for carriers to make appropriate travel arrangements and to ensure they arrive on time to pick-up the customer products. This is the first juncture where the 3PL comes in contact with Dow. Once receiving the carrier notification, the 3PL has to communicate and arrange arrival times with Dow (time slot booking) Proceeding further, the 3PL is now responsible for the timely delivery of products within the previously agreed conditions. The amount of interactions between Dow and 3PL reduce after this point and timely interaction takes place in case of exceptions. The entire process is referred to as ‘Order Life-cycle’ and is depicted in figure 4.4

![Figure 4.4: The Order Life-cycle](image)

The order life cycle(figure 4.4 and 3PL interaction with Dow) gives a summary of the current supply chain operations. Being familiar with this facilitates in progressing towards understanding the added value of 3PL partnerships.

### 4.2 Definition of Added Value

The previous section covered topics related to the current operations being carried out at Dow to help in determining the interactions and involvement of 3PL providers with Dow. The purpose being to help point out possible operations which can help determine the ‘added value’ of the 3PL providers. Before a stand can be taken on the added value of current 3PL providers for Dow, it now becomes important to understand:

- the meaning of the term added value
• what constitutes for an added value

• what does the term mean for Dow

De Chernatony, Harris and Riley (2000) mention the role of added value as securing competitive advantage and long-term success and at the same time stating that intangible added values are more sustainable than tangible ones. The authors mention the paucity in the definitions of added value and try to analyze the meaning of added value by studying the nature, role and sustainability of added value. The authors view added value as a multi-dimensional construct. In an interview with brand experts, it was noted that majority of the experts cited ‘pricing/value for money’ and ‘relative to competitors’ as the main components of added value. It is also stated that actions with a long-term perspective are the results of strategic thinking and are going to add value compared to short-term solution mentality. It is also worth noting that added value is more of a relative rather than absolute concept. The article quotes one of the consultant saying that discussion about added value and competitors go hand in hand. It is stated that a value which can be differentiated and considered superior than that of the competitor can be considered as added value. The article stresses upon the importance of focusing on the processes rather than only the products. The role of the added value is to help consumers decide between brands, when taken in the context of this project can be stated as to help Dow decide between 3PL partners.

At the early stages of this project, semi-structured interviews were carried out with personnel involved in logistic operations. Among other questions asked, ‘what is considered as an added value’ was one of the questions asked to each of them. The responses received were mostly similar and highly subjective stating “something extra”. In addition to this, there were few responses which lead to further thinking and also were in relation to the explanation provided by the authors. Some of the personnel responded “3PL partners have the data regarding our shipments. We expect them to analyze this data and provide some new inputs”, “Many customers are keen in knowing the real-time location of their order” are some of the examples as to what Dow considers to be added value

From an operational point of view, the 3PL operators carried out the tasks they were assigned to. Starting from order receipt, the responsibility was theirs to ensure the product is successfully transported to the customer. However, there were no notable activities that could be categorized into one of the characteristics of added value.

From an organizational point of view, it can be said that there are certain positive aspects of 3PL partnerships and outsourcing in general which can be added to the category of added value

An attempt was made to carefully study the operations expected from the 3PL providers. The contract agreements were used as an aid to compare the actual operations and required operations. While studying the order entry and order dispatch data, an interesting pattern was observed. There were repetitive instances where a particular customer had requested for multiple consignments to be delivered on the same day. The database recorded these events as any other orders and were assigned with unique order numbers and forwarded to 3PL providers. In other words, multiple consignments being delivered to the same customer on the same day continued to be recognized as separate orders and hence, in few cases, were shipped by more than one truck by the 3PL provider. This provided a lead in indicating that an order consolidation system was not in place and at the same time served as a motivation to build a consolidation model that can assist Dow in reducing the cost associated with multiple shipments.

4.3 Transportation Management System (TMS)

Transportation management systems (TMS) are software applications that facilitate in better planning of freight movements and optimization of transportation activities. Typical services that can be obtained via TMS include route planning and reporting. Table 2 shows some of the functionalities and benefits of TMS.
4.3.1 Capabilities of TMS

The functionality of TMS makes it highly attractive to be used in collaboration with a Warehouse management system(WMS) and an Enterprise resource planning(ERP). The individual capabilities of a TMS are listed below Demir et al. (n.d.):

**Order handling** Order entry, order control, order consolidation, order distance calculation

**Order completion** Invoicing

**Asset management** Type of asset, amount of kilometres driven, damage control

**Driver management** Skills, licenses

**Planning** Usually a separate planning system is used to aid a TMS

**Document control** enables to print documents like CMR

**Customs control** Movement reference number which is required by an LSP while exporting goods is done via Electronic data interchange(EDI) triggered by a TMS

**Security control** When maintaining multiple LSPs, specialized security control to maintain classified information is available to be maintained for each LSP

**Reverse Logistics** provision to assist in keeping a track of empty containers/trolleys etc.,

**Charter control** Keeps list of charters, selecting a charter, pricing and allocation of orders to the main or alternative carrier

Seiler (2012) analyzes various dimensions contributing to a TMS in the published book. These are shown in Table 4.2.

<table>
<thead>
<tr>
<th>VEHICLE ROUTING AND SCHEDULING</th>
<th>ONLINE/OFFLINE PLANNING</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPTIMIZATION ALGORITHMS</td>
<td></td>
</tr>
<tr>
<td>MULTI-OBJECTIVE OPTIMIZATION</td>
<td></td>
</tr>
<tr>
<td>INTER-MODAL TRIP PLANNING</td>
<td></td>
</tr>
<tr>
<td>GREEN LOGISTICS</td>
<td></td>
</tr>
<tr>
<td>CONGESTION/TIME DEPENDENCY</td>
<td></td>
</tr>
<tr>
<td>SYNCHROMODAL TRIP PLANNING</td>
<td></td>
</tr>
<tr>
<td>EVENT HANDLING</td>
<td></td>
</tr>
<tr>
<td>MESSAGE PROCESSING/INTEGRATION(TELEMATICS)</td>
<td></td>
</tr>
</tbody>
</table>

Table 4.2: Dimensions of TMS

4.3.2 TMS at Dow

Dow currently makes use of Oracle Transportation Management(OTM) system to collaborate with its processes and the SAP system. OTM is a TMS responsible for outbound freight shipments from order to settlement. Three main operations are carried out using OTM:

- Carrier Selection
- Freight Rating
- Freight Settlement
The three operations can be considered as hierarchial in nature. Carrier selection process is an automated process of allocating OTM route and carrier to the Customer order (referred to as Sales Order). In the next step, Freight rates are applied to OTM SAW (Shipment As Work). SAW is nothing but a document that contains Shipment number, Shipment Accrual, Shipment stages and information about Service providers. The final step is the freight settlement where the OTM calculates the additional costs that might have incurred in addition to base freight rate and settles the payment of invoice with carrier. From the perspective of carrier, there is a flexibility to download/upload the document which enables them to download the orders to their respective TMS software package. This is a positive aspect of Dow’s OTM. Comparing the OTM capabilities with that general TMS capabilities listed earlier (Table 4.2) will provide a frame of reference which may enable in determining the possible areas which can be addressed by TMS in the near future.

<table>
<thead>
<tr>
<th>DIMENSIONS OF TMS</th>
<th>OTM CAPABILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>VEHICLE ROUTING AND SCHEDULING</td>
<td>YES</td>
</tr>
<tr>
<td>ONLINE/OFFLINE PLANNING</td>
<td>YES</td>
</tr>
<tr>
<td>OPTIMIZATION ALGORITHMS</td>
<td>NO</td>
</tr>
<tr>
<td>MULTI-OBJECTIVE OPTIMIZATION</td>
<td>NO</td>
</tr>
<tr>
<td>INTER-MODAL TRIP PLANNING</td>
<td>YES</td>
</tr>
<tr>
<td>GREEN LOGISTICS</td>
<td>UNKNOWN</td>
</tr>
<tr>
<td>CONGESTION/TIME DEPENDENCY</td>
<td>UNKNOWN</td>
</tr>
<tr>
<td>SYNCHROMODAL TRIP PLANNING</td>
<td>NO</td>
</tr>
<tr>
<td>EVENT HANDLING</td>
<td>YES</td>
</tr>
<tr>
<td>MESSAGE PROCESSING/INTEGRATION(TELEMATICS)</td>
<td>YES</td>
</tr>
</tbody>
</table>

Table 4.3: Comparison of OTM with TMS dimensions

Table 4.3 is indicative of the strength of OTM in use. It can be clearly seen that OTM handles most of the important dimensions that are expected from a TMS software package. Dimension of Optimization Algorithms is not completely relevant from Dow’s perspective since this is associated with planning actual movement of goods, which is outsourced to 3PL partners. (Note for self: Possible areas to be benefited to be put in recommendations)

4.3.3 Insight into Transwide TMS solutions

During the course of the project, an opportunity was provided to attend a workshop organized by ‘Transwide’ (a product brand of Wolters Kluwer Transport Services) targeted at European shippers to interact and gain specific knowledge about Transport Management Systems (TMS). The workshop stated a possible savings of 5-15% can be achieved in the field of Planning and upto 5% in Freight Cost Management. One of the interesting findings at the workshop was to understand the importance of Transport Communication System (TCS). TCS involves connectivity and execution wherein compatibility of different systems is checked for and fundamental points are listed out. In other words, Key Performance Indices (KPIs) are created for the implementation project. The compatibility is a key factor especially when the shipper is maintaining multiple 3PL partners. However, it remains to be seen how the compatibility of a particular TMS software is analyzed. In case of non-compatibility, there is a possibility the TMS package is not utilized completely. Figure 4.5 is a simple pictographic representation of a TMS functionality. One of the attractive features of Transwide TMS solutions is the promise to provide seamless connectivity. With the help of connectivity platform, it is promised to link with other TMS/SAP platforms. This will be a positive feature for any TMS since it can be considered to be of universal type. Figure 4.6 indicates the general nature of TMS packages.

34 Analyzing the added value of 3PL partners in chemical logistics
4.4 Motivation

The findings from previous sections intend to determine added value from the current 3PL relationship leading to focus on 3PL operations and in turn providing key information about the state of order dispatching, indicated that there is no formal order consolidation system whose purpose is to look for opportunities feasible for consolidating multiple orders. Order consolidation not only contributes to monetary savings but also helps in optimizing the preceding and succeeding supply chain operations. With this in mind, it was decided to build a Decision Support System facilitating the use of an order consolidation tool.

The main motivation to build a DSS is briefly summarized in the following section including the choice for the optimization model under consideration.

Contribution to added value previous section highlighted the meaning of added value and what activities of carriers can be said to be a contributing factor for added value. Order consolidation is one of them. It is much appreciated by any shipper when a carrier suggests an improvement based on historical shipment data. This concept not only benefits the carriers, by helping them to fill the truck, but also for shippers as they can be awarded a concession in the shipment costs. It is also important to note that this activity is not confined only to carriers. Shippers can take up the role of contributing to the added value of the Shipper-Carrier relationship. Any type of order consolidation process is a positive step towards contributing to added value.

Need for the tool During the semi-structured interview sessions, it was also observed that on few occasions, the CSRs or the LSCs observed some obvious opportunities for consolidation and hence manually performed the task of consolidation. At the same time, it was also mentioned that the sheer amount of data and orders needed to be handled in one day,
made it an extremely difficult task for the concerned personnel to look for consolidation opportunities for every batch of orders. There appeared to be a need for a tool which can proved transparency for the order dispatching process and at the same time consolidate when an opportunity arises.

**In-house advantage** Dow currently has ties with several 3PL parties operating in different parts of Europe. With such diverse ties, it becomes difficult to keep a track of activities associated with order consolidation. i.e., keeping a track of opportunities and then verifying if the opportunities were translated into productive output is a tedious and repetitive work. The time and effort in doing so can alternatively be invested in developing a tool in-house. By doing so, a single common tool will not only help in keeping a track of multiple carriers but also ensure consolidation is carried out.

**Revenue saving opportunity** Considering the amount of shipments operated by Dow, a small saving per one order consolidation can help contributing to the overall monetary savings.

**Insight into technology/gateway to alternative solutions** The tool also serves as an aid to the responsible personnel interacting with 3PL partners and involved with shipment dispatching while at the same time providing capabilities of a tool and possible transition to a sophisticated Transport Management System(TMS)

The main part of the intended DSS is the optimization model which serves as the heart of the tool. Consolidation is carried out with the intention to optimize a process meaning the objective is then to

- maximize the number of orders per truck
- minimize the cost incurred with shipment dispatching

A mathematical model which excels in addressing these types of objectives is the Linear programming problem. The LP problem helps build a model around the objectives while considering various constraints that are needed to be satisfied. At the same time, it is easy to replicate and test the model using one of the many available computer programs to check for results.

![Figure 4.7: Ishikawa diagram showing the need for a DSS](image)

The findings from the previous sections provided motivation for looking into the shipments closely and at the same time analyzing various aspects associated with a shipment like the pricing, goods issue date, weight etc. A random sample was taken from the available data. Figure 4.7 translates the above information into an Ishikawa(fish-bone) diagram.
Chapter 5

Methodology

This chapter explains the steps taken to address the problem statement. A detailed explanation of the choices made, the reason behind the choices and thorough description will aim at preparing for the realization phase. Figure 5.1 lists the steps executed in the methodology phase.

5.1 Data Collection

The preliminary data analysis was performed to understand the basic functions and operations existing between Dow and its 3PL partners. Section 4.2 very briefly described the preliminary analysis and its findings. This section attempts to provide a broader view of the data analysis that was carried out in the initial stages of this project.

Preliminary analysis began by gaining access to the off-line database of Dow for Land transport; Road Shipment Monitor (RSM) and learning to handle large amounts of data. With the intention of transforming data into information, various filters were created to narrow down the focus for packed goods transport. The packed goods data by itself was huge and various aspects in it were cross-referenced using different classifications. For instance, Dow makes use of certain codes referred to as Dispatch Type Sequence (DTS) which contain a two-digit number. The DTS is one
of the parameters of the Customer order (Figure 5.3) which defines the type of transport that will be assigned to the particular order. Currently, there are 8 different types of shipments that can be classified as transport type for packed goods. These DTS codes helped in a great manner to sort the available data. The focus in the next step shifted to different 3PL partners (referred to as carriers) who are contracted to Dow to provide their services. The carriers were then short-listed based on the ‘volume moved’ in the last 6 months. One of the top 3 carriers was selected to study the available data. To help simplify the process, a single ship-point (origin) was chosen; Terneuzen being the origin in this case. The data available indicated the shipments going to particular region rather than the country. Again, given the magnitude of data, the regions were combined and the initial examination of data was carried out on Country-wise. Majority of the shipments were dispatched to Germany and France. These countries were further short-listed and data was observed on a smaller geographic coverage. At this point, it was observed that there were multiple shipments being shipped from the same ship-point to a particular region on the same date. Adding further, the multiple shipments were picked-up by the same truck (recognized using truck number information) and in many cases, the consignees of these shipments were the same. One of the examples was that of where a lot of shipments were being sent as multiple orders. However, this was handled by a Dow-subsidiary and hence the process was immediately stopped and focus was given to operations carried out completely by Dow. Similar observations were found with considerable amount of shipments dispatched from the same ship-point. On further enquiry with Dow personnel, it was learnt that the unique structure at Dow made it very difficult to use a consolidation system. The order entry process was performed business-wise and it is difficult to maintain a cross-departmental verification system to look for consolidation opportunities. This proved to be one of the main motivations for considering a DSS with the intention to aid the order entry process.

5.2 Choice of Database

The database to be embedded in the DSS should contain information which can help sort only those orders which prove to be of interest. This means the database should contain information about order identification, weight of the product, dispatch date, delivery date, consignee. The database available at Dow referred to as Road Shipment Monitor (RSM) is extracted from the ERP system and stored in Microsoft Access and is Raw data. The sheer amount of data which also included unwanted information could not be directly used as a feeder to the DSS. Only select components of the existing data are selected and a separate database is created. A screenshot of the data fields in this new database is shown in the appendix. Figure 5.2 shows the data collection hierarchy used.

![Figure 5.2: Data collection hierarchy](image-url)
5.3 The model

Once the database is created, the next step is to build the model itself. The problem description presents an optimization problem posing a challenge to consolidate the orders before being dispatched to the customer. Keeping in mind that there were constraints that needed to be satisfied, formulating a Linear Programming problem was deemed to be the first essential step in building the model. A linear programming problem contains an objective function with decision variables which are to be determined. At the same time, it has a set of constraints that are to be satisfied and hence suits the problem description mentioned earlier. The steps followed in realizing the model included determining the appropriate candidates to be considered for the objective function and their associated constraints to be formulated.

5.3.1 Model 1

The task of determining the appropriate candidate for objective function has been influenced by two main factors:

- the need to combine multiple orders and tag them as one entity
- the unknown element of total available trucks from the 3PL provider

The first factor instigates the thought process of keeping a count on total number of orders at the disposal. Consolidation would be effective when the total weight of the truck is maximized. The second factor poses an interesting challenge in formulating the objective function. It makes it difficult to include a limiting factor to reduce the total number of trucks used. After considering these two factors, an attempt has been made to formulate an objective function with the aim of maximizing the number of orders dispatched per truck. The end result is a model with a maximizing convex function. It is however important to note that origin of all the orders is assumed to be the same. The custom database while being built will contain the set of orders which have common origin but different destinations.

\[
\text{maximize } \sum_{i=1}^{j} y_i
\]

where ‘i’ denotes a particular truck. With the idea of objective function in place, focus is now given to formulation of the constraints. The formulation of constraints are indicative of those orders which qualify to be considered for consolidation. Some of the constraints which appear in a straightforward manner are the weight constraints (maximum capacity for individual truck), dispatch dates of the orders are to be the same, the destination of all the orders are to be the
CHAPTER 5. METHODOLOGY

Sets
- $K$ set of orders
- $P$ set of trucks
- $I$ set of destinations

Parameters
- $q_p \quad p \in P$ maximum capacity of truck $p$
- $w_k \quad k \in K$ weight of order $k$
- $r_k \quad k \in K$ goods issue/release date of order $k$
- $\tau_k \quad k \in K$ transit time for order $k$
- $i_k \quad k \in K$ destination of order $k$
- $i_p \quad p \in P$ destination of truck $p$

Variables
- $y_{kpt} \quad k \in K, p \in P, t=1...7$ binary variable indicating a particular order for a truck $p$ and time $t$

Objective
\[
\max \sum \sum \sum y_{kpt} \quad (5.1)
\]

Subject to constraints:
\[
\sum_{k: r_k \leq t \leq (d_k - \tau_k), i_k \in I} y_{kpt} w_k \leq q_p \quad \forall p \in P, t = 1...7 \quad (5.2)
\]
\[
\sum_{t=1}^7 \sum_{p: i_p = i_k, p \in 1...P} y_{kpt} = 1 \quad \forall k \in K \quad (5.3)
\]
\[
y_{kpt} \in 0, 1 \quad \forall k \in K, p \in P, t = 1...7 \quad (5.4)
\]
same. Translating the objective function and constraints into a mathematical model results in:

As mentioned earlier, the objective function aims at maximizing the number of orders. \((5.1)\) represents a decision variable \(y\) which is of binary nature. The decision variable takes the value 1 if for a given \(k, p\) and \(t\) the constraints mentioned are satisfied.

The first constraint shown in \((5.2)\) ensures that the combined weight of multiple orders in a given truck does not exceed the maximum capacity of the respective truck. In addition, measures are provided to ensure only appropriate orders are taken into consideration. \(LHS\) of \((5.2)\) is formulated in such a way that an order \(k\) is selected if time period \(t\) is positive and the value lies within the GI date and delivery date. Also, the destination of the order should belong to the permitted set. This constraint also serves as a filter by eliminating abnormal entries containing extreme combination of \(r_k, d_k\) and \(\tau_k\). (e.g., an order with \(r_k = 12/6/2014, \tau_k = 4\) days and \(d_k = 14/6/2014\) is automatically filtered and not considered for evaluation) The purpose of the second constraint shown in \((5.3)\) is to ensure that a particular ordered is entered only to one truck. In other words, it keeps a check on the LP model and prevents the same order being considered for multiple trucks. At the same time, \(LHS\) of \((5.3)\) is designed to make sure that the destination of the truck and the ‘orders to be consolidated’ are the same. The final constraint states the nature of the decision variable being a binary type.

While attempting to replicate the model for a test run, it was noted that a flaw in the model might be present. It was observed that the constraint \((5.3)\) ensures the destination of the truck and the orders are the same but does not mention anything about the protocol to be followed when the destination of the truck and order do not match. This meant that even those possibilities were taken into consideration while the model was performing. In addition to this, the model is a pure consolidation model aimed at maximizing the orders per truck. There has been no attempt to include any means of cost function which would make the model much more stronger and the
output of the model would be ready to use. However, with the present model, one would need to identify the orders consolidated (by trying to backtrack the orders) add the weights of individual orders and then calculate the prices leading to an overall cumbersome process. Due to these limitations, it was decided to make an attempt in building a mathematical model incorporating the cost function.

5.3.2 Model 2: Cost minimization model-NLP

5.3.1 presented a model which provided an outline of the nature of requirements and what approach can be taken to meet those requirements. The intention to include cost function in the mathematical model induces a change in the model presented in 5.3.1. The presence of cost function makes it only logical to have a minimization function as the objective. Any simple minimization function would include the cost function associated with either the quantity or unit of a product and can be easily formulated. At the same time, Dow does not own any assets in transportation infrastructure, i.e., Dow does not own any trucks, warehouse, etc. which means that ‘fixed cost’ of a truck cannot be used as a limiting factor for the model. It is also essential that some incentive is given to the LP model to facilitate optimization process. In the current case, the cost serves as an incentive which translates ‘the more the consolidation, the lesser the cost’ concept into the language of the LP model. The pricing strategy in use at Dow is based on the weight factor. This means that the price would reduce with increase in the weight of an order. However, there were two challenges posed by Dow’s pricing strategy:

- the price variation based on weights was not linear
- the prices were assigned for a weight-range (for eg., 1500-3000kg have a price of x/100kg)

To address both challenges, a known concept of Piece-wise Linearization was deemed appropriate for use. The motivation behind this is the similarity in the nature of the piecewise function and the first challenge. A piecewise function is characterized by a common functional notation whose body has an array of functions and associated sub-domains. Comparing this with the model requirements, the array of functions explain the different cost structure for varying weight bands. A piecewise linear function is one where the array of functions are linear in nature. The following steps explain the model building process.

Stage 1 The first stage in building the model is formulating a linear equation which includes the cost function in it. This linear equation will form the base for the piecewise function to follow. The process of creating the linear equation begins by representing the cost in the form of $y = ax + b$. The equation is created for each set of pricing available with Dow for various weight bands. Once the base equation is created, the next step is to include the parameters/decision variables from the previous model (5.3.1) into the formulated linear equation which makes it compatible with the overall model requirements.

$$y = m_1 \sum y_{kpt}w_k + x_{kp}b_1$$

in the above equation, $y_{kpt}w_k$ and $x_{kp}$ will be extracted from the LP model and used to calculate the price for a particular weight band. $x_{kp}$ is one of the additional variables (binary variable) introduced when compared to previous model. This new binary constraint is designed to ensure that an order is assigned to a second truck only when the first truck is full.

Stage 2 The next stage is followed by considering the individual equations as part of a bigger group and transforming them into a piecewise function. As the name indicates, a piecewise function is a special type of function which takes different values for a particular variable value or for a range of value. A suitable piecewise linear function for the model takes the
shape of:
\[
f(x) = \max \left\{ \begin{array}{ll}
m_1 \sum y_{kpt}w_k + x_{kp}b_1 & 0 \leq y_{kpt}w_k \leq W_1 \\
m_2 \sum y_{kpt}w_k + x_{kp}b_2 & W_1 < y_{kpt}w_k \leq W_2 \\
\vdots & \\
m_n \sum y_{kpt}w_k + x_{kp}b_n & W_{n-1} < y_{kpt}w_k \leq W_n \end{array} \right).
\]

In the above piecewise function, the value of each equation is dependent on the value of the slope \((m_1, m_2 \text{ etc.})\) and the value of the intercept \((b_1, b_2 \text{ etc.})\). In turn, these values are dependent on their respective weight bands. For a particular weight band, the values of slope and intercept are extracted by using the ‘two-point formula’ to determine the equation of a line. Two consecutive points representing different but consecutive weight bands are considered for formulating the equation of the line and hence determining the values of slope and intercept from the resulting straight line equation. To summarize this part, the values obtained on solving individual equations are all different and are influenced by the values of the slopes.

**Stage 3** The final stage is the construction of the mathematical model with the aid of piecewise function. In practicality, there is a need for a mathematical model of the format: Objective

\[
\min f(x) \tag{5.5}
\]

Subject to constraints:

\[
\sum_{k: r_k \leq t \leq (d_k - r_k), i_k \in I} y_{kpt}w_k \leq q_p \quad \forall p \in P, t = 1 \ldots 7 \tag{5.6}
\]

\[
\sum_{i=1}^{7} \sum_{p_i=i, p=1 \ldots P} y_{kpt} = 1 \quad \forall k \in K \tag{5.7}
\]

\[
y_{kpt} \in 0, 1 \quad \forall k \in K, p \in P, t = 1 \ldots 7 \tag{5.8}
\]

On carefully analyzing the piecewise function it can be noted that each equation in the piecewise function, an interesting finding was made. The price function from the database of Dow contains values of the format ‘x/100kg’ meaning that the values resulting from each equation in the piecewise function is the cost/100kg(say ‘g’) for that particular weight band. This indicates that there is a need to calculate the cost for the total weight of the truck rather than just indicating the cost/100kg. In other words, the value ‘g’ needs to be multiplied with the total weight of the truck \(q_p\). The resulting objective function becomes a Non-linear Programming problem which is not an ideal form for practical applications. The following lines represent the creation of the NLP problem and the transformation of piecewise function into NLP problem. Firstly, each equation in the piecewise function mentioned above is identified by a unique representation to make it easier for reference. For instance, \(m_1 \sum y_{kpt}w_k + x_{kp}b_1 \) \(0 \leq y_{kpt}w_k \leq W_1\) is denoted as \(S_1\), \(m_2 \sum y_{kpt}w_k + x_{kp}b_2 \) \(W_1 \leq y_{kpt}w_k \leq W_2\) is denoted as \(S_2\) and so on. Transforming the requirements to formulate an NLP problem results in:

The objective function defined in the equation (5.9) clearly shows the non-linearity nature of the model. Variable \(z\) is the representation of piecewise function ‘\(f(x)\)’ in an NLP environment and \(q_p\) is the total weight of the truck. The product of the two results in the total cost associated with a particular consolidation. Equations are again representation of individual values of piecewise function in an NLP environment. The condition of ‘maximum of the set of values’ of the piecewise function is represented by the constraint set The constraints , and
Sets
\( K \) set of orders
\( P \) set of trucks
\( I \) set of destinations
\( N \) set of weight bands

Parameters
\( q_p \) \( p \in P \) maximum capacity of truck \( p \)
\( w_k \) \( k \in K \) weight of order \( k \)
\( r_k \) \( k \in K \) goods issue/release date of order \( k \)
\( \tau_k \) \( k \in K \) transit time for order \( k \)
\( i_k \) \( k \in K \) destination of order \( k \)
\( i_p \) \( p \in P \) destination of truck \( p \)
\( m_n \) \( n = 1...N \) slope of the cost equation
\( b_n \) \( n = 1...N \) intercept of the cost equation

Variables
\( y_{kpt} \) \( k \in K, p \in P, t=1...7 \) binary variable indicating a particular order for a truck \( p \) and time \( t \)
\( x_{kp} \) \( k \in K, p \in P \) binary variable to facilitate usage of a new truck only when the previous truck is full/nearly full
\( z \) piecewise function equivalent for LP/NLP formulation

Objective
\[
\min \quad q_p z \tag{5.9}
\]

Subject to constraints:
\[
z \geq S_1 \tag{5.10}
\]
\[
z \geq S_2 \tag{5.11}
\]
\[
\vdots \tag{5.12}
\]
\[
z \geq S_n \tag{5.13}
\]
\[
\sum_{k: r_k \leq t \leq (d_k - \tau_k), i_k \in I} y_{kpt} w_k \leq q_p \quad \forall p \in P, t = 1...7 \tag{5.14}
\]
\[
\sum_{t=1}^{7} \left( \sum_{p: i_p = i_k, p=1...P} y_{kpt} \right) = 1 \quad \forall k \in K \tag{5.15}
\]
\[
\sum_{t=1}^{7} \sum_{p: i_p = i_k, p=1...P} y_{kpt} = 1 \quad \forall k \in K \tag{5.16}
\]
\[
y_{kpt} \in 0, 1 \quad \forall k \in K, p \in P, t = 1...7 \tag{5.17}
\]
\[
x_{kp} \in 0, 1 \quad \forall k \in K, p \in P \tag{5.18}
\]
are similar to that explained in Model 1. They ensure the combined weight of the orders is within the Truck capacity. An order is assigned to only one truck and the binary variable constraint respectively. A new constraint is \( x_{kp} \) which is the binary variable to facilitate appropriate truck usage represented in As mentioned earlier, it is difficult to solve an NLP and with increased set of values, it becomes impossible to solve the model altogether. Hence, it will be advantageous to modify this NLP problem into an LP problem to obtain the desired results.

5.3.3 Model 3: Cost minimization model-LP

The findings during the formulation of Model 2 in 5.2 which indicated that the resulting mathematical model will be an NLP type can be used to try and modify the model into an LP problem. The reason for generation of NLP was the presence of product of two decision variables in the objective function. Taking a step back, it can be seen that \( z \) results in a numerical value for cost for the total weight in the format of “x/100kg” and hence it is multiplied with the total weight “q_p” to obtain the actual total price. Since the first preference is for order consolidation, the model can be formulated with only the unit price and not as a product of weight and unit price. This method will continue to support the idea of consolidation and the final calculation of price can be performed as a separate entity, independent of the mathematical model. Keeping all the parameters and definitions same as in Model 2, the LP model takes the form of:

Objective

\[
\text{min } z
\]  

Subject to constraints:

\( z \geq S_1 \)  
(5.21)

\( z \geq S_2 \)  
(5.22)

\( \vdots \)  
(5.23)

\( z \geq S_n \)  
(5.24)

\[
\sum_{k:t \leq t \leq (d_k - \tau_k), i_k \in I} y_{kpt} w_k \leq q_p \quad \forall p \in P, t = 1,...,7
\]  
(5.26)

\[
\sum_{t=1}^{7} \sum_{p,i_k=p,g=1...P} y_{kpt} = 1 \quad \forall k \in K
\]  
(5.27)

\( y_{kpt} \in 0,1 \quad \forall k \in K, p \in P, t = 1...7 \)  
(5.28)

\( x_{kp} \in 0,1 \quad \forall k \in K, p \in P \)  
(5.29)

The resulting value of \( z \) from the above model can then be multiplied with the total weight of the truck as a simple mathematical calculation.

5.4 Graphical User Interface(GUI)

The final part in the building of DSS is to have a user friendly GUI. The complexity involved in building a GUI depends on the end requirement of such DSSs. For instance, the purpose of DSS being built now is to provide improved visibility of the LTL shipments being dispatched...
thereby highlighting the opportunities for order consolidation. With this in mind, the GUI is designed to assist the user in providing necessary information by making the most of the DSS engine (mathematical model). The level of detail in the GUI will be kept to minimum and more focus will be given to ensure all the options of the model are made use of. Much of the attention will be given to the following requirements while building the GUI:

1. Provide an option to select an origin from the available ones

2. Providing the filters for
   - Destination Country
   - Destination Region
   - Goods Issue date

3. Possibility to select particular carriers

4. Ability to accommodate further model expansion
Chapter 6

Implementation

This chapter explains the implementation steps employed in realizing the DSS.

6.1 Choice of Software

One of the main factors considered while selecting the software was the purpose/intent of use. The model is built with the intention of providing much needed transparency in the dispatch of LTL shipments while also suggesting on possible order consolidations. The purpose of the tool is to highlight the significance of order consolidation and serve as a reference tool. Keeping this in mind, Microsoft Excel was chosen as the platform mainly due to:

- Company already has a license for it
- built in solver engine
- use of Visual Basic Application for GUI

The built in solver engine enables to solve optimization problem to a large extent with the exception of non-linear problem in which case the ability of solver reduces significantly. With Dow possessing a commercial license for MS Excel, no further investment is required.

6.2 Design and User Interface

Figure 6.1 shows the design of the model explaining the various interaction and operating phases. The flow process on the LHS marked ‘Interaction’ is a hierarchial interaction phase found while using the model. It is designed in this manner to facilitate ease of use by narrowing down the orders with filtering options. Each interaction phase is associated with a process which is activated on selection of that particular phase. The first process makes use of the master data, and feeds the filtered data into a temporary database. The remaining processes use this temporary database to extract and store the filtered data. Selection of Consolidation option initiates the Solver tool which incorporates the model built in the previous section. The results emerging from the solver tool are aggregated and are used for total cost calculations. The values are then extracted and displayed in the output page. At the end of each iteration, the temporary database is cleared. Figure 6.2 displays the part of the tool which is used by users to enter input parameters.

Visual Basic for Applications (VBA) was made use of which makes use of programming language to automate processes, build user friendly interfaces etc., VBA can be used within the Excel which made it ideal for building the user interface. Different functionalities of VBA were used to create the user entry form providing ease of use and eventually link it with the solver engine. The final output of the tool includes the result of the solver and further calculation of prices for the consolidation which are compared against the non-consolidated orders.
CHAPTER 6. IMPLEMENTATION

Figure 6.1: Design and operation of the Tool

Figure 6.2: A screenshot of the tool’s GUI

48 Analyzing the added value of 3PL partners in chemical logistics
Chapter 7

Results

The tool is used against the performance of 3PL partners operating for Dow. The results are summarized in the form of case study for the concerned partner. The later sections of the chapter describe the limitations and discrepancies of the current model. The chapter begins by stating the assumptions made during the model construction and execution phase.

7.1 Model Assumptions

1. The contents of the database under consideration have a common common shipping point

2. The prices of different weight bands were modified before being considered for the LP model. Geometric Progression concept was made use of to obtain a series of prices for the different weight bands whose slopes were decreasing in a desired pattern of exponential approximation.

7.2 Case Study A

The first 3PL partner (hereafter referred to as ‘Carrier 1’) provides services for both LTL and FTL shipments and has a significant share in the packed shipments category (refer to 1.2 for product classification). The following paragraphs explain the scenario under which the tool was tested. The scenario is mainly related to database creation. The outputs were extracted with the help of the tool and are analyzed below.

The tool essentially lists all the possible destinations and the user can choose one country at a time. The table below gives an overview of the results for the selected country.

Table 7.1 and Figure 7.1 together explain the shipments classification. There were a total of 497 shipments which were classified as LTL and hence qualified to be considered for order consolidation. The extra-payment made for the period of 6 months for all outgoing shipments which had the origin as Terneuzen was €6275. This extra-payment constitutes 24.5% of the total payments made. (total number of shipments and possible shipments for consolidation). It can be observed from the Figure 7.2 that Italy has the highest amount of extra payment which indicates that shipments going to Italy had the highest chances of benefiting from consolidation. Also,

<table>
<thead>
<tr>
<th>Shipment Origin</th>
<th>Terneuzen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time Period</td>
<td>December 2013 - June 2014</td>
</tr>
<tr>
<td>Total Shipments</td>
<td>2437</td>
</tr>
<tr>
<td>Total LTL Shipments</td>
<td>497</td>
</tr>
<tr>
<td>Shipment Type</td>
<td>LTL</td>
</tr>
</tbody>
</table>

Table 7.1: Model Execution Scenario-Carrier 1
CHAPTER 7. RESULTS

Figure 7.1: Order Classification

Figure 7.3 indicates that on an average, 20-30% of extra payments were made. In Figure 7.3, the x-axis represents the class-interval of ‘percentage extra payment’ and the y-axis denotes the frequency. It can be seen that there is a significant opportunity to benefit from order consolidation when the orders are dispatched to the same consignee. In the next chapter, the possibilities of expanding the horizon is explained.

The tool justifies the purpose of consolidation by highlighting the possible savings that can be obtained through order consolidation.

Figure 7.2: Extra payment classification

From a generic perspective, Figure 7.4 represents the functioning of the tool. In other words, the figure depicts what results are obtained when certain parameters are entered into the tool. The parameters are categorized into 3 parts and the resulting output can be viewed as 3 types of output providing various information.

Some of the trivial sections of the actual tool are displayed below. Figure 7.5 shows the display unit of the tool and Figure 7.6
CHAPTER 7. RESULTS

Figure 7.3: Percentage extra payment with Carrier 1

Figure 7.4: Relation between Input parameters and Output display

Analyzing the added value of 3PL partners in chemical logistics 51
CHAPTER 7. RESULTS

Figure 7.5: Display Area of the Tool

<table>
<thead>
<tr>
<th>Order No.</th>
<th>Tag</th>
<th>Truck1 weight</th>
<th>Truck2 weight</th>
<th>Total Truck Weight (in kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

What we have been charged (as shown in invoice)
What we could have been charged
Difference
% Extra Payment

Figure 7.6: Output Display showing the possible savings

52 Analyzing the added value of 3PL partners in chemical logistics
7.3 Case Study B

The second 3PL partner (hereafter referred to as ‘Carrier 2’) has been working with Dow for few years already. Carrier 2 mainly provides services for LTL shipments originating from Antwerp (redaction). The data analyzed below are all having common shipment origin as Antwerp.

From the set of 819 shipments, 737 were classified as LTL (Figure 7.7 and hence considered for consolidation scenario. On an average, 15% of the payment already made constituted for extra payment (Reference Tables D.2 and 7.2). The highest extra payment made constituted 62.7% of the total payment made. The majority destination point of consignees for Carrier 2 were Italy and hence the chart in the figure indicates the percentage extra payment made for different regions within Italy. The figure shows the frequency of different extra payments made for the given scenario. The x-axis represents the class-interval of ‘percentage extra payment’ and the y-axis denotes the frequency. The results of the model show a significant opportunity for consolidation.

![Carrier 2-Distribution of Orders](image)

Figure 7.7: Order Classification for Carrier 2

<table>
<thead>
<tr>
<th>Shipment Origin</th>
<th>Antwerp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time Period</td>
<td>December 2013 - June 2014</td>
</tr>
<tr>
<td>Total Shipments</td>
<td>819</td>
</tr>
<tr>
<td>Total LTL Shipments</td>
<td>737</td>
</tr>
<tr>
<td>Shipment Type</td>
<td>LTL</td>
</tr>
</tbody>
</table>

Table 7.2: Model Execution Scenario 2
CHAPTER 7. RESULTS

7.4 Limitations

As mentioned in 5, the purpose to formulate an LP model instead of NLP was to make the implementation and realization of the model easier and provide a feasible solution. When the model was tested against the data from the carriers, an interesting finding was made with respect to the results of optimization. For certain product mix, the model presented an unusual order consolidation. Table 7.3 shows an example scenario where the model showed some discrepancies. As can be seen, the model suggested consolidation of orders 1 and 2 for truck 1 and order 3 for truck 2. However, knowing the cost structure in place at Dow, one would expect consolidation of orders resulting in maximum weight. That is, a combination of orders 2 and 3 for truck 1 and order 1 for truck 2.

<table>
<thead>
<tr>
<th>Order No.</th>
<th>Payload/Weight(kg)</th>
<th>Suggested Consolidation</th>
<th>Optimum Consolidation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Truck1</td>
<td>Truck2</td>
</tr>
<tr>
<td>1</td>
<td>3700</td>
<td>Order 1 3700</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>9000</td>
<td>Order 2 9000</td>
<td>Order 3 9000</td>
</tr>
<tr>
<td>3</td>
<td>9000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 7.3: Sample data showing model discrepancy

This reasoning was well supported by providing the price calculations for Suggested Consolidation and Optimal Consolidation. Hence, it was not a surprise when the pricing for Optimal Consolidation was lower than that of Suggested Consolidation. With the intention to recognize the cause of discrepancy, all the parameters associated with the LP model were closely analyzed. The discrepancy was a result of the cost structure. As mentioned earlier, the cost function included in the minimization function is the cost/100kg for a particular weight band. The minimization objective function was aiming to minimize theses costs(cost/100kg) for both the trucks. As a result of this, the consolidation priorities were no longer constant. In very few cases (like the one mentioned in Table 7.3), the sum of the unit prices were less for a certain combination whereas
the total cost (unit cost * total weight) would be less for another combination of orders. This is explained in Table 7.4.

<table>
<thead>
<tr>
<th>Combination 1</th>
<th>Combination 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truck 1</td>
<td>Truck 2</td>
</tr>
<tr>
<td>9000kg</td>
<td>9000kg</td>
</tr>
<tr>
<td>3700kg</td>
<td>9000kg</td>
</tr>
<tr>
<td>Unit Cost</td>
<td></td>
</tr>
<tr>
<td>6.5</td>
<td>4.85</td>
</tr>
<tr>
<td>3.39</td>
<td>10.67</td>
</tr>
<tr>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>11.35</td>
<td>14.06</td>
</tr>
</tbody>
</table>

Table 7.4: Unit Cost Discrepancy

The above explanation is summarized in a pictographic representation of Solution Methodology

With the presence of such limitation in the LP model, an effort was made to implement the NLP model in Excel solver and test the model with similar data. On executing the command, the excel solver provided desired solutions and particularly for the example provided in table 7.3. It was however observed that the Excel solver is not always constant and provided unexpected errors in the execution of the model for the same data set under consideration. As a whole, the NLP model does give the optimal solution at all times but the excel solver engine is not very reliable. The LP model gives seamless service for the consideration of different dataset but with a limitation in the accuracy of the output and user intervention is advisable. The model capacities for both LP model and NLP model are listed in table 7.5. A total of 9 orders can be considered for consolidation at the same time for LP model whereas only 4 orders can be considered for NLP model. Also, for both the models, a maximum of two trucks can be considered as resource availability. This means that a situation where-in the total weight of orders for consolidation exceeds the maximum capacity of 40MT (both the trucks put together) will not be handled by the models. It can be concluded by saying that LP model provides consistent feasible solution with minor discrepancies which requires user intervention whereas the NLP provides inconsistent results with the Excel Solver engine and may require testing on a different NLP supported software platform.

<table>
<thead>
<tr>
<th>Capacity</th>
<th>LP-model</th>
<th>NLP-model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. no. of orders per attempt</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>No. of trucks for consideration</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 7.5: Model Capacities

Analyzing the added value of 3PL partners in chemical logistics
Chapter 8

Conclusion

This is the final chapter of the report where a brief description about the conclusions, recommendation to the company is provided.

8.1 Conclusions

This project was aimed at analyzing the current 3PL relationships and to help determine the possible added value of such partnerships. At the same time, the gaps in the current relationship (if any) were to be determined and addressed. Two main research questions were formulated at the beginning of the project and the following paragraphs summarize the findings.

(1) What is the added value of 3PL partners in road logistics (for chemical goods) offered for Dow chemicals?

(2) How can the gaps in the current 3PL relation be addressed with the use of technology thereby providing visibility in the supply chain?

The first part of the project focused on understanding the current processes in the supply chain domain of Dow Chemical company. The focus was narrowed down to operations which involved interaction with 3PL partners. The decision to outsource the logistic operations are very much comparable with those mentioned in the Literature review (2.3). Given that logistic operations is not the core-competency of Dow Chemical company, outsourcing of these operations eliminates investment in fixed assets and the need for expertise in this field. One of the added values of such relationship is the flexibility to reduce logistic costs or improve supply chain efficiency. In Dow Chemical company's scenario, the strategic operations are held by Dow due to the presence of multiple 3PL partnerships. The control on strategic operations enable Dow to analyze the trade-off between logistic costs and supply chain efficiency. The improvement in supply chain efficiency requires investment in technology by both the parent company as well as the 3PL partner. Another advantage of outsourcing is the elimination of maintaining links with small carriers for remote areas. On interaction with Dow personnel it was learnt that some of the customers have request for deliveries in remote locations which require apt geographical knowledge. A 3PL partner has the knowledge of smaller carriers to whom he can sub-contract and thereby ensuring the end user is provided with the best service. The presence of multiple 3PL partners combined with the high magnitude of shipments being dispatched by Dow has at times created barrier within the supply chain operation. As observed in Chapter 4, the operations involving transfer of responsibilities to 3PL partner are the most sensitive locations. It is difficult to establish a clear demarcation of responsibilities at these junctures which has led to less importance being given to order consolidation.

The second part of the project focused specifically on the findings from the Analysis phase. The
process of determining the added value of 3PL partners in turn led to finding a gap in the current partnership. Data analysis revealed that multiple orders (LTLs and FTLs) were being sent to the same consignee on the same day but were tagged as different orders which led to being invoiced as multiple orders. With an aim to provide visibility to the process, a tool incorporating a mathematical model was developed which can be used by the help of custom built GUI. Dow’s partnership with multiple 3PL parties meant:

- It is difficult to keep a track of all the 3PL partners to verify if the order consolidation opportunities were considered
- It also provides an opportunity for Dow to establish a universal method for order consolidation which can be collaborated with the existing system in place at Dow.

Dow currently possess forecast information of orders to be dispatched for the next 4-6 weeks. The intention of the tool built was mainly to show the opportunities for order consolidation thereby not only improving supply chain efficiency, but also reducing the logistic costs with no further investments. The tool was tested on historical data and the findings are shown in chapter 7. An average of 20-30% extra payment provided an opportunity to optimize this part of the supply chain process. This part of the project also showed the strength of mathematical models and technology which can be used to build custom based in-house solutions. At the same time, it establishes a foundation for future large scale technological developments such as insourcing of Transport Management Systems (TMS) which have a reputation for customization, expansion and adaptability. The use of such technology provides another dimension for Dow’s already existing strong supply chain network. Dow is currently keen in further analyzing the tool before taking a key step in strategic decision making.

8.2 Recommendations

Based on analysis and findings, the following recommendations were made:

- Some of the studies in the literature study indicated the importance of collaboration between shipper and 3PLs and ways to improve them. As a method to facilitate innovation among 3PLs, one of the techniques suggested was a reward system. For Dow’s scenario, one of the reward system that can facilitate innovation among the 3PLs is allocation of more geographical regions for a carrier. Currently, certain parts of geographical regions are assigned to certain carriers via tendering process and thorough market analysis by Dow personnel. 3PL partners are always keen on expanding their share of the business geographically as well as in volume. Assurance of providing an incentive for any new innovation brought forward by the 3PL partner can be largely beneficial
- The results obtained from the tool revealed two promising opportunities with respect to Geographic expansion
  - The current model considers the orders shipped from a particular origin and shipped to the same consignee on the same day. One of the possibilities to expand the current model is to consider the shipments which not only go to the same consignee but also to the same region. The possibilities of consolidating more orders are higher which means the the possibility of increasing the truck load is higher as well.
  - Another observation made while studying the pricing strategy between Dow and its third party service providers was the fact that the pricing was based on certain regions which are assigned via contract procedure. This meant that the prices for multiple neighbouring regions remained the same and hence provided an opportunity to look for possible consolidation opportunities for these regions. The regions are numbered based on standard convention and is used across all shippers and carriers.
Dow can consider the possibility of the above mentioned consolidation opportunities with its 3PL partners since such consolidation promises complete trucks for the 3PL partners as well.

- 20MT is considered as the current maximum capacity for a Truck (define what type of truck is it). Extending this capacity to 24MT can be advantageous since this allows for few more orders to be considered for consolidation. From the view point of geographic expansion, the number of orders can increase with more regions falling under one group and this may require increasing the truck capacity. It results in fewer requirement of trucks and lower costs for the orders dispatched.

- The tool is also intended to showcase the capabilities of the information technology. Dow has already equipped itself with state of the are technological aids which makes it easier to consider the option of upgrading to an improved level promising the possibilities of order consolidation
References


REFERENCES

Demir, E., van Woensel, T., Bharatheesha, S., Burgholzer, W., Burkart, C., Jammerneegg, W., ... Charrel Ernst, A. (n.d.). A review of transportation planning tools. In Service platform for green european transportation.


Keen, P. G. (1980). Decision support systems: a research perspective. 25


Appendix A

Dispatch Type Sequence

In this chapter, we provide a series of figures explaining the various types of Road transportation. This includes briefing about the type of containers/trailers required to transport particular type of shipments.

Figure A.1: Bulk liquid transportation

Figure A.2: Packed full truck load
APPENDIX A. DISPATCH TYPE SEQUENCE

Figure A.3: Bulk Granules

Figure A.4: Bulk liquid intermodal transport

Figure A.5: Packed full truck intermodal

<table>
<thead>
<tr>
<th>DTS code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>02</td>
<td>Truck-Tank</td>
</tr>
<tr>
<td>03</td>
<td>Truck-Package</td>
</tr>
<tr>
<td>04</td>
<td>Truck-Hopper/Silo</td>
</tr>
<tr>
<td>05</td>
<td>Truck-Container(Bulk)</td>
</tr>
<tr>
<td>06</td>
<td>Truck-Container(PKG)</td>
</tr>
<tr>
<td>07</td>
<td>Truck-Parcel Service</td>
</tr>
<tr>
<td>08</td>
<td>Truck-Container(Hopper/Silo)</td>
</tr>
<tr>
<td>35</td>
<td>Intermodal Short Sea BLQ</td>
</tr>
<tr>
<td>36</td>
<td>Intermodal Short Sea Packed</td>
</tr>
<tr>
<td>38</td>
<td>Intermodal Short Sea BGR</td>
</tr>
<tr>
<td>92</td>
<td>Truck PKG(LTL)</td>
</tr>
<tr>
<td>93</td>
<td>Compartment Tank Truck</td>
</tr>
</tbody>
</table>

Table A.1: Dispatch Type Sequence codes
Appendix B

Introduction
Figure B.1: Logistic operations hierarchy
Figure B.2: A snapshot of outbound truck operation MFWP
Appendix C

Literature Study
Figure C.1: Flow chart showing ISM methodology for 3PL provider identifying criteria.

Source: Qureshi et al. (2008)
Appendix D

Results

Figure D.1: Major LTL destinations for shipments departing Terneuzen
<table>
<thead>
<tr>
<th>Country</th>
<th>Germany</th>
<th>Italy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Regions</td>
<td>39</td>
<td>77</td>
</tr>
<tr>
<td>Consolidation Possibilities (more than one order on a given GI)</td>
<td>9</td>
<td>38</td>
</tr>
<tr>
<td>Total possible savings</td>
<td>596€</td>
<td>2537€</td>
</tr>
</tbody>
</table>

Table D.1: Case Study A: Specific Scenario - Germany

Table D.2: Case Study B: Specific Scenario - Italy