PARTNERING WITH SUPPLIERS FOR QUALITY IMPROVEMENT

A Dissertation

by

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DECLARATION

"I, Unathi Baliso, hereby declare that the contents of this dissertation submitted for the degree, Magister Technologiae: Quality at the Cape Peninsula University of Technology, represents my own original unaided work and that the dissertation has not previously been submitted to any institution of higher education towards any qualification. I further declare that all sources cited or quoted are indicated and acknowledged by means of a comprehensive list of references. Furthermore, it represents my own opinions and not necessarily those of the Cape Peninsula University of Technology.

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Unathi Baliso

DEDICATION

“This research is dedicated to my mother Lucy Nokulunga Baliso and my father Wezile Lennox Baliso for the love and support that they have shown over the years.”

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“I would like to express my sincere gratitude and appreciation to the following persons:

God my creator, the ultimate giver of wisdom and understanding.

My two sisters, Thabisa and Nangamso, as well as my brother, Sinakho for their support and encouragement.

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ABSTRACT

Uneven surfaces on national roads that often lead to difficulty and even danger can be extremely hazardous when wet, due to mud and cracks, and also create dust pollution for motorists, pedestrians, residents and businesses. The continuing use of low quality raw materials in producing hot mix asphalt for national roads, leads to regular maintenance at a very high cost. The quality of aggregates (stone that is used to produce asphalt), and the quality of bitumen are often inadequate for the correct composition of hot mix asphalt. The most important factors affecting initial and long term performance of the highways is the inferior pavement structure and condition, due to poor aggregates (raw material) from suppliers. The performance of asphalt is largely determined by the characteristics of its constituents, the asphalt binder and aggregates.

The cause of most of the above factors, cannot be investigated individually, but necessitates that emphasis be placed on the performance, design, and analysis of the supply chain as a whole. This attention to supply is largely as a result of the rising cost of manufacturing, shrinkage in resources, shortened product life cycle and competition among manufacturers. The limited involvement of both the customer and supplier in the important activities within the supply chain is a cause for great concern. Ultimately the customer, namely the road user is requires safe smooth roads. It becomes crucial for the manufacturers of asphalt to recognize that involving suppliers in product development initiatives, processes and service developmental efforts calls for partnering with suppliers for quality improvement.

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SCOPE OF THE RESEARCH

1.1 INTRODUCTION AND MOTIVATION

More than eighty percent of South African National Roads is surfaced with hot-mix asphalt, which is a mixture of aggregates, filler and bitumen. The quality of the hot mix asphalt on the national roads and the roughness of the pavement, depends on the quality of the raw materials obtained from an external supplier. Pavement roughness directly influences driving comfort, fuel consumption and traffic safety.

According to Ziliute (2008:47), the main factors that cause deterioration of the asphalt pavement and the occurrence of defects, are the high intensity of traffic, the choice of base pavement structure, and the use of low quality, low strength construction material used in the preparation of the asphalt. There is nothing more distracting to the road end user than bumping, twisting and avoiding potholes that are ever so common on national roads today. The objective in manufacturing hot mix asphalt for national roads, is to achieve comfort, quality, safety and efficiency for the end user, in a cost effective way. This is not always the case as poor road surfaces, fatigue, rutting and potholes adversely affect the quality of our roads, driver safety and pavement performance.

'Much Asphalt' specialises in and focuses on the production of asphalt from fixed and mobile plants located throughout Southern Africa, and is the region's single largest supplier. Within the company's business strategy, mutual beneficial supplier relationships are of key importance, as partnering with suppliers to address customer satisfaction issues is widely recognized as a successful way to improve the overall performance of a supply chain. There is increasing interest in inter-firm relationships as Much Asphalt relies on resources, such as raw materials, for the final product from outside suppliers and manufacturer's to produce a quality product. One of the key elements in improving the quality of asphalt on national roads is the supplier. As a result, supplier selection is a key issue

that should be considered. It is best to take the time to inspect incoming raw materials before accepting them for production of the final product. To develop a sound partnership between customer and supplier, a mutually beneficial program must be developed in which both parties contribute to the stability and capability of the production process.

In the past, several conceptual research studies have been conducted that promoted the advantages of partnering with suppliers. According to Wong (2002:580), partnering with suppliers can assist companies to achieve improved customer satisfaction. In this case it is a demanding public who requires sound roads, less maintenance, and less down time on freeways. Therefore, the management of supply chains in a business environment has a major financial impact on all the parties involved in the chain. As a result, research into, and implementation of supply chain management principles to improve the supply chain are of key importance to any national or global company. The producer of asphalt needs to be assured that the raw materials supplied are of the type and quality ordered thus ensuring the consistency of the product, with consequent improved customer satisfaction and less wastage.

1.2 BACKGROUND TO THE RESEARCH PROBLEM

Uneven surfaces on national roads, which lead to poor ride ability, can be extremely dangerous, especially when wet, due to mud and cracks. When dry, it creates dust pollution for motorist, pedestrians, residents and businesses. The continuing use of low quality raw materials in producing hot mix asphalt for national roads, leads to regular maintenance at a very high cost. The quality and properties of the aggregates (stone that is used to produce asphalt), and the quality of bitumen is often inadequate to meet the conditions of hot mix asphalt. The most important factors affecting initial and long term performance of the highways is the pavement structure and condition, due to poor aggregates (raw material) form suppliers. The performance of asphalt is largely determined by the characteristics of its constituents, asphalt binder and aggregates.

At the start of the construction project for a new road, contractors are required to verify that the asphalt produced at the asphalt plant exactly replicates the volumetric parameters of the mix design. For verification, the contractor randomly collects samples during the production process. The volumetric and gradation parameters of the samples are evaluated and compared with the specifications for the mix. If the samples are within the requirements, the asphalt production is verified and accepted; alternatively the producer of the asphalt must halt production, should the asphalt not meet the desired standard, until the mix proportions are corrected and verified. The most common defects on the roads are cracks, due to a number of factors, which make up to 70% of defects. Cracks are amongst the most significant asphalt pavement defects that impact on the deterioration of the pavement

The causes of these defects cannot be investigated individually, however there have been calls for emphasis to be placed on the performance, design, and the analysis of the supply chain as a whole. This attention is largely as a result of the rising cost of manufacturing, the shrinking resource of the manufacturing base and a shortened product life cycle on the roads.

Figure 1: Cracked asphalt surfacing section. **(Source:** Own source**)**

Figure 1 graphically depicts a worst case scenario of a failed product as is commonly evident on South African national roads today. When a road surface fails the question is, “who bears the cost?” The paver of the road argues that he used the manufacturers premix. The premix manufacturer states that he too used materials from a supplier. The supplier in turn says

he supplied aggregate from a crusher owner and bitumen from a producer.

The limited involvement of both the customer and the supplier in the extremely important activities within the supply chain is cause for great concern. It becomes crucial for the manufacturer of asphalt to recognize that involving suppliers in the product development initiatives, processes and service developmental efforts calls for partnering with suppliers for quality improvement. At the end of the day the ultimate customer, namely the road end user, requires safe effective roads.

1.2.1 Statement of the research problem

Against the background to the research problem elaborated upon above, the research problem statement reads as follows: Lack of efficiency in coordinating the processes across the supply chain in the manufacturing of asphalt, culminates in poor road surface quality, which requires sustained renewal, at high costs.

1.3 RESEARCH QUESTION

The research question forming the crux of the research in this dissertation, reads as follows: “What key strategies or approaches can be adopted to improve the operational effectiveness and reliability between partners of the supply chain in the manufacturing of asphalt, thereby increasing the reliability of national roads and enhancing customer satisfaction?”

1.3.1 Investigative questions

The following investigative or sub questions will be researched in support of the above research question:

To what extent can reliability between the partners in the supply chain, be

increased to ensure trust?

Can planning processes be integrated to coordinate efforts across the supply chain?

How can the performance of suppliers be brought to the desired levels?

Is it possible to set up achievable targets and realistic expectations regarding the supply of raw materials?

To what extent can the cost of setting up, planning and maintaining quality by all the parties in the supply chain be maintained?

1.4 PRIMARY RESEARCH OBJECTIVES

The primary research objectives for this dissertation are the following:

- To identify a customer focused approach to quality management of the raw materials and of the final product.
- To define identifiable and appropriate partnering attributes.
- To follow a continuous improvement process of defining and redefining attributes based on the previous experience with suppliers over time.
- To develop business-specific metrics to enhancing supplier integration and partnering development decision-making process
- To evaluate improvements according to the contribution to the desired result.

1.5 THE RESEARCH PROCESS

The research process provides insight into the process of 'how' the research will be conducted from formulation the research proposal to final submission of the thesis or dissertation. Fundamental stages in the research process common to all scientific based investigation are listed below:

Remenyi, Williams, Money and Swartz (2002:64-65) explain the research process as consisting of eight specific phases, namely:

- Reviewing the literature.
- Formalizing a research question.
- Establishing the methodology.

- Collecting evidence.
- Analysing the evidence.
- Developing conclusion.
- Understanding the limitations of the research.
- Producing management guidelines' or recommendations.

According to Collis and Hussey (2003:16) there are six fundamental stages in the research process, namely:

- The identification of the research topic.
- Definition of the research problem.
- Determining how the research is going to be conducted.
- Collection of the research data.
- Analysis and interpretation of the research data.
- Writing up of the dissertation or thesis.

The research process as described by Watkins (2008:30-31), will be followed within the ambit of this research:

- Determine the field of study for the proposed research.
- Identify a specific complex problem within a researchable application area.
- Conduct a holistic survey of the functional area in which the complex problem exists, to determine the impact of the problem on the specific area of application and the value the proposed research may bring.
- Conduct an abbreviated literature review on the subject matter being investigated.
- Describe and formulate the research problem.
- Describe and formulate the research question and associated investigative (sub-) questions.
- Select an appropriate research design and methodology, which

includes the data collection design and methodology.

- Determine the key research objectives for the proposed research.
- Document the research process which will be followed for the proposed research and formulate an associated work plan.
- Identify the limitations which may impact on the proposed research.
- Based on the above, formulate a formal research proposal and submit it for approval.
- Establish a structured working relationship with the allocated supervisor or promoter
- Conduct an in-depth literature review on the research subject.
- Collect, analyze and interpret the research data.
- Write up dissertation or thesis.
- Proofread the dissertation/ thesis and submit for formal vetting.

1.6 THE RESEARCH DESIGN AND METHODOLOGY

Every type of research has an implicit, if not an explicit, research design. In the most elementary sense, the design is a logical sequence that connects empirical data to a study's initial research questions and ultimately to its conclusion (Yin, 1998: Online). The selection of the 'most appropriate' research design and methodology for a research study cannot be overemphasised. Action research will serve as research method in this research study.

According to O'Brien (1998: Online), action research aims to contribute both to the practical concerns of people in an immediate problematic situation simultaneously further the goals of social sciences. As a result, there is a dual commitment in action research to study a system and concurrently collaborate with members of the system in changing it into what is agreed upon as a desired direction.

Gabel (1995: **Online**) points out that action research aims to contribute

both to the practical concerns of people in an immediate problematic situation and the goals of social sciences by joint collaboration with a mutually acceptable ethical frame work. Action research is described by Gummesson (2000:116), as “a method of doing case study research”. According to Collis and Hussey (2003:66-67), “action research is a type of applied research, designed to find an effective way of bringing about a conscious change in a partly controlled environment. The main aim of action research, (often referred as ‘action science’) is to enter into a situation within an organization, attempt to bring about change, and monitor results. Coghlan and Brannick (2002:6-7) list the following most salient features of ‘action research’:

- An action researcher, takes action.
- Action science always involves two goals, namely ‘to solve a problem for the client’ and ‘to contribute to science’. This implies being a ‘management consultant’ and an ‘academic researcher’ at the same time.
- Action research is interactive. It requires co-operation between the researcher and the client personnel, and continuous adjustment to new information and new events.
- Action science is applicable to understanding, planning and implementation of change in business firms and other organizations.
- In action research it is essential to understand the ethical framework, values and norms with which action research is used in a particular context.
- Action research can include all types of data collection methodologies, and requires the total involvement of the researcher.
- Constructively applied pre-understanding of the environment and

of the conditions of business in which the action research will be conducted is essential.

- 'Management action research' should be conducted in real time, though retrospective action research is also acceptable.
- The 'management action research' paradigm requires its own quality criteria.

Coghlan and Brannick (2002:17-18) describe the action research cycle as follows:

- **Diagnosing**: Diagnosing involves naming what the issues are, however provisionally, as the working theme, on the basis of which action will be planned and taken.
- **Planned action**: Planning action follows from the analysis of the context and purpose of the project, the framing of the issue and the diagnosis, and is consistent with them.
- **Taking action**: Plans are implemented and interventions are made.
- **Evaluation action**: The outcomes of the action, both intended and unintended, are examined with a view to see:
  - If the original diagnosis was correct.
  - If the action taken was correct.
  - If the action was taken in an appropriate manner.
  - The above, which feeds into the next cycle of diagnosis planning and action.

1.7 DATA COLLECTION DESIGN AND METHODOLOGY

The following data collection methodologies will be employed in the ambit of this research: Focus groups, in-depth surveys and questionnaires. In addition to selecting a data collection methodology, the methodology

selected will be described comprehensively and expanded upon in terms of the following criteria, namely, the 'unit of analysis', the 'variables' and the selection of a 'sample and sample type.

1.7.1 Focus groups

According to Barnett (2008: **Online**), a focus group is a group interview of approximately six to twelve people who share similar characteristics or common interests. A facilitator guides the group on a predetermined set of topics. The facilitator creates an environment that encourages participants to share their perceptions and points of views. Focus groups are a qualitative data collection method, meaning that the data is descriptive and cannot be measured numerically.

Within the ambit of this research, this data collection method will be employed for gathering a subjective perspective on the current performance of the existing supply chain. The unit of analysis will be a focus on the impact of mutual beneficial supplier relationships. The variables around mutual beneficial supplier relationships are output performance measures that not only correspond to the organization's goals, but also to those of the supplier to meet the customer's goals values and requirements. The selection of a sample and a sample type follows once the researcher has decided the various sources from which the relevant information pertaining to the research will be gathered. Individuals forming the focus groups shall be made up of those who represent diverse perspectives on the research issue at hand.

1.7.2 In-depth surveys

Rita (1999:1), explains that in-depth surveys, are surveys that are used to elicit information in order to achieve a holistic understanding of the interviewee's point of view or situation. It can also be used to explore interesting areas for further investigations. This type of survey involves asking open-ended questions, and probing wherever necessary to obtain data deemed useful by researcher. In-depth survey will be employed as another data collection method for this research, since an interpretative

approach (qualitative in nature) is adopted. The central concern of this approach is discovering the key strategies or approaches that can be adopted to improve operational effectiveness, reliability and trust between the partners in a supply chain.

1.7.3 Questionnaires

In contrast with interviews, where the enumerator poses questions directly, questionnaires will be handed out or sent to different sample sectors that are involved in the research. Falling within the ambit of a broader definition of survey research, Remenyi *et al*. (2002:290), defines questionnaires as "… the collection of a large quantity of evidence, usually numeric, or evidence that will be converted to numbers, normally by means of a questionnaire. The sample or sample type will be made up of participants in the supply chain, such as the manufacturer of asphalt, the producer of raw materials, and the contractor on the road. Sampling will be conducted from a population size of around 100 participants, of whom 75 participants will be engaged in the research. The researcher employed convenient sampling as means of drawing the sample.

1.8 DATA VALIDITY AND RELIABILITY

According to Collis and Hussey (2003:186) 'validity' is concerned with the extent to which the research finding accurately represents what is happening; more specifically, whether the data is a true picture of what is being studied. According to Cooper and Schindler (2006:318-320) three major forms of validity can be identified, namely 'content validity', 'criterion-related validity' and' construct validity', which are expanded upon below to provide a holistic perspective of each concept:

- **Content validity**: Content of measuring instruments is the extent to which it provides adequate coverage of the investigative (sub-) questions guiding the study. If the instrument contains a representative sample of the universe of subject matter of interest, then the content validity is good.

- **Criterion-related validity:** Reflects the success of measures used for prediction or estimation. Any criterion measure must be judged in terms of the following four qualities:
  - **Criterion is relevant:** If the criterion is defined and scored in the terms we judge the proper measure of success.
  - **Freedom from bias:** When the criterion gives each respondent the opportunity to score well.
  - **Reliability:** A reliable criterion is stable and reproducible.
  - **Availability:** The information specified by the criterion must be available.
  - **Construct validity**: In an attempt to evaluate validity, both the theory and the measuring instrument being used should be considered. According to Collis and Hussey (2003:59) construct validity relates to the problem that there is a number of phenomena, which are not directly observable, such as motivation, satisfaction, ambition and anxiety. These are known as hypothetical construct, which is assumed to exist as factors which explain observable phenomena
- **Reliability** (also referred to as 'trustworthiness'), is concerned with the findings of the research (Collis & Hussey, 2003:186). The findings can be said to be reliable if the researcher, or anyone else, repeated the research and obtained the same results. The researcher will estimate the reliability of responses to questions in questionnaires or interviews in the following three ways: 'test retest method', 'split-halves method' and the 'internal consistency method':
- **Test re-test method:** The questions are asked of the same people, but on two separate occasions. Responses given on the two occasions are correlated and the correlation coefficient of the two sets of data computed, thus providing an index of reliability.

- **Split-halves method:** The questionnaires or interview record sheets are divided into two equal halves. The two piles are then correlated and the correlation coefficient of the two sets of data is computed, thus providing an index of reliability.

- **Internal consistency method**: Every item is correlated with every other item across the entire sample and the average inter-item correlation is taken as the index of reliability.

1.9 ETHICS

In the context of research, according to Saunders, Lewis and Thornhill, (2000:130), "...ethics refers to the appropriateness of your behaviour in relation to the rights of those who become the subject of your work, or are affected by it." Most ethical issues in research fall into one of the four categories namely, protection from harm, informed consent, right to privacy, and honesty with professional colleagues (Leedy & Ormord, 2001:107-108).

This research will therefore be conducted in an ethical manner and the following ethical codes of behavior will be applied:

- **Informed consent:** Participants will be told in advance about the nature of the research, and will be given the choice of either participating or not participating. They will also be given the right to withdraw from the research at any time, as participation in the research should be strictly voluntary. An informed consent form that describes the nature of the research as well as the nature of the required participation will be presented to participants in the research study. According to Leedy & Ormrod (2001:108), informed consent forms contain the following information.

    - A brief description of the nature of the study.

    - A description of what participation will involve in terms of activities and duration.

- A statement indicating that participation is voluntary and can be terminated any time without penalty.
- A list of potential risks and/or discomfort that participants may encounter.
- The guarantee that all responses will remain confidential and anonymous.
- The researcher's name, plus information about how the researcher can be contacted.

To ensure that the research is conducted in an ethical manner, the following checklist provided by Collis and Hussey (2003:39) will be utilised:

- Will the research process harm participants in an ethical manner: information is gathered (indirect participants)?
- Are the findings of the research likely to cause harm to others not involved in the research?
- Is accepted research practise violated in conduction the research, the data analysis, and drawing conclusions?

1.10 RESEARCH ASSUMPTIONS

According to Watkins (2008:71) an assumption represents a condition that is taken for granted, and without which the research study would be pointless. The requirement to state assumptions on which the research is undertaken is based on the fact that it is essential that others know what one assumes with respect to a research study.

The assumptions made by the researcher in this study are the following:

- The proposed idea of supply chain management may not be a universally understood concept by the existing stake holders within the Much Asphalt supply chain.
- The management and employees within the value chain of the

suppliers as well the producers of asphalt might not be completely aware of some of the principles and main strategies around integration, optimization and logistic of partnering with suppliers to improve the overall performance of products and as well as relationships.

1.11 RESEARCH CONSTRAINTS

Watkins (2008:72), defines research constraints (or 'limitations' and 'de-limitations'), as any inhibiting factor which would in any way constrain the research student's ability to conduct the research in a moral way.

The following are the Limitations and De-limitations of the research:

- Limitations: The research may be weakened by the fact that as the supply chain increases in complexity, it then becomes more difficult to measure its efficiency.
- De-limitations: The researcher realises that although the supply chain management approach is very broad and may relate to the integration of decisions across multiple dimensions of operational planning and control, this research focuses on only a few areas such as the planning and control that is associated with the inputs, processes and outputs.
- This is the first dimension which focuses on the integration regarding purchasing, manufacturing and distribution activities with the company and between the company and its suppliers and customers.

1.12 SIGNIFICANCE OF THE PROPOSED RESEARCH

This research aims to identify the key strategies for improving supply

chain management by strengthening relationships within the key members of the supply chain itself. The importance of this research to evaluate improvement potential as well as the management of the supply chain as a whole, is actually increasing, as the complexity of the supply chain in term of products, markets and members is growing. This research places more effort on increasing product quality to ensure ultimate customer satisfaction. Also, creating a management model for mastering internal collaboration within the supplier's value chain, is important.

1.13 CHAPTER CONTENT AND ANALYSIS

The Chapter and content analysis pertaining to this dissertation is as follows:

Chapter 1- The Scope of the Research: Includes introduction and motivation of why the research is necessary. It highlights, in detail, some of the broader issues around the quality of raw materials and how they adversely affect the quality of the end product.

Chapter 2 – The holistic perspective of research environment: Provides a holistic overview of the research environment. 'Much Asphalt', is the organization in which the research has been conducted. The impact of producing low quality product, and the performance of the product on public roads, has also been researched.

Chapter 3- Literature review: Presents a literature review on the concept of supply chain management. It expresses an overview and critical analysis of the relevant literature as it relates to all the concepts of mutual beneficial supplier relationships, the production planning and inventory control processes. These include some literature on the current issues regarding the supply of raw materials, and the application of the principles of supplier relationships in the asphalt industry. Supply chain performance measures, quality performance measures and also included measures based on customer responsiveness. The chapter also describes key components or building blocks needed for successful supply chain management. The chapter concludes with describing the most common

benefits of supply chain management as well as the most common barriers and bridges of its implementation.

Chapter 4- Data collection and interpretation of results: This chapter deals with the research design and methodology. For this research 'action study research' is used, designed to find an effective way of bringing about operational change within Much Asphalt's supply chain policies and methods, and to improve the process within the organisation.

Chapter 5- Conclusion: Contains the overall conclusions and recommendations of the research to originate the research problem.

1.14 CONCLUSION

Disputes between customers, subcontractors and suppliers are always caused by a lack of efficiency in coordinating the processes across the supply chain. This lack of communication and inefficiency in coordination leads to significant negative impacts, low productivity, cost and time overruns, changes in orders, inadequate design specifications and liability claims. Conflicts and disputes impact generally direct on the customer. In the Asphalt industry, the reluctance of many suppliers to guarantee their product (raw materials) and a poor and inconsistent risk sharing mechanism between suppliers and contractors is a challenge that adversely affects the quality of the final product. The paradigm of Supply Chain Management can play a significant role in developing relationships and collaboration within the supply chain members, to reduce exposure to contractual claims and disputes resulting from the cost of a final product of inconsistent quality.

In Chapter 2, the steps in production of asphalt will be discussed, as well as the holistic overview of the research environment. The activities around the manufacturing of asphalt, as well as how they are linked to suppliers, are described.

Chapter 2 – The holistic perspective of research environment:

Provides a holistic overview of the research environment. Much Asphalt,

is the organization in which the research has been conducted, as well looking into the impact of producing a low quality product and the performance of the product on public roads.

Chapter 3- Literature review: Presents a literature review on the concept of supply chain management. It expresses an overview and critical analysis of the relevant literature as it relates to all the concepts of mutual beneficial supplier relationships, the production planning and inventory control processes. These include some literature on the current issues with the supply of raw materials, and the application of the principles of supplier relationships in the asphalt industry, as well as supply chain performance measures, quality performance measures and measures based on customer responsiveness. It also describes the key components or building blocks needed for successful supply chain management. The chapter concludes with describing the most common benefits of supply chain management and the most common barriers and bridges of its implementation.

Chapter 4- Data collection and interpretation of result: Deals with the research design and methodology. The method of research used for this research is action study research, designed to find an effective way of bringing about operational change within Much Asphalt's supply chain policies and methods, and to improve the process within the organisation. **Chapter 5- Conclusion:** Contain the overall conclusions and recommendations of the research to originate the research problem.

CHAPTER 2

HOLISTIC PESPECTIVE OF RESEARCH ENVIRONMENT

1.1 INTRODUCTION

This Chapter provides a holistic perspective of Much Asphalt (Pty) Ltd as the organization in which the research is conducted, highlighting the suppliers as well as the customers of Much Asphalt. The upstream processes, which constitute the suppliers of raw materials, as well as the downstream process, which is the customer or the contractor will be analysed as part of research environment.

1.2 'MUCH ASPHALT': AN OVERVIEW

Operating in the bituminous industry, Much Asphalt is Southern Africa's largest commercial supplier of an extensive range of hot and cold asphalt products for road construction. The Company strives to achieve sustainable growth by the formation of tactical alliances and partnerships, and by strategically positioning stationary and mobile mixing plants in the developing regions of sub-Saharan Africa. In South Africa its wide

customer base consists of National, Provincial, local government and affiliated organizations, private organizations and the public at large.

Much Asphalt is a subsidiary of Murray and Roberts (Pty) Ltd, which is a major group of world class companies, with a strong presence in the South African construction industry. Worldwide Murray and Roberts services more than 50 countries and employs approximately 30 000 people in its core operations in South Africa.

With a history spanning 100 years, the group has been responsible for constructing much of the built environment of Southern Africa. Much Asphalt aspires to remain the market leader by entrenching itself as the preferred supplier of asphalt in all areas of operation. The company strives to achieve sustainable growth by strategically positioning its fixed and mobile plants in developing regions of South Africa. Much Asphalt is positioned to supply a large variety of asphalt for all types of roads, from short access roads, municipal streets, to proclaimed provincial roads and national freeways.

1.2.1 **Production process**

The operational processes within the Much Asphalt internal supply chain are graphically depicted in Figure 1 below:

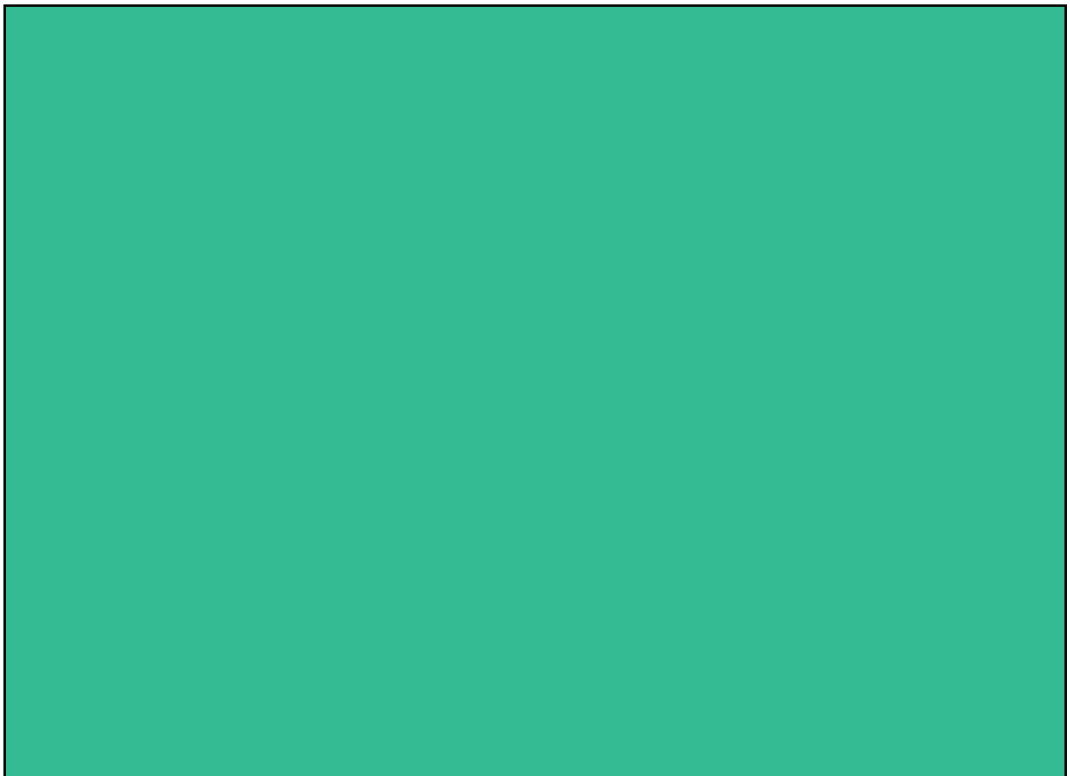


Figure 2.1: The Much Asphalt Process Flow Chain. (**Source:** Own source)

The production department at Much Asphalt has distinguished itself as the 'the heart' of the operations division. This is where all the raw materials are incorporated into the final product. The aim of the production department is to utilize the necessary resources that are needed to ensure that the asphalt produced meets the quality demands of the customer at all times. This includes determining the design and developmental stages, review, verification and validation of each stage. As graphically depicted in Figure 2.1 above, the production departments employs:

- Raw Material storage.
- Aggregate feeding.
- Drying and heating.
- Weighing
- Filler handling
- Bitumen heating and feeding.
- Mixing.
- Offloading of product onto trucks.

All the processes at Much Asphalt are aligned with the objectives of the organization, which is to add value, relative to the complexity of the internal customers as well as the external customers. The processes are as follows:

- Receiving orders from the customer (Contract review).

- Buying raw materials.
- Receiving, testing and inspection.
- Starting up the batching process
- Sampling and quality control.
- Dispatching of the final product.

1.1.2 **The product: Asphalt**

Asphalt is a mixture or a combination of aggregates (crushed stone), sand and bitumen. The requirements for asphalt to work efficiently on the road lie in a number of different product quality specifications which include the monitoring of road surfaces under wet conditions, riding quality and low noise level for the public. There are two types of raw materials that are used in the production of premix asphalt, namely aggregates and bitumen

.

1.1.3 **Aggregates**

Aggregates are a major component of all asphalt mixes. A large number of types of aggregate with various properties are available. These aggregates are normally obtained from local suppliers of natural rock, which may occur either as outcrops or as gravel deposits along old stream beds. They constitute about 94 percent by weight of hot mix asphalt. The properties of coarse and fine aggregates used in the production of hot mix asphalt are crucial to the overall performance of the asphalt surface on national roads. Much Asphalt employs a stringent service level agreement with its suppliers of raw materials. There are different suppliers of raw materials on the supply list for each different region covered by Much Asphalt across the country. The Cape Town plant employs Lafarge as its main aggregates supplier. Lafarge has a reputation for technical excellence, innovation and the ability to meet the needs of its customers

in South Africa. The service contract between Lafarge, as the supplier of aggregates, and Much Asphalt, as the producer of asphalt, is based on strong ethics of service, quality and delivery.

1.1.4 **Bitumen**

Two main types of road binder or bitumen are currently available in South Africa, bitumen and tar. Tar is obtained from the destructive distillation of coal. It is hardly ever used today as a binder on account of its having undesirable properties such as very high temperature susceptibility and significant health problems. Bitumen is derived from petroleum and consists of dispersed hydrocarbons in crude petroleum obtained by refining crude petroleum. Petroleum refining is easily controlled and the bitumen produced is generally of good quality. There are three main suppliers of bitumen to Much Asphalt, namely: Shell, Esso and Chevron.

1.1.5 **The Supplier selection process**

At Much Asphalt, the suppliers of raw materials are chosen using the strict guidelines laid down in the organization's service level agreement governing processes for the purchasing of raw materials and goods from suppliers.

The implementation of the requirements of the purchasing procedure according to ISO 9001 Clause 7.4 is a function of the Quality Assurance Manager. Purchasing specifications for raw materials are recorded in the Quality manual which is continually updated.

Suppliers of goods and services are approved in terms of evaluations based on historical information such as the company's listing status or evidence of compliance by means of certificates of compliance. Price, quality and service form an integral part of these evaluations. Suppliers and subcontractors are subject to ongoing evaluations, and re-evaluation.

1.3 **CONTRACTS AND MARKETS**

Two major contracts at the core of this research have been the R300

and the N1 from Koelenhof to Huguenot Toll Plaza in Cape Town, South Africa. The R300 linking the N1 and N2 freeways required the placement of 220 000 tones of asphalt over a 14 month period. The contract, awarded to Much Asphalt by the South African Roads Agency, is a joint venture with Roadmac and Haw & Iglis (H&I). It involves milling out and replacing the entire section of road with asphalt, coupled with the addition of two new lanes in the median. The 17 km route which encompasses the R300, remains open to the general public whilst the construction work is underway. It therefore requires smooth collaboration between the asphalt producer, the consultants and the Engineers. The raw materials employed on this contract are expected to be relatively trustworthy and within specification at all times. There are several major road development contract and projects running concurrently at all Much Asphalt sub Saharan regions. To highlight a few, Figure 2 below graphically depicts a new road linking the the Langeni saw Mill to the R61 in the pine forested mountains near Gqugqura, 40 km North West of Mthatha.

Figure 2.2: A new road linking Langeni, Gqugqura, Mthatha. (**Source:** Own source)

Cape Town international Airport has 69 000 tones of new asphalt on its main runway. This has been a collaborative work of Much Asphalt, Rand Roads and Zebra. The 3.2 km long, 60m wide runway was milled, replacing it with new asphalt. Meticulous pre-contract planning and risk analysis is a critical success factor for all major contracts. Close co-operation with transport subcontractors, raw material supplier, and consulting engineers is essential throughout the project.

The rehabilitation of the OR Tambo international Airport awarded to Much Asphalt required 43 000 tones of asphalt. The Asphalt used on these runways must be specifically designed to cope with the heavy load of new

airbuses; therefore layers of asphalt used must not only be resistant to deformation in general but to cracking and rutting. Close collaboration between all parties involved is a non negotiable on all of the contracts that are awarded for business at Much Asphalt**.**

1.4 THE SUPPLY CHAIN PROCESS AT MUCH ASPHALT

The asphalt industry, not unlike other industries, is undergoing a major change in technical specifications and quality requirements. The final product is a highway consisting of many activities, such as obtaining the right asphalt and aggregate for the job, product delivery, translating laboratory mix designs to field specifications, etc. As graphically depicted in Figure 2.1, it is important to examine all activities within Much Asphalt to determine the value chain of the organisation.

To extend the economic concepts of the value chain, the supply chain includes several suppliers, plants and customer groups. Supply chain management is a complex task, which requires management of the organizations in the supply chain and relationships between partners in the supply chain.

Managing inbound logistics in the Much Asphalt supply chain involves work with the raw material suppliers, Lafarge, Chevron, Esso, Shell, Aggregate rushers, FFS refineries and other suppliers. The role of the purchasing dept is to manage the supplier portfolio, with the target of optimal material acquisition and a controlled supply of raw materials. The role of managing inbound logistics involves careful availability management, to balance the raw material demand with supply. If at any time the suppliers of raw materials do not operate on schedule, the overall production in the supply chain will be affected.

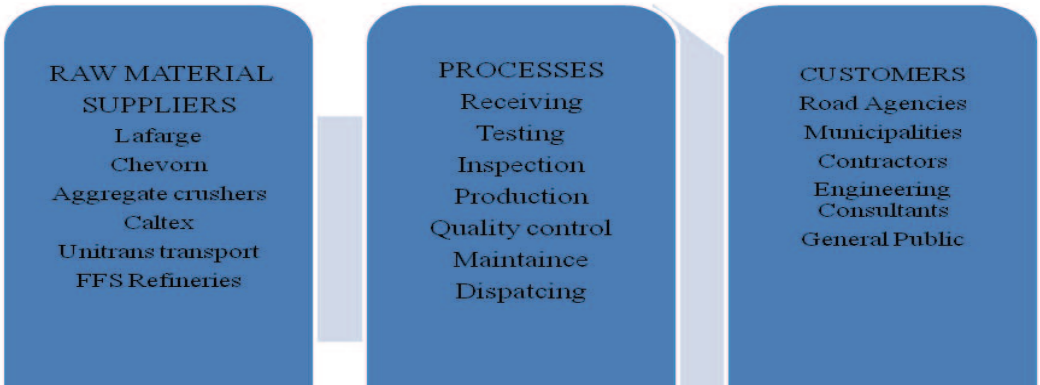


Figure 2.3: Core Activities in the supply chain. (**Source:** Own source)

Figure 2.3 graphically depicts the core activities in the supply chain, the inputs, process and the output. It is clear that the performance of the raw material suppliers directly affects the reliability of Much Asphalt to its customers. Perusing the activities along the value chain sequentially, it is clear that the links in the value chain depend on people performing different functions. The chain of Much Asphalt customers, which consists of road contractors, municipalities, private engineering companies, as well as the general public, is revealed after the steps in the internal processes of Much Asphalt. This means that every work station in the continuous process of production should make sure that the work done is absolutely impeccable before the product is released to the next phase of the process.

1.5 ISSUES THAT MOOTED THE RESEARCH

Some of the concerns that added impetus to the conduct of this research are elaborated on below:

Concerns with regard to the use of aggregates including those synthesized from mineral or other resources, in the construction of roads. These issues of concern include aggregate properties, mineralogy, physical and chemical characteristics, degradation, testing for quality control, quality assurance, sources of current and future supply, production, distribution and subsequent uses of aggregates in roads.

1.5.1 Aggregate Resources

During a meeting with the suppliers of aggregates, a continuing concern that was raised is the availability of the materials needed to maintain

or increase the supply of high-quality, economical aggregates to meet demands. There are two major influences on the availability of these materials; they are depletion of current production sites and establishment of new sites. Many of the existing sites for the aggregate production have been in use for some time and are running out of services, because the quality or type of source material is changing, specification for aggregate material have changed, or the boundaries of the sites are being approached.

1.1.2 Aggregate testing for quality and performance

The issue of aggregate testing is closely related to the production issue discussed above. As knowledge of the mechanistic, as opposed to empirical, behaviour of aggregates in various application increases, there is a concomitant increase in the need to better define and measure the relevant characteristics and properties of the aggregate to ensure quality and predict performance. The industry must also wrestle with moving targets in the areas of both quality and performance, which can vary widely depending on the application, climate and expected performance involved. The engineer needs sound guidance to help determine the quality and performance tests that should be conducted, as well as the proper acceptance levels in those test for the particular application.

Much Asphalt and the aggregate suppliers will have to work to work together to achieve performance standards. Doing so will require setting performance standards for testing and acceptance that can be applied quickly and economically in both the laboratory and field. It will also be necessary to develop and maintain a keen understanding of the processes in the field that impact on performance in order that the performance level specified for a particular application is realistic.

1.1.3 Integration measures in the overall supply chain

Issues pertaining to the overall supply chain have been established through conducting internal surveys, external customer surveys, as well as costing reports. These issued are elaborated upon below:

Communication between all the parties involved in the inputs, processes and outputs has to be improved. Workers and managers in the organization are somewhat limited by their particular functional preparation and specialization pertaining to the overall customer.

- There is a lack of direction in terms of project timelines, deadlines, standardized performance measurement systems and overall clarification with regard to tenders and specifications.
- The set objectives for different supply chain units were conflicting and not co-ordinated.
- Little trust and reliability between the partners of the supply chain. The plant starting times, aggregate delivery, production demand, quantities on order by means of a pre planned schedule are not established at the start of contracts which leads to delays in production.
- A lack of integrated process planning to coordinate processes within the supply chain, leads to frustration of all the stake-holders involved.
- The lead times to customers has increased. This is not acceptable as the workability of asphalt depends on reactions times of the chemical properties of the product as well as the temperatures.

2.5.4 Impact of rutting or deformation of Asphalt on national roads

Premature rutting or degradation of national roads has increased in recent years. Studies concluded by the national centre in asphalt technology, have indicated that the rutting has occurred in the top 75 to 100mm of hot mix asphalt paving in roads. Increase rutting results primarily from high-pressure truck tires and increased wheel loads. Although proper selection of asphalt binder minimizes rutting, the properties of aggregates (e.g., size, gradation, particle shape, angularity and surface texture) also affect rutting.

According to research conducted under the strategic highway research

program, it has been shown that the chemical surface properties of mineral aggregates are more important than the asphalt binder properties in terms of adhesion and moisture induced stripping. Some mineral aggregates are inherently very susceptible to moisture–induced stripping.

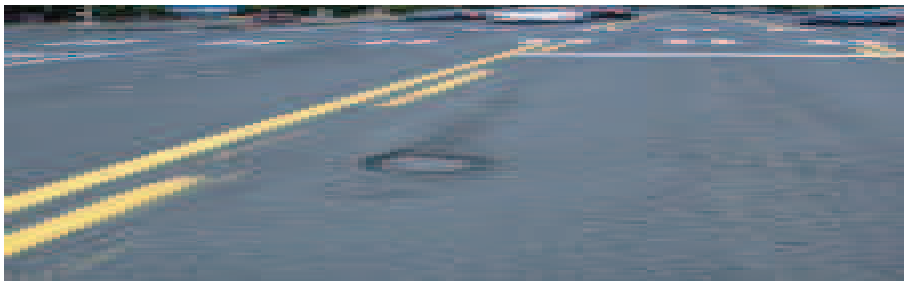


Figure 2.4: A pothole in the course of an urban road. (**Source:** Own source)

Figure 2.4, graphically depicts the progressive disintegration of an asphalt layer from the surface downward as a result of the dislodgement of aggregate particles. Loss of bond between aggregate particles and the asphalt binder occurs as a result of a dust coating on the aggregate particles that forces the asphalt binder to bond with the dust rather than the aggregate.

1.5 CONCLUSION

The primary purpose of this of this research is two-fold, firstly to investigate the direct and indirect effects of supply chain management in the construction industry, and secondly to provide more research on guidelines for developing partnering relationships with suppliers that will address issues around product realization and ultimate customer satisfaction.

According to clause 7 of ISO 9001:2008 the onus is on the organization to plan and develop the processes needed for product realization. The type and the extent of control applied to the supplier and the purchased product shall be dependent upon the effect of the purchased product on subsequent product realization of the final product.

Lack of high quality raw materials from suppliers is becoming a major

problem in many areas of operation and, as quality raw materials become depleted, a need arises for selecting suppliers that meet the approved requirements for procedures, product, processes and equipment.

The emphasis of this study is to establish an integrated process wherein suppliers, manufacturers and contractors work together in an effort to acquire raw materials, convert the raw material into a specified final product and deliver the final product to the customer in order to achieve the ultimate customer satisfaction, a winning product.

While the research on this issue has been substantial in recent years, there are not enough studies that provide clear guidelines for developing partnerships that will improve customer satisfaction. Furthermore, the producer of asphalt and the supplier of raw materials will have to work together to achieve performance standards and meet warranty provisions. Chapter 3 offers a detailed literature review on the importance of partnerships, and collaborations under the blanket of supply chain management.

CHAPTER 3

SUPPLY CHAIN MANAGEMENT

A LITERATURE REVIEW

1.1 INTRODUCTION

Citing the work of Gill and Johnson (1997), Saunders, Lewis and Thornhill (2000:42) are of the opinion that reviewing the literature is essential as assessment criteria usually require one to demonstrate awareness of the current state of knowledge in a particular subject, its limitations and how the research will fit into the wider context. This chapter focuses on the identification of the key elements pertaining to supply-chain management by highlighting various supply-chain strategies and the need for collaborative efforts amongst entities within the supply-chain. Some widely used definitions of supply-chain management and the value chain are summarized, and the relationship between Total Quality Management (TQM) and Supply Chain Management (SCM) as well as the evolution of supply chain management is reviewed.

Throughout the literature review, an attempt is made to develop a framework for assessing the main strategic, tactical and operational level performances in a supply-chain. The emphasis is on the review of the supply-chain as a management philosophy, defining performance measures, supplier certification, deterministic and stochastic models as well as the key components of successful supply-chain management.

This chapter concludes by highlighting the common benefits of supply chain collaboration amongst entities, its impact on the overall system performance and the ultimate quality of the final product. The growing importance of understanding the underlying nature of industries through the correct facilitation of the supply chain in order to achieve customer satisfaction is adopted as the underlying theme to the literature review. It is proposed that improved relationships and the integration of key stakeholders are critical to addressing the perceived problems of

supply-chain management.

1.2 SUPPLY CHAIN MANAGEMENT DEFINED

Douglas (2000:66) defines supply-chain management as the integration of key business processes from end user through original suppliers that provide products, services, and information which add value for customers and other stakeholders. Benita (1998:281), defines a supply chain as an integrated process in which a number of various business entities (i.e., suppliers, manufactures, distributors, and retailers) work together in an effort to acquire raw materials, convert them into specified final products and deliver these final products to retailers.

All companies participate in a supply chain, from the acquisition of raw materials to delivery of a product to the ultimate customer. How much of this supply-chain needs to be managed depends on several factors including the complexity of the product, the number of available suppliers and the availability of raw materials. Dimensions to be considered include the length of the supply-chain and the number of suppliers and customers at each level. It would be rare for a company to participate in only one supply-chain. For most manufactures, the supply chain looks less like a pipeline or a chain than an uprooted tree, where the branches and roots are the extensive network of customers and suppliers (Douglas, 2000:69).

According to Murray (2008: **Online**), supply chain management operates at three levels; strategic, tactical and operational. At the strategic level, company management makes high level strategic supply chain decisions relevant to the whole organization. Ellram (1991:13) expresses the view that SCM is an integrative approach to dealing with the planning and control of the materials flow from suppliers to end-users. It is an approach aimed at cooperative management and control of distribution channel relationships for the benefit of all parties involved This would maximize efficient use of resources in achieving the supply-chain's customer service goals. New and Payne (1991:60) describe supply chain management as the chain linking each element of the manufacturing and supply process

from raw materials through to the end user, encompassing several organizational boundaries.

Farley (1997:38) supports the views of Douglas (2006:281) and avers that Supply Chain Management (SCM) focuses on how firms utilize their supplier's processes, technology, and capability to enhance competitive advantage. Cooper (1979:93), explains that related to the integrated behaviour, mutual sharing of information amongst supply chain members is required to implement a supply-chain philosophy, especially for the planning and monitoring processes. Lambert (1997:20), supports the view of Cooper (1979:93), and emphasizes frequent information updating among the chain members for effective supply-chain management.

3.3 THE SUPPLY CHAIN DEFINED

According to Sahay (2001:1), (citing Handfield 1999), a supply-chain perspective entails looking at the supply-chain partners. It is important to have a relationship of trust between them, where each party has confidence in the other party's capabilities and actions. The supply-chain has been defined as a network of organizations that are, through upstream and downstream linkages, involved in the different processes and activities that produce value in the form of products and services in the hands of the ultimate customer (Christopher, 1992:1).

According to Cooper, Ellram, Gardner and Hanks (1997:67), all firms participate in a supply chain, from the raw material and, ultimately, to the consumer. The extent to which the supply chain should be managed depends on several factors including the complexity of the product, the number of available suppliers, and the availability of raw materials. La Londe and Masters (1994:36), explain that a supply-chain is a set of firms that pass materials forward. Several independent firms are usually involved in manufacturing a product and placing it in the hands of the end user.

Beamon (1998:281) explains that at its highest level, a supply-chain is comprised of two basic integrated processes namely: the production

planning and the inventory control process as well as the distribution and logistical process. Figure 3.1 depicts graphically the basic framework for the conversion and movement or raw material into final products. The production planning and inventory control process encompasses the manufacturing and storage sub-processes, and their interface(s). More specifically, production planning describes the design and management of the entire manufacturing process including raw material scheduling and acquisition, the manufacturing process design and scheduling as well as material handling design and control.

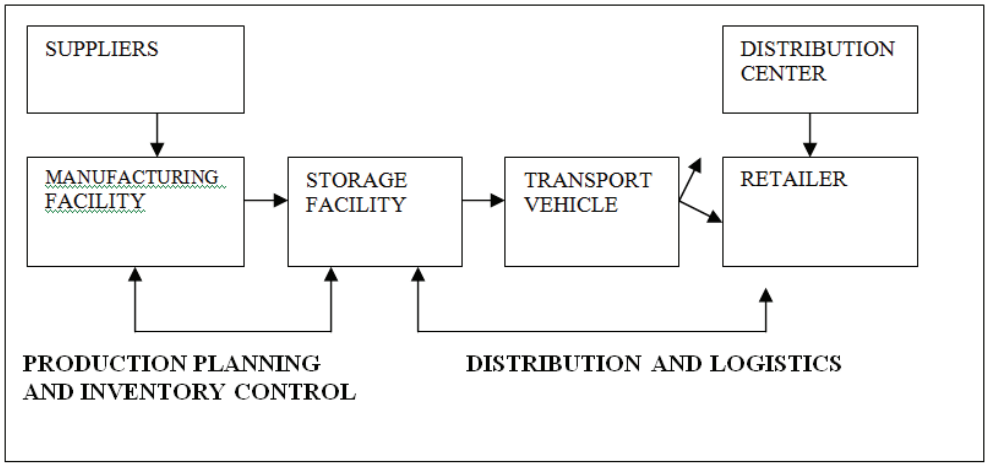


Figure 3.1: The Supply Chain Process (**Source:** Beamon, 1998:3).

Inventory control describes the design and management of storage policies and procedures for raw material, work-in-process inventories, and usually final products. The distribution and logistics process determines how products are retrieved and transported from warehouse to retailers. This includes the management of inventory retrieval, transportation and final product delivery (Benita, 1999:281).

Mentzer, DeWitt, Keebler, Min, Smith,& Zacharia (2001:4), point out that encompassed within the definition of the supply-chain, there are three degrees of supply-chain complexity, namely; a direct supply chain, an extended supply chain, and an ultimate supply chain. A direct supply chain consists of a company, a supplier and a customer involved in the upstream and/or down stream flows of products, services, finances, and/or

information. An extended supply chain includes suppliers of the immediate supplier and customers of the immediate customer, all involved in the upstream and/or downstream flows of products, services, finances and/ or information. An ultimate supply chain includes all the organizations involved in all the upstream and downstream flows of products, services, finances, and information form the ultimate supplier to the ultimate customer. Figure 3.2 graphically depicts the complexity of supply chains.

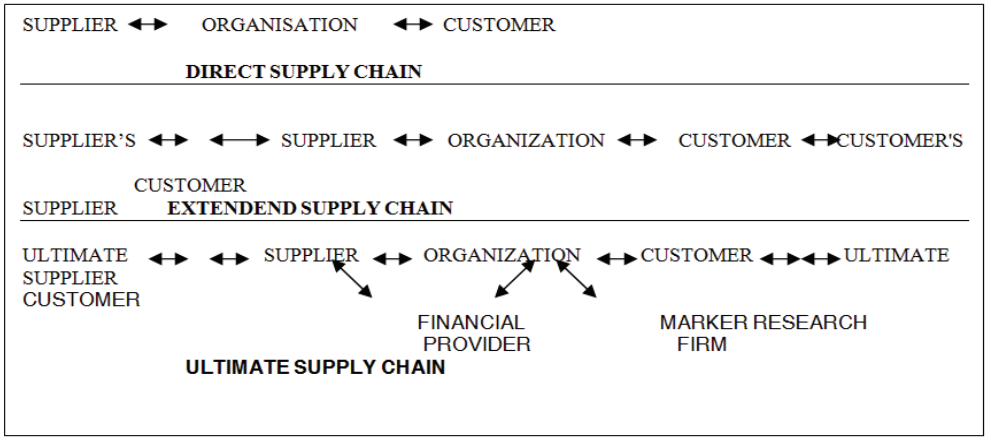


Figure 3.2: Types of Channel Relationships (**Source:** Mentzer *et al*., 2001:5).

3.4 THE BUSINESS VALUE CHAIN

According to Foster (2007:263) in order to understand the supply-chain it is necessary to first discuss the economic concept of the value chain. Porter (1985:33) identified a systematic means of examining all the activities a firm performs and how those activities interact. The value chain is a tool that disaggregates a firm into its core activities to help reduce cost and identify sources of competitiveness. It is part of the value system that consists of a network of value chains. Value chain analysis describes the activities within and around the organization, and relates them to a competitive strength of the organization. Therefore, it evaluates which value each particular activity adds to the organization, products or services. This idea was built upon in the insight that an organization is more than a random compilation of machinery, equipment, people and money. Only if these things are arranged into systems and systematic activities, will it become possible to produce something for which the

customers are willing to pay (Porter, 1985:34).

According to Recklies (2001:**Online**), (citing Porter 1985), companies in the same industry may have similar chains, but the main competitors often differ. Differences amongst competitor's value chains are the key source of the competitive advantage. Gaining and sustaining competitive advantage depends on understanding, not only the firm's value chain but also how the firm fits into the overall value system.

Porter (1985:35), distinguishes between primary activities and supporting activities within the value chain. Primary activities are directly concerned with the creation or delivery of the product or service. They can be grouped into five main areas, namely: inbound logistics, operations, outbound logistics, marketing and sales, and services. Each of these primary activities is linked to supporting activities which help to improve their effectiveness or efficiency. Four main areas of supporting activities are: procurement, technology development, human resources management, and infrastructure (systems for planning, finance, quality, information technology etc.).

The term margin in the value chain model implies that organizations realize a profit margin which depends on their ability to manage the linkages between all the activities in the value chain. In other words, the organization is able to deliver a product or service for which the customer is willing to pay more than the sum of the costs of all activities in the value chain. The linkages are flow of information, goods and services, as well as systems and processes for adjusting activities (Recklies, 2001: **Online**). They are crucial for corporate success.

The research of Klemencic (2006:20) suggests that the value chain can be used as a model for defining the logistics in relation to supply chain management. Logistics are concerned with optimizing material and information flow for a business unit by optimizing logistic processes such as planning, distributing, and warehousing within a single business unit. Supply chain management explores value creation opportunities along the

entire supply chain. Such opportunities start with exploring a customer's needs and the supplier's capabilities, and continue with an evaluation of common improvement opportunities. Those efforts can result in joint product development projects, process integration, joint information sharing, integrated planning, or marketing activities with the aim to improve the overall performance of all parties involved. The diagram below schematically represents the core activities and the supporting activities of the value chain.

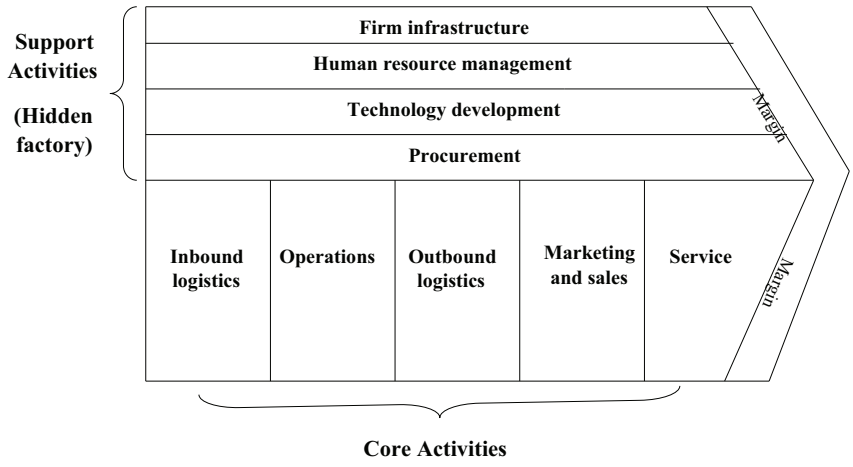


Figure 3.3: The Value Chain (**Source:** Foster, 2004: 267).

1.1.1 **Organization culture conducive to supply chain management**

Tan (2000:44), expresses the view that supply chain management may allow organizations to realize the advantages of backward vertical integration while overcoming its disadvantages. However, certain conditions must be present for successful supply-chain management adoption. According to Farley (1997:38) the single most important

prerequisite for the introduction of supply chain management to an organisation is a change in the corporate culture of all members in the value chain. Forster (2007:241) avers that organizational learning leads to change in organization behaviour in a way that improves performance. This type of learning takes place through a network of interrelated components which include teamwork, strategies, structures, cultures, systems, and their interactions. Grieco (1989:38) points out that a traditional culture which emphasizes seeking good, short-term, company-focused performance appears to be in conflict with the objective of supply chain management.

Looking at the activities along the value chain sequentially, we see that the links in the values chain are really people performing different functions. The chain of customers is revealed when employees who work on the processes view the next step in the chain as their own customer. This means that if an employee is stationed at work station number four in a process at the core of the value chain, the onus is on the employee to make sure that the work that is done is impeccable before being released to the following work station, or their customer. This chain extends from raw materials through supplier firms to the producing firm, with the final link in the chain being the ultimate consumer of the product. The justification is that if each employee along the chain works to satisfy their own internal customer, the final customer will be satisfied, and the services will be free of defects and mistakes (Schonberger 1990:2).

Foster (2007:510), supports the views of Schonberger (1990:2), and states that the building block of all supply chains and quality systems is people. People represent the core of a firm's capabilities because they work on systems. Thus for a supply chain to function effectively, people who work on processes must understand that they are integral to that system.

1.4 **EVOLUTION OF SUPPLY CHAIN MANAGEMENT**

In the 1950s and 1960s, most manufacturers emphasized mass

production to minimize unit production cost as their primary operational strategy, with little product or process flexibility. New product development was slow and relied exclusively on in-house technology and capacity. 'Bottleneck' operations were cushioned with inventory to maintain a balanced line flow, resulting in huge investment in Work In Process (WIP) inventory. Sharing technology and expertise with customers or suppliers was considered too risky and thus unacceptable and little emphasis appears to have been placed on cooperative and strategic buyer-supplier partnership. The purchasing function was generally regarded as being a service to production and managers paid limited attention to issues concerned with purchasing. (Farmer, 1997) cited by (Tan 2001:39).

According to Tan (2001:39), manufacturing resource planning was introduced in the 1970's and managers realized the impact of WIP on manufacturing cost, quality, new product development and delivery lead time. Manufacturers resorted to new materials management concepts to improve performance within the 'four walls' of the company. The intense global completion in the 1980's forced world-class organizations to offer low cost, high quality and reliable products with greater flexibility. Manufacturers utilized Just-In-Time (JIT) and other management initiatives to improve manufacturing efficiency and cycle time. In the fast 'past-paced' JIT manufacturing environment with little inventory to cushion production or scheduling problems, manufacturers began to realize the potential benefit and importance of strategic and cooperative buyer-supplier relationships. The concept of supply chain management emerged as manufacturers experimented with strategic partnerships involving other immediate suppliers. In addition to the procurement professionals, experts in transport and logistics carried the concept of materials management a step further to incorporate the physical distribution and transportation function, resulting in the integrated logistics concept, know as supply chain management.

Inman and Hubler(1992:1) explain that the evolution of supply chain

management continued into the 1990's as organizations further extended best practice in managing corporate resources to include strategic suppliers and the logistic function into the value chain. Supplier efficiency was broadened to include more sophisticated reconciliation of cost and quality considerations. Instead of duplicating non-value-adding activities, such as receiving inspection, manufacturers trusted suppliers' quality control by purchasing only from a handful of certified suppliers. According to Ragatz, Handfield and Scannell (1997:190), more recently many manufacturers have embraced the concept of supply chain management to improve efficiency across the value chain. Manufacturers, now commonly exploit supplier strengths and technology in support of new product development. Figure 3.2 graphically depicts key facilitating mechanisms in the evolution of supply chain management in a customer-focused corporate vision which drives change throughout a firm's internal and external linkages.

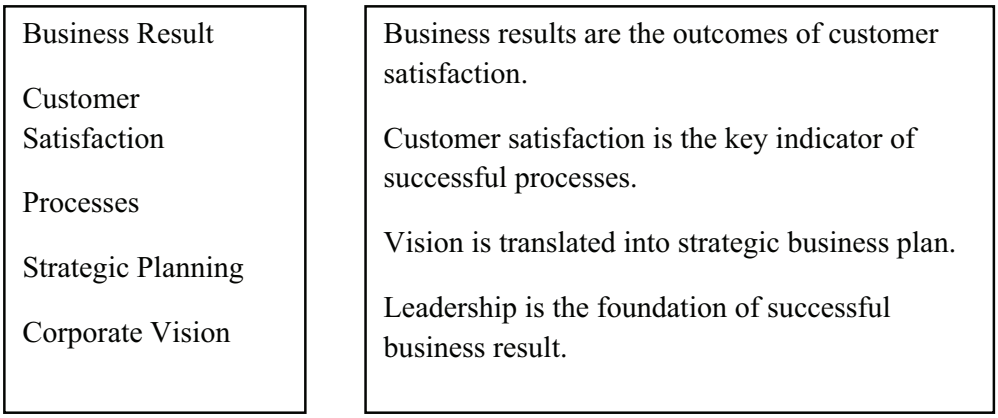


Figure 3.4: Strategic vision of supply chain management (**Source:** Tan, 2001:5).

1.5 THE RELATIONSHIP BETWEEN TQM AND SCM

According to Kanji and Asher (1993:121), for an organization to perform successful blending together of the various management principles such as process management, customer satisfaction, strategic leadership, systems thinking as well as continuous improvement is required. Total Quality Management (TQM), is a holistic and integrated approach

blending together these various principles which are necessary for an organization to achieve business excellence. Youssef, Boyd & Williams (1996:127), support the view of Kanji & Asher (1993:21), and aver that on the other hand, in order to perform well an organization has to rely on the performance of its upstream and downstream organizations, i.e. there is a quality chain or value chain linking these organizations with the customer. This is the Supply Chain Management (SCM), concept which focuses on integrating the different parties in order to meet the needs of the customer. Comparing the views of Youssef *et al*. (1996:127), with those of Kanji & Asher (1992:21), it is clear that partnering is the key element of SCM, while SCM is the horizontal view of the TQM system.

Total Quality Management (TQM), is an approach that seeks to improve quality performance to a level which will meet or exceed customer expectations. This can be achieved by integrating all quality-related functions and processes through the company. TQM includes the overall quality measures used by a company including managing quality design and development, quality control and maintenance, quality improvement, and quality assurance. TQM takes into account all quality measures taken at all levels involving all company employees (Murray 2010: **Online**).

According to Arditi and Gunaydin (1997:237), TQM is a culture and philosophy that must permeate an organization as the method of management. It can thrive only under a senior management that establishes TQM as a top priority. Arditi and Gunaydini (1997:237), further asserts that TQM can thrive only under a senior management that establishes this philosophy as a top priority. This approach is supported by Anderson, Rungtusanatham, Schroeder and Devaraj (1995:26), who identified visionary leadership, internal and external cooperation, process management and employee fulfilment as key constructs of quality management. Moreover they demonstrated that these constructs are drivers of customer satisfaction.

Comparing the views of Anderson and Katz (1998:10), with those of Golahr and Waller (1996:27), similar constructs have been identified and

have been shown to positively affect product quality as well as broader measures of manufacturing performance. Wilson and Collier (2000:31), support the underlying premise of the Malcolm Baldrige National Quality Award in stating that leadership drives the quality management system, which, in turn, drives business performance.

According to Foster (2007:24-25) one way to conceptualize the field of total quality management is known as the three spheres of quality. These spheres are quality control, quality assurance, and quality management, and their function overlaps, as graphically depicted in figure 3.5. The first sphere is quality control. The control process is based on the scientific method which includes the phases of analysis, relation and generalization. In the analysis phase, a process is broken into its fundamental pieces. Relation involves understanding the relationship between the parts. Finally, generalization involves perceiving how interrelationships apply to the larger phenomenon of quality being studied. Activities relating to quality control include the following:

- Monitoring process capability and stability.
- Measuring process performance.
- Reducing process variability.
- Optimising processes to nominal measures.
- Performing acceptance sampling.
- Developing and maintaining control charts.

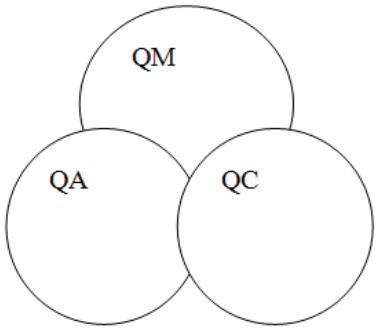


Figure 3.5: The three spheres of quality (Source**:** Forster, 2007:24).

Quality Assurance refers to activities associated with guaranteeing the quality of the product or service. Often, these activities are design related. This view of quality states that the quality control is reactive rather than proactive by detecting quality problems after they occur. Given this, the best way to ensure quality is in the design of products, services and processes. Quality assurance activities include tasks such as:

- Failure mode and effect analysis.
- Concurrent engineering.
- Experimental design.
- Process improvement.
- Design team formation and management.
- Off-line experimentation.
- Reliability/durability testing.

The management processes that overarch and tie together the control and assurance activities make up quality management (Foster, 2007:24-26).

The approach of the relationship between Total Quality Management and Supply-Chain Management is supported by Kannan and Tan (2005:158), who explains that all TQM factors correlate significantly with supply-chain management, and all SCM practises correlate with the design of TQM. These results are an indication of the importance to a quality strategy of effective supply base management and of ensuring that the supply chain is responding quickly to the customer's defined needs.

1.6 SUPPLY CHAIN MANAGEMENT AS A MANAGEMENT PHILOSOPHY

As a philosophy, Supply Chain management takes a systematic approach to viewing the supply chain as a single entity, rather than a set of fragmented parts, each part performing its own function (Ellram & Cooper,

1990:7). This means that the partnership concept is extended into a multi-firm effort to manage the flow of members was well as the overall performance of the supply chain.

(Copper, Douglas & Pagh 1997:5), Ross (1998:1), aver that supply chain management as a philosophy seeks synchronization and convergence of intra-firm and inter-firm operational and strategic capabilities into a unified, compelling market place force. According to Cooper *et al.* (1997:10), supply chain management as a philosophy has the following characteristics:

- A systematic approach to viewing the supply chain as a whole and managing the total flow from the supplier to the ultimate customer.
- A strategic orientation toward cooperative efforts to synchronize and converge intra-firm and inter-firm operational and strategic capabilities into a unified whole.
- A customer focus, to create unique and individualized sources of customer value, leading toward customer satisfaction.

1.6.1 SCM as a set of activities to implement a Management Philosophy

Mentzer, De Witt, Keeblerm, Min, Nix, Smith & Zacharia (2001:7), explains that, in adopting a supply chain management philosophy, organizations must establish management practices which permit them to act or behave consistently with the philosophy. Various activities that are needed for successful implementation of the supply chain management philosophy are as follows:

- Integrated behaviour.
- Mutual sharing of information.
- Mutual sharing of risks and rewards.
- Cooperation.

- The same goal and focus on serving customers.
- Integration of processes.
- Partners to build and maintain long term relationships.

To be fully effective in today's competitive environment, firms must expand their integrated behavior to incorporate customers and suppliers. This extension of integrated behaviour, through external integration, is referred to as supply chain management. In this context, the philosophy of supply chain management turns into the implementation of supply chain management: a set of activities that carries out the philosophy (Bowersox & Closs, 1996) cited by (Mentzer *et al.,* 2001:8). Kanji and Wong (1999:1153), avers that members in a supply chain have to work closely together in order to coordinate their work better and reach synergy. Therefore it is necessary to have an integrated structure among different supply chain members so that resources can be shared in order to carry out the operation smoothly.

Blancero and Ellram (1997:616), are of the opinion that in order to have best performance from utilizing the resources of a company's supplier, the operation between them should be seamless and smooth, which also requires an integrated structure or closely linked structure. Mutually sharing information among supply chain members is required to implement a supply chain management philosophy, especially for planning and monitoring processes. (Cooper, Lambert & Pahg, 1997:34). Cooper, *et al*. (1997:35), emphasize frequent information updating among the chain members for effective supply chain management. Andel (1997:26), defines information sharing as the willingness to make strategic and tactical data available to the other members of the supply chain. Open sharing of information such as inventory levels, forecasts, sales promotion strategies and marketing strategies reduces the uncertainty between supply partners and results in enhanced performance. Effective supply chain management also requires mutually sharing risks and rewards that yield a competitive advantage (Cooper and Ellram, 1993:13). According to Cooper *et al.*

(1997:6), risk and reward sharing should happen over the long term and is important for the long-term focus and cooperation among the supply chain members.

Cooperation among the supply chain members is required for effective supply chain management (Ellram & Cooper, 1990) cited by (Mentzer *et al.,* 2001:8). According to Jackson (1993:14), supply chain members in a co-operative mode are often more willing to engage in joint efforts in order to find the optimal solution to a problem. For examples supply-chain members may form a joint task force to address specific problems or design engineers from both firms may work as a team on a new product. Such joint activities represent substantial investments in the relationship between supply chain members.

The supply chain members should all have the goal of satisfying the final customers' requirements. This goal will direct the creation of strategies and plans, as well as the operation and performances of different supply chain members. In order to meet the needs of the ultimate customers, the needs of different supply chain members should also be satisfied. The different supply chain members are, in fact, operating as internal customers and suppliers within the supply chain (Kanji & Wong, 1999:1153). According to Forster (2007:138), customer driven quality represents a proactive approach to satisfy customer needs that is based on gathering data about the customers to learn their needs and preferences and then providing products and service that satisfies them. LaLonde and Masters (1994:35), suggest that a supply-chain succeeds if all the members of the supply chain have the same goal and the same focus to serve customers. Establishing the same goal and the same focus among supply-chain members is a form of policy integration. Lassar and Zinn (1995:81), suggest that successful relationships aim to integrate supply-chain policy to avoid redundancy and overlap, while seeking a level of co-operation that allows participants to be more effective at lower cost levels.

The implementation of supply chain management needs the integration

of processes from sourcing, to manufacturing, to distribution across the supply chain. Integration can be accomplished through cross-functional teams, in-plant supplier personnel, and third party service providers. (Cooper *et al*., 1997:67). The research of Stevens (1989:8), suggested that there are four stages of supply chain integration and discussed the planning operation implications of each stage.

- **Stage 1**: Represents the base line case. The supply chain is a function of fragmented operations within the individual company and is characterized by stages inventories, independent and incompatible control systems and procedures, and functional segregation.
- **Stage 2**: Begins to focus on internal integration, characterized by an emphasis on cost reduction rather than performance improvement, buffer inventory, evaluation of internal trade-offs, and reactive customer service.
- **Stage 3**: Reaches towards internal corporate integration and is characterized by full visibility of purchasing through distribution, medium-term planning, tactical rather than strategic focus, emphasis on efficiency, extended use of electronics support for linkages and a continued reactive approach to customers.
- **Stage 4**: achieves supply chain integration by extending the scope of integration outside the company to embrace suppliers and customers.

1.6.2 SCM as a set of Management Processes

According to Lambert, Stock & Elram (1998:**Chapter 14**), to successfully implement SCM, all firms within a supply-chain must overcome their own functional silos and adopt a process approach. Thus all the functions within a supply chain are reorganized as key processes. The critical difference between the traditional functions and the process approach are that the focus of every process is on meeting the customer's requirements

and that the firm is organized around these processes. Davenport (1993:1), defines process as a structured and measured set of activities designed to produce specific output for a particular customer or market. This view is supported by LaLonde (1994:50), who proposes that supply-chain management is the process of managing relationships, information and materials flow across enterprise borders to deliver enhanced customer service and economic value through synchronized management of the flow of materials.

The research of Klemencic (2006:20) returned that implementation of supply chain management as a set of management processes is increasingly being recognized as the integration of key business processes across the supply chain. Ross and David (1998:1), defines supply chain process as the actual physical business function, institutions and operations that characterize the way a particular supply chain moves goods and services to market through the supplier pipeline. In other words, a process is a specific ordering of work activities across time and place, with a beginning and end, clearly identified inputs and outputs, and a structure for action. Lambert, Stock and Ellram (1998:1), propose that to successfully implement supply chain management, all firms within a supply chain must overcome their functional silos and adopt a process approach. Thus, all the functions within a supply chain are reorganized as key processes.

1.7 **THE PARTNERING CONCEPT**

Kanchan (2004:42), believes that global competition in supply chains has grown so intense that recent research on mutual beneficial supplier relationships has increased significantly. The research of Wong (2002:567-580), analyzed survey information from 139 supply chain managers and concluded that partnering with suppliers can help companies achieve improved customer satisfaction. Lee (2007:444-452),

considered survey information from 122 senior supply chain managers from the United States, and then conducted a multivariate regression analysis of determinant characteristics to find links between supply chains stakeholders, such as suppliers employees and buyers. Veludeo (2006:21), proposed a framework for partnering factors with buyer/supplier transaction based on a case study done of a single business.

According to Chen (2009: **Online**), the role of the supplier constitutes a crucial relationship in the value chain in QMS. He continues to state that the ISO 9001:2008 Standard defines this relationship under clause 7.4, 'Purchasing'. In dealing with suppliers, the standard is focused on the control of the purchased items and the reliability and capability of the supplier in relation to the requirements.

The extent of dependencies and the need for mutually beneficial relationships depend on the way business is conducted. At one extreme, purchasing control could be the mere issuing of a purchase order and the receiving of the items on delivery to a highly complex working relationship of a sub-contractor working at the organization's worksite over and extended period of time. What this means is that the degree of working together and control of the inputs-materials, services, information etc can range from a simple, over-the telephone relationship to a very complex team relationship. The first element of control is to ensure that the supplier has the capability to supply and deliver to the specified customer requirements of the organization. This calls for the assessment of the supplier or the subcontractor on many criteria, including the relevant experience for the job, the performance of the supplier against other competing suppliers, the product quality, price, delivery performance, the ability to respond to problems, the management and financial capability, the history of performance, it's logistic capability, it's awareness of, and compliance with statutory and regulatory requirements, it's response inquires, quotation and tendering, amongst others (Olhager, 2006: **Chapter 8**).

The approach of sustaining company performance through partnering

with suppliers is supported by Wong (2002:567-580), who states that companies are expected to achieve a high level of customer satisfaction in order to outperform their competitors. He states that many companies focus on how they themselves can do better to meet the customer's needs, however they may not be aware that they can best satisfy their customer needs by teaming up with suppliers.

1.8 SUPPLY CHAIN ORIENTATION

According to Mentzer *et al.* (2002:15), the idea of the co-ordination of a supply chain is, from an overall perspective defined above, as a management philosophy, is more accurately called supply chain orientation. Lambert and Cooper (2000:63), explain that when determining the network structure, it is necessary to identify who the members of the supply chain are. According to Copper, Ellram, Gardner and Hanks (1997:670), the members of a supply chain include all companies/ organizations with whom the focal company interacts directly or indirectly through suppliers or customers, from its point of origin to point of consumption.

The research of Lambert (1998:72), suggests that the first step towards integrated SCM is to identify the customers or customer groups which the organization targets as critical to its business mission. There are two parties in a supply chain: supplier and organization. The organization provides information on its requirement to the supplier and the supplier produces goods or services to meet the organization's needs. The organization should try to develop good relationships and close operation with the supplier, for it can meet the needs of its customers better with supplier's support.

These two parties in the supply-chain have both internal and external customers. The internal customers of the supplier are mainly its employees and the external suppliers refer to organizations, governments etc that purchase goods or services from it. Regarding the organization, its internal customers are its employees and its external customers are

organizations, governments and individuals that buy its goods or services. In order to meet the needs of the ultimate customer of a supply-chain, both the needs of the internal customer and external customers of the supplier and the organization should be satisfied. For instance, when the supplier does not meet the needs of its employees, which may be appropriate rewards, training, technical support, etc. the quality of their output will be endangered and hence organizations obtaining supplies from the supplier will not be satisfied if they receive defective goods. If the organization includes inferior quality raw material from its supplier to its products, without knowing it, and later sells the finished product to its customers, then the customer will be dissatisfied when using the products. Hence, it is believed that a supplier having dissatisfied internal customers leads to the dissatisfaction of external customers. It is believed that a supplier who has satisfied internal customers should be able to best serve its external customers. Furthermore, if it is satisfied with the relationship and operations with its external customers the organisation will be even more committed to serving them better in the future. Therefore, a good SCM model, as graphically depicted in figure 3.6 below, should simultaneously take into consideration the supplier's satisfaction with its relationships and operations with the organization, the organization's satisfaction with the contribution of the supplier, the competitive position of the organization and the satisfaction of its external customers (Kanji and Wong, 1999:1149).

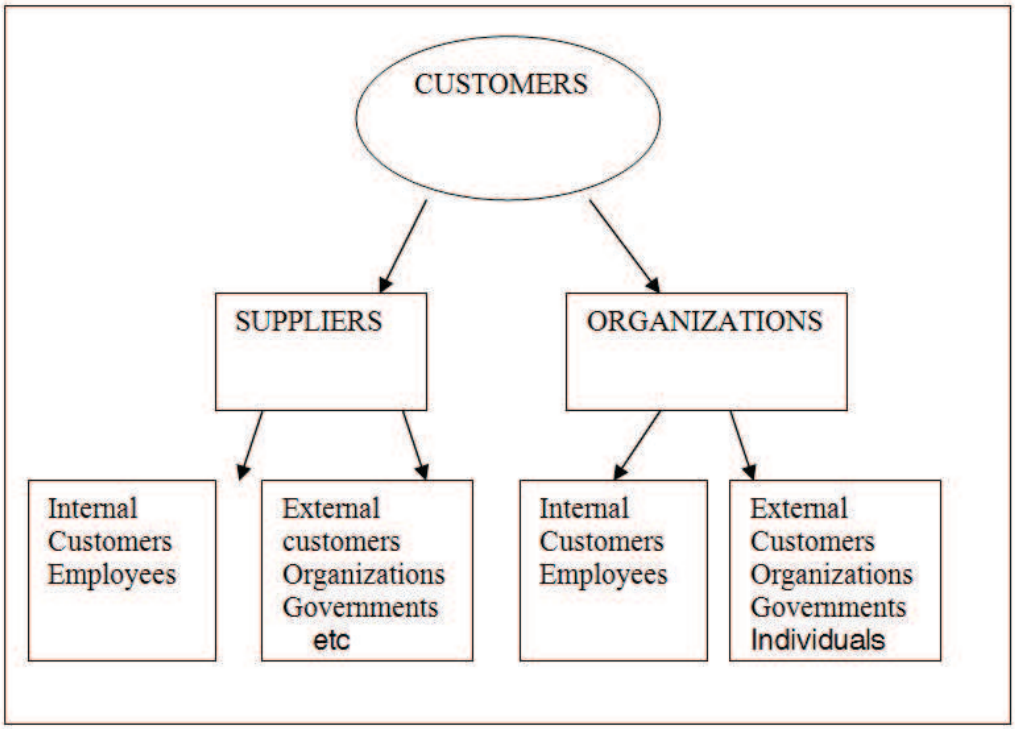


Figure 3.6: Customers of a Supply Chain (**Source**: Kanji & Wong), 1999:1150).

1.9 QUALITY AND PARTNERING ATTRIBUTES

According to Kanchan (2004:42), in a supply-chain management process, one should select quality and partnering attributes that are readily definable in terms of some general performance indicators for the organization. Ansari (1990:405) is of the view that effective supplier quality management is facilitated by long-term cooperative relationships with as few suppliers as possible to obtain quality materials and/or services.

Maloni and Benton (1997:75) present a set of criteria/parameters that need to be considered in evaluating partnerships, for example, the level of assistance in mutual problem solving supports the buyer-supplier partnership development. This also shows the extent of partnership that exists between them. These measures are summarized as follows:

- Level and degree of information sharing.
- Buyer-vendor cost saving initiatives.

- Extent of mutual co-operation leading to improved quality.
- The entity and stage at which the supplier is involved.
- Extent of mutual assistance in problem solving efforts.

According to Cooper, Ellram, Gardner and Hanks (1997:67), the key is to sort out some basis for determining which members are critical to the success of the company and the supply chain and should thus be allocated managerial attention and resources. In contrast, supporting members are companies that simply provide resources, knowledge, utilities or assets for primary members of the supply chain. For example, supporting companies include those that lease trucks to the manufacturer; banks that lend money to a retailer, the owner of the building that provides warehouse space, or companies that supply production equipment, print marketing brochures or provide temporary secretarial assistance.

Christy and Grout (1994:9) developed an economic, game-theoretical framework for modeling the buyer-supplier relationship in a supply chain. The basis of this work is a 2 x 2 supply chain “relationship matrix”, which may be used to identify the conditions under which each type of relationship is desired. These conditions range from high to low process specificity, and from high to low product specificity.

Emerson (1962:27), states that the perception of dependence is an important dimension of buyer-seller relationships. Dependence exists when one party does not entirely control all of the conditions necessary for achievement of an action, or a desired outcome, performed by the other party. Feffer and Salancik (1978:10), explains that resource-dependence theory specifies conditions under which one social unit is able to obtain compliance with its demands when dependence between the parties is present. Three critical factors that affect the degree of perceived dependence include the importance of the resources, the extent to which the interest group has discretion over them, and the extent to which there are limited alternatives (Feffer & Salancik, 1978:10).

1.10 SUPPLY CHAIN PERFORMANCE MEASURES

An important component in supply chain design and analysis is the establishment of appropriate performance measures. A performance measure or a set of performance measures is used to determine the efficiency and effectiveness of an existing system, or to compare competing alternative systems. Performance measures are also used to design a proposed system by determining the values of the decision variables that yield the most desirable level(s) of performance. Available literature identifies a number of performance measures as important to the evaluation of supply chain effectiveness and efficiency (Benita, 1998:281). According to Corbett (1992:283), performance measures must not only correspond to the organization's strategic goals, but must also correspond to the customer's goals and values since strategic goals generally address meeting customer requirements.

The level of supply chain maturity drives both supply-chain and financial performance. However, companies must select supply-chain practices that are most closely aligned with their supply-chain strategy and overall business. Blind adoption of generic supply-chain best practices may allow a company to catch up with its industry peers, however it will not create a basis for competitive advantage. The question is how to develop necessary supply performance measures and select the critical best practices; those that will drive a company's strategic objectives forward (Cohen *et al*., 2004:12).

1.10.1 Qualitative Performance Measures

Qualitative performance measures are those for which there is no single direct numerical measurement, although some aspects of them may be quantified. These objectives have been identified as important but are not used in the models reviewed here:

- Customer Satisfaction: The degree to which customers are

satisfied with the product and service received, and many apply to internal customers or external customers. Customer satisfaction is comprised of three elements.

- Pre-Transaction Satisfaction: satisfaction associated with service elements occurring prior to product purchase.
- Transaction Satisfaction: satisfaction associated with service elements directly involved in the physical distribution of products.
- Post-Transaction Satisfaction: satisfaction associated with support provided for products while in use (Benita,1998:294).

1.10.2 Partnerships and related metrics

According to Gunasekaran and Tirtirouglu (2001:75), a set of criteria or parameters needs to be considered in evaluation partnerships. For example, the level of assistance in mutual problem solving supports the collaboration and enhances the performance of supply chains. The following are some of the parameters that measure the level of partnerships:

- Level and degree of information sharing.
- Buyer-vendor cost saving initiatives.
- Extent of mutual co-operation leading to improved quality.
- The entity and stage at which the supplier is involved.
- Extent of mutual assistance in problem solving efforts.

1.11 SUPPLIER CERTIFICATION

Another issue that has often been discussed under supply chain performance measures is supplier certification, primarily focused on purchased raw materials, components and final goods (Scheneider, Pruettm & Lagrange, 1995:225). According to Grieco (1989:38), the ultimate goal of supplier certification is quality at the source, to reduce

inventory, non-conformance, communication errors, duplicate testing, receiving inspection, delivery to point of use, cycle time, and the ability to shift focus from process input to output. Inman & Hubler (1992:11), carry the concept of supplier certification further by suggesting that manufacturers should consider certification of the supplier's product as well as its processes to avoid the situation where the supplier's product falls well within customer specifications but fails to perform as required. The literature reveals three basic approaches to certify suppliers, products. A growing number of organizations are adopting standardized systems, primarily based on ISO 9000 or Balbridge Award criteria, in an effort to streamline the certification process (Maass, Brown, & Bossert, 1990:1).

ISO 9000:2000 is the European standard for quality that has been expanded world wide. The focus of this standard is for organizations to document their quality systems in a series of manuals to facilitate trade through supplier conformance. The key characteristics of the Balbrige Award are the focus on business results. The criteria support a company wide alignment of goals and processes (Foster, 2004: 26).

1.12 DETERMINISTIC ANALYTICAL MODELS

Williams (1981:45), presents seven heuristic algorithms for scheduling production and distribution operations in an assembly supply chain network (i.e., each station has, at most, one immediate successor, but any number of immediate predecessors). The objective of each heuristic is to determine minimum-cost production and/or a product distribution schedule that satisfies final product demand. The total cost is a sum of average inventory holding and fixed (ordering, delivery, or set-up) costs. Finally, the performance of each heuristic is compared using a wide range of empirical experiments, and recommendations are finally made on the bases of solution quality and network structure.

Ishii ***et al***. (1988: 25), develops a deterministic model for determining the base stock levels and lead times associated with the lowest cost solution for an integrated supply chain on a finite horizon. The stock levels and

lead times are determined in such a way as to prevent stock out, and to minimize the amount of obsolete (dead) inventory at each stock point. Their model utilizes a pull-type ordering system which is driven by, in this case, linear (and known) demand processes.

Voudouris (1996:50), develops a mathematical model designed to improve efficiency and responsiveness in a supply chain. The model maximizes system flexibility, as measured by the time-based sum of instantaneous differences between the capacities and utilizations of two types of resources: inventory resources and activity resources. Inventory resources are resources directly associated with the amount of inventory held. Activity resources are resources that are required to maintain material flow. The model requires, as input, product-based resource consumption data and bill-of-material information, and generates, as output: (1) a production, shipping and delivery schedule for each product and (2) target inventory levels for each product.

1.13 STOCHASTIC ANALYTICAL MODELS

Cohen and Lee (1988:22), describe a model for establishing a material requirements policy for all materials at every stage in the supply chain production system. In this work, the authors use four different cost-based sub-models (there is one stochastic sub-model for each production stage considered). Each of these sub-models is listed and described below:

- **Material Control:** Establishes material ordering quantities, reorder intervals, and estimated response times for all supply-chain facilities, given lead times, fill rates, bills of material, cost data, and production requirements.
- **Production Control:** Determines production lot sizes and lead times for each product, given material response times.
- **Finished Goods Stockpile (Warehouse):** Determines the economic order size and quantity for each product, using cost data, fill rate objectives, production lead times, and demand data.

- **Distribution:** Establishes inventory ordering policies for each distribution facility, based on transportation time requirements, demand data, cost data, network data and fill rate objectives.

Tzafestas and Kapsiotis (1994:25), utilize a deterministic mathematical programming approach to optimize a supply chain, then uses simulation techniques to analyze a numerical example of their optimization model. In this work, the authors perform the optimization under three different scenarios:

- **Manufacturing Facility Optimization:** Under this scenario, the objective is to minimize the total cost incurred by the manufacturing facility only; the costs experienced by other facilities are ignored.
- **Global Supply Chain Optimization:** This scenario assumes a cooperative relationship among all stages of the supply chain, and therefore minimizes the total operational costs of the chain as a whole.
- **Decentralized Optimization:** This scenario optimizes each of the supply chain components individually, and thus minimizes the cost experienced by each level.

Towill and Del Vecchio (1994:34), consider the application of filter theory and simulation to the study of supply chains. In their research, the authors compare filter characteristics of supply chains to analyse various supply-chain responses to randomness in the demand pattern. These responses are then compared using simulation, in order to specify the minimum safety stock requirements that achieve a particular desired service level.

1.14 THE RESULTS OF SUPPLY-CHAIN MANAGEMENT

The motive behind the formation of a supply-chain arrangement is to increase supply-chain competitive advantage (Monczka,Trent & Handfield, 1998:8). Porter (1985:1), defines two types of competitive advantage: cost leadership and differentiation. According to Giunipero and Brand (1996:29), improving a firm's competitive advantage and profitability

through supply-chain management can be accomplished by enhancing overall customer satisfaction. By the same token, Lalonde (1997:6), proposed that supply-chain management aims at delivering enhanced customer service and economic value through synchronized management of the flow of physical goods and associated information from sourcing to consumption. According to Porter (1985:2), competitive advantage grows fundamentally out of the customer value a firm creates when it aims to establish a profitable and sustainable position against the forces that determine industry competition. Specific objectives to improve profitability, competitive advantage, and customer value/satisfaction of a supply chain, as well as its participants, are suggested by several researchers. For example a key objective of SCM is to lower the costs to provide the necessary level of customer service to a specific segment (Jones and Riley, 1985:33). The other key to improving customer service is through increased stock availability which reduces order cycle time (Cooper and Ellram, 1993:14).

Customer services objectives are also accomplished through a customer-enriched supply system focused on developing innovative solutions and synchronizing the flow of products, services and information to create unique, individualized sources of customer service value (Ross,1998:10). Finally, low cost and differentiated services help build a competitive advantage for the supply-chain, and to this end supply-chain management is concerned with improving both efficiency (i.e., cost reduction) and effectiveness (i.e., customer service) in a strategic context to obtain competitive advantage that ultimately brings profitability(Cooper and Ellram 1993:13).

3.16 KEY ELEMENTS OF SUCCESSFUL SCM

As discussed earlier, certain conditions must be present for a successful supply chain management adoption. Farley (1997:38), avers that the single most important prerequisite is a change in the corporate cultures of all members in the value chain to make it conducive to supply chain management. However organizations must select supply chain practices

that are most closely aligned with their supply chain strategy and overall business.

A traditional culture that emphasizes seeking good, short–term, company-focused performance appears to be in conflict with the objectives of supply-chain management. Supply-chain management focuses on positioning the virtual organization in such a way that all contributors in the value chain benefit. Effective supply-chain management rests on the twin pillars of trust and communication (Grieco, 1989:38). According to Ellram (1994:8), a buyer's market is an ideal situation in which to develop long-term strategies with key suppliers because buyers have the leverage to negotiate cost, quality and certification of processes, acquisition and sharing of new technology and production competences.

Cohen and Rousell (2004:12), developed a framework that takes into account broader perspectives of supply chain-management, extending it beyond process only, those disciplines are:

- To view the supply chain as a strategic asset.
- To develop end to end processes and systems to interface efficiently with the rest of the organisation.
- To design organisation and necessary skills required.
- To build the right collaborative model based on core competencies and selection of the right partners to maximise focus and profitability.
- To use metrics to measure the health of the processes and identify problem areas.

The framework according to Cohen is graphically depicted in figure 3.7 below:

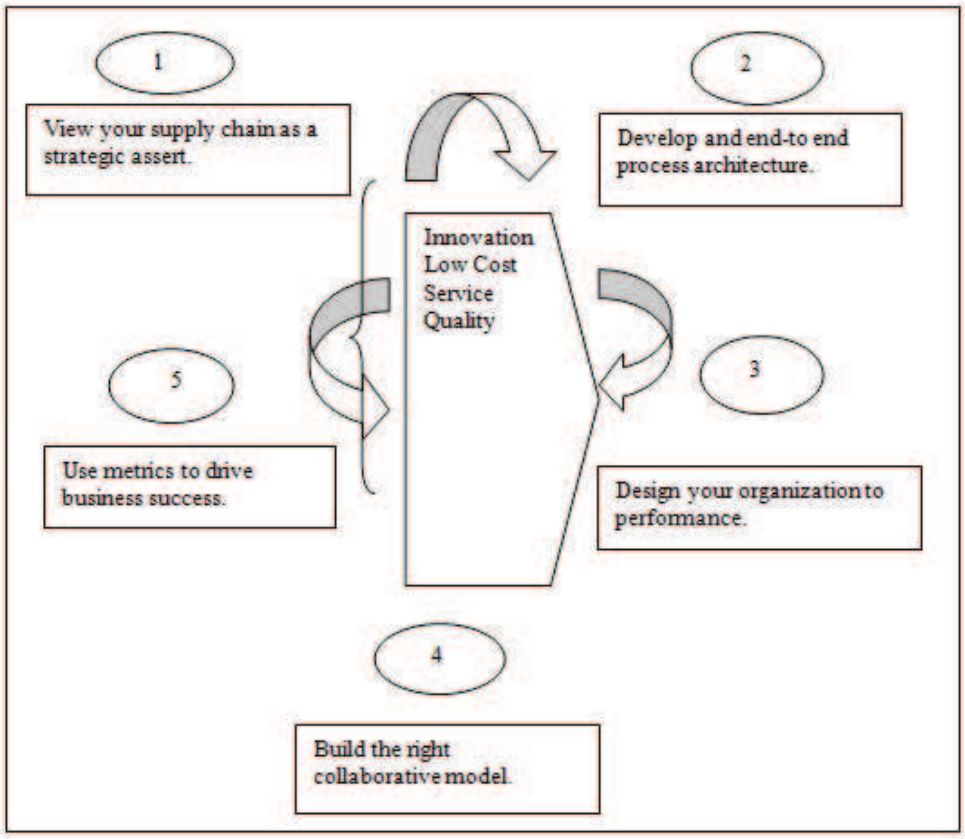


Figure 3.7: Five Disciplines for Strategic Supply Chain Management. (**Source:** Cohen: 2004)

1.1.1 The current issues with the supply of raw materials to Much Asphalt

The asphalt industry, not unlike other industries, is undergoing a major cultural change in technical specifications and quality requirements. The final product, a flow chain consisting of many activities, such as obtaining the right asphalt and aggregate for the job, product delivery, translating laboratory mix designs to field specifications, et cetera (Delmar, 2009: **Online**).

According to Delmar (2009:**Online**), the schematic diagram below illustrates the relationship of the core players in the quality management model in the asphalt industry:

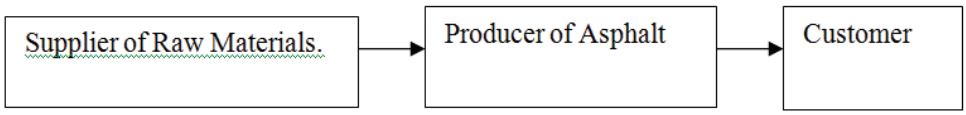


Figure 3.8: The relationship of the core players.(**Source:** Own source)

Stephen (2009:**Online**), found that the aggregates industry has a number of concerns with regard to the use of certain aggregates, including those synthesized from mineral or other resources, in the construction of roads. These issues of concern include aggregate properties, mineralogy, physical and chemical characteristics, degradation, quality control, quality assurance, sources of current and future supply, production, distribution and subsequent uses of aggregates in roads.

Below some of the current issues that are facing the producer of asphalt are revisited:

- **Aggregate Resources:** According to Stephen (2009**:Online**), a continuing concern of the roads and transportation industry is the availability of materials needed to maintain or increase the supply of high-quality, economical aggregates to meet demands. There are two major influences on the availability of these materials- depletion of current production sites and establishment of new sites. Many of the existing sites for aggregate production have been in use for some time and are running out of reserves, because either the quality or type of source material is changing, specifications for aggregate material have changed, or the boundaries of the sites are being approached.

- **Aggregate Production:** Various factors influence the equipment and processes used to produce aggregate. The principal factors are the nature and characteristic of the raw materials, the local market demand for specific aggregate products, and the technology available to produce the desired aggregate from the available raw materials. Because the capital investment in resources and production facilities is large and the return is low, the producer needs to maximize the saleable products produced from any given

resource. Current research into the properties and characteristics that enhance the performance of aggregates in particular is leading to refinements in specification requirements aimed at optimizing performance. For each application area (e.g. in asphalting, base material), there may be one or more sets of requirements (e.g., grading, particle shape, surface texture, durability, abrasion resistance) intended to ensure optimal performance. In attempting to produce materials that meet more exacting requirements, aggregate producers must often confront a growing inventory of material that has no current market and consequently drive up the cost of marketable products. Continuing research is needed to determine the actual benefit to performance and ultimate cost of tighter aggregate specification, and to develop innovative uses for excess by products from the production line (Stephen, (2009)**:** **Online**).

1.1.1.1 Aggregate Testing for Quality and Performance

The issue of aggregate testing is closely related to the production issue discussed above. As knowledge of the mechanistic, as opposed to empirical, behavior of aggregates in various applications increases, there is a concomitant increase in the need to better define and measure the relevant characteristics and properties of the aggregate to ensure quality and predict performance. The industry must also wrestle with moving targets in the areas of both quality and performance, which can vary widely depending on the application, climate, and expected performance involved. The engineer needs sound guidance to help determine the quality and performance tests that must be conducted, as well as the proper acceptance levels in those tests for the particular application (Stephen 2009: **Online**).

Lee (2007: 444), is of the opinion that as the shift toward the end-result (or performance-related) specifications takes place, the relationship amongst the specifying agency, the aggregate supplier, and the customer

will change. The specifying agency will have to cede the traditional role of recipe specification and delegate these decisions to the customer. The customer and the aggregate supplier will have to work together to achieve performance standards. Doing so will require setting performance standards for testing and acceptance that can be applied quickly and economically in both the laboratory and field. It will also be necessary to develop and maintain a keen understanding of the processes in the field that impact on performance so the performance level specified for a particular application will be realistic.

1.16 THE ROLE OF AGGREGATES IN SUPPLY-CHAINS

Forster, (2009: **Online**), explains that aggregates make up the majority of the materials that are used in road construction. Aggregate is therefore likely to remain the principal ingredient used in construction, The challenge for the future is to integrate increasing knowledge of the role played by aggregates in the performance of the end product with approaches to resource management, and to use systems that encourage aggregate suppliers to improve production techniques, and control quality during the production process in order to ensure the required performance.

The research of Prithvi (2009:**Online**), revealed that because aggregates constitute about 94 percent by weight of hot mix asphalt, the properties of coarse and fine aggregates used in the production of hot mix asphalt are crucial to the overall performance of the asphalt on national roads.

The following three asphalt performance procedures were included in his research:

- Permanent Deformation
- Fatigue Cracking
- Potholes

The research team selected a wide range of aggregates in order to determine a wide of test values for the specific properties to be investigated. Road performance history was factored into the selection

process for the toughness, the durability and soundness of the study.

According to Prithvi (2009:**Online**), road pavement distress such as stripping and rutting, can often be traced directly to improper aggregate selection, and his research revealed the following relating to the asphalt performance procedure discussed above.

1.16.1 Applying the principle of Supply Chains Management in the Asphalt industry

Salomons (2002:24), states that new quality requirements have placed tremendous pressure on asphalt manufactures to change and implement quality assurance procedures that will facilitate the product realization clause of the ISO 9001:2008 standard. These quality demands became the new requirements that the asphalt manufactures must translate to the supplier's of raw material (aggregates). These demands are down-loaded from the customer specification and requirements, to the producers of asphalt and the suppliers of the raw materials needed to produce the desired quality asphalt for use in national roads.

According to Lane (2009:**Online**), as the shift towards the end result, or performance related, specifications takes place, the relationship of the customer, supplier and producer of asphalt will change to a new dimension.

Comparing the views of Salomons (2002:24), with those of Lane (2009: **Online**), it is clear that the asphalt industry must consider Clause 7.4 of the ISO 9001 quality standard as it applies to customers, supplier, and producers of product. In this way the core issue of quality will be targeted through the standardization of quality assurance practices.

An organization and its suppliers are interdependent and a mutually beneficial relationship enhances the ability of both to create value (ISO 9004:2000). It is generally necessary to establish documented procedure(s) and the supporting documents to control the effectiveness and efficiency of the purchasing function. Being a key function, quality

objectives must be established and monitored.

According to Benita (1998:281-294), an important component in supply chain design and analysis is the establishment of appropriate performance measures. A performance measure, or a set of performance measures, is used to determine the efficiency and/or effectiveness of an existing system, or to compare competing alternative systems. Performance measure is also used to design proposed systems, by determining the value of the decision variables that yield the most desirable level(s) of performance. Available literature identifies a number of performance measures as important in the evaluation of supply-chain effectiveness and efficiency. These measures may be either qualitative or quantitative

1.16.2 **Qualitative Performance Measures in Asphalt production.**

Qualitative Performance Measures are those measures for which there is no single direct numerical measurement, although some aspects of them may be quantified. (Martin (1994:24)

- Customer Satisfaction: The degree to which customers are satisfied with the product and/ or service received, and may apply to internal customers or external customers. Customer satisfaction is comprised of three elements: Martin (1994:24)
- Pre-Transaction Satisfaction: satisfaction associated with service elements occurring prior to product purchase.
- Transaction Satisfaction: satisfaction associated with service elements directly involved in the physical distribution of product.
- Post- Transaction Satisfaction: satisfaction associated with support provided for products while in use.
- Flexibility: The degree to which the supply chain can respond to random fluctuations in the demand pattern.
- Information and Material Flow Integration: The extent to which all

fluctuation within the supply chain communicates information and transports materials (Johnson, 1995:512).

Effective Risk Management: All of the relationships within the supply chain contain inherent risk. Effective risk management describes the degree to which the effects of these risks are minimized (Nicoll, 1994:594).

1.16.3 **Quantitative Performance Measures in Asphalt Production.**

Quantitative performance measures are those measures that may be directly described numerically. Quantitative supply chain performance measures may be categorized by:

- Objectives that are based directly on cost or profit and
- Objectives that are based on some measure of customer responsiveness (Williams,1981:336-352).

1.16.4 **Measures Based on Cost**

- Cost Minimization: The most widely used objective. Cost is typically minimized for an entire supply chain (total cost), or is minimized for particular business units or stages.
- Sales Maximization*:* Maximize the number of sales dollars or units sold.
- Profit Maximization: Maximize revenues less costs.
- Inventory Investment Minimization*:* Minimize the amount of inventory costs
- Return on Investment Maximization: Maximize the ratio of net profit to capital employed to produce that profit (Williams,1981:336-352).

1.16.5 **Measures Based on Customer Responsiveness**

- Fill Rate Maximization: Maximises the fraction of customer orders filled on time.
- Product Lateness Minimisation: Minimises the amount of time between the promised product delivery date and the actual product delivery date.
- Customer Response Time Minimisation: Minimises the amount of time required from the time an order is placed until the time the order is received by the customer. Usually refers to external customers only.
- Lead Time Minimisation: Minimises the amount of time required from the time a product has begun its manufacture until the time it is completely processed.
- Function Duplication Minimisation: Minimises the number of business functions that are provided by more than one business entity (Nicoll, 1994: 590-594).

1.17 SUPPLY CHAIN MANAGEMENT: STRATEGIES

To understand the supply chain, the economic concepts of the value chain cannot be ignored. Porter (1995:20), identified a systematic means of examining all the activities a firm performs and how those activities interact. The value chain is a tool that divides a firm into its core activities to help reduce costs and identify sources of competitiveness. It is part of the value system that consists of a network of value chains.

When companies view supply chain as a strategic asset, supply-chain strategy is part of the overall business strategy, designed around a well-defined basis of competition (innovation, cost, service quality). It is integrated with marketing strategy and with customer needs, product strategy and power position. On the other hand, supply-chain strategy must adapt as market conditions and competitive advantages change. In that way, supply-chain strategy designs a unique supply-chain

configuration that drives strategic objectives forward. A supply-chain strategy consists of five building blocks (Cohen, 2004:10).

- Manufacturing strategy
- Outsourcing strategy
- Channel strategy
- Customer service strategy
- Asset network

1.17.1 **Manufacturing Strategy**

According to Klemencic (2006:33), manufacturing strategy means deciding how to produce products or services. Will products be made to stock, to orders, or to some combination of both? Will some of the manufacturing be outsourced or production moved to low cost regions? Will final configuration be completed outside the manufacturing plant or closer to the plant? Cohen (2004:12), states that changing the manufacturing strategy can be a key source of competitive advantage. Sometimes, it can be an advantage to choose different manufacturing strategies for different products. The key drivers for manufacturing strategy are product life-cycle, demand changes, and the number of product variants.

1.17.2 **Channel Strategy**

Anderson (1999:5) maintains that channel strategies define how products or services will be delivered to buyers or end users. It therefore needs to answer questions such as: Will the product be sold via distributors? Which market segments will be served? Which channel will be used? Which are the priorities in case of material shortage? Will dedicated inventories for strategic partners be kept? The decision regarding the company's asset and cost performance must be part of the channel strategy, including pricing, promotions, financing and others.

The decisions regarding outsourcing are an important source of flexibility.

Through outsourcing, the company can focus on core competences and enhance its competitive positioning. Outsourcing of activities with low strategic importance, or activities that outsourcing partners can do better, faster or cheaper are areas to be considered. If the product processes, or technology are the source of a company's differentiation, outsourcing should not be considered. Nevertheless, before the final decision is made, risk and strategic implication should be evaluated (Anderson, 1999:20).

3.18.3 Customer service strategy

Klemencic (2006:34), believes that customer service strategy should be based two things: the overall customer volume and profitability, and an understanding of what the customer really wants. Should the company aim for different service levels depending on what the customer wants? Bolton and Lemon (1999:171), found that perceived value and overall customer satisfaction are closely related, and Rachel(1996:57) states that customers are loyal because of the value created for them. A customer-centric organisation is one in which all employees consider the effect of their plans and actions from a customer perspective. It requires that employees consider their plans or actions, not just from the viewpoint of their own department, product or service, but also from the perspective of all the products and services offered by the company.

Figure 3.7 graphically depicts the competitive framework in supply-chain management.

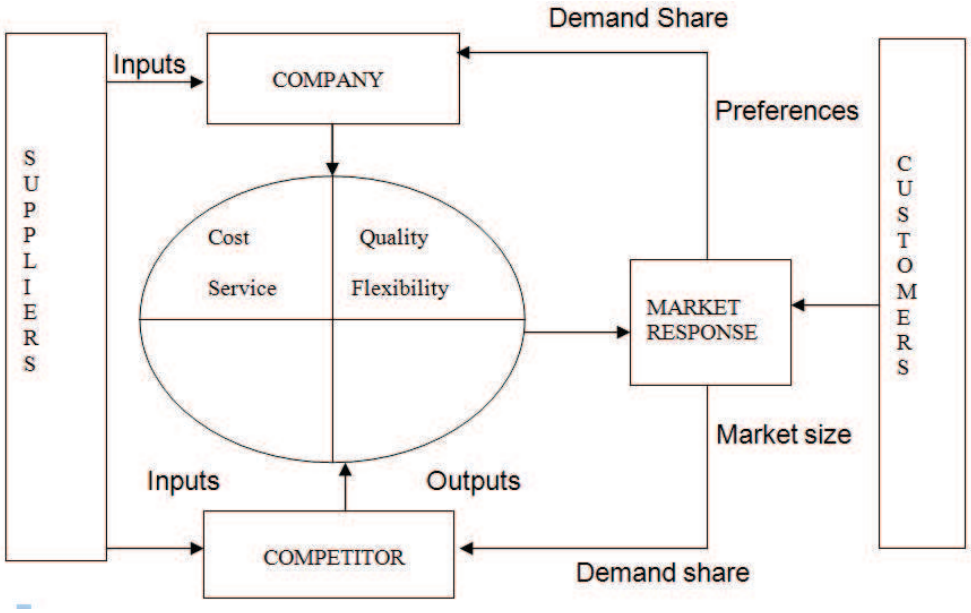


Figure 3.9: Competitive Framework in the Supply Chain (**Source:** Ernest 2002:120).

No matter what strategy a company has chosen for the supply chain the above model is a framework for the implementation of that strategy. Cohen (2004:50), describes the four main components of the supply-chain processes as:

- A description of supply chain processes and how they relate.
- A view of the interactions between the supply chain processes and the rest of the core enterprise processes.
- A description of the IT applications required to support the supply chain processes, including the data and performance indicators needed for execution and control.
- A description of how the applications will be integrated including specification of data and frequency of communications.

According to Cohen (2004:51), effective supply chain processes in the company should do the following:

- Fit in to the supply chain strategy and support the ethos of completion.

- Ensure end-to-end management by having the same vision and set of shared objectives.
- Be simple and easy to understand and reduce complexity, which adds to cost and decreased manageability.
- Have an adequate level of integrity in terms of integrated applications, accurate data and documented processes.

The company must choose a 'state of the art, practice that is an appropriate strategy for improving the basis of competition and avoiding the trap of choosing cost-cutting practices that provide marginal support.

According to Forster (2007:130), complex supply chains are difficult to understand, improve and manage. Therefore the supply-chain should be simple so as to overcome problems. Drivers of complexity are:

- Supply chain configuration.
- Products and services proliferation.
- Process and information systems inconsistency.
- Over automation

To simplify these processes the company should according to Cohen (2004:63),

- Set the rules
- Measure and manage products, service complexity, and related costs.
- Define and adhere to standards for components and materials.
- Review the physical supply chain configuration (warehouse, order desks, factories, supplier location, distribution centers) regularly and simplify it where possible

1.18 **CONCLUSION**

The ability to produce a quality product depends to a large extent on

the relationship between the parties involved in the processes, namely: the supplier, the manufacturer and the customer. The most salient feature of this literature review has been to indicate a supply-chain management approach that drives quality, and tracks the effectiveness of an organization's total quality management system. The three closely related elements crucial to managing a supply-chain were cited by different authors as:

- Supply Chain network structure.
- Supply Chain business processes.
- Management of the processes.

Effective integration of suppliers into product development initiatives is also a key factor for manufactures in achieving the improvements necessary to remain competitive. It has been argued in the literature review by different authors that in order to remain effective in a fast paced market a high degree of information sharing and co-ordination between partners in a supply chain is of vital importance. In Chapter 4, the critical aspects pertaining to data collection design and methodology in order to connect the empirical data that relates to the research question will be elaborated upon,.

CHAPTER 4:

THE RESEARCH DESIGN AND METHODOLOGY

1.1 INTRODUCTION

According to White (2004:2), research is a systematic process of collecting and logically analyzing information or data for a specific purpose. Yin (1994:19), defines a research design as the logical sequence that connects the empirical data to a study's initial research question and ultimately, to its conclusion. The research design and methodology for this research falls within the ambit of action research. Action research is defined by Collis and Hussey (2003:66-77), as a type of applied research designed to find an effective way of bringing about a conscious change in

a partly controlled environment.

1.2 THE SURVEY ENVIRONMENT

Much Asphalt (Pty) Ltd is the organization in which the research is conducted. The upstream processes, consists of the suppliers of raw material, and the downstream processes consists of the customer or the contractors. The supply chain processes, which will serve as the focal point of the research environment, are as follows:

- Receiving of orders from customers (Contract Review).
- Purchasing Management.
- Process Control.
- Inspection Control.
- Quality Control.

1.3 AIM OF THIS CHAPTER

The aim of this chapter and the survey contained in it is to determine the key strategies or approaches that can be adopted to improve the operational effectiveness and reliability between partners of the supply chain in the manufacturing of asphalt, thereby increasing the reliability of national roads and enhancing customer satisfaction. The ultimate objective is to solve the research problem as defined in Chapter 1, and reads as follows:

"Lack of efficiency in coordinating the processes across the supply chain in the manufacturing of asphalt, culminates in poor road surface quality, calling for sustained renewal thereof at high cost."

1.4 CHOICE OF SAMPLING METHOD

According to Emory and Cooper (1995:228), there are two methods of survey sampling namely;

- The conventional sample, which is a way of choosing a limited number of elements which are smaller than the chosen population but are representative of the entire population.
- The census approach, where every element within the population is sampled.

A 'sample' is made up of members of a population (the target population), the latter referring to a body of people or to any other collection of items under consideration for the purpose of research. There are three methods of non-probability sampling, convenience sampling, quota sampling and purposive sampling. Purpose sampling as the name suggests, is used for a particular purpose, for instance choosing people who are 'typical' of a group, or those who represent diverse perspectives on an issue (Hussey & Collis, 2003:155-160).

1.5 THE TARGET POPULATION

The target population for this research consists of the road contractors, the suppliers of raw materials as well as the producers of asphalt. The various functional areas, which will serve as the purposive sampling approach, include the following:

- Collaboration with external partners.
- View of the Supply Chain.
- Process infrastructure.
- Integrated planning processes.
- Measurement systems.

The road contractor, the suppliers of raw materials and the producer of asphalt represents a set of three organizations that are directly involved in the flow of products and services to the ultimate customer. For this survey 10 employees from each organization represented in this supply chain are selected from a population of 100 employees in the integrated supply

chain.

4.6 DATA COLLECTION

The following data collection methodologies will be employed within the ambit of this research: Focus groups, in-depth surveys, and questionnaires. In addition to selecting a data collection methodology, the methodology selected will be described comprehensively and expanded upon in terms of the following criteria, namely the 'unit of analysis', the 'variables' and the selection of a 'sample and a sample type.'

1.1.1 Focus groups

According to Barnett (2008: **Online**), a focus group is a group interview of approximately six to twelve people who share similar characteristics or common interests. A facilitator guides the group based on a predetermined set of topics. The facilitator creates an environment that encourages participants to share their perceptions and point of views. Focus groups are a qualitative data collection method, meaning that the data is descriptive and cannot be measured numerically.

Within the ambit of this research, data collection methods will be employed for gathering a subjective perspective around the current performance of the existing supply chain. The unit of analysis will be a focus on the impact of mutual beneficial supplier relationships. The variables around mutual beneficial supplier relationships are output performance measures that not only correspond to the organization's goals, but also to those of the supplier to meet the customer's goals values and requirements. The selection of a sample and a sample type follows once the researcher has decided on the various sources from which the relevant information pertaining to the research will be gathered. Individuals forming the focus groups will be made up of those who represent diverse perspectives on the research issue at hand.

1.1.2 In-depth surveys

Rita (1999:1), explains that in-depth surveys are surveys that are used

to elicit information in order to achieve a holistic understanding of the interviewee's point of view or situation. It can also be used to explore interesting areas for further investigations. This type of survey involves asking open-ended questions, and probing wherever necessary to obtain data deemed useful by the researcher. In-depth survey will be employed as another data collection method for this research since an interpretative approach (qualitative in nature) is adopted for the research. The central concern of this approach is to discover key strategies or approaches that can be adopted to improve operational effectiveness, reliability and trust between partners in a supply chain.

1.1.3 **Questionnaires**

In contrast with the interviews, in which the enumerator poses questions directly, questionnaires will be handed out or sent to different sectors involved in the research. Remenyi, *et al*. (2002:290) defines questionnaires as "… the collection, normally by means of a questionnaire, of a large quantity of evidence usually numeric, or evidence that will be converted to numbers". The sample or sample type will be made up of participants in the supply-chain, such as the manufacturing of asphalt, the production of raw materials, and constructing the road. Sampling will be conducted from a population size of around 100 participants, of whom 75 participants will participate in the research.

1.1.4 **Measuring Scales**

This survey will be based on Likert scales. According to Anorld, Prichard and MacCroskey (2010: **Online**), the original scale of this type was developed by Renisis Likert and it is a technique for the measurement of attitudes. A Likert type scale consists of a series of declarative statements. The subject is asked to indicate whether a respondent agrees or disagrees with the statement. The following serves and an example of a Likert scale:

- Strongly agree.
- Agree.

- Undecided.
- Disagree.
- Strongly disagree.

1.6 THE DEMAND FOR A QUALITATIVE RESEARCH STRATEGY

According to Black (1994:48), a finding or a result is more likely to be accepted as a fact if it is quantified (expressed in numbers) than if it is not. Denkin and Lincolin (1994:1) are of the view that researchers who use qualitative methods seek a deeper truth. They aim to 'study effects in their natural setting, attempt to make sense of, or interpret, phenomena in terms of the meanings people give to them'. This view is supported by Black (1994:48), who points out that qualitative methods use a holistic perspective which preserves the complexities of human behaviour. Jones, Murphy and Stacy (1995:104), summarize qualitative strategy as follows:

- Qualitative methods aim to make sense of, interpret, phenomena in terms of the meaning people bring to them.
- Qualitative research may define preliminary questions which can then be addressed in quantitative studies.
- A good qualitative study will address a clinical problem through a clearly formulated question and using more than one research method.
- Analysis of qualitative data can and should be done using explicit, systematic and reproducible methods.

1.7 SURVEY DESIGN

The survey mostly commonly used in business and management is that of the 'descriptive survey'. According to Leedy and Ormrod (2001:196), …' a survey is simple in design': The researcher poses a series of questions to willing participants; summarizes their responses with percentages, frequency counts, or more sophisticated statistical indexes; and then draws inferences about a particular population from the responses of the

sample.

According to Hussey and Hussey (1997), in order for research to be conducted in an efficient manner and make the best opportunities of resources available, it must be organized. A survey should be designed with the following stages:

- **Stage one:** Indentify the topic and set some objectives
- **Stage two:** Pilot a questionnaire to find out what people know and what they see as important issues.
- **Stage three:** List areas of information needs and refine objectives.
- **Stage four:** Review the response to the pilot.
- **Stage five:** Finalize the objectives.
- **Stage six:** Construct the questionnaire.
- **Stage seven:** Re-pilot questionnaire.
- **Stage eight:** Finalise the questionnaire.
- **Stage nine:** Code the questionnaire.

Within the process of survey design, the researcher has identified the following variables as being pertinent to the research:

- Dependent variables.
- Controlled variables.
- Uncontrolled variables.

The statements within the survey have been designed with the following principle in mind:

- Avoidance of double-barreled statements.
- Avoidance of double-negative statements.
- Avoidance of prestige bias.

- Avoidance of leading statements.
- Avoidance of assumptions to prior knowledge.

The survey employed for this research falls within the ambit of a descriptive survey. Furthermore, in order to ascertain that the survey addresses the primary theme of the dissertation the researcher collected primary data by means of interviews, an approach which leads to acceptable data collection methods as proposed (Emroy and Cooper, 1995:4).

1.8 RESPONDED BRIEFING

All the respondents to the surveys were briefed regarding the content of the questionnaire to facilitate common understanding of the research objectives and the problem statement.

1.9 SURVEY QUESTIONS

The survey consists of three sections relevant to the road contractor, the supplier of raw material and the producer of asphalt respectively. The questions are as follows:

- **MANAGING THE SUPPLY CHAIN FUNCTIONS**

Question 1: Managing the processes within the supply chain has a major financial impact on the parties involved in the chain. To what extent do you agree with this statement?

Question 2: Increased reliability between partners in a supply increases trust.
To what extent do you agree with this statement?

Question 3: It is important for members of the supply chain to establish

the same goal and focus on serving the customer.
To what extent do you agree with this statement?

Question 4: There are cooperative arrangements that tie the contractor, the supplier and the producer of asphalt to each other and in that way their success to the supply chain as a whole.
To what extent do you agree with this statement?

Question 5: The supply chain partners must work together towards improving the internal processes that will lead to improvement of the service level agreements.
To what extent do you agree with this statement?

- **CONTINUAL IMPROVEMENT OF INTERNAL PROCESSES**

Question 6: It is important to improve the internal processes of the company before successful supply chain processes can be improved.
To what extent do you agree with this statement?

Question 7: Nothing can be improved without the right people with the right competencies.
To what extent do you agree with this statement?

Question 8: People are trained at the jobs that they do and they are competent in doing them.
To what extent do you agree with this statement?

Question 9: There is an effective measurement system that monitors the internal process to ensure conformance to specification.
To what extent do you agree with this statement?

Question 10: The organization is not lacking direction in terms of vision and its performance measurement systems.
To what extent do you agree with this statement?

- **CUSTOMER SATISFACTION**

Question 11: In order to ensure that satisfaction of the ultimate customer

(the road end-user), the customers within the supply chain must be satisfied with the quality of the relative products.
To what extent do you agree with this statement?

Question 12: The quality of asphalt on national roads depends on the quality of raw materials from the supplier of raw materials.
To what extent do you agree with this statement?

Question 13: There are clear ownerships and mechanisms in place to ensure immediate corrective actions in case of product failure.
To what extent do you agree with this statement?

Question 14: The cost of quality should be borne by all members of the supply-chain.
To what extent do you agree with this statement?

Question 15: Customer service strategies are clearly documented and communicated.
To what extent do you agree with this statement?

CHAPTER 5:

DATA COLLECTION AND INTERPRETATION

5.1 INTRODUCTION

Data analysis is “the process of bringing order, structure and meaning to the mass of collected data” (de Vos 2002, 339). The aim of this study is to determine whether lack of efficiency in coordinating the processes across the supply chain in the manufacturing of asphalt, culminates in poor road surface quality, which in turn calls for sustained renewal thereof at high

costs. This chapter discusses the results of the data analysis in the survey conducted by participants in the supply-chain, such as the manufacturer of asphalt, the producer of raw materials and the contractor on the road. The data obtained from the completed questionnaires will be presented and analysed by way of various analytical methods (uni-variate, bi-variate and multivariate) as it comes applicable.

In most social research the analysis entails three major steps performed in the following order:

- Cleaning and organising the information collected which is called the data preparation step,
- Describing the information that was collected (Descriptive Statistics); and
- Testing the assumptions made through hypothesis and modelling (Inferential Statistics).

This information has been analysed by using SAS software. The distribution of biographical variables and statement responses are shown as descriptive statistics and frequency tables displayed in paragraph 5.2. As a measure of central tendency, table 5.4 shows the means and standard deviation of the statement responses of survey respondents.

5.2 ANALYSIS METHOD

The following methods were employed in the ambit of the research:

5.2.1 Validation Survey Results

A descriptive analysis of the survey results returned by the research questionnaire respondents are reflected below. The responses to the questions obtained through the questionnaires are indicated in table format for ease of reference. Each variable is tested to fall within the boundaries.

5.2.2 Data Format

The data was received in questionnaires, which were coded and captured on a database developed on Microsoft Access. These questionnaires are captured twice and the two datasets are compared to make sure that the information was correctly captured. A comparison report is attached in Annexure A. When the database was developed use was made of rules with respect to the questionnaire that set boundaries for the different variables (questions). For instance, in this case, the Likert scale was used and coded as follows:

Completely disagree is coded as 1.

Mostly disagree is coded as 2.

Slightly disagree is codes as 3.

Undecided is coded as 4.

Slightly agree is coded as 5.

Mostly agree is coded as 6.

Completely agree is coded as 7.

A boundary is set on Microsoft Access as less than 8. This means if the number 8 or more than 8 is captured an error will show until a number less than 8 is captured. This was then imported into SAS-format through the SAS ACCESS module. This information which was double checked for correctness was then analysed by the custodian of this document. Take note that the Likert scale is an ordinal scale but is sometimes treated as an interval scale in the literature.

1.1.3 Preliminary Analysis

The reliability of the statements in the questionnaire posted to the supply chain participants were measured by using the Cronbach Alpha tests. (See paragraph 5.3.1). Descriptive statistics were performed on all variables; displaying means, standard deviations, frequencies, percentages, cumulative frequencies and cumulative percentages. These

descriptive statistics are discussed in paragraphs 5.3.2 and 5.3.3. (See computer printout in Annexure C).

1.1.4 **Inferential Statistics**

The following inferential statistics are performed on the data:

- Cronbach Alpha test. Cronbach's Alpha is an index of reliability associated with the variation accounted for by the true score of the "underlying construct". Construct is the hypothetical variables that are being measured (Cooper & Schindler, 2001:216-217). In other words Cronbach's alpha measures how well a set of items (or variables) measures a single uni-dimensional latent construct.

- The Kruskal-Wallis test is a nonparametric (distribution free) test, which is used to compare three or more groups of sample data. Kruskal-Wallis Test is used when assumptions of ANOVA are not met.

- Kruskal-Wallis test for interval data with more than 2 independent samples. The ***Kruskal-Wallis one-way analysis of variance*** by ranks is a non-parametric method for testing equality of population medians among groups. Intuitively, it is identical to a one-way analysis of variance with the data replaced by their ranks. It is an extension of the ***Mann-Whitney U test*** which compares two groups to three or more groups. Since it is a non-parametric method, the Kruskal-Wallis test does not assume a normal population, unlike the analogous one-way analysis of variance. However, the test does assume an identically-shaped and scaled distribution for each group, except for any difference in medians.

- Chi-square tests for nominal data. The Chi-square (two-sample) tests are probably the most widely used nonparametric test of significance that is useful for tests involving nominal data, but it can be used for higher scales as well like cases where persons, events or objects are grouped in two or more nominal categories such as 'yes-no' or cases

A, B, C, D. The technique is used to test for significant differences between the observed distribution of data among categories and the expected distribution based on the null hypothesis. It must be calculated with actual counts rather than percentages (Cooper & Schindler, 2001:499).

- SAS computes a P-value (Probability value) that measures statistical significance which automatically incorporates the chi-square values. Results will be regarded as significant if the p-values are smaller than 0.05, because this value presents an acceptable level on a 95% confidence interval ($p \leq 0.05$). The p-value is the probability of observing a sample value as extreme as, or more extreme than, the value actually observed, given that the null hypothesis is true. This area represents the probability of a Type 1 error that must be assumed if the null hypothesis is rejected (Cooper & Schindler, 2001:509).

- The p-value is compared to the significance level () and on this basis the null hypothesis is either rejected or not rejected. If the p value is less than the significance level, the null hypothesis is rejected (if p value <, reject null). If the p value is greater than or equal to the significance level, the null hypothesis is not rejected (if p value ≥, does not reject null). Thus with =0.05, if the p value is less than 0.05, the null hypothesis will be rejected. The p value is determined by using the standard normal distribution. The small p value represents the risk of rejecting the null hypothesis.

- A difference has statistical significance if there is good reason to believe the difference does not represent random sampling fluctuations only. Results will be regarded as significant if the p-values are smaller than 0.05, because this value is used as cut-off point in most behavioural science research.

5.2.5 Technical Report with Graphical Displays

A written report with explanations of all variables and their outcome has been compiled. A Cross analysis of variables was performed where

necessary, attaching statistical probabilities to indicate the magnitude of differences or associations.

All inferential statistics are discussed in paragraph 5.3.4.

5.2.6 Assistance to the researcher

The conclusions made by the researcher, were validated by the statistical report. Help was given to interpret the outcome of the data. The final report written by the researcher was validated and checked by the statistician to exclude any misleading interpretations.

5.2.7 Sample

The target population is participants in a supply chain such as the manufacturer of asphalt, the producer of raw materials and the contractor on the road. The total population is 100 participants from which a sample of 75 is drawn and 25 (33.3%) realised. The method used by the researcher to draw the sample was a convenient sampling method.

5.3 ANALYSIS OF DATA

In total 25 respondents from the supply chain answered the questionnaires posted to them. The items (statements) in the questionnaires will be tested for reliability in the following paragraph.

5.3.1 Reliability Testing: The reliability test (Cronbach's Alpha Coefficient) was done on all the items (statements) which represent the measuring instrument of the participants in the supply chain, with respect to the responses rendered in this questionnaire. The testing was done for each of the different concepts that are measured separately. The results are represented in table 5.1 to 5.6. The resulting printouts are also displayed in Annexure A.

TABLE 5. 1: Cronbach's Alpha Coefficients for for managing supply chain functions statements.

Statements	Variable nr.	Correlation with total	Cronbach's Alpha Coefficient

Statements	Variable nr.	Correlation with total	Cronbach's Alpha Coefficient
Managing the supply chain function			
1. Managing the processes within the supply chain has a major financial impact on the parties involved in the chain.	Q01i	0.0713	0.6676
2. Increased reliability between partners in a supply chain increases trust.	Q02	0.3011	0.5937
3. It is important for members of the supply chain to establish the same goal and focus on serving the customer.	Q03	0.6049	0.4253
4. There are cooperative arrangements that tie the contractor; the supplier and the producer of asphalt to each other and in that way their success to the chain as a whole.	Q04	0.3071	0.6422
5. The supply chain partners must work together towards improving the internal processes that will lead to the improvement of the service level agreements.	Q05	0.6750	0.3805
Cronbach's Coefficient Alpha for standardized variables			**0.6182**
Cronbach's Coefficient Alpha for raw variables			**0.6109**

Table: 5. 2: Cronbach's Alpha Coefficients for internal processes statements.

Statements	Variable nr.	Correlation with total	Cronbach's Alpha Coefficient
Continual improvement of internal processes			
6. It is important to improve the internal	Q06i	0.0033	0.6523

Statements	Variable nr.	Correlation with total	Cronbach's Alpha Coefficient
processes of the company before successful supply chain processes can be improved.			
7. Nothing can be improved without the right people with the right competences.	Q07	0.1148	0.6504
8. People are trained at the jobs that they do and they are competent in doing them.	Q08	0.4026	0.5166
9. There is an effective measurement system that monitors the internal process to ensure conformance to specification.	Q09	0.6854	0.3132
10. The organisation is not lacking direction in terms of vision and its performance measurement systems.	Q10	0.5323	0.4293
Cronbach's Coefficient Alpha for standardized variables			**0.5169**
Cronbach's Coefficient Alpha for raw variables			**0.5984**

Table 5. 3: Cronbach's Alpha Coefficients for customer satisfaction statements.

Statements	Variable nr.	Correlation with total	Cronbach's Alpha Coefficient
Customer satisfaction			
11. In order to ensure the satisfaction of the ultimate customer (the road end-user, the commuters); the customers within the supply chain must be satisfied with quality of the relative products.	Q11i	0.0038	0.5151
12. The quality of the asphalt on national roads is dependent on the quality of the raw materials from the suppliers of raw materials.	Q12	0.3140	0.3284
13. There are clear ownership and mechanisms in place to ensure immediate corrective actions in case of product failure.	Q13	0.2297	0.3934
14. The cost of quality should be borne by all members of the supply chain.	Q14	0.2161	0.4033
15. Customer service strategies are clearly documented and communicated.	Q15	0.3996	0.2333
Cronbach's Coefficient Alpha for standardized variables			**0.4234**
Cronbach's Coefficient Alpha for raw variables			**0.4438**

The reliability for each of these measuring instruments is shown to be low, which could be because the data is multidimensional. When data has a multidimensional structure, Cronbach's alpha will usually be low.

Shown in tables 5.1 to 5.3 are the results of the statements used as a measuring instrument. They show the correlation between the respective item and the total sum score (without the respective item) and the internal consistency of the scale (coefficient alpha) if the respective item were deleted. By deleting the items (statements) one by one each time with the statement with the highest Cronbach Alpha value, the Alpha value will increase. In the right hand column of tables 5.1-5.3, we can see that the reliability of the scale would be higher if any of these statements is

deleted. Thus, we will delete the items (statements) from the 3 scales, one by one, until we get a final set that makes up the reliable scales. (Note the fewer items in a scale, the less reliable the scale). In this case there are only a few questions posted to the respondents and if items are deleted the scale may not improve. After deleting the items (statements) the alpha coefficients were calculated on the remaining items (statements) and the results are shown in tables 5.4-5.6.

Table 5. 4: Cronbach's Alpha Coefficients for the remaining managing supply chain functions statements.

Statements	**Variable nr.**	**Correlation with total**	**Cronbach's Alpha Coefficient**
Managing the supply chain function			
2. Increased reliability between partners in a supply chain increases trust.	Q02	0.3731	0.8636
3. It is important for members of the supply chain to establish the same goal and focus on serving the customer.	Q03	0.7000	0.5129
5. The supply chain partners must work together towards improving the internal processes that will lead to the improvement of the service level agreements.	Q05	0.7486	0.4422
Cronbach's Coefficient Alpha for standardized variables			**0.7398**
Cronbach's Coefficient Alpha for raw variables			**0.7507**

Table 5. 5: Cronbach's Alpha Coefficients for the remaining internal processes statements.

Statements	Variable nr.	Correlation with total	Cronbach's Alpha Coefficient
Continual improvement of internal processes			
8. People are trained at the jobs that they do and they are competent in doing them.	Q08	0.3948	0.8264
9. There is an effective measurement system that monitors the internal process to ensure conformance to specification.	Q09	0.7326	0.4176
10. The organisation is not lacking direction in terms of vision and its performance measurement systems.	Q10	0.5648	0.6334
Cronbach's Coefficient Alpha for standardized variables			**0.7320**
Cronbach's Coefficient Alpha for raw variables			**0.7319**

TABLE 5.6: Cronbach's Alpha Coefficients for remaining customer satisfaction statements.

Statements	Variable nr.	Correlation with total	Cronbach's Alpha Coefficient
Customer satisfaction			
12. The quality of the asphalt on national roads is dependent on the quality of the raw materials from the suppliers of raw materials.	Q12	0.3273	0.4250
13. There are clear ownership and mechanisms in place to ensure immediate corrective actions in case of product failure.	Q13	0.3792	0.3705
14. The cost of quality should be borne by all members of the supply chain.	Q14	0.2270	0.5047
15. Customer service strategies are clearly documented and communicated.	Q15	0.3026	0.4534
Cronbach's Coefficient Alpha for standardized variables			**0.5188**
Cronbach's Coefficient Alpha for raw variables			**0.5151**

The results in tables 5.4 and 5.5 indicate that the 3 remaining items in the measurement are both more than 0.70 thus, according to (***Nunnally, 1978****:* 245), acceptable for assuming being reliable. Note should also be taken that some of the items can still be deleted to improve the scale.

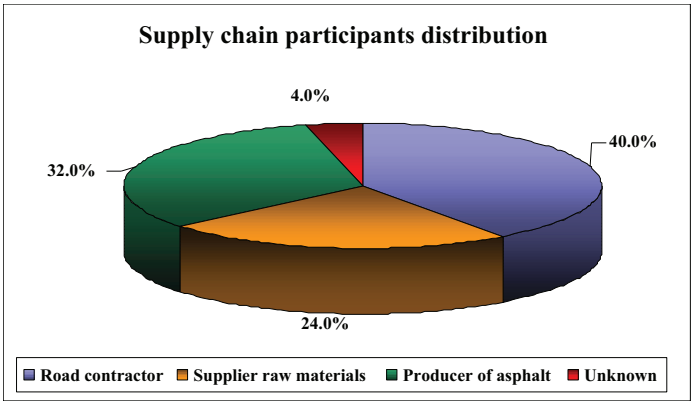
Due to the low Cronbach Coefficient Alpha's and the fact that there only a few items in each questionnaire, the assumption is made that the data have a multidimensional structure which measures more than one construct. If the study is repeated the reliability can be improved by minimizing the external sources of variation. The equivalence can be enhanced through improved investigator consistency if well trained, supervised and motivated persons are used to conduct the interviewing of respondents. When the sample of items(questions) used is broadened better consistency can also be achieved by adding a few similar questions to the questionnaire.

This, however, proves that the client questionnaire may by multi dimensional and measures more than one construct. This problem can be dealt with by determining whether there are more dimensions in which this questionnaire operates (in other words that the statements describe more than one latent variable), and by doing a factor analysis on the client questionnaire or by deleting the items that add to the inconsistency of the questionnaire. The latter path is followed.

5.3.2 Descriptive Statistics

Tables 5.7 and 5.8 show the descriptive statistics for all the information in the questionnaires that measure whether lack of efficiency in coordinating the processes across the supply chain in the manufacturing of asphalt, culminates in poor road surface quality, which in turn calls for sustained renewal of road surfaces thereof at high costs. Note that the descriptive statistics are based on the total sample. These descriptive statistics are also shown in Annexure C. Table 5.8 shows the descriptive statistics like mean, standard deviation and range for the continuous variables. Due to the voluminous nature of Table 5.7 and Table 5.8 they are, for ease of reference, contained within Annexures E and F respectively.

5.3.3 Uni-variate graphs



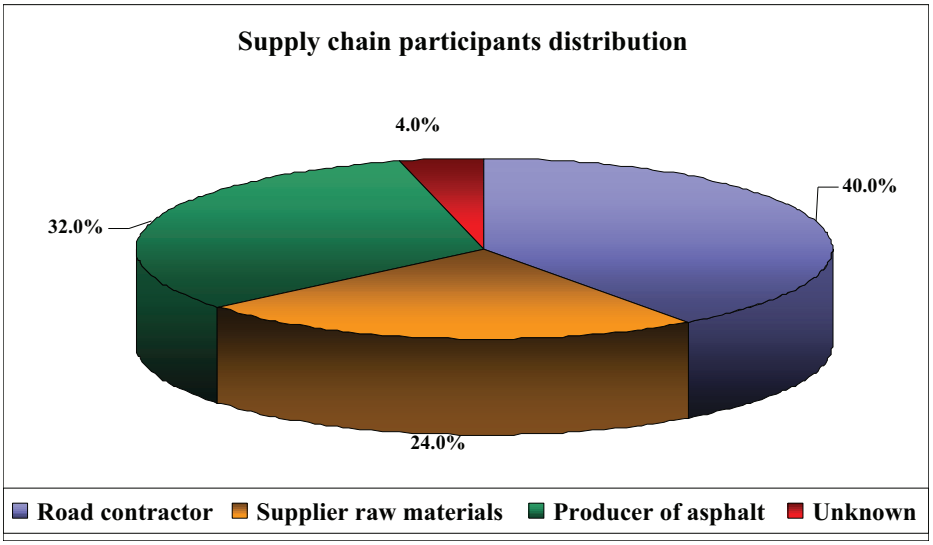


Figure 5.1 : Supply chain participants' distribution

Most (40.0%) of the respondents were road contractors. Nearly 25% of the respondents were suppliers of raw material and less than a third of the respondents were producers of asphalt.

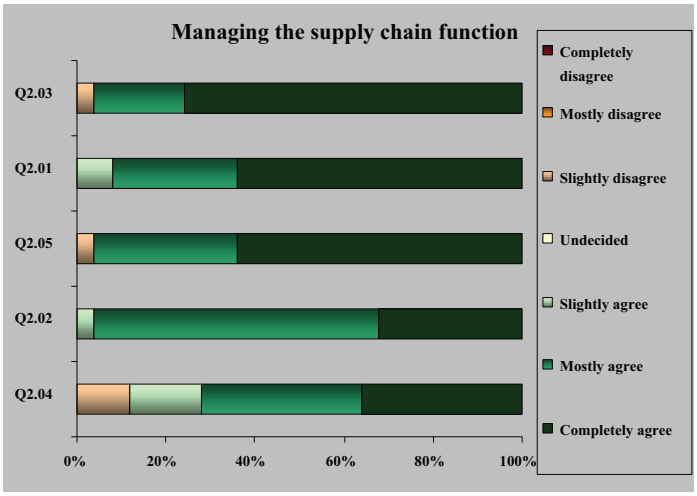


Figure 5.2: Statements regarding managing the supply chain function.

Although the rest of the respondents slightly agree to completely agree with all these statements; the statements with which the degree of agreement were the highest are:

- It is important for members of the supply chain to establish the same goal and focus on serving the customer. (76.0% completely agree).
- Managing the processes within the supply chain has a major financial impact on the parties involved in the chain. (64.0% completely agree).
- The supply chain partners must work together towards improving the internal processes that will lead to the improvement of the service level agreements. (64.0% completely agree)

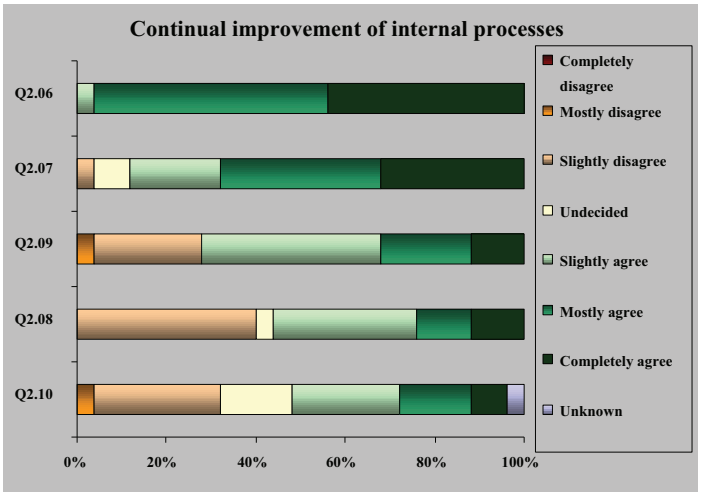


Figure 5.3: Statements regarding continual improvement of internal processes.

The statements with which the rest of the respondents mostly agree with are:

- It is important to improve the internal processes of the company before successful supply chain processes can be improved. (96.0% slightly to completely agree).
- Nothing can be improved without the right people with the right competences. (86.0% slightly too completely agree)

Figure 5.4: Statements regarding customer satisfaction.

The statements with which the rest of the respondents mostly agree with are:

- In order to ensure the satisfaction of the ultimate customer (the road end-user, the commuters), the customers within the supply chain must be satisfied with quality of the relevant products. (96.0% slightly too completely agree).
- The cost of quality should be borne by all members of the supply chain. (84.0% slightly too completely agree).

The statement with which the rest of the respondents mostly disagree is:

- There is clear ownership, and mechanisms in place to ensure immediate corrective actions in case of product failure. (48.0% slightly too mostly disagree).

5.3.4 Comparative Statistics

Comparisons are made between the types of participant in the supply chain to ascertain whether the respondents differed with respect to their responses on the different statements made. Due to the small sample, the scale of the measurements and doubt whether the data was normally

distributed, the non-parametric test Kruskal-Wallis for more than 2 independent samples was performed on the survey data. The results of these statistics are shown in table 5.9.

In the Kruskal-Wallis Test, the null hypothesis assumes that the samples are from identical populations. Thus, as the result showed the null hypothesis will not be rejected as none of the p-values were less than 0.05, when comparing the groups for each statement. This means that there were no differences in the responses to the statements between these groups.

5.4 CONCLUSION

The results obtained regarding the management of a supply-chain focus on the supply-chain, from the road contractors to the actual producers of asphalt.

The following analogies can be drawn from this research:

- It is important for members of the supply chain to establish the goals and focus on serving the customer.
- Managing the processes within the supply chain has a major financial impact on the parties involved in the chain.
- The supply chain partners must work together towards improving the internal processes that will lead to improvement of the service level agreements.

From the results obtained about the continual improvement of internal processes by way of this survey the following analogies can be drawn:

- It is important to improve the internal processes of the company before successful supply chain processes can be improved.

- Nothing can be improved without the right people with the right competencies.

From the results obtained about customer satisfaction through this survey on the supply chain from road contractors to the actual producers of asphalt the following analogies can be drawn from this research:

- In order to ensure the satisfaction of the ultimate customer (the road end-user, the commuters), the customers within the supply chain must be satisfied with the quality of the relevant products.
- The cost of quality should be borne by all members of the supply chain.
- There is not clear ownership of, or mechanisms in place to ensure immediate corrective actions in case of product failure.

To sum up, the road contractor, the supplier of raw materials and the producer of asphalt felt the same on all the statements.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

1.1 INTRODUCTION

In this chapter, the research is summarized and final conclusions drawn. The research problem is revisited to ascertain whether it has been solved as a result of the research. The key research objectives, research question and investigative questions will be revisited to determine whether the research contained within the ambit of the dissertation produced not only feasible, but also viable, answers to the posed research questions.

The research design and methodology, as well as the data collection design and methodology will be evaluated to determine if the research was executed in terms of the stated design and methodology. The key research objectives will be re-stated together with key findings culminating as a result of the research. The chapter will conclude with recommendations to Much Asphalt on key strategies and approaches that can be adopted to improve the operational effectiveness and reliability between partners of the supply chain in the manufacturing of asphalt.

1.2 THE RESEARCH THUS FAR

The research thus far offers a holistic perspective of the research conducted at Much Asphalt, which reads as follows:

Partnering with suppliers for quality improvement.

The objective of the research thus far is to compare all the information obtained from the previous chapters with the research during this dissertation. The background to this research is that uneven surfaces on national roads lead to poor performance, and the continuing use of low quality raw materials leads to regular maintenance at high cost. It has been established that the performance of the product, asphalt, is largely determined by the characteristics of the raw materials from suppliers to Much Asphalt. The poor involvement of the suppliers in production planning, product development initiatives and important activities within

the supply-chain, are a cause for great concern.

The holistic perspective to Much Asphalt, as research environment, uncovered the operational divisions of Much Asphalt: an upstream process that consists of the suppliers of raw materials, and a downstream process which is the customer or the contractor. These were analysed as part of the research. In order to reach the ultimate goal of the research and make recommendations to the management of Much Asphalt, an extended literature review was conducted on supply-chain management and strategies to effect management of supply-chains. The research design and methodology fell within the ambit of action study research, which is discussed in Chapter 4. The sample for the research was drawn using the conventional sample. This is a way to choose a limited number of elements smaller than the chosen population, but representative of the entire population.

1.3 FINDINGS AND ANALOGIES DRAWN FROM DATA ANALYSIS

With reference to results obtained through this survey, regarding Supply Chain Management, from road contractors to the producers of asphalt the following analogies can be drawn:

- It is important for members of the supply chain to establish the same goals and focus on serving the customer.
- Managing the processes within the supply-chain has a major financial impact on all the parties involved..
- The supply-chain partners must co-operate in improving internal processes. This will lead to the improvement of the service level agreements.

Results obtained about the continual improvement of internal processes through this survey on the supply chain from road contractors to the actual producers of asphalt the following analogies can be drawn from this research:

- It is important to improve the internal processes of a company before successful supply chain processes can be improved.
- Nothing can be improved unless employees have the right competences.

From the results obtained through this survey, the following analogies can be drawn:

- To ensure the satisfaction of the ultimate customer, the road user, the customers within the supply-chain must be satisfied with the quality of the products.
- The cost of quality should be borne by all members of the supply chain.
- There are no clear ownership mechanisms in place to ensure immediate corrective action in case of product failure.

The road contractor, the supplier of raw materials and the producer of asphalt felt the same on all the above statements.

1.4 ANALOGIES DRAWN FROM LITERATURE REVIEW

The extended review of literature reveals the definitions of supply-chain management, supply-chain and the organizational culture conducive to supply-chain. According to Murray (2008:**Online**), Supply Chain Management operates at three levels; strategic, tactical and operational. At the strategic level, company management makes high-level strategic supply-chain decisions that are relevant to the whole organization. Ellram (1991:13) expresses the view that SCM is an integrative approach to dealing with the planning and control of the materials flow, from the suppliers to the end-users. It is an approach aimed to co-operatively manage and control distribution channel relationships for the benefit of all parties involved, and to maximize the efficient use of resources in achieving the supply-chain's customer service goals. New and Payne (1991:60) describe supply-chain management as the chain linking each element of the manufacturing and supply process, from raw materials

through to the end user, encompassing several organizational boundaries.

Beamon (1998:281) explains that, at its highest level, a supply-chain is comprised of two basic integrated processes, namely: the production planning and inventory control process, and the distribution and logistic process. The production planning and inventory control process encompasses the manufacturing and storage sub-processes, and their interface(s). More specifically, production planning describes the design and management of the entire manufacturing process including raw material scheduling and acquisition, manufacturing process design and scheduling, and material handling design and control).

According to Foster (2007:263) to understand the supply chain, it is necessary to discuss the economic concept of the value chain. Porter (1985:33) identified this systematic means of examining all the activities a firm performs and how those activities interact. The value chain is a tool that divides a firm into its core activities to help reduce cost and identity sources of competitiveness. It is part of the value system that consists of a network of value chains. Value chain analysis describes the activities of the organization, and relates them to the organisation's competitive strength. It thus establishes which value each particular activity adds to the organization and its products or services. This idea is built upon the fact that an organization is more than a random compilation of machinery, equipment, people and money. Only if these components are arranged into systems and systematic activities, will it become possible to produce something for which the customers are willing to pay.(Porter, 1985:34).

As a philosophy, Supply Chain Management views the supply-chain as a single entity, rather than a set of fragmented parts, with each part performing its own function (Ellram & Cooper, 1990:7). This means that the partnership concept is extend into a multi-company effort to manage the flow of items as well as the overall performance of the supply-chain (Cooper, Douglas & Pagh 1997:5). Ross (1998:1) states that SCM as a philosophy seeks synchronization and convergence of intrafirm and inter-firm operational and strategic capabilities into a unified, compelling market

place force. .According to Cooper *et al.* (1997:10) SCM as a philosophy has the following characteristics:

- A systematic approach to viewing the supply-chain as a whole and managing the total flow from the supplier to the final customer.
- A strategic orientation towards cooperative efforts to synchronize and converge intra-firm and inter-firm operational and strategic capabilities into a unified whole.
- A customer focus in order to create unique and individualized sources of customer value, leading toward customer satisfaction.

The supply chain members should all have the goal of satisfying the final customers' requirements. This goal will direct the setting of strategies and plans as well as the operation and performances of different supply-chain members. Furthermore in order to meet the needs of the ultimate customers, the needs of different supply chain members should also be satisfied. The different supply chain members are operating as internal customers and suppliers within the supply-chain (Kanji & Wong, 1999:1153). According to Forster (2007:138) customer driven quality represents a proactive approach to satisfy customer needs. This is based on the gathering of data regarding the customers in order to learn their needs and preferences, thus providing products and services that satisfy them. LaLonde and Masters (1994:35) propose that a supply-chain succeeds if all its members have the same goal and the same focus on serving customers. Establishing the same goal and focus in supply-chain members is a form of policy integration. Lassar and Zinn (1995:81) suggest that successful relationships aim to integrate supply-chain policy in order to avoid redundancy and overlap, while seeking a level of cooperation that allows participants to be more effective, at lower costs levels.

According to Farely (1997:38) the single most important requisite for supply chain management of an organization is a change in the corporate culture of al members in the value chain. This view is supported by Foster

(2007:241) who maintains that informed organization leads to change in organizational behaviour in a way that improves performance.

Furthermore, researchers in SCM aver that companies world-wide recognize the importance of meeting a customer's need to succeed in the competitive market-place. Thus, it is often argued that optimizing operations within the four walls of their enterprises is not enough to achieve business excellence. Kanji (1998:1147) defines business excellence as "the simultaneous measurement of customers', employers' and shareholders' delight within an organization at providing overall business success. Comparing the views of Anderson and Katz (1998:10) with those of Golahr and Waller (1996:27) similar constructs have been identified and have been shown to positively affect product quality and broader measures of manufacturing performance.

1.5 THE RESEARCH PROBLEM REVISITED

The research problem which was formulated in Chapter 1 paragraph 3 reads as follows:

"Lack of efficiency in co-ordinating the processes across the supply chain in the manufacturing of asphalt, culminates in poor road surface quality, calling for sustained renewal thereof at high costs."

Recommendations to mitigate the research problem, culminating from the results of the literature review and the data analysis are as follows:

- To achieve customer satisfaction, which is the goal of any organization, It is of vital importance to co-ordinate the processes across the supply chain efficiently to the benefit of all the stakeholders.
- According to the uni-variate graphs from the data analysis of the questionnaires that were sent out to respondents, of whom most (40.0%) were road contractors, nearly 25% were suppliers of raw material and less than a third producers of asphalt. 76% of respondents completely agree that it is important for members of the

supply-chain to establish the same goals, and focus on serving the customer. 64% of the respondents completely agree that managing the processes within the supply-chain has a major financial impact on the parties involved. 64% of the respondents completely agree that the supply-chain partners must work together towards improving the internal processes that will lead to the improvement of the service level agreements.

Much Asphalt Management, and the respective stakeholders in its supply chain, should consider the key activities needed for a successful co-ordination of processes as listed in the literature review as:

- Integrated behaviour.
- Mutually sharing information.
- Mutually sharing risks and rewards.
- Cooperation.
- The same goal and the same focus on serving the customer.
- Integration of processes.
- Partners to build and maintain long term relationships.

The questionnaire also reveals that about 50% of the members within the Much Asphalt supply-chain indicate that suppliers and customers have little communication and have no role in demand management, inventory management or product development processes. The researcher recommends an emphasis on more collaborative effort as expressed by (Kanji& Wong, 1999:1153), because the supply-chain members should all have the goal of satisfying the final customers' requirements. This goal will direct the setting of strategies and plans, the operation and the performance of different supply-chain members. In order to meet the needs of the ultimate customers, the needs of different supply-chain members should also be satisfied.

In the manufacture of asphalt lack of efficiency in co-ordinating the processes across the supply-chain has often resulted from the lack of collaboration between the partners and customers, and from the lack of sharing of information regarding contract requirements. The researcher recommends a range of possible managerial actions:

- Specific performance metrics and clauses should be communicated clearly, and the expectations of all stakeholders must be noted.
- Improved production planning and forecasting.

The survey results reveal that 96% of those who responded to the survey agree that, in order to ensure the satisfaction of the ultimate customer (the road end-user, the commuters), the customers within the supply-chain must be satisfied with quality of the relative products. They also agree that it is important to improve the internal processes of the company before successful supply chain processes can be improved.

Regarding clear ownership and mechanisms in place to ensure immediate corrective actions in case of product failure, the result of the survey reveals that 48.0% of respondents disagree that ownership mechanisms are in place. The researcher strongly asserts that the people who work on processes must be encouraged to take full ownership of, and pride in their process. At the core of every quality system, there is a group of people doing the job. Nothing can be implemented without the people who work on the process, hence it is crucial that they are equipped with the relevant competencies and are supporting the development of supply-chain management as well as the focus on producing a quality product.

Although there is growing awareness of the importance of supply-chain collaboration with supply-chain management, the bulk of the survey results, from the different members of the supply-chain, suggest that the degree of involvement varies across different processes and sectors. For instance, responses from the process of manufacturing asphalt differ from those from the process of refining crude oil to get the bitumen that is needed by the manufacturer of asphalt. One of the reasons for this could

be that organizations are wary of committing their systems to activities that they do not consider critical to their own process. Another reason could be that the complexity of the processes vary depending on the structure of the particular industry. Moreover, successful supplier integration involves a large number of variables. The researcher recommends that only variables that are aligned with the organizational requirements of Much Asphalt must be employed, because the integrating processes are so complex.

6.6 THE RESEARCH QUESTION REVISITED

The research question which was formulated in Chapter 1 paragraph 4 reads as follows:

“What key strategies or approaches can be adopted to improve the operational effectiveness and reliability between partners of the supply chain in the manufacturing of asphalt, thereby increasing the reliability of national roads and enhancing customer satisfaction?”

In the Asphalt industry, there appears to be a gap in the understanding between the input-process-output methodology, as a technique for interdependence between the suppliers, contractors, engineers, and the ultimate customer. By means of intense literature review, benchmarking, and assessing the strategies adopted by world class companies, the researcher bridges that gap, through proposing a concept that integrates the input-process-output methodology into a unified theme.

It is thus clear from analysis of the literature review, as well as the data analysis, that at both strategic and operational levels, it is imperative for supply-chain management that strategies be adopted as a means of increasing the total business effectiveness, and that partnering with suppliers be perceived as a means to offer the greatest operational improvement opportunities.

The era of both globalization of markets and outsourcing has begun. Many companies select supply chain management for effective operations and to achieve business results. The results of the survey conducted have

implications for both customers and supplier and therefore it is imperative that organizations adopt closer working relationships. The methodology offered by supply chain management will contribute to better understanding and the resolution of bottle necks in the processes of manufacturing asphalt, from the supplier of aggregates and bitumen to the engineer on site as well as the road end-user. The survey results reveal that, the statements with which most of the respondents agree, is that it is important to improve the internal processes of a company before a successful supply-chain process can be improved. 96% slightly to completely agree with this statement. Lambert, Stock & Elram (1998: **Chapter 14**) aver that to successfully implement supply-chain management, all firms within a supply chain must overcome their own functional silos and adopt a process approach. Thus all functions within a supply chain are reorganized as key processes. Another important strategy that can improve the operational effectiveness and the reliability between partners in the supply-chain of Much Asphalt is to allow more opportunities for collaboration. The survey reveals the following results with regard to collaboration efforts:

- It is important for members of the supply-chain to establish the same goals and focus on serving the customer. (76.0% completely agree).
- Managing the processes within the supply chain has a major financial impact on the parties involved in the chain. (64.00% completely agree).
- The supply chain partners must work together towards improving the internal processes that will lead to the improvement of the service level agreements. (64.0% completely agree).

Opportunities for collaboration amongst the members of the supply chain will vary depending on the organizations role in the supply chain. Thus, this collaboration will enable the partners to jointly gain a better understanding of the future product demand, as well as the interrelated processes that are interlinked together during the manufacture of the product. This will mean that, the suppliers of raw materials which are

Larfarge, Caltex, Esso, Shell, Aggregates quarries and the manufacturer of the product, asphalt, can be aligned to enhance the value of the chain's combined activities.

According to the survey the statement with which the rest of the respondents mostly disagree is the fact of 'clear ownership and mechanisms in place to ensure immediate corrective actions in case of product failure', (48.0% slightly too mostly disagree). This is a cause for a great concern, as production failure often calls for sustained renewal recalling of the product at very high cost. It has been argued that when trust is limited between parties, contractual agreements are commonly established to enhance legal obligations. Benita (1999:275), argues that contractual safeguards are important in determining the level of trust that the manufacturer has in the supplier, in that they help define the nature of the relationship from the outset.

From the evaluation of the literature review and the result of the survey, the conclusion is that it is evident that the success in improving the operational effectiveness of a supply chain or customer-supplier relationship depends on the frequent interaction, collaboration and communication between partners. Once organisations realise the importance of involving their customers and suppliers, as is the common theme in the review of the literature, then efficiency, effectiveness, productivity and quality will improve dramatically. Hence supply-chain management is advocated as the means to improve quality, as well as enhance an organisations' competitive edge.

6.7 KEY RESEARCH OBJECTIVES REVISITED

The research objectives which were formulated in chapter 1 paragraph 5 read as follows:

- To identify a customer focused approach to quality management of the raw materials through to the final product.
- To define identifiable and appropriate partnering attributes.

- To follow a continuous improvement process of defining and redefining attributes based on previous experience with suppliers over time.
- To develop business-specific metrics to enhance supplier integration and partnering development decision-making processes.
- To evaluate improvements according to their contribution to the desired result.

The objectives of the research were executed by analyzing the results of the survey as well as the data analysis. Each objective has been met as follows:

Objective 1: To identify a customer focused approach to quality management of raw materials and that of the final product.

A customer-focused approach to quality management of raw material, and that of the final product, can be achieved through the relationship between the specifying agency, the aggregate supplier, and the customer. Lee (2007:444) advocates that the specifying agency will have to cede the customary role of dictating specifications, and delegate such decisions to the customer. The customer and the aggregate supplier have to work hand in hand to set performance standards for testing and acceptance.

Moreover, successful quality management of raw materials as well as the final product involves supplier integration. In order to integrate the quality of the raw materials from the suppliers to Much Asphalt, the variables highlighted in the literature review need to be assessed. These include the integrated structure, responsibility for design, specific responsibilities in the requirement setting process, when to involve suppliers in the process, inter-company communication, intellectual property agreements, supplier membership on the project team, alignment of the organization's objectives with regard to outcomes and the quality management of the final product (Handfield *et al*., 1999:60).

It is therefore crucial for the management of Much Asphalt to understand that the involvement of suppliers in new product development, is beneficial, as their contribution will bring about a competitive advantage that is especially meaningful in cases where research and development are shared.

If Much Asphalt could accept a paradigm shift in supplier partnership, the advantages are vast. This is suggested in the literature reviewed for this research. Regarding the suppliers of raw materials to Much Asphalt, their existing knowledge of Much Asphalt's internal processes and objectives enables suppliers of raw material to plan for future product development efforts, and to develop in advance the capabilities to meet those needs. This will ensure sustainable quality of the final product which is transported to the contractor on the road. The questionnaire sent out, each respondent, whether representing the supplier of raw materials, the producer of asphalt, or the customer for the end product (asphalt), was requested to rate the extent to which they view the importance of various objectives related to integrating the supplier in product developmental efforts and also the extent of the impact that supplier integration had on achieving the objective of a quality product.

The objective that merged as most are consistent with the competitive and strategic factors that are driving supplier integration and it is believed that the supply chain partners must work together towards improving the internal processes that will lead to the improvement of the service level agreements. The respondents believed that supplier integration has a positive impact on the final quality of the product and on all the objectives of the supply chain.

Objective 2: To define identifiable and appropriate partnering attributes.

From the literature review, it is clear that a supply-chain management process should select quality and partnering attributes that are readily definable in terms of general performance indicators. Maloni and Benton (1997:75) defined the necessary partnering attributes as follows:

- Level and degree of information sharing.
- Buyer-vendor cost saving initiatives.
- Extent of mutual co-operation, leading to improved quality.
- The entity and stage at which the supplier is involved.
- Extent of mutual assistance in problem solving efforts.

In their research paper, as cited in the literature review, Handfield *et al.* (1999:72) argue that in some cases suppliers may not always have the best partnering attributes and therefore collaboration with them may not always result in successful outcomes. Therefore a set of specific performance measures, related to customer needs and requirements, should be used to reach consensus on the potential supplier's capabilities and subsequent selection. The identifiable and appropriate patterning attributes were found to be the following: cost, quality, delivery rate and targets.

Based on an extensive review of literature, the following elements are most important to consider when assessing the attributes of current or potential suppliers for integration into a supply-chain with Much Asphalt:

- Targets - Is the supplier capable of meeting affordable targets regarding cost, quality and product performance?
- Timing- Is the supplier able to meet the product development and delivery schedules?
- Ramp up - When dealing with major contracts, will the supplier be able to increase capacity and production fast enough to meet volume production requirements?
- Innovation and Technical - Does the supplier have the required engineering expertise and facilities to adapt, design, develop, and manufacture plant, to solve problems when they occur?

Following the above recommendations, Much Asphalt must maintain

a competitive edge and be aware of potential new suppliers and technologies that emerged.

Objective 3: To follow a continuous improvement process by defining and redefining attributes based on previous experience with suppliers over time.

As highlighted in the literature review to which the author has alluded, the specific process that occurs when suppliers become involved in new product development, as highlighted in objective 2, there is a growing need for continual improvement and the continuous monitoring of the products, processes and supply base.

Objective 4: To develop business-specific metrics to enhancing supplier integration and partnering development decision-making process.

The results of the survey reveal that 46% of the respondents agree that they are currently satisfied with the results of supply chain management and collaboration of partners within the supply chain, 40% disagree with the above statement. Despite these mixed results respondents are committed to the development of business-specific metrics to enhance supplier integration and partnering. This is indicated by the fact that 64% of the respondents completely agree that supply chain partners must work together towards improving the internal processes that will lead to the improvement of the service level agreements.

The research clearly indicates how knowledge of a supplier's capacities and capabilities is a critical success factor for supplier integration projects. To be fully effective in today's competitive environment, firms must expand their integrated behaviour to incorporate customers and suppliers. This extension of integrated behaviour, through external integration, is referred to as supply chain management. In this context, the philosophy of supply chain management turns into the implementation of supply chain

management: a set of activities that carries out the philosophy (Bowersox & Closs, 1996) cited by (Mentzer *et al.,* 2001:8).

Objective 5: To evaluate improvements according to the contribution to the desired result.

According to Anderson (1995:637), it is crucial for organizations to benchmark their supply chains with world class organizations that have been practicing supply-chain management for decades. One model to use is called “The Benchmarking Wheel”, which allows an organization to plan, search, observe, analyze, adapt is described as follow:

- Plan: Critical success factors, select a process for benchmarking, document the process, and develop performance measures.
- Search: Find benchmarking partners.
- Observe: Understand and document the partner’s process, both performance and practice.
- Analyze: Identify gaps in performance and find the root cause of performance gaps.
- Adapt: Choose best practice and adapt the company’s objective and implement changes.

1.8 CONCLUSION

It makes business sense to pay attention to the ultimate customer’s needs, no matter how full an organizations order book is, as this affects the bottom line. It is critical for an organization to develop an excellent customer loyalty base that is consistent at all costs. Companies world-wide recognize the importance of meeting customer needs in order to succeed in the competitive market place. Individual organizations can no longer do this on their own, but must realize that partnering with suppliers will improve their quality initiatives to a large extent. There are several

contributions to this research which elaborate on the growing awareness of supply chain management as an alternative. The driving force of effective supply chain management is collaboration. The result from the extensive review of literature and the survey analysis suggests that the supplier is critical to organizational success. Their effective involvement in the supply chain is a must. Successful supply chain management requires cross-functional integration of suppliers into product developmental initiatives. The purpose of this research was to highlight the need for the recognition and the adoption of effective supply chain management, partnership and collaboration efforts in the Asphalt industry. This calls for a dispensation involving suppliers in new product/processes/ service development efforts which have the potential to provide significant results. The researcher therefore maintains that, partnering with suppliers to improve the quality of asphalt on national highways is critical.

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ANNEXURES

6.10.1 Annexure A: Comparison of two captured data sets for unequal values

Comparing Observations of 2 captured datasets for validity

The COMPARE Procedure

Comparison of WORK.TABLE1 with WORK.TABLE2

(Method=EXACT)

Data Set Summary

Dataset	Created	Modified	NVar	NObs
WORK.TABLE1	14SEP10:06:52:57	14SEP10:06:52:57	17	38
WORK.TABLE2	14SEP10:06:53:30	14SEP10:06:53:30	17	38

Variables Summary

Number of Variables in Common: 17.

Number of ID Variables: 1.

Observation Summary

Observation	Base	Compare	ID
First Obs	1	1	ID=1
Last Obs	38	38	ID=38

Number of Observations in Common: 38.

Total Number of Observations Read from WORK.TABLE1: 38.

Total Number of Observations Read from WORK.TABLE2: 38.

Number of Observations with Some Compared Variables Unequal: 0.

Number of Observations with All Compared Variables Equal: 38.

NOTE: No unequal values were found. All values compared are exactly equal.

1.1.2 Annexure B: First round of descriptive statistics and Cronbach alpha simple statistics

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum	Label
Q2_01	25	6.56000	0.65064	164.00000	5.00000	7.00000	Q2_01
Q2_02	25	6.28000	0.54160	157.00000	5.00000	7.00000	Q2_02
Q2_03	25	6.64000	0.86023	166.00000	3.00000	7.00000	Q2_03
Q2_04	25	5.84000	1.28062	146.00000	3.00000	7.00000	Q2_04
Q2_05	25	6.52000	0.87178	163.00000	3.00000	7.00000	Q2_05

Cronbach Coefficient Alpha

Variables	Alpha
Raw	0.566840
Standardized	0.570164

Cronbach Coefficient Alpha with Deleted Variable

Deleted Variable	Raw Variables Correlation with Total	Raw Variables Alpha	Standardized Variables Correlation with Total	Standardized Variables Alpha	Label
Q2_01	-.071309	0.667636	-.059765	0.709022	Q2_01
Q2_02	0.387337	0.508010	0.408697	0.468096	Q2_02
Q2_03	0.470593	0.426667	0.450592	0.442682	Q2_03
Q2_04	0.336032	0.545185	0.321967	0.518572	Q2_04
Q2_05	0.636651	0.316366	0.617559	0.334467	Q2_05

Pearson Correlation Coefficients, N = 25

Prob > |r| under H0: Rho=0

	Q2_01	Q2_02	Q2_03	Q2_04	Q2_05
Q2_01	1.00000	0.12770	-0.22036	0.01200	-0.09403
Q2_01		0.5430	0.2899	0.9546	0.6548
Q2_02	0.12770	1.00000	0.31480	0.18743	0.38476
Q2_02	0.5430		0.1254	0.3696	0.0575
Q2_03	-0.22036	0.31480	1.00000	0.24812	0.76007
Q2_03	0.2899	0.1254		0.2317	<.0001
Q2_04	0.01200	0.18743	0.24812	1.00000	0.37620
Q2_04	0.9546	0.3696	0.2317		0.0638
Q2_05	-0.09403	0.38476	0.76007	0.37620	1.00000

Q2_05	0.6548	0.0575	<.0001	0.0638

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum	Label
Q2_06	25	6.40000	0.57735	160.00000	5.00000	7.00000	Q2_06
Q2_07	25	5.84000	1.10604	146.00000	3.00000	7.00000	Q2_07
Q2_08	25	4.52000	1.44684	113.00000	3.00000	7.00000	Q2_08
Q2_09	25	4.84000	1.43411	121.00000	2.00000	7.00000	Q2_09
Q2_10	24	4.45833	1.41357	107.00000	2.00000	7.00000	Q2_10

Cronbach Coefficient Alpha

Variables	Alpha
Raw	0.597126
Standardized	0.531766

Cronbach Coefficient Alpha with Deleted Variable

Deleted Variable	Raw Variables Correlation with Total	Raw Variables Alpha	Standardized Variables Correlation with Total	Standardized Variables Alpha	Label
Q2_06	-.003304	0.652344	0.015964	0.632851	Q2_06
Q2_07	0.195978	0.614670	0.240515	0.509986	Q2_07
Q2_08	0.398729	0.517002	0.364995	0.433194	Q2_08
Q2_09	0.618759	0.362029	0.493111	0.347205	Q2_09
Q2_10	0.503489	0.446861	0.423960	0.394517	Q2_10

Pearson Correlation Coefficients

Prob > |r| under H0: Rho=0

Number of Observations

	Q2_06	Q2_07	Q2_08	Q2_09	Q2_10
Q2_06	1.00000	0.23490	-0.00998	-0.12078	-0.06010
Q2_06		0.2584	0.9623	0.5652	0.7803
	25	25	25	25	24
Q2_07	0.23490	1.00000	0.15831	0.11453	0.10440
Q2_07	0.2584		0.4498	0.5857	0.6273
	25	25	25	25	24
Q2_08	-0.00998	0.15831	1.00000	0.46347	0.27664
Q2_08	0.9623	0.4498		0.0196	0.1907
	25	25	25	25	24

Q2_09	-0.12078	0.11453	0.46347	1.00000	0.68954
Q2_09	0.5652	0.5857	0.0196		0.0002
	25	25	25	25	24
Q2_10	-0.06010	0.10440	0.27664	0.68954	1.00000
Q2_10	0.7803	0.6273	0.1907	0.0002	
	24	24	24	24	24

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum	Label
Q2_11	25	6.48000	1.08474	162.00000	2.00000	7.00000	Q2_11
Q2_12	24	5.29167	1.33447	127.00000	3.00000	7.00000	Q2_12
Q2_13	25	4.12000	1.50886	103.00000	2.00000	7.00000	Q2_13
Q2_14	24	5.37500	1.05552	129.00000	3.00000	7.00000	Q2_14
Q2_15	24	4.87500	1.62354	117.00000	1.00000	7.00000	Q2_15

Cronbach Coefficient Alpha

Variables	Alpha
Raw	0.440350
Standardized	0.420403

Cronbach Coefficient Alpha with Deleted Variable

Deleted Variable	Raw Variables Correlation with Total	Raw Variables Alpha	Standardized Variables Correlation with Total	Standardized Variables Alpha	Label
Q2_11	-.003802	0.515143	-.002707	0.518790	Q2_11
Q2_12	0.299110	0.334358	0.308373	0.294924	Q2_12
Q2_13	0.490897	0.145479	0.474616	0.152471	Q2_13
Q2_14	0.213423	0.400210	0.217171	0.366076	Q2_14
Q2_15	0.175108	0.440802	0.133219	0.427429	Q2_15

Pearson Correlation Coefficients

Prob > |r| under H0: Rho=0

Number of Observations

	Q2_11	Q2_12	Q2_13	Q2_14	Q2_15
Q2_11	1.00000	-0.03847	0.29429	-0.00467	-0.25808
Q2_11		0.8584	0.1533	0.9827	0.2234
	25	24	25	24	24
Q2_12	-0.03847	1.00000	0.21094	0.39419	0.13221
Q2_12	0.8584		0.3225	0.0627	0.5476

	24	24	24	23	23
Q2_13	0.29429	0.21094	1.00000	0.08738	0.41605
Q2_13	0.1533	0.3225		0.6847	0.0432
	25	24	25	24	24
Q2_14	-0.00467	0.39419	0.08738	1.00000	0.03306
Q2_14	0.9827	0.0627	0.6847		0.8810
	24	23	24	24	23
Q2_15	-0.25808	0.13221	0.41605	0.03306	1.00000
Q2_15	0.2234	0.5476	0.0432	0.8810	
	24	23	24	23	24

Descriptive statistics and Cronbach Alpha after items were deleted

Simple Statistics

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum	Label
Q2_02	25	6.28000	0.54160	157.00000	5.00000	7.00000	Q2_02
Q2_03	25	6.64000	0.86023	166.00000	3.00000	7.00000	Q2_03
Q2_05	25	6.52000	0.87178	163.00000	3.00000	7.00000	Q2_05

Cronbach Coefficient Alpha

Variables	Alpha
Raw	0.750696
Standardized	0.739769

Cronbach Coefficient Alpha with Deleted Variable

Deleted Variable	Raw Variables Correlation with Total	Raw Variables Alpha	Standardized Variables Correlation with Total	Standardized Variables Alpha	Label
Q2_02	0.373106	0.863636	0.372859	0.863680	Q2_02
Q2_03	0.699951	0.512941	0.645882	0.555704	Q2_03
Q2_05	0.748579	0.442211	0.705983	0.478856	Q2_05

Pearson Correlation Coefficients, N = 25

Prob > |r| under H0: Rho=0

	Q2_02	Q2_03	Q2_05
Q2_02	1.00000	0.31480	0.38476
Q2_02		0.1254	0.0575
Q2_03	0.31480	1.00000	0.76007
Q2_03	0.1254		<.0001
Q2_05	0.38476	0.76007	1.00000
Q2_05	0.0575	<.0001	

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum	Label
Q2_08	25	4.52000	1.44684	113.00000	3.00000	7.00000	Q2_08
Q2_09	25	4.84000	1.43411	121.00000	2.00000	7.00000	Q2_09
Q2_10	24	4.45833	1.41357	107.00000	2.00000	7.00000	Q2_10

Cronbach Coefficient Alpha

Variables Alpha

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Raw 0.731880

Standardized 0.731993

Cronbach Coefficient Alpha with Deleted Variable

	Raw Variables		Standardized Variables		
Deleted Variable	Correlation with Total	Alpha	Correlation with Total	Alpha	Label
Q2_08	0.394799	0.826368	0.402624	0.816249	Q2_08
Q2_09	0.732612	0.417583	0.721582	0.433392	Q2_09
Q2_10	0.564754	0.633370	0.564748	0.633387	Q2_10

Pearson Correlation Coefficients

Prob > |r| under H0: Rho=0

Number of Observations

	Q2_08	Q2_09	Q2_10
Q2_08	1.00000	0.46347	0.27664
		0.0196	0.1907
	25	25	24
Q2_09	0.46347	1.00000	0.68954
	0.0196		0.0002
	25	25	24
Q2_10	0.27664	0.68954	1.00000
	0.1907	0.0002	
	24	24	24

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum	Label
Q2_12	24	5.29167	1.33447	127.00000	3.00000	7.00000	Q2_12
Q2_13	25	4.12000	1.50886	103.00000	2.00000	7.00000	Q2_13
Q2_15	24	4.87500	1.62354	117.00000	1.00000	7.00000	Q2_15

Cronbach Coefficient Alpha

Variables Alpha

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Raw 0.504686

Standardized 0.504069

Cronbach Coefficient Alpha with Deleted Variable

Deleted Variable	Raw Variables Correlation with Total	Raw Variables Alpha	Standardized Variables Correlation with Total	Standardized Variables Alpha	Label
Q2_12	0.196946	0.580890	0.203900	0.587623	Q2_12
Q2_13	0.422229	0.222679	0.416660	0.233536	Q2_13
Q2_15	0.357220	0.339546	0.352298	0.348384	Q2_15

Pearson Correlation Coefficients

Prob > |r| under H0: Rho=0

Number of Observations

	Q2_12	Q2_13	Q2_15
Q2_12	1.00000	0.21094	0.13221
		0.3225	0.5476
	24	24	23
Q2_13	0.21094	1.00000	0.41605
	0.3225		0.0432
	24	25	24
Q2_15	0.13221	0.41605	1.00000
	0.5476	0.0432	
	23	24	24

6.10.3 Annexure C: Descriptive statistics for each variable the supply chain survey.

Q1_0	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	5	13.16	5	13.16
A road contractor	14	36.84	19	50.00
The supplier of raw materials	11	28.95	30	78.95
The producer of asphalt	8	21.05	38	100.00

Chi-Square Test for Equal Proportions

Chi-Square	4.7368
DF	3
Pr > ChiSq	0.1921

Sample Size = 38

Q2_01	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	13	34.21	13	34.21
Slightly agree	2	5.26	15	39.47
Mostly agree	7	18.42	22	57.89
Completely agree	16	42.11	38	100.00

Chi-Square Test for Equal Proportions

Chi-Square	12.3158
DF	3
Pr > ChiSq	0.0064

Sample Size = 38

Q2_02	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	13	34.21	13	34.21

Slightly agree	1	2.63	14	36.84
Mostly agree	16	42.11	30	78.95
Completely agree	8	21.05	38	100.00

Chi-Square Test

for Equal Proportions

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Chi-Square 13.5789

DF 3

Pr > ChiSq 0.0035

Sample Size = 38

Q2_03	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	13	34.21	13	34.21
Slightly disagree	1	2.63	14	36.84
Mostly agree	5	13.16	19	50.00
Completely agree	19	50.00	38	100.00

Chi-Square Test

for Equal Proportions

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Chi-Square 20.5263

DF 3

Pr > ChiSq 0.0001

Sample Size = 38

Q2_04	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	13	34.21	13	34.21
Slightly disagree	3	7.89	16	42.11
Slightly agree	4	10.53	20	52.63
Mostly agree	9	23.68	29	76.32
Completely agree	9	23.68	38	100.00

Chi-Square Test

for Equal Proportions

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Chi-Square 8.8421

DF 4

Pr > ChiSq 0.0652

Sample Size = 38

Q2_05	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	13	34.21	13	34.21
Slightly disagree	1	2.63	14	36.84
Mostly agree	8	21.05	22	57.89
Completely agree	16	42.11	38	100.00

Chi-Square Test

for Equal Proportions

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Chi-Square 13.5789

DF 3

Pr > ChiSq 0.0035

Sample Size = 38

Q2_06	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	13	34.21	13	34.21
Slightly agree	1	2.63	14	36.84
Mostly agree	13	34.21	27	71.05
Completely agree	11	28.95	38	100.00

Chi-Square Test

for Equal Proportions

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Chi-Square 10.4211

DF 3

Pr > ChiSq 0.0153

Sample Size = 38

Cumulative Cumulative

Q2_07	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	13	34.21	13	34.21
Slightly disagree	1	2.63	14	36.84
Undecided	2	5.26	16	42.11
Slightly agree	5	13.16	21	55.26
Mostly agree	9	23.68	30	78.95
Completely agree	8	21.05	38	100.00

Chi-Square Test for Equal Proportions

Chi-Square	16.3158
DF	5
Pr > ChiSq	0.0060

Sample Size = 38

Q2_08	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	13	34.21	13	34.21
Slightly disagree	10	26.32	23	60.53
Undecided	1	2.63	24	63.16
Slightly agree	8	21.05	32	84.21
Mostly agree	3	7.89	35	92.11
Completely agree	3	7.89	38	100.00

Chi-Square Test for Equal Proportions

Chi-Square	17.5789
DF	5
Pr > ChiSq	0.0035

Sample Size = 38

Q2_09	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	13	34.21	13	34.21

Mostly disagree	1	2.63	14	36.84
Slightly disagree	6	15.79	20	52.63
Slightly agree	10	26.32	30	78.95
Mostly agree	5	13.16	35	92.11
Completely agree	3	7.89	38	100.00

Chi-Square Test

for Equal Proportions

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Chi-Square 15.6842

DF 5

Pr > ChiSq 0.0078

Sample Size = 38

Q2_10	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	14	36.84	14	36.84
Mostly disagree	1	2.63	15	39.47
Slightly disagree	7	18.42	22	57.89
Undecided	4	10.53	26	68.42
Slightly agree	6	15.79	32	84.21
Mostly agree	4	10.53	36	94.74
Completely agree	2	5.26	38	100.00

Chi-Square Test

for Equal Proportions

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Chi-Square 20.5789

DF 6

Pr > ChiSq 0.0022

Sample Size = 38

Q2_11	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	13	34.21	13	34.21
Mostly disagree	1	2.63	14	36.84
Slightly agree	1	2.63	15	39.47

Mostly agree	6	15.79	21	55.26
Completely agree	17	44.74	38	100.00

Chi-Square Test

for Equal Proportions

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Chi-Square 27.2632

DF 4

Pr > ChiSq <.0001

Sample Size = 38

Q2_12	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	14	36.84	14	36.84
Slightly disagree	4	10.53	18	47.37
Undecided	1	2.63	19	50.00
Slightly agree	8	21.05	27	71.05
Mostly agree	6	15.79	33	86.84
Completely agree	5	13.16	38	100.00

Chi-Square Test

for Equal Proportions

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Chi-Square 15.3684

DF 5

Pr > ChiSq 0.0089

Sample Size = 38

Q2_13	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	13	34.21	13	34.21
Mostly disagree	2	5.26	15	39.47
Slightly disagree	10	26.32	25	65.79
Undecided	4	10.53	29	76.32
Slightly agree	3	7.89	32	84.21
Mostly agree	4	10.53	36	94.74
Completely agree	2	5.26	38	100.00

Chi-Square Test

for Equal Proportions

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Chi-Square 20.5789

DF 6

Pr > ChiSq 0.0022

Sample Size = 38

Q2_14	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	14	36.84	14	36.84
Slightly disagree	2	5.26	16	42.11
Undecided	1	2.63	17	44.74
Slightly agree	10	26.32	27	71.05
Mostly agree	8	21.05	35	92.11
Completely agree	3	7.89	38	100.00

Chi-Square Test

for Equal Proportions

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Chi-Square 21.0526

DF 5

Pr > ChiSq 0.0008

Sample Size = 38

Q2_15	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	14	36.84	14	36.84
Completely disagree	1	2.63	15	39.47
Slightly disagree	5	13.16	20	52.63
Undecided	3	7.89	23	60.53
Slightly agree	5	13.16	28	73.68
Mostly agree	6	15.79	34	89.47
Completely agree	4	10.53	38	100.00

Chi-Square Test

for Equal Proportions

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Chi-Square 18.7368

DF 6

Pr > ChiSq 0.0046

Sample Size = 38

Variable: Q2_01 (Q2_01)

N	25	Sum Weights	25
Mean	6.56	Sum Observations	164
Std Deviation	0.65064071	Variance	0.42333333
Skewness	-1.2265055	Kurtosis	0.50734726
Uncorrected SS	1086	Corrected SS	10.16
Coeff Variation	9.9183035	Std Error Mean	0.13012814

Basic Statistical Measures

Location		Variability	
Mean	6.560000	Std Deviation	0.65064
Median	7.000000	Variance	0.42333
Mode	7.000000	Range	2.00000
		Interquartile Range	1.00000

Quantiles (Definition 5)

Quantile	Estimate
100% Max	7
99%	7
95%	7
90%	7
75% Q3	7
50% Median	7
25% Q1	6
10%	6
5%	5
1%	5
0% Min	5

Variable: Q2_02 (Q2_02)

N	25	Sum Weights	25
Mean	6.28	Sum Observations	157
Std Deviation	0.54160256	Variance	0.29333333
Skewness	0.1532562	Kurtosis	-0.3466664
Uncorrected SS	993	Corrected SS	7.04
Coeff Variation	8.62424459	Std Error Mean	0.10832051

Basic Statistical Measures

Location		Variability	
Mean	6.280000	Std Deviation	0.54160
Median	6.000000	Variance	0.29333
Mode	6.000000	Range	2.00000
		Interquartile Range	1.00000

Quantiles (Definition 5)

Quantile	Estimate
100% Max	7
99%	7
95%	7
90%	7
75% Q3	7
50% Median	6
25% Q1	6
10%	6
5%	6
1%	5
0% Min	5

Variable: Q2_03 (Q2_03)

N	25	Sum Weights	25
Mean	6.64	Sum Observations	166
Std Deviation	0.86023253	Variance	0.74
Skewness	-3.4614749	Kurtosis	13.857234
Uncorrected SS	1120	Corrected SS	17.76
Coeff Variation	12.9553091	Std Error Mean	0.17204651

Basic Statistical Measures

Location		Variability	
Mean	6.640000	Std Deviation	0.86023
Median	7.000000	Variance	0.74000
Mode	7.000000	Range	4.00000
		Interquartile Range	0

Quantiles (Definition 5)

Quantile	Estimate
100% Max	7

99%	7
95%	7
90%	7
75% Q3	7
50% Median	7
25% Q1	7
10%	6
5%	6
1%	3
0% Min	3

Variable: Q2_04 (Q2_04)

N	25	Sum Weights	25
Mean	5.84	Sum Observations	146
Std Deviation	1.28062485	Variance	1.64
Skewness	-1.229268	Kurtosis	0.8328376
Uncorrected SS	892	Corrected SS	39.36
Coeff Variation	21.9285077	Std Error Mean	0.25612497

Basic Statistical Measures

Location		Variability	
Mean	5.840000	Std Deviation	1.28062
Median	6.000000	Variance	1.64000
Mode	6.000000	Range	4.00000
		Interquartile Range	2.00000

Quantiles (Definition 5)

Quantile	Estimate
100% Max	7
99%	7
95%	7
90%	7
75% Q3	7
50% Median	6
25% Q1	5
10%	3
5%	3
1%	3

0% Min	3

Variable: Q2_05 (Q2_05)

N	25	Sum Weights	25
Mean	6.52	Sum Observations	163
Std Deviation	0.87177979	Variance	0.76
Skewness	-2.9372564	Kurtosis	10.9442918
Uncorrected SS	1081	Corrected SS	18.24
Coeff Variation	13.3708557	Std Error Mean	0.17435596

Basic Statistical Measures

Location		Variability	
Mean	6.520000	Std Deviation	0.87178
Median	7.000000	Variance	0.76000
Mode	7.000000	Range	4.00000
		Interquartile Range	1.00000

Quantiles (Definition 5)

Quantile	Estimate
100% Max	7
99%	7
95%	7
90%	7
75% Q3	7
50% Median	7
25% Q1	6
10%	6
5%	6
1%	3
0% Min	3

Variable: Q2_06 (Q2_06)

N	25	Sum Weights	25
Mean	6.4	Sum Observations	160
Std Deviation	0.57735027	Variance	0.33333333
Skewness	-0.2823996	Kurtosis	-0.7173913
Uncorrected SS	1032	Corrected SS	8

Coeff Variation	9.02109796	Std Error Mean	0.11547005

Basic Statistical Measures

Location		Variability	
Mean	6.400000	Std Deviation	0.57735
Median	6.000000	Variance	0.33333
Mode	6.000000	Range	2.00000
		Interquartile Range	1.00000

Quantiles (Definition 5)

Quantile	Estimate
100% Max	7
99%	7
95%	7
90%	7
75% Q3	7
50% Median	6
25% Q1	6
10%	6
5%	6
1%	5
0% Min	5

Variable: Q2_07 (Q2_07)

N	25	Sum Weights	25
Mean	5.84	Sum Observations	146
Std Deviation	1.106044	Variance	1.22333333
Skewness	-0.8637424	Kurtosis	0.33886585
Uncorrected SS	882	Corrected SS	29.36
Coeff Variation	18.9391096	Std Error Mean	0.2212088

Basic Statistical Measures

Location		Variability	
Mean	5.840000	Std Deviation	1.10604
Median	6.000000	Variance	1.22333
Mode	6.000000	Range	4.00000
		Interquartile Range	2.00000

Quantiles (Definition 5)

Quantile	Estimate
100% Max	7
99%	7
95%	7
90%	7
75% Q3	7
50% Median	6
25% Q1	5
10%	4
5%	4
1%	3
0% Min	3

Variable: Q2_08 (Q2_08)

N	25	Sum Weights	25
Mean	4.52	Sum Observations	113
Std Deviation	1.44683563	Variance	2.09333333
Skewness	0.31567472	Kurtosis	-1.1950011
Uncorrected SS	561	Corrected SS	50.24
Coeff Variation	32.0096378	Std Error Mean	0.28936713

Basic Statistical Measures

Location		Variability	
Mean	4.520000	Std Deviation	1.44684
Median	5.000000	Variance	2.09333
Mode	3.000000	Range	4.00000
		Interquartile Range	2.00000

Quantiles (Definition 5)

Quantile	Estimate
100% Max	7
99%	7
95%	7
90%	7
75% Q3	5
50% Median	5
25% Q1	3

10%	3
5%	3
1%	3
0% Min	3

Variable: Q2_09 (Q2_09)

N	25	Sum Weights	25
Mean	4.84	Sum Observations	121
Std Deviation	1.43410832	Variance	2.05666667
Skewness	-0.3409588	Kurtosis	-0.7805973
Uncorrected SS	635	Corrected SS	49.36
Coeff Variation	29.6303371	Std Error Mean	0.28682166

Basic Statistical Measures

Location		Variability	
Mean	4.840000	Std Deviation	1.43411
Median	5.000000	Variance	2.05667
Mode	5.000000	Range	5.00000
		Interquartile Range	3.00000

Quantiles (Definition 5)

Quantile	Estimate
100% Max	7
99%	7
95%	7
90%	7
75% Q3	6
50% Median	5
25% Q1	3
10%	3
5%	3
1%	2
0% Min	2

Variable: Q2_10 (Q2_10)

N	24	Sum Weights	24
Mean	4.45833333	Sum Observations	107

Std Deviation	1.41357292	Variance	1.99818841
Skewness	0.19305132	Kurtosis	-0.9611148
Uncorrected SS	523	Corrected SS	45.9583333
Coeff Variation	31.7063085	Std Error Mean	0.28854436

Basic Statistical Measures

Location		Variability	
Mean	4.458333	Std Deviation	1.41357
Median	4.500000	Variance	1.99819
Mode	3.000000	Range	5.00000
		Interquartile Range	2.50000

Quantiles (Definition 5)

Quantile	Estimate
100% Max	7.0
99%	7.0
95%	7.0
90%	6.0
75% Q3	5.5
50% Median	4.5
25% Q1	3.0
10%	3.0
5%	3.0
1%	2.0
0% Min	2.0

Variable: Q2_11 (Q2_11)

N	25	Sum Weights	25
Mean	6.48	Sum Observations	162
Std Deviation	1.08474267	Variance	1.17666667
Skewness	-3.244228	Kurtosis	12.4032654
Uncorrected SS	1078	Corrected SS	28.24
Coeff Variation	16.7398561	Std Error Mean	0.21694853

Basic Statistical Measures

Location		Variability	
Mean	6.480000	Std Deviation	1.08474
Median	7.000000	Variance	1.17667

Mode	7.000000	Range	5.00000
		Interquartile Range	1.00000

Quantiles (Definition 5)

Quantile	Estimate
100% Max	7
99%	7
95%	7
90%	7
75% Q3	7
50% Median	7
25% Q1	6
10%	6
5%	5
1%	2
0% Min	2

Variable: Q2_12 (Q2_12)

N	24	Sum Weights	24
Mean	5.29166667	Sum Observations	127
Std Deviation	1.3344651	Variance	1.7807971
Skewness	-0.4677201	Kurtosis	-0.6349789
Uncorrected SS	713	Corrected SS	40.9583333
Coeff Variation	25.2182381	Std Error Mean	0.27239655

Basic Statistical Measures

Location		Variability	
Mean	5.291667	Std Deviation	1.33447
Median	5.000000	Variance	1.78080
Mode	5.000000	Range	4.00000
		Interquartile Range	1.00000

Quantiles (Definition 5)

Quantile	Estimate
100% Max	7
99%	7
95%	7
90%	7

75% Q3	6
50% Median	5
25% Q1	5
10%	3
5%	3
1%	3
0% Min	3

Variable: Q2_13 (Q2_13)

N	25	Sum Weights	25
Mean	4.12	Sum Observations	103
Std Deviation	1.50886271	Variance	2.27666667
Skewness	0.57069389	Kurtosis	-0.8799033
Uncorrected SS	479	Corrected SS	54.64
Coeff Variation	36.6228812	Std Error Mean	0.30177254

Basic Statistical Measures

Location		Variability	
Mean	4.120000	Std Deviation	1.50886
Median	4.000000	Variance	2.27667
Mode	3.000000	Range	5.00000
		Interquartile Range	2.00000

Quantiles (Definition 5)

Quantile	Estimate
100% Max	7
99%	7
95%	7
90%	6
75% Q3	5
50% Median	4
25% Q1	3
10%	3
5%	2
1%	2
0% Min	2

Variable: Q2_14 (Q2_14)

N	24	Sum Weights	24
Mean	5.375	Sum Observations	129
Std Deviation	1.05552377	Variance	1.11413043
Skewness	-0.6087708	Kurtosis	0.6382719
Uncorrected SS	719	Corrected SS	25.625
Coeff Variation	19.6376516	Std Error Mean	0.21545789

Basic Statistical Measures

Location		Variability	
Mean	5.375000	Std Deviation	1.05552
Median	5.000000	Variance	1.11413
Mode	5.000000	Range	4.00000
		Interquartile Range	1.00000

Quantiles (Definition 5)

Quantile	Estimate
100% Max	7
99%	7
95%	7
90%	7
75% Q3	6
50% Median	5
25% Q1	5
10%	4
5%	3
1%	3
0% Min	3

Variable: Q2_15 (Q2_15)

N	24	Sum Weights	24
Mean	4.875	Sum Observations	117
Std Deviation	1.62353613	Variance	2.63586957
Skewness	-0.5122631	Kurtosis	-0.3451462
Uncorrected SS	631	Corrected SS	60.625
Coeff Variation	33.3033052	Std Error Mean	0.33140292

Basic Statistical Measures

Location		Variability	
Mean	4.875000	Std Deviation	1.62354
Median	5.000000	Variance	2.63587
Mode	6.000000	Range	6.00000
		Interquartile Range	2.50000

Quantiles (Definition 5)

Quantile	Estimate
100% Max	7.0
99%	7.0
95%	7.0
90%	7.0
75% Q3	6.0
50% Median	5.0
25% Q1	3.5
10%	3.0
5%	3.0
1%	1.0
0% Min	1.0

6.10.4 Annexure D: Inferential statistics for supply chain survey

Wilcoxon Scores (Rank Sums) for Variable Q2_01

Classified by Variable Q1_0

Q1_0	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
The supplier of raw materials	6	62.0	75.0	12.448153	10.333333
A road contractor	10	128.0	125.0	14.172846	12.800000
The producer of asphalt	8	110.0	100.0	13.551833	13.750000

Kruskal-Wallis Test

Chi-Square	1.2071
DF	2
Pr > Chi-Square	0.5469

Wilcoxon Scores (Rank Sums) for Variable Q2_02

Classified by Variable Q1_0

Q1_0	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
The supplier of raw materials	6	77.00	75.0	12.727922	12.833333
A road contractor	10	116.50	125.0	14.491377	11.650000
The producer of asphalt	8	106.50	100.0	13.856406	13.312500

Kruskal-Wallis Test

Chi-Square	0.3659
DF	2
Pr > Chi-Square	0.8328

Wilcoxon Scores (Rank Sums) for Variable Q2_03

Classified by Variable Q1_0

Q1_0	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
The supplier of raw materials	6	58.50	75.0	11.324752	9.7500
A road contractor	10	140.50	125.0	12.893797	14.0500

The producer of asphalt	8	101.00	100.0	12.328828	12.6250

Kruskal-Wallis Test

Chi-Square	2.4395
DF	2
Pr > Chi-Square	0.2953

Wilcoxon Scores (Rank Sums) for Variable Q2_04

Classified by Variable Q1_0

Q1_0	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
The supplier of raw materials	6	82.50	75.0	14.271437	13.75000
A road contractor	10	119.00	125.0	16.248746	11.90000
The producer of asphalt	8	98.50	100.0	15.536773	12.31250

Kruskal-Wallis Test

Chi-Square	0.2929
DF	2
Pr > Chi-Square	0.8638

Wilcoxon Scores (Rank Sums) for Variable Q2_05

Classified by Variable Q1_0

Q1_0	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
The supplier of raw materials	6	90.50	75.0	12.727922	15.083333
A road contractor	10	131.00	125.0	14.491377	13.100000
The producer of asphalt	8	78.50	100.0	13.856406	9.812500

Kruskal-Wallis Test

Chi-Square	2.8173
DF	2
Pr > Chi-Square	0.2445

Wilcoxon Scores (Rank Sums) for Variable Q2_06

Classified by Variable Q1_0

Q1_0	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score

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The supplier of raw materials	6	73.00	75.0	13.247641	12.166667
A road contractor	10	109.50	125.0	15.083103	10.950000
The producer of asphalt	8	117.50	100.0	14.422205	14.687500

Kruskal-Wallis Test

Chi-Square	1.6147
DF	2
Pr > Chi-Square	0.4460

Wilcoxon Scores (Rank Sums) for Variable Q2_07

Classified by Variable Q1_0

Q1_0	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
The supplier of raw materials	6	61.50	75.0	14.370486	10.25000
A road contractor	10	113.00	125.0	16.361518	11.30000
The producer of asphalt	8	125.50	100.0	15.644604	15.68750

Kruskal-Wallis Test

Chi-Square	2.7468
DF	2
Pr > Chi-Square	0.2532

Wilcoxon Scores (Rank Sums) for Variable Q2_08

Classified by Variable Q1_0

Q1_0	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
The supplier of raw materials	6	79.50	75.0	14.137139	13.25000
A road contractor	10	123.00	125.0	16.095841	12.30000
The producer of asphalt	8	97.50	100.0	15.390567	12.18750

Kruskal-Wallis Test

Chi-Square	0.1026
DF	2
Pr > Chi-Square	0.9500

Wilcoxon Scores (Rank Sums) for Variable Q2_09

Classified by Variable Q1_0

Q1_0	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
The supplier of raw materials	6	97.00	75.0	14.404483	16.166667
A road contractor	10	89.50	125.0	16.400225	8.950000
The producer of asphalt	8	113.50	100.0	15.681615	14.187500

Kruskal-Wallis Test

Chi-Square	4.9768
DF	2
Pr > Chi-Square	0.0830

Wilcoxon Scores (Rank Sums) for Variable Q2_10

Classified by Variable Q1_0

Q1_0	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
The supplier of raw materials	5	82.50	60.0	13.043330	16.50000
A road contractor	10	91.00	120.0	15.676132	9.10000
The producer of asphalt	8	102.50	96.0	15.061140	12.81250

Kruskal-Wallis Test

Chi-Square	4.3846
DF	2
Pr > Chi-Square	0.1117

Wilcoxon Scores (Rank Sums) for Variable Q2_11

Classified by Variable Q1_0

Q1_0	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
The supplier of raw materials	6	58.0	75.0	11.905881	9.666667
A road contractor	10	137.0	125.0	13.555442	13.700000
The producer of asphalt	8	105.0	100.0	12.961481	13.125000

Kruskal-Wallis Test

Chi-Square	2.0854
DF	2

Pr > Chi-Square 0.3525

Wilcoxon Scores (Rank Sums) for Variable Q2_12

Classified by Variable Q1_0

Q1_0	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
The supplier of raw materials	5	46.50	60.0	12.964683	9.30000
A road contractor	10	106.00	120.0	15.581610	10.60000
The producer of asphalt	8	123.50	96.0	14.970326	15.43750

Kruskal-Wallis Test

Chi-Square 3.5056

DF 2

Pr > Chi-Square 0.1733

Wilcoxon Scores (Rank Sums) for Variable Q2_13

Classified by Variable Q1_0

Q1_0	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
The supplier of raw materials	6	79.0	75.0	14.384094	13.166667
A road contractor	10	104.0	125.0	16.377012	10.400000
The producer of asphalt	8	117.0	100.0	15.659419	14.625000

Kruskal-Wallis Test

Chi-Square 1.8028

DF 2

Pr > Chi-Square 0.4060

Wilcoxon Scores (Rank Sums) for Variable Q2_14

Classified by Variable Q1_0

Q1_0	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
The supplier of raw materials	5	50.50	60.0	12.704843	10.10000
A road contractor	10	113.00	120.0	15.269321	11.30000
The producer of asphalt	8	112.50	96.0	14.670289	14.06250

Kruskal-Wallis Test

Chi-Square 1.3814

DF 2

Pr > Chi-Square 0.5012

Wilcoxon Scores (Rank Sums) for Variable Q2_15

Classified by Variable Q1_0

Q1_0	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
The supplier of raw materials	6	91.0	72.0	13.986936	15.166667
A road contractor	10	91.0	120.0	15.790438	9.100000
The producer of asphalt	7	94.0	84.0	14.656542	13.428571

Kruskal-Wallis Test

Chi-Square 3.5942

DF 2

Pr > Chi-Square 0.1658

6.10.5 Annexure E: Table 5.7

TABLE 5. 7: Descriptive statistics for categorical variables

Variables	Categories	Frequency	Percentage out of total
Biographical variables			
A. Participant in supply chain.	A road contractor	10	40.0%
	The supplier of raw materials	6	24.0%
	The producer of asphalt.	8	32.0%
	Unknown	1	4.0%
Managing the supply chain function			
1. Managing the processes within the supply chain has a major financial impact on the parties involved in the chain.	Completely disagree	0	0.0%
	Mostly disagree	0	0.0%
	Slightly disagree	0	0.0%
	Undecided	0	0.0%
	Slightly agree	2	8.0%
	Mostly agree	7	28.0%
	Completely agree	16	64.0%
	Unknown	0	0.0%
2. Increased reliability between partners in a supply chain increases trust.	Completely disagree	0	0.0%
	Mostly disagree	0	0.0%
	Slightly disagree	0	0.0%
	Undecided	0	0.0%
	Slightly agree	1	4.0%
	Mostly agree	16	64.0%
	Completely agree	8	32.0%

Variables	Categories	Frequency	Percentage out of total
	Unknown	0	0.0%
3. It is important for members of the supply chain to establish the same goal and focus on serving the customer.	Completely disagree	0	0.0%
	Mostly disagree	0	0.0%
	Slightly disagree	1	4.0%
	Undecided	0	0.0%
	Slightly agree	0	0.0%
	Mostly agree	5	20.0%
	Completely agree	19	76.0%
	Unknown	0	0.0%
4. There are cooperative arrangements that tie the contractor; the supplier and the producer of asphalt to each other and in that way their success to the chain as a whole.	Completely disagree	0	0.0%
	Mostly disagree	0	0.0%
	Slightly disagree	3	12.0%
	Undecided	0	0.0%
	Slightly agree	4	16.0%
	Mostly agree	9	36.0%
	Completely agree	9	36.0%
	Unknown	0	0.0%
5. The supply chain partners must work together towards improving the internal processes that will lead to the improvement of the service level agreements.	Completely disagree	0	0.0%
	Mostly disagree	0	0.0%
	Slightly disagree	1	4.0%
	Undecided	0	0.0%
	Slightly agree	0	0.0%
	Mostly agree	8	32.0%
	Completely agree	16	64.0%
	Unknown	0	0.0%

Variables	Categories	Frequency	Percentage out of total
Continual improvement of internal processes			
6. It is important to improve the internal processes of the company before successful supply chain processes can be improved.	Completely disagree	0	0.0%
	Mostly disagree	0	0.0%
	Slightly disagree	0	0.0%
	Undecided	0	0.0%
	Slightly agree	1	4.0%
	Mostly agree	13	52.0%
	Completely agree	11	44.0%
	Unknown	0	0.0%
7. Nothing can be improved without the right people with the right competences.	Completely disagree	0	0.0%
	Mostly disagree	0	0.0%
	Slightly disagree	1	4.0%
	Undecided	2	8.0%
	Slightly agree	5	20.0%
	Mostly agree	9	36.0%
	Completely agree	8	32.0%
	Unknown	0	0.0%
8. People are trained at the jobs that they do and they are competent in doing them.	Completely disagree	0	0.0%
	Mostly disagree	0	0.0%
	Slightly disagree	10	40.0%
	Undecided	1	4.0%
	Slightly agree	8	32.0%
	Mostly agree	3	12.0%
	Completely agree	3	12.0%
	Unknown	0	0.0%

Variables	Categories	Frequency	Percentage out of total
9. There is an effective measurement system that monitors the internal process to ensure conformance to specification.	Completely disagree	0	0.0%
	Mostly disagree	1	4.0%
	Slightly disagree	6	24.0%
	Undecided	0	0.0%
	Slightly agree	10	40.0%
	Mostly agree	5	20.0%
	Completely agree	3	12.0%
	Unknown	0	0.0%
10. The organisation is not lacking direction in terms of vision and its performance measurement systems.	Completely disagree	0	0.0%
	Mostly disagree	1	4.0%
	Slightly disagree	7	28.0%
	Undecided	4	16.0%
	Slightly agree	6	24.0%
	Mostly agree	4	16.0%
	Completely agree	2	8.0%
	Unknown	1	4.0%
Customer satisfaction			
11. In order to ensure the satisfaction of the ultimate customer (the road end-user, the commuters); the customers within the supply chain must be satisfied with quality of the relative products.	Completely disagree	0	0.0%
	Mostly disagree	1	4.0%
	Slightly disagree	1	4.0%
	Undecided	0	0.0%
	Slightly agree	0	0.0%
	Mostly agree	6	24.0%
	Completely agree	17	68.0%
	Unknown	0	0.0%

Variables	Categories	Frequency	Percentage out of total
12. The quality of the asphalt on national roads is dependent on the quality of the raw materials from the suppliers of raw materials.	Completely disagree	0	0.0%
	Mostly disagree	0	0.0%
	Slightly disagree	4	16.0%
	Undecided	1	4.0%
	Slightly agree	8	32.0%
	Mostly agree	6	24.0%
	Completely agree	5	20.0%
	Unknown	1	4.0%
13. There are clear ownership and mechanisms in place to ensure immediate corrective actions in case of product failure.	Completely disagree	0	0.0%
	Mostly disagree	2	8.0%
	Slightly disagree	10	40.0%
	Undecided	4	16.0%
	Slightly agree	3	12.0%
	Mostly agree	4	16.0%
	Completely agree	2	8.0%
	Unknown	0	0.0%
14. The cost of quality should be borne by all members of the supply chain.	Completely disagree	0	0.0%
	Mostly disagree	0	0.0%
	Slightly disagree	2	8.0%
	Undecided	1	4.0%
	Slightly agree	10	40.0%
	Mostly agree	8	32.0%
	Completely agree	3	12.0%
	Unknown	1	4.0%
15. Customer service strategies	Completely	1	4.0%

Variables	Categories	Frequency	Percentage out of total
are clearly documented and communicated.	disagree		
	Mostly disagree	0	0.0%
	Slightly disagree	5	20.0%
	Undecided	3	12.0%
	Slightly agree	5	20.0%
	Mostly agree	6	24.0%
	Completely agree	4	16.0%
	Unknown	1	4.0%

6.10.6 ANNEXURE F: TABLE 5.8

TABLE 5. 8: Descriptive statistics for the statements.

Variable	N	Mean	Median	Standard Deviation	Range
Managing the supply chain function					
1. Managing the processes within the supply chain has a major financial impact on the parties involved in the chain.	25	6.56	7.00	0.6506	2
2. Increased reliability between partners in a supply chain increases trust.	25	6.28	6.00	0.5416	2
3. It is important for members of the supply chain to establish the same goal and focus on serving the customer.	25	6.64	7.00	0.8302	4
4. There are cooperative arrangements that tie the contractor; the supplier and the producer of asphalt to each other and in that way their success to the chain as a whole.	25	5.84	6.00	1.2806	4
5. The supply chain partners must work together towards improving the internal processes that will lead to the improvement of the service level agreements.	25	6.52	7.00	0.8718	4
Continual improvement of internal processes					
6. It is important to improve the internal processes of the company before successful supply chain processes can be improved.	25	6.40	6.00	0.5774	2
7. Nothing can be improved without the right people with the right competences.	25	5.84	6.00	1.1060	4
8. People are trained at the jobs that they do and they are competent in doing them.	25	4.52	5.00	1.4468	4
9. There is an effective measurement system that monitors the internal process to ensure conformance to specification.	25	4.84	5.00	1.4341	5
10. The organisation is not lacking direction in terms	24	4.46	4.50	1.4136	5

of vision and its performance measurement systems.					
Customer satisfaction					
11. In order to ensure the satisfaction of the ultimate customer (the road end-user, the commuters); the customers within the supply chain must be satisfied with quality of the relative products.	25	6.48	7.00	1.0847	5
12. The quality of the asphalt on national roads is dependent on the quality of the raw materials from the suppliers of raw materials.	24	5.29	5.00	1.3345	4
13. There are clear ownership and mechanisms in place to ensure immediate corrective actions in case of product failure.	25	4.12	4.00	1.5089	5
14. The cost of quality should be borne by all members of the supply chain.	24	5.38	5.00	1.0555	4
15. Customer service strategies are clearly documented and communicated.	24	4.88	5.00	1.6235	6

1.1.7 Annexure G: Table 5.9

TABLE 5. 9: Test statistics showing the comparison between type in supply chain.

Type	Statistics	Road contractor	Supplier raw materials	Producer of asphalt
Managing the supply chain function				
1. Managing the processes within the supply chain has a major financial impact on the parties involved in the chain.	N	10	6	8
	Mean score	12.80	10.33	13.75
	Chi-Square			1.2071
	P-Value			0.5469
2. Increased reliability between partners in a supply chain increases trust.	N	10	6	8
	Mean score	11.65	12.83	13.31
	Chi-Square			0.3659
	P-Value			0.8328
3. It is important for members of the supply chain to establish the same goal and focus on serving the customer.	N	10	6	8
	Mean score	14.05	9.75	12.62
	Chi-Square			2.4395
	P-Value			0.2953
4. There are cooperative arrangements that tie the contractor; the supplier and the producer of asphalt to each other and in that way their success to the chain as a whole.	N	10	6	8
	Mean score	11.90	13.75	12.31
	Chi-Square			0.2929

	P-Value			0.8638
5. The supply chain partners must work together towards improving the internal processes that will lead to the improvement of the service level agreements.	N	10	6	8
	Mean score	13.10	15.08	9.81
	Chi-Square			2.8173
	P-Value			0.2445
Continual improvement of internal processes				
6. It is important to improve the internal processes of the company before successful supply chain processes can be improved.	N	10	6	8
	Mean score	10.95	12.17	14.69
	Chi-Square			1.6147
	P-Value			0.4460
7. Nothing can be improved without the right people with the right competences.	N	10	6	8
	Mean score	11.30	10.25	15.69
	Chi-Square			2.7468
	P-Value			0.2532
8. People are trained at the jobs that they do and they are competent in doing them.	N	10	6	8
	Mean score	12.30	13.25	12.19
	Chi-Square			0.1026
	P-Value			0.9500
9. There is an effective measurement system that monitors the internal process to ensure conformance to specification.	N	10	6	8
	Mean	8.95	16.17	14.19

	score			
	Chi-Square			4.9768
	P-Value			0.0830
10. The organisation is not lacking direction in terms of vision and its performance measurement systems.	N	10	5	8
	Mean score	9.10	16.50	12.81
	Chi-Square			4.3846
	P-Value			0.1117
Customer satisfaction				
11. In order to ensure the satisfaction of the ultimate customer (the road end-user, the commuters); the customers within the supply chain must be satisfied with quality of the relative products.	N	10	6	8
	Mean score	13.70	9.67	13.12
	Chi-Square			2.0854
	P-Value			0.3525
12. The quality of the asphalt on national roads is dependent on the quality of the raw materials from the suppliers of raw materials.	N	10	5	8
	Mean score	10.60	9.30	15.44
	Chi-Square			3.5056
	P-Value			0.1733
13. There are clear ownership and mechanisms in place to ensure immediate corrective actions in case of product failure.	N	10	6	8
	Mean score	10.40	13.17	14.62
	Chi-			1.8028

	Square			
	P-Value			0.4060
14. The cost of quality should be borne by all members of the supply chain.	N	10	5	8
	Mean score	11.30	10.10	14.06
	Chi-Square			1.3814
	P-Value			0.5012
15. Customer service strategies are clearly documented and communicated.	N	10	6	8
	Mean score	9.10	15.17	13.13
	Chi-Square			3.5942
	P-Value			0.1658