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Abstract [Provide an abstract of the mini-dissertation. An abstract is a short summary of the contents covered in the item.]	This project analyses the current supply chain at Mercedes-Benz Bus using the SCOR model and is followed by the development of a potential solution to improve the visibility level.
Category [Enter the category in which the project was done. E.g. Operations Research, Simulation, Logistics…]	Supply Chain, Logistics,

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IMPROVING SUPPLY CHAIN VISIBILITY AT

MERCEDES-BENZ BUS

by

TASNEEM MUKADAM

A project submitted in partial fulfilment of the requirements for the
degree
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Executive Summary

Supply chain visibility can be viewed as the transparency of a company's supply chain as well as the level of information sharing, collaboration and integration between the partners in the supply chain. Many firms struggle with obtaining a high level of visibility; which is in fact necessary as it ensures that the supply chain performs well. Mercedes-Benz South Africa (MBSA), one of the leading automotive companies in South Africa, is one such firm facing this issue. One of the company's prominent products, the Mercedes-Benz (MB) Bus, is the result of a complex supply chain where visibility between different partners is a constant challenge. This report focuses on the analysis of the current supply chain and the development of a potential solution.

To begin with, an extensive literature review is presented, which explores the supply chain industry and its various trends. The review highlights the supply chain of the automotive industry and various supply chain analysis tools. This phase makes use of the Supply Chain Operations Reference (SCOR) framework and the general visibility model to map the current process and identify areas of poor visibility. Lack of communication between the members in the supply chain as well as inefficient procedures for product tracking appear to be the main causes for poor visibility. The analysis identifies three areas of major concern: the inefficiency of the collaboration between MBSA and the supplier MB Brazil, the capability of the carrier and the communication between MBSA and the bodybuilder.

An analysis of the current metrics is conducted to further investigate the problem. The current metrics are analysed and are found to be more indicative of process outcomes rather than supply chain visibility. This leads to the development of a new set of metrics used to measure the level of visibility throughout the supply chain.

These metrics are then used to perform an internal benchmark. Due to the process similarity and a recommendation from the supply chain manager, the MBSA Van department was chosen for this benchmarking.

Subsequently, findings from the analysis are used in the solution development phase where an improvement plan is developed. The solution proposes implementing service level agreements between the respective parties within the MB Bus supply chain. This is followed by an Analytic Hierarchy Process (AHP) to select the best carrier and improve visibility in the delivery process.

The conditions stipulated in the service agreements are then used as a guide for the development of an improved process, which is aimed at bettering communication activities

between the parties. An order tracking tool, developed using Microsoft Excel, is used to facilitate the new process.

Lastly, a brief best practice analysis is conducted to determine the suitability of the practices listed in the SCOR framework. The range of technological solutions for increased visibility is highlighted in this section.

The report concludes with a discussion of the findings of the analysis and the subsequent solution development. Further recommendations are made to ensure the success of the proposed solution and ultimately improve the visibility of the MB Bus supply chain.

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List of Abbreviations

AHP - Analytic Hierarchy Process

BP - Best Practices

CKD - Completely Knocked Down

CV - Commercial Vehicles

CVDS - Commercial Vehicle Delivery Service

EL – East London

FBU - Fully Built Up

FMCDM - Fuzzy Multiple Criteria Decision Making

IT - Information Technology

MB - Mercedes-Benz

MBSA - Mercedes-Benz South Africa

PKD - Partially Knocked Down

RFID – Radio Frequency Identification

SA - South Africa

SCOR - Supply Chain Operations Reference

SLA – Service Level Agreement

3PL - Third Party Logistics

Chapter 1: Introduction

1.1 Company Background

MBSA is a subsidiary of the global motor manufacturer, Daimler AG. The company has a history of over 60 years in South Africa as a committed corporate citizen as well as being a supplier of both passenger cars and commercial vehicles.

MBSA headquarters, marketing and support divisions are located in Zwartkop, Gauteng. It is here that the Mercedes-Benz, Smart, Freightliner, Western Star and FUSO products are marketed and financed. The manufacturing plant is located in East London (EL), where the company manufactures the Mercedes-Benz C-Class model for the local and US market. The assembly of the Mercedes-Benz commercial vehicles and buses, FUSO trucks, and Freightliner trucks (Mercedes-Benz, n.d.) also occurs at the MB EL plant. The commercial division of the company produces a range of vehicles which include:

1. Mercedes-Benz Vans (for passenger and commercial use)
2. Mercedes-Benz Trucks
3. Freightliner Trucks
4. Fuso Trucks
5. Mercedes-Benz Busses

1.2 Problem Introduction

The bus department is especially complex as its' supply chain does not conform to that of the other commercial vehicles.

The process begins at the MBSA headquarters in Pretoria, where an order for bus chassis (completely knocked down (CKD) kits and partially knocked down (PKD) kits), based on demand forecast and sales information is formulated. The order is then sent to the MB manufacturing plant in Brazil. On receipt of this order, MB Brazil will send MBSA an order confirmation and a lead time for delivery of the chassis, which is usually approximated at 90 days. However, no expected delivery date is given and MBSA is only notified of the shipment arrival one or two days before, or occasionally after, the actual arrival at the port in Port Elizabeth.

The CKD and PKD (chassis) kits are then transported, by Safmarine Vessels, to the MB manufacturing plant in East London where the chassis are assembled. During production at this plant, MBSA headquarters can effectively track the production progress via the MB SAP system.

The assembled chassis are then moved and stored at either a stockyard or a body builder until an order is placed. MBSA utilises three stockyards for chassis storage purposes, one of which is located in East London and the other two in Gauteng.

Joint stock units are stored at the bodybuilder instead of at a stockyard, as per agreement between MBSA and the respective body builder. The reason for this is twofold: firstly, it is a strategic decision as it decreases the lead time for the production of busses, thus increasing sales and secondly, it protects the chassis from damage and harsh environmental conditions that may occur at the stockyard.

The transportation between the plant, stockyard and bodybuilder is outsourced to a third party logistics company, Commercial Vehicle Delivery Services (CVDS), who is responsible for all commercial vehicle transportation. However, this company contracts the bus transportation to another logistics provider, Eagle Trans, as they are better equipped for moving the bus chassis. During this phase, MBSA has limited ability to track the progress or position of the units.

There are five body builders that work with the MB Bus Department. One of the bodybuilders is located in Cape Town, while the other four are located in Gauteng. The choice of body builder is determined by the customer. At the body builder, the body of the bus is built on to the chassis. This is done according to the customer specification, which can vary significantly. The production however, must conform to the standards set out by MBSA. As the body builder is an external partner in the supply chain, it is difficult for MBSA to track the progress of the units in this phase, as well as the processes involved.

On total completion of the bus, it is delivered to the customer. There are also instances where the bus arrives from Brazil as a FBU (fully built up) vehicle and is delivered straight to the customer, or bodybuilder if required. The overall process is depicted in figure 1.

The evident lack of visibility across the supply chain is proving to become a setback in supply chain performance as well as to MBSA's customer service level. MBSA are looking to solve this issue and increase the visibility, as well as improve control of their bus units throughout their supply chain. This requires developing an improved supply chain collaboration and visibility strategy between MBSA and its partners.
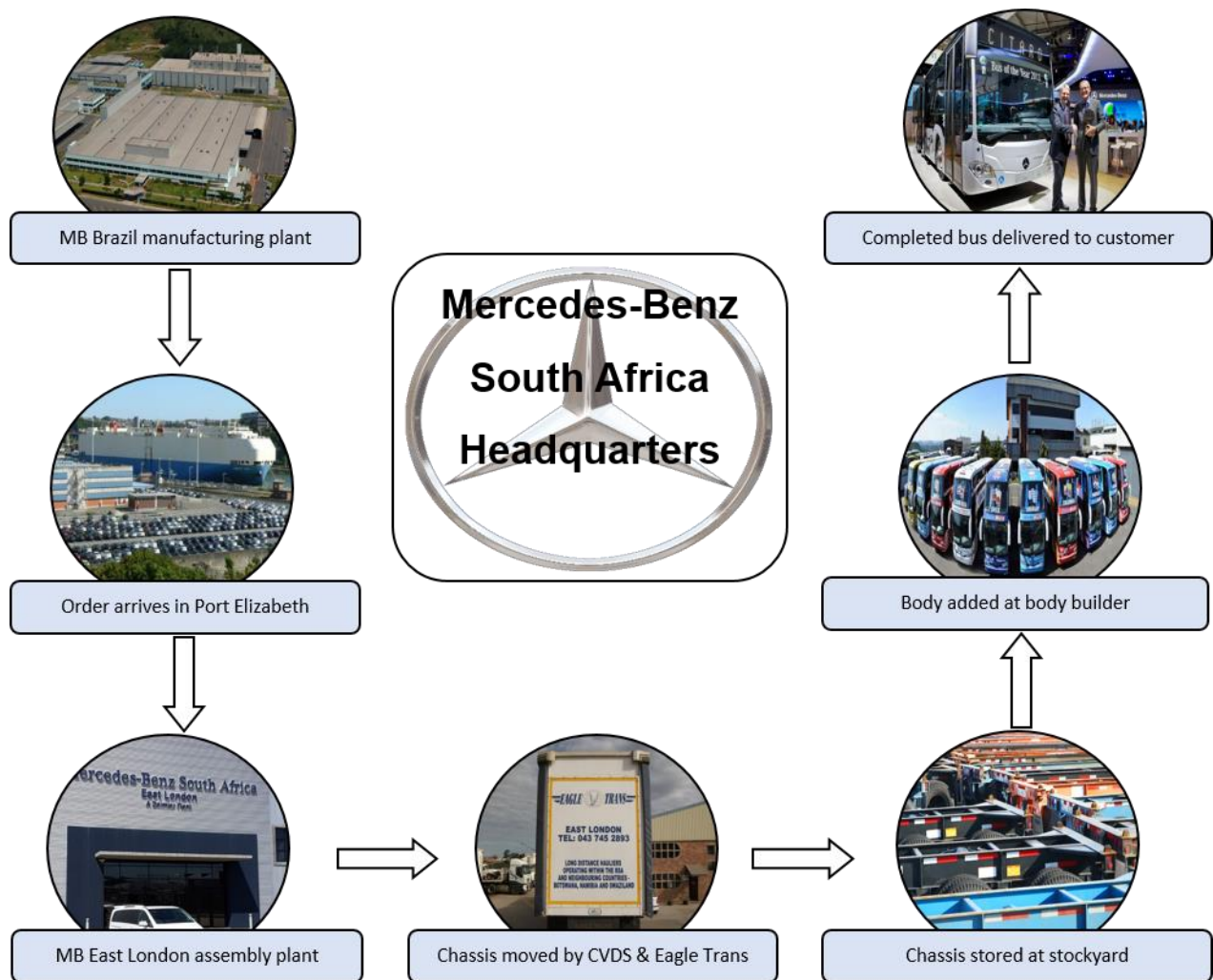
Figure 1: Bus production

1.3 Problem Statement

The MB Bus is the result of a complex supply chain consisting of various partners. The complexity of the chain has given rise to many visibility challenges for the company. This lack of visibility has made it difficult for MBSA to track the progress of the units through the chain, thereby negatively affecting their customer service. Thus, it is important for MBSA to overcome these challenges. The focus on this project will be on answering the following question:

How can the visibility of the Mercedes-Benz Bus supply chain be improved?

1.4 Project Aim

The project is aimed at analysing the current supply chain and developing a plan to improve and increase the supply chain visibility of the Mercedes-Benz Bus. This will be achieved by focusing on the following objectives:

1. Analysing and documenting the current processes in the MB Bus supply chain.
2. Improving the collaboration and integration strategy between MBSA headquarters and its partners, specifically those partners identified as areas of major concern.
3. Improving the communication processes and product tracking method used throughout the MB Bus supply chain.

1.5 Project Approach

The project will be divided into two phases, i.e., an analysis phase and a solution development phase.

1.5.1 Supply Chain Analysis Phase

Data Gathering

The goal of this stage is to gather as much information as possible, in order to gain a thorough understanding of the processes involved in the MB Bus supply chain. The usefulness of the collected data is also important in achieving the goal of increased supply chain visibility. Information including process descriptions, cycle times, process times at each phase and lead times will be gathered from all partners involved. The following activities will be carried out to achieve this:

1. Review available documentation and data from each partner.
2. Visit sites of selected partners in the supply chain.
3. Interview the supply chain managers at MBSA headquarters, MB Brazil, logistics providers as well as the operation managers at the body builder.
4. Conduct time studies or other data gathering techniques to obtain extra information which may not be readily available.

Process Mapping and General Visibility Model

The data collected in the previous stage will be used to map the process. The maps will illustrate the information flow and system interactions. The general visibility model will then be applied to establish the visibility gaps in the processes. The following activities are required for this stage:

1. Create a geomap, based on the Supply Chain Operations Reference (SCOR) framework, to describe material flows in a geographic context.
2. Create a thread diagram to show information and material flow.
3. Create a workflow diagram to highlight information and interactions in the system.
4. Apply the general visibility model.

Metric Development and Process Benchmark

Metrics will be chosen in order to measure supply chain visibility. SCOR metrics will be considered first and if need be, alternative metrics for measuring visibility will also be explored.

A SCORcard or balanced scorecard approach will be used to determine the company's level of performance with regards to visibility across the supply chain. An internal benchmark will then be conducted to compare the MB Bus supply chain with the MB Van supply chain .The following activities will be completed at this stage:

1. Determine supply chain strategy.
2. Determine or develop applicable metrics.
3. Benchmark the bus supply chain against the van supply chain.

1.5.2 Solution Development Phase

Improvement Suggestions

In this final phase, the findings and results of the previous stages will be integrated into an improvement plan for the supply chain visibility. This plan will include the following key elements:

1. Recommendation on process improvements.
2. Recommendation on information sharing, communication and technology improvements.
3. Documented improved process and relevant process maps.

Best Practice Analysis

Industry practices involving visibility and information management, as well as those listed in the SCOR framework will be explored. The most fitting practices will be selected for further analysis and aid in determining a solution. Technology and information systems available for facilitating visibility improvement will also be explored and analysed in this phase. The activities involved at this stage are:

1. Best practice analysis
2. Alternative technology and IT system analysis

The scope of this project excludes the implementation of the proposed improvement plan.

1.6 Document Structure

Supply chain visibility will be handled using a process-based approach to measure and improve performance.

To begin with, a thorough literature review will be presented in chapter 2. The review will explore supply chain visibility, its characteristics and trends in this field. A number of analysis tools and improvement methods will be discussed in an attempt to identify the most appropriate solution.

Chapter 3 offers a supply chain analysis of the current process. This will include gathering of relevant data and a description of the as-is process. The data will then be analysed and used to create various process maps. Problem areas will also be highlighted in this section.

Chapter 4 deals with developing a set of metrics to measure the visibility of the process. These metrics will then be used to conduct an internal benchmark between the MB Bus and the MB Van departments.

Chapter 5 details the proposed solution for increasing visibility. The solution includes reviewing service level agreements, selecting a new third party logistics (3PL) provider and improving the communication processes. It also includes a method to track the product progress and continue measuring the newly developed visibility metrics. Additionally, a brief best practice analysis is incorporated as a means of reviewing alternative solutions.

Chapter 6 offers a conclusion based on the analysis phases as well as the solution development. The problem is briefly revisited and the solution is evaluated in terms of meeting the project aim. Recommendations are made for future tasks to facilitate the proposed solution.

Chapter 2: Literature Review

2.1 Supply Chain Management

A well-managed supply chain is imperative to the success of any organisation. A supply chain is defined comprehensively by Mentzer *et al.* (2001, p.3) as being; "A network of organisations that are involved in both upstream and downstream processes and activities, with the goal of delivering a product or service to the ultimate consumer." The Supply Chain Council (SCC) (*n.d*) provides a more practical explanation of the term; "A group of processes, organisations or functions, which cover interactions with suppliers up to interactions with customers, with a focus on fulfilling customer orders." From these definitions it is clear that a supply chain consists of many facets that need to be well managed to achieve an organisation's main goal of satisfying customer demand.

Supply chain management can be simply defined as the process of planning, implementing and controlling the efficient flow of materials and related information through the various stages of the supply chain for the purpose of conforming to customer requirements (Estampe *et al.* 2010). There are many methods that can be used to successfully manage a supply chain. Furthermore, Mentzer *et al.* classifies supply chain management into three categories namely; a management philosophy, implementation of a management philosophy, and a set of management processes.

Numerous tools and approaches exist for effective supply chain management. Importance is placed on information sharing, collaboration and visibility. Bartlett et al. (2007) state that today's supply chains are becoming more complex and the visibility of key information and collaboration across organisational boundaries is increasingly viewed as essential criteria to the long-term success and competitiveness of the supply network.

2.2 Supply Chains in the Automotive Industry

The supply chains involved in the automotive industry are unique and complex. Veleso *et al.* (2002) point out that there are many influential factors that affect decision making in the automotive world. Consumer preferences, regulations and corporate strategies are a few of the factors that determine styles, performance standards, design innovation and changes in the processes involved. All automakers are constantly searching for an angle which will give them an advantage in the market. Therefore the ability to adapt quickly to changing conditions determines their future success. These factors have immense implications which are conveyed along the supply chain of the automakers.

A few emerging trends in the industry are explored below.

2.2.1 Supplier Parks

A supplier park is a cluster of suppliers located close to an assembly plant. The area is clearly demarcated and is made up of buildings and infrastructure built for the purpose of serving the assembly plant and the suppliers. The park is provided and supplied by a specified operator (Pfohl *et al.* 2005).

The supplier park concept is popular in the German automotive industry. In this scenario, the automotive manufacturer is viewed as the focal company of the supply chain and is responsible for formulating objectives for the supplier park. Examples of these objectives include an increase in delivery service levels, cost savings and the development or safeguarding of tight relationships for the just-in-time procurement (Pfohl *et al.* 2005).

2.2.2 Modular Consortium

A product can be broken down into various sub-assemblies or pieces known as modules. Pires (1998) uses this concept to explain the idea of modular consortium as being the delegation of modules to specific module suppliers. These suppliers are in turn responsible for providing the specified module to the automotive manufacturer as well as ensuring the correct assembly of this module directly on the manufacturer's production line. In this way the automaker has clear sight of all the modules and processes involved in the production.

Supplier parks and modular consortium are two popular trends that indicate a strong focus on collaboration and integration between partners on the supply chain. Both trends emphasise the need for greater visibility in the supply chain, indicating that supply chain visibility is a major area of concern in the automotive industry. However, these trends will not be further explored in this project due to the limited applicability to the current situation at MBSA. Applying these techniques will involve a complete restructuring of the supply chain as well as the relocation of the supply chain partners, which will not be considered by MBSA. Instead, other supply chain tools will be investigated to improve the visibility without drastically changing the design of the supply chain.

2.3 Supply Chain Visibility

Wei *et al.*(2010, p.238) view supply chain visibility as the degree to which supply chain partners have access to information related to supply chain operations. Information sharing, supporting infrastructure, innovative technology as well as supply chain collaboration and integration strategies appear to be the focus areas with regards to supply chain visibility.

A great importance is placed on the role of information in the supply chain. According to Coyle *et al.* (2012, p.189); "Information provides insights and visibility into the supply chain activities taking place at distant supplier and customer locations. This visibility of demand, customer

orders, delivery status, inventory stock levels, and production schedules provide managers with the knowledge needed to make effective situational assessments and develop appropriate responses."

Increasing supply chain visibility begins with a systematic analysis of the supply chain, followed by the selection of an appropriate tool or methodology that can be applied to bring about the required improvement.

2.4 Tools for Supply Chain Analysis and Improvement

2.4.1 Simulation Models

A supply chain, specifically in the automotive industry, comprises of a global network of production facilities, service providers, contractors and subcontractors. This complexity makes it difficult to capture and analyse the system behaviour (Pierreval *et al.* 2006). This is where simulation modelling becomes a powerful tool. Simulation can be used to determine the result of various scenarios in an attempt to improve decision making in the supply chain (Terzi *et al*. 2003).

The supply chain can be modelled from a microscopic or macroscopic point of view. The microscopic perspective focuses on entities moving through the chain whereas modelling from a macroscopic perspective assists in analysing the overall supply chain. This macroscopic perspective is ideal for identifying areas of concern and improving decision making in the supply chain (Pierrreval et al. 2006).

The simulation process can be conducted by following a nine-step procedure detailed below.

Simulation Modelling Procedure (Persson et al. 2000):

1. Project Planning
    The project schedule is determined and the initial experiments are designed.

2. Conceptual Modelling
    At this stage the system logic and data necessary for the simulation is captured. This is represented in the form of a simple flow chart.

3. Conceptual model validation
    The conceptual model is checked and corrected.

4. Modelling
    Simulation software is then used to transform the conceptual model into a computer-based simulation model.

5. Verification

   The conceptual model is tested against the simulation model and any necessary corrections are made. This is to ensure the model works as planned.

6. Validation

   At this phase the simulation model is compared to the real life system to determine if the system is accurately depicted. Discrepancies are corrected accordingly.

7. Sensitivity analysis

   This stage involves exploring the model outputs resulting from varying inputs.

8. Experimentation and analysing output data

   In this phase, the experiments designed earlier are run. The outputs are collected and analysed.

9. Implementation

   The analysed output data are used to draw conclusions and make recommendations for system improvement and implementation.

It is important to note that modelling a supply chain differs from the modelling of a conventional manufacturing environment as there are many activities that occur at various facilities and locations throughout the chain. This gives rise to a few obstacles in accurately modelling the supply chain. The segmented nodes in the chain make it difficult to collect all the necessary data for the relevant experiments. It is also challenging to validate a model of a supply chain. Model validation relies heavily on experienced personnel with extensive knowledge of all processes within the system. However, it is not common in a supply chain to find such personnel as all the partners in the supply chain are not necessarily part of the same organisation. The effectiveness of the model and the reliability of the results depend on the accuracy and accessibility of data (Persson et al. 2000). This tool cannot be extended to use in the supply chain analysis of MB Bus as the data is not always readily available.

2.4.2 Quantitative Models – Fuzzy-Based Model

Information flow in supply chain management has been identified as the basis for a successful supply chain. The effectiveness of this information flow leads to essential supply chain integration between the partners in the chain. This essential integration allows the organisation to gain a competitive advantage in the market, which emphasises the importance of establishing high levels of supply chain integration as a mechanism for improving the supply

chain performance. Quantitative methodologies such as fuzzy logic can be used to analyse and evaluate the supply chain (Cigolini *et al.* 2008).

The fuzzy logic approach is used for modelling human-like reasoning when the data is vague or inaccurate. This model can provide a better representation of this uncertainty as well as a way to implement simple yet robust solutions that can perform in any situation (Lau et al. 2002).

There is extensive literature available providing models and examples on how fuzzy logic is used to analyse, measure and evaluate the supply chain. Chan *et al.* (2003) provide an innovative performance measurement method which addresses the integration between existing performance measurement methods and practical requirements for supply chain management. Lau *et al.* (2002) consider a framework for supply chain management which is based on analysing relationships with suppliers and their performances. A Fuzzy Multiple Criteria Decision Making (FMCDM) has been proposed by Zangoueinezhad *et al.* (2011, p.93) as an approach for supply chain competitiveness positioning. This analysis is then coupled with the SCOR framework to serve as a useful and effective tool for measuring competitiveness.

However, all the models share similar disadvantages. Accuracy and reliability are compromised due to the fuzzy nature of the models. Experienced personnel are heavily relied upon for the data input and for adjusting and developing the fuzzy rules (Lau *et al.* 2002). Due to the further validation required for these models, they will not be applied to this project.

2.4.3 Evaluation and Selection of Third-party Logistics (3PL) Providers Using AHP

Logistics and product transportation are not often part of a company's core competencies. 3PL providers specialise in managing logistics requirements thereby giving companies the chance to focus on their core business competencies. Activities and services offered by 3PL providers include transportation and distribution, tracking and tracing of products as well as integrated IT services (Gol et al. 2007).

 A strategically selected 3PL can reduce company costs, improve customer service and improve overall integration throughout the supply chain by means of increasing the supply chain visibility (Vaidyanathan 2005). Additionally, Vaidyanathan (2005, p. 91) indicates the importance of a 3PL as it helps to improve a company's supply chain visibility by emphasising the role of effective information sharing between all parties in the supply chain. However, the selected 3PL must be able to facilitate this communication which will require appropriate IT infrastructure.

Gol *et al.* (2007, p.382) presents an approach to selecting a 3PL provider that has been applied to a Turkish automotive company. This methodology is based on the analytic hierarchy process (AHP). AHP is a widely used technique for decision making based on both qualitative and quantitative criteria. Selection criteria are listed and weighted according to their relevance in supporting the company's strategy and logistic goals using a simple pair-wise comparison. The performances of the 3PLs are then ranked and rated according to the selected criteria. A provisional decision based on these results is made and then followed by a sensitivity analysis to determine the robustness of the selected decision.

From this research, it becomes clear that the correct selection of a 3PL can significantly increase the supply chain visibility and should be included in the improvement strategy.

2.4.4 Metrics for Measuring the Supply Chain

A metric can be defined as a qualitative or quantitative measurement of an activity or process involving a calculation, ratio or a combination of measures (Coyle *et al.* 2012, p.145). An effective set of supply chain metrics is critical for improving the supply chain performance and its chances of success (Lambert *et al.* 2001).

It is important for companies to measure the correct metrics for their supply chain. Often the correct or effective metrics are not available and may have to be developed. The following suggestions are offered for effective metric development (Coyle et al. 2012, p.151):

1. The metrics should be developed by a team comprising of members from various functional areas in the supply chain.

2. Customers, suppliers and other partners in the supply chain should be consulted where appropriate.

3. Metrics should follow a tiered structure so as to ensure the clarity of measurement at each level.

4. Metrics should be allocated to an owner to increase the owner's performance.

5. A mitigation procedure should be developed for metrics that may cause conflict between functions or departments.

6. The metrics must be consistent with and compliment the organisation's corporate strategy.

7. Top management must be involved and willing to support the implementation of the new metrics.

There are many existing metrics available for measuring the performance of a supply chain. The Supply Chain Operations Reference (SCOR) model is a popular source of supply chain metrics. This framework links the metrics to five performance attributes, i.e. reliability, responsiveness, flexibility, costs and asset management (Coyle *et al.* 2012, p.152). The SCOR model will be discussed in section 2.4.5 below.

For the purposes of this project, existing metrics will be considered before developing a set of new metrics. Subsequent development of new metrics will reflect the suggestions outlined in this section.

2.4.5   SCOR Framework

The Supply Chain Operations Reference (SCOR) model was developed by the Supply Chain Council, a global non-profit organisation. This model was developed to enable firms to increase the performance of their supply chains and to provide a process-based approach to supply chain management (Lockamy *et al.* 2004).

SCOR Processes

The model presents a common process-orientated language for partners in a supply chain which allows for easy communication in decision areas. These areas or processes are defined as Plan, Source, Make, Deliver and Return (Lockamy *et al*. 2004). Using these process building blocks, the SCOR model can be used to describe supply chains that are either extremely simple or extremely complex using a common set of definitions across disparate industries. The model is designed to support supply chain analysis at multiple levels, as shown in figure 2.

Figure 2: SCOR process level hierarchy (SCC, 2013)

SCOR Metrics and Performance Attributes

The SCOR framework suggests that competing supply chains can be evaluated and compared by defining key performance attributes. SCOR identifies five core supply chain performance attributes: Reliability, Responsiveness, Agility, Costs, and Asset Management. Each of these attributes are linked to strategic metrics which allow these attributes to be measured. Like the process elements, the metrics in the SCOR model are hierarchical. Level 1 metrics are the calculations by which an organisation can measure how successful it is, and are created from lower level calculations (SCC, 2013).

SCOR Practices

A practice is a unique identifiable way to organise one or more processes. SCOR recognises four types of practices and nineteen classifications. Best Practice (BP) can be described as a current method that can be duplicated to bring about a positive change and improvement in operations and the results thereof (SCC, 2013).

BP selection is done by determining both the risk and the return a certain practice will have on a supply chain. Those practices with high returns and low risk are usually the best fit. This technique helps companies standardise processes, identify alternative ways of operating the supply chain and formulating a wish list of process configurations or automation (SCC, 2013).

Benchmarking with SCOR
Benchmarking can be defined as the comparison of an organisation's performance with those of other organisations in either the same or a comparable industry. This technique is used to establish realistic goals, to know where the company is relative to others, and then to state where it is going (SCC, 2013).

Standard, well-defined metrics are used for this comparison. These metrics are then arranged to form a SCORcard. A SCORcard is a visual display of the most important information needed to achieve one or more objectives, consolidated and arranged in a single view. The SCORcard lists the selected metrics and the desired level of performance for each of these metrics. The actual performance of each of these metrics is also shown. This then provides a clear view of the improvements necessary to reach the desired performance level (Francis, 2010).

SCOR Process Mapping
The SCOR framework also provides modeling tools for effective process mapping. The key mapping tools are explained here.

Geomap
A geomap is a graphical model that shows the location of all partners in the supply chain and the material flow throughout the process. Each partner in the supply chain is represented as a node on the map and level 2 processes are used to describe the high level activities that occur at each node (SCC, 2013).

Thread Diagram
A thread diagram builds on the geomap as it illustrates material flow as well as information flow throughout the supply chain. Level 2 processes are also used to define the process. The partners which were represented as nodes from the geomap are now represented as columns. The columns are then categorised into customers, suppliers and the core organisation. The material flow is indicated with a solid line while the information flow is indicated with a dotted line (SCC, 2013).

Workflow Diagram
A workflow diagram is used to map the process in more detail. The generic description of the process activities are translated into the appropriate level 3 SCOR processes which are then used to map the flows through the supply chain. Information flow, material flow and any other

relevant data can be mapped on this diagram. The partners are represented as swim lanes and their respective processes placed in these swim lanes. This model also reflects the inputs and outputs of the processes (SCC, 2013).

Example of SCOR Application

The SCOR framework is applied to numerous industries and companies. Chen *et al.* (2006) provide a comprehensive example of how the SCOR framework can be adapted and applied to a mobile phone component industry.

In the first phase of this example, a background to the company was given and the supply chain of a selected component was identified as the focus of the case study. This specific supply chain was then mapped on a high level using a geomap and level 2 SCOR processes as shown in figure 3. This process indicated that the main problem areas were the high costs of sourcing and the low levels of customer satisfaction.
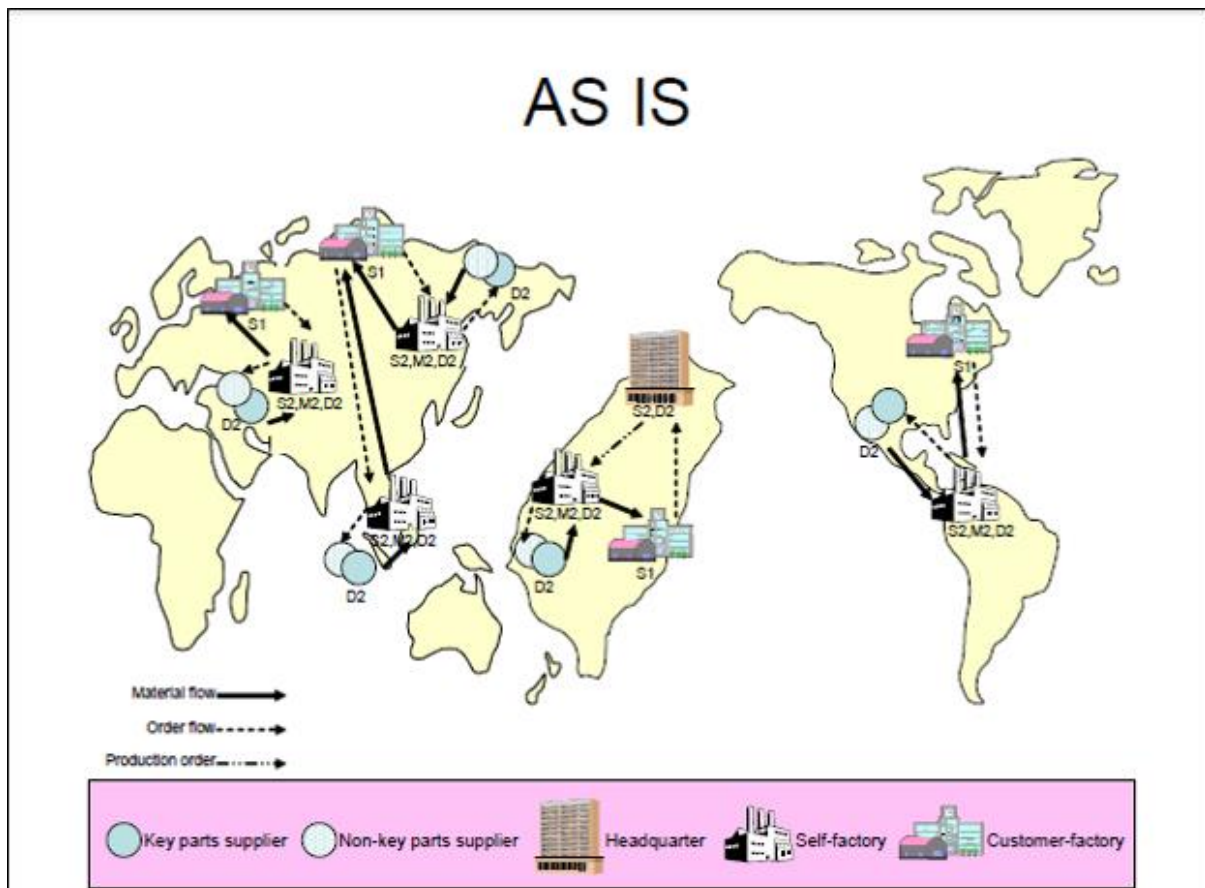
Figure 3: Example geomap (Chen et al., 2006)

A SWOT analysis was then conducted to identify the company's competitive advantages and disadvantages. The acronym SWOT stands for Strengths, Weaknesses, Opportunities and Threats. This tool allows for data to be arranged in a matrix to allow for logical presentation of data thereby enabling strategic decision making (Business Balls n.d.).

The results from this analysis were then used to determine the company's strategy and their operational goals. These goals included developing a global sourcing strategy to lower costs, decreasing the delivery time as well as inventory levels and also improving customer satisfaction.

Metrics were then selected for measuring the performance of these areas. Chen et al. (2006) acknowledge that the SCOR model is just a framework, and although the SCOR procedure for analysis is followed, SCOR does not provide applicable metrics for every situation that may occur. For this reason Chen et al. (2006) used metrics defined by other authors as shown in figure 4.

Result Type	Result Indicator	Calculation Form	Current Value	Target Value
Increase customer satisfaction	Order forecast accuracy	Order quantity and total amount	80%	95%
	Perfect order fulfillment	[Quantity according to delivery date]/[Total Quantity]		
Supply chain cost	Supply chain management total cost	[Total-cost - Manufacturing cost]		
Supply chain flexibility	Order fulfillment lead times	[Satisfy order lead time + Purchasing cycle time]	14 days	7 days
	Urgent order response time	Time to delivery from receipt of urgent order	289,797 (thousand)	
Supply chain asset management efficiency	Inventory value	Inventory value at month's end		173,878 (thousand)

Figure 4: Example metrics (Chen et al., 2006)

The authors then developed a thread diagram for the current process shown in figure 5. This process was then used to develop an improved thread diagram for a future ideal process which is shown in figure 6.

17
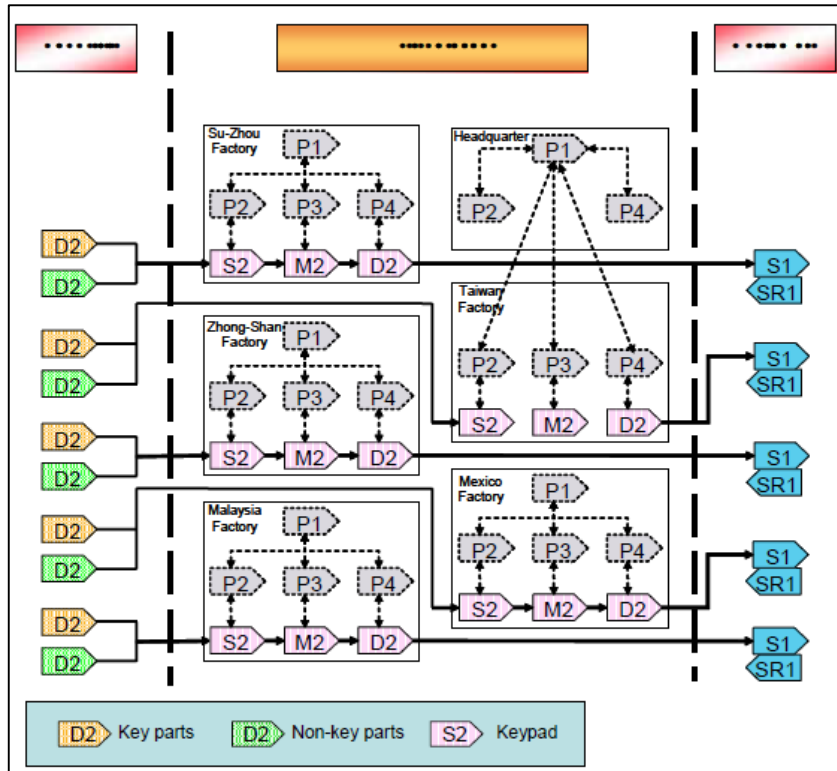
Figure 5: Current thread diagram (Chen et al., 2006)
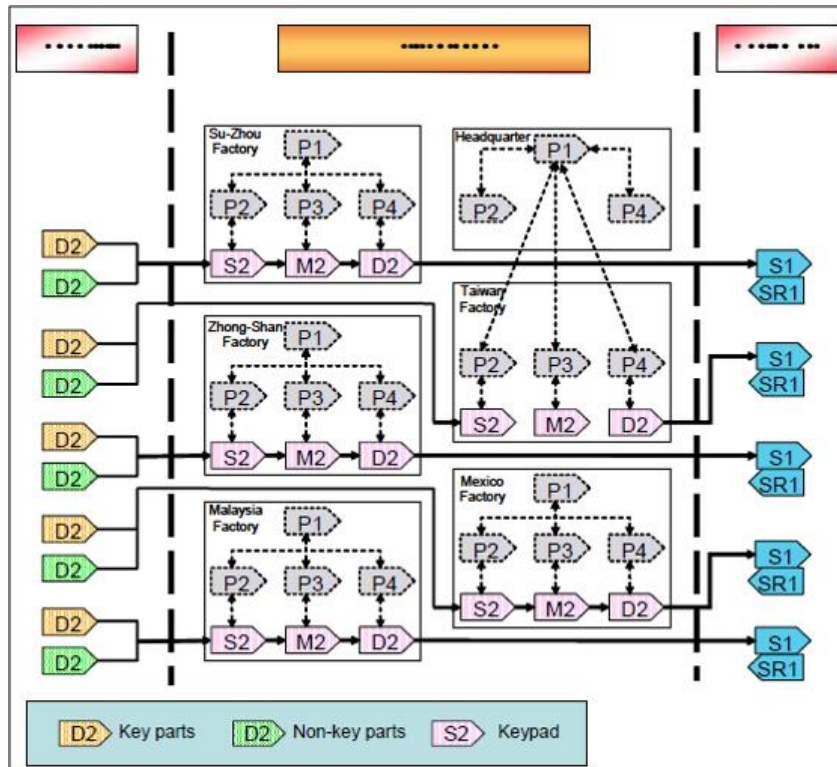
Figure 6: Future thread diagram (Chen et al., 2006)

In this application a work flow diagram for the future improved process is also represented as illustrated in figure 7.
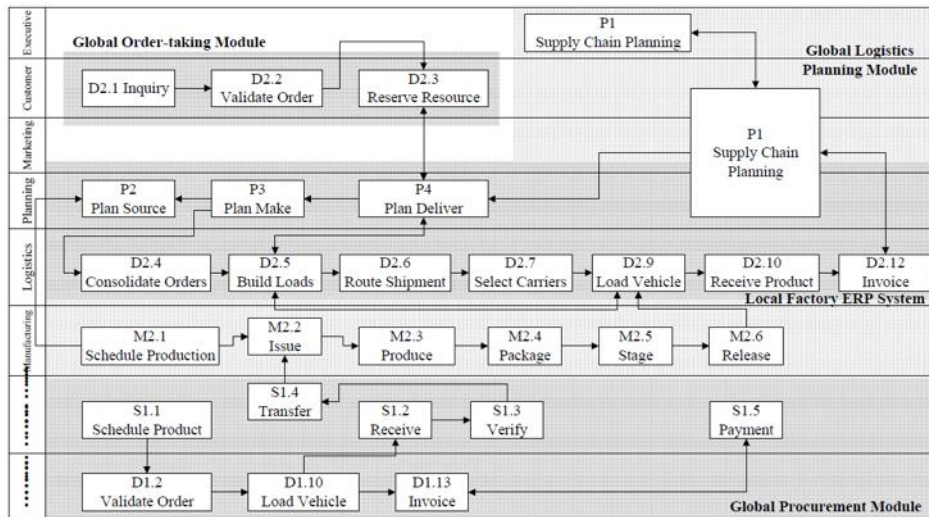
Figure 7: Workflow diagram (Chen et al., 2006)

Finally, a solution plan for achieving the envisioned future process, with a focus on IT solution was tabled as shown in figure 8.

Process	Process Content	Best Price	IT Needs
S2.1	Schedule product deliveries	◆ Use EDI technology to reduce time. ◆ VMI, allow supplier to control inventory and automatic restocking.	◆ EDI size (830, 850, 856, 862) ◆ Use VMI, establish communication system with supplier.
S2.2	Receive product	◆ Use barcode to lower handing time and increase accuracy.	◆ Barcode system and information collection equipments.
S2.3	Verify product	◆ Supplier makes replacement of failed goods at customer's site.	◆ Electronic label tracking system.
S2.4	Transfer product	◆ Designate place and time for supplier delivery.	◆ System to indicated accurately where and when to ship goods.
S2.5	Authorize supplier payment	◆ Electronic payment mechanism.	◆ Payment system online.

Figure 8: Improvement plan (Chen et al., 2006)

This example showcases the relevance of applying the SCOR model to the analysis of a supply chain and the extent to which the results are used to improve the underperforming areas. It also highlights the flexibility of the model and the ability to use the SCOR procedure with metrics defined by other sources. These attributes illustrate the applicability of the SCOR model to the case of MB Bus supply chain. A similar process will be extended to analyse the current state of the MB Bus supply chain and develop a potential improvement strategy.

For further analysis and measurement of the visibility within the supply chain, the SCOR framework and a defined set of metrics are used as a basis within the general visibility model.

2.4.6 The General Visibility Model

McIntyre (2010) suggests that a better alternative is to view supply chain visibility as a process, thus focusing on actions and their usefulness in transforming inputs into outputs. By thinking of supply chain visibility as a process, it places focus on actions and their usefulness in converting input to output. It also allows for easier measurement of the visibility by using appropriate metrics. McIntyre (2010) has developed a general visibility model, which illustrates how visibility can be viewed as a process. This model is shown in figure 9.
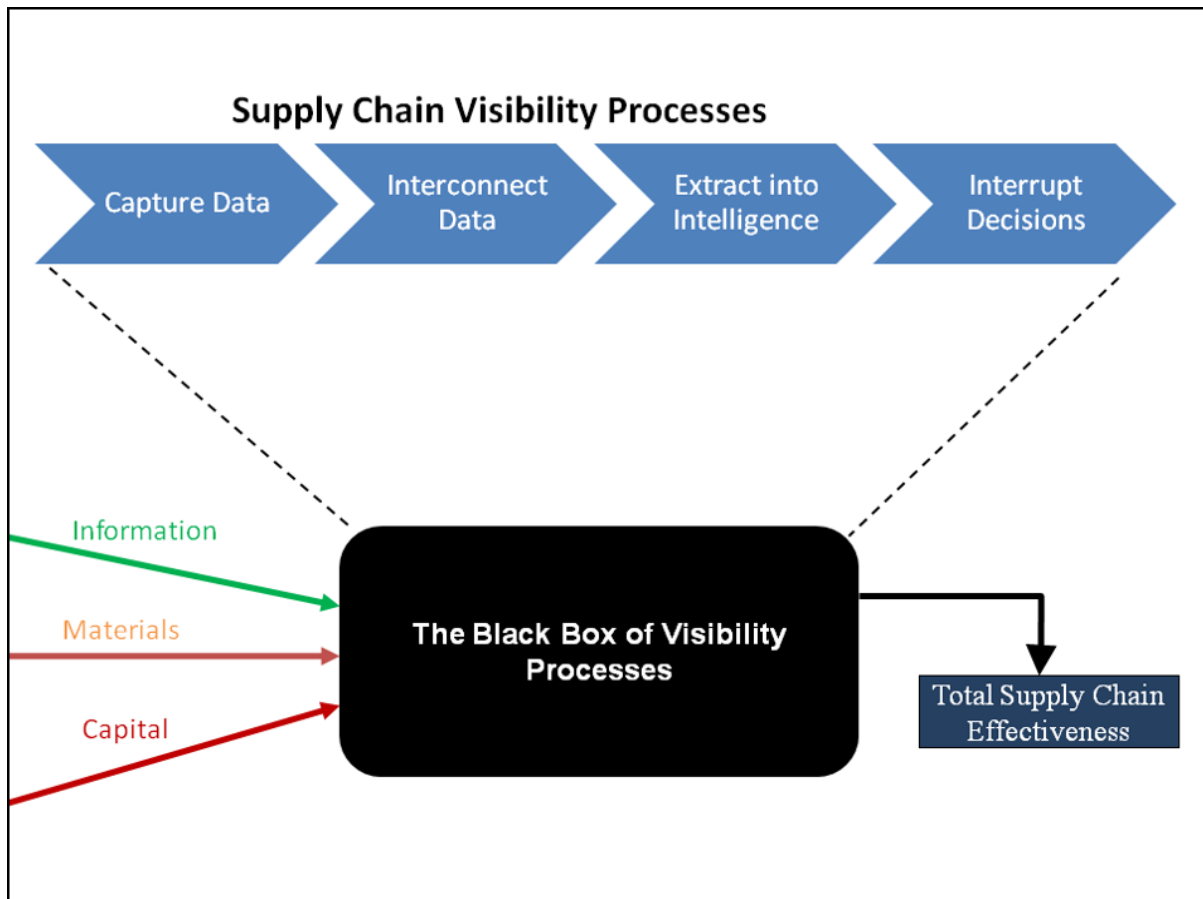
Figure 9: General Visibility Model (McIntyre, 2010)

Figure 9 depicts the macro processes of supply chain visibility. This model is based on the assumption that all visibility improvement initiatives will entail the same processes of capturing data; interconnecting this data; extracting intelligence from the data; using this information to interrupt decisions and ultimately bring about improvements (McIntyre, 2010). This is applied by using the workflow diagrams developed in the SCOR model, to identify the activities which represent each of these four processes.

This model will serve as a key tool in the analysis of the current MB Bus supply chain. The results of the application of this model, will provide insightful suggestions as to which areas should be improved in order to increase the visibility within the supply chain.

2.5 Concluding Remarks

In this chapter, an extensive literature review is conducted to provide a background to supply chain management with a focus on supply chain visibility. Many methodologies and tools are explored with the intention of finding the appropriate tools for the subsequent supply chain analysis and the solution design phase.

From this review, it is evident that the SCOR framework along with the general visibility model and other supply chain tools can be used to strategically map the MB Bus supply chain, identify problem areas and develop a potential improvement strategy. These tools and models will be used as a basis for this project.

Chapter 3: Supply Chain Analysis

3.1 Data Gathering

The initial phase encompasses gaining an understanding of the process and the system logic. Which is essential for identifying areas where there is a lack of visibility and a need for improvement. The data gathering comprises of conducting interviews with personnel from all functional areas of the supply chain and reviewing the available documentation to gain valuable insight into the process. This evaluation shows that there is a significant shortage of documentation governing the MB Bus supply chain.

Data gathered from the interviews and available documents is used to form a current process description. The process proves to be quite complex and is subsequently broken down into four sub-processes described below.

Ordering Process

Specific customer orders for busses are received from the network of MB Commercial Vehicle dealers. Orders can be placed at MBSA headquarters at any time. The trend and patterns of these orders are used to determine the volume for chassis orders in a monthly forecasting meeting (FRM). The FRM is held by members of the various management areas to determine chassis orders up to four months in advance. The order is then sent to MB Brazil and an order confirmation is sent back to MBSA headquarters. The confirmed order is entered onto the SAP system which is used to track the progress of the bus throughout the supply chain. At this stage the company adapts a make-to-stock strategy as they try and ensure that there are sufficient chassis available in South Africa to satisfy any orders placed by the dealers.

Receiving Process

The receiving process begins when MB Brazil sends an invoice and packing list to MBSA. The ordered chassis kits are then shipped to the local port in South Africa. A shipping advice is emailed to MBSA at the time of shipping so that deliveries can be scheduled at the port and the necessary clearance can be carried out before the containers arrive. Bidvest has been contracted to manage this clearance procedure. The shipping advice also contains an expected time of arrival, which is then used by the MB EL plant to schedule the assembly of the arriving chassis. The process is concluded once the containers arrive at the port and MBSA is notified of the arrival.

Assembly Process

The assembly starts with a procedure referred to as calling in the containers. This is done by the MB EL plant and involves bringing in the containers from the port to the plant. Once at the plant, the containers are emptied and sent back to the port. The chassis kits are then unboxed

and prepared for assembly on the commercial vehicle assembly line. On completion of the assembly, the chassis are inspected and then released for delivery. The units are then introduced onto the eNatis system. This system is used for registering all vehicles and is a legal requirement for the production of any vehicle. At this stage a delivery instruction is sent to CVDS.

Delivery Process

The delivery process can be further categorised into three types of deliveries. The first delivery is from the plant to the Denel CV storage yard in Gauteng. This delivery is carried out by CVDS, the contracted transport provider for MB Commercial Vehicles. However, CVDS does not have the necessary resources available in East London for the safe transfer of bus chassis, thus they subcontract this move to a company called Eagle Trans. Before the vehicle is collected for delivery, CVDS notifies DataDot that the chassis is ready to be tagged. DataDot is a microdot tagging company that sprays the chassis with microdots in accordance with legal regulations. Eagle Trans is then responsible for collecting the vehicle from the MB EL plant and delivering the unit to the Denel CV storage yard.

The second type of delivery is from the MB EL plant to the bodybuilder in Gauteng. For this project, the supply chain manager at MBSA has recommended Marcopolo to be used for the analysis of the supply chain as it currently exists. A chassis is only delivered directly to a bodybuilder if it is a joint stock unit or if an order has been placed for that specific unit. The delivery process however, remains the same as that of the Denel CV storage yard.

The final delivery process is from the Denel storage yard to the bodybuilder. Once an order is placed with MB headquarters, CVDS is sent a delivery instruction to move the chassis from the storage yard to the bodybuilder. CVDS then collects the chassis from the storage yard and delivers it to the bodybuilder. This is where MBSA hands over responsibility of the final bus production to the bodybuilder. It is also important to note that the company adapts a make-to-order strategy from the time an order is placed for a specific chassis.

At the bodybuilder, the bus of the body is fitted according to customer requirements. Once completed, the bus is delivered to the MB CV dealer. This move is planned by the dealer and the bodybuilder so MBSA headquarters does not play any part in this arrangement. MBSA headquarters only monitors the progress of the bus at the bodybuilder to ensure that the bus is completed on time.

At the dealer the completed bus undergoes a final inspection. The dealer is also responsible for the final registration of the vehicle on the eNatis system. The sale is then completed and the dealer captures the sale on the SAP system which concludes the process.

A more detailed description of the activities outlined above is provided in section 3.2.

3.2 Process Mapping

3.2.1 Geomap

The first stage of mapping uses SCOR level 1 and 2 processes to describe the process at a high level. This particular tool focuses on the flow of material and not information. Management can use this map as a tool to gain insight on the overall supply chain, the location of the partners on the supply chain and the flow of material between them.

As stated previously, the material flow starts in Brazil where the chassis kits are manufactured. The chassis are then shipped to South Africa and are received at the local port. Thereafter the chassis are moved to the MB EL plant for assembly. From here the assembled chassis is moved by CVDS and Eagle Trans to the storage yard and then to the bodybuilder. The last move is to the MB CV dealer.

The nodes on the geomap represent the different partners on the chain. The arrows indicate the actual flow of material. The nodes that are not connected with arrows, indicate that no material flow passes through that node, i.e., MBSA headquarters which only manages information flow.

Figure 10 shows the initial material flow, i.e. from MB Brazil to the local port in South Africa. Figure 11 shows the material flow within South Africa.

Figure 10: Geomap- Brazil to South Africa
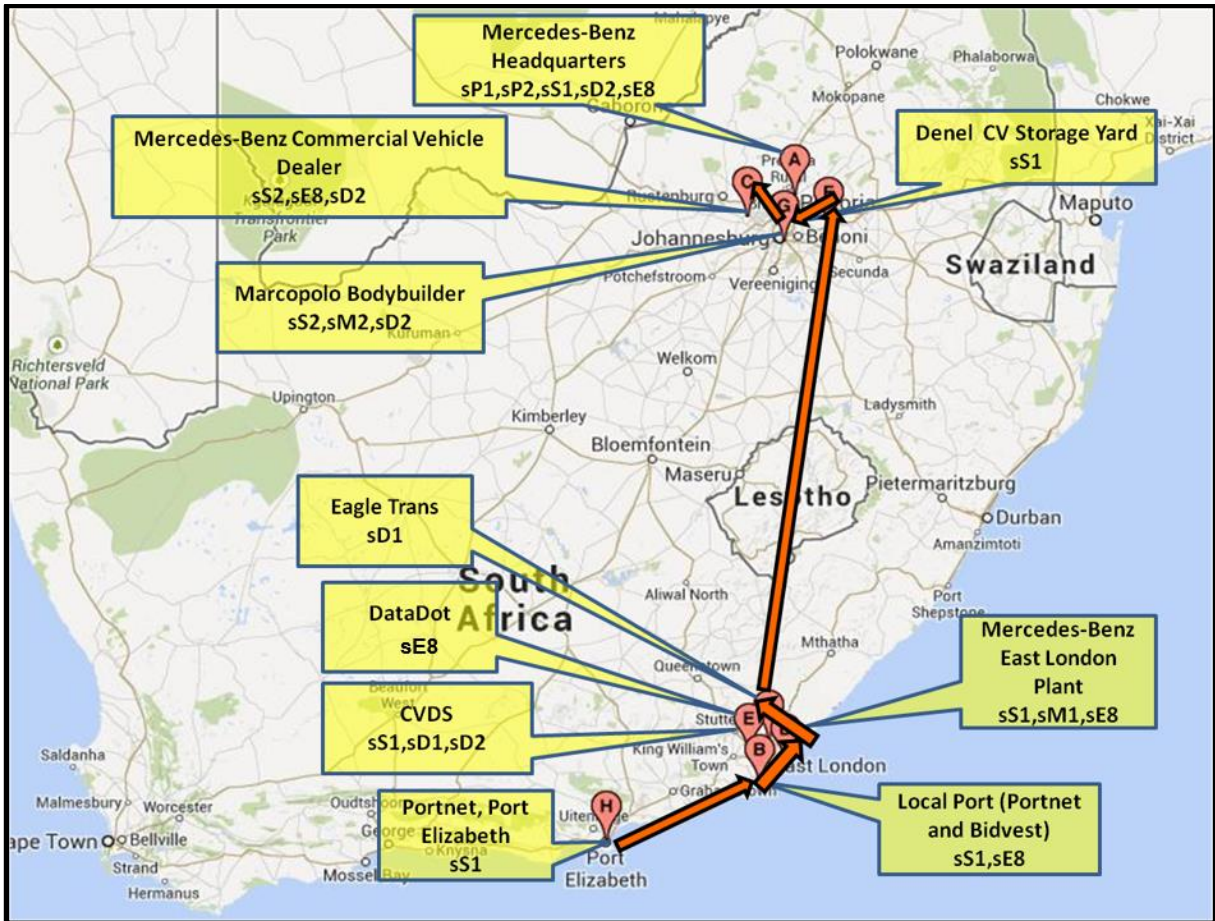
Figure 11: Geomap - Material flow within SA

3.2.2 Thread Diagram

The next model used is the thread diagram. This model builds on the geomap described previously. In addition to the material flow, the information flow along the supply chain is also mapped. The thread diagram serves as a high level process map for the entire supply chain.

The nodes from the geomap are now represented as columns. These columns are then categorised into: customers, core organisations and suppliers. For this project, MB Brazil is considered to be the supplier due to the fact that although this project is focused on the bus supply chain of MBSA, the production activities of MB Brazil do not fall within the scope. The MB CV dealer network regarded as the customer since the dealer network is managed separately, although the dealers do fall under the banner of MBSA. The dealers are responsible for placing orders with MBSA who then plan the supply chain activities accordingly. Therefore, the internal members of the supply chain comprises of MBSA headquarters, the MBSA East London plant as well as the service providers. The service providers form an essential part of the chain as the bus cannot be produced without their contributions. The service providers contribute considerably towards the complete production of the bus and for this reason are considered to be part of the core organisation.

The thread diagram for the supply chain is shown in figure 12.
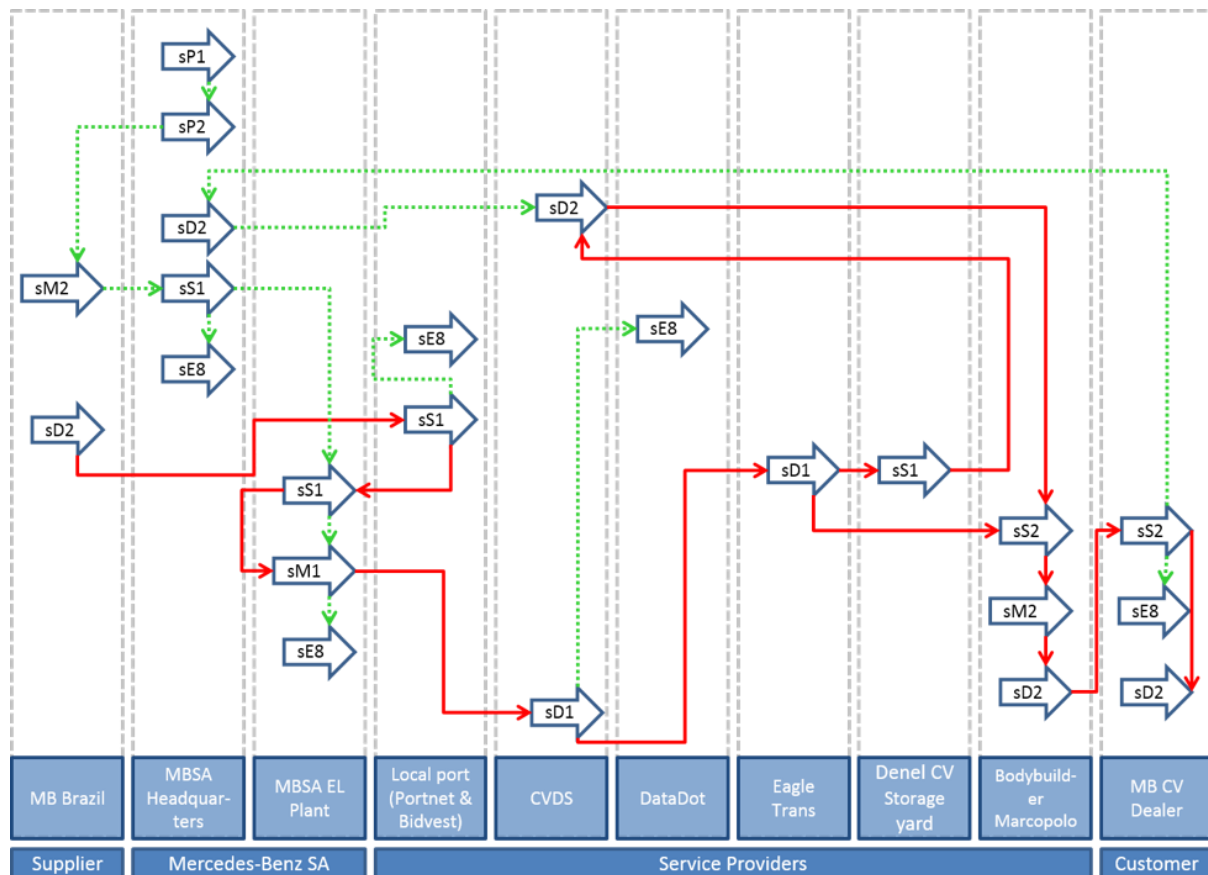
Figure 12: Thread diagram

3.2.3 Workflow Diagram

The workflow diagram uses level 3 processes to map the process details. The model shows the information and material flow of the process as well as the outputs and additional activities throughout the process.

The bus supply chain was found to be quite complex hence the process was broken down into the following six sub-processes: ordering, receiving, assembling, transporting of MB stock chassis from the plant to storage yard, transporting of joint stock chassis (or pre-ordered) from the plant to the bodybuilder to the dealer and transporting of ordered chassis from the storage yard directly to the bodybuilder and then to the dealer.

The generic description of each sub-process, obtained from employees, was noted and then transformed into a SCOR process description using level 3 processes. This is illustrated in tables 1-6. Each of the processes are broken down into activities which are listed in the first column of the table. The second column links each activity to the corresponding SCOR process. Thereafter the workflow diagram for each process is shown in figures 13-18. These

diagrams depict the work flow of each process by sequentially linking the SCOR level 3 processes.

Ordering Process

The first column of table 1 describes the activities involved in the ordering process and the related SAP actions. These activities are typically carried out by the logistics specialist of the MB Bus Department. The corresponding SCOR processes are shown in the second column and the workflow diagram is illustrated in figure 13.

Table 1: Ordering process description

Ordering Process:	
Process Description	SCOR Description
FRM meeting to discuss order volumes and trends	sP1.4 Establish and communicate supply chain plans
Receive signed order sheet from FRM meeting	sP2.4 Establish sourcing plans
Complete order form and email to MB Brazil	sS1.1 Schedule product deliveries
Receive order confirmation from MB Brazil via email	sD2.2 Receive, enter and validate order and sM2.1 Schedule production activities
Confirmed order is entered onto the SAP system using the commission number (same as order number on the Daimler AFAB system)	sS1.1 Schedule product deliveries
System creates a VMS number for internal tracking (SAP Action : ZCRE)	
System links commission number to VMS number (SAP Action: ZCOM)	
System confirms order (SAP action: ZFOC)	
Unit is made available on system (SAP Action: ZMVA)	
Generate expected receipt report to send to MB East London plant for production planning	sM1.1 Schedule production activities
Unit is frozen on system to check order details are correct. Interactive Difference Report is generated. (SAP actions: ZFSN,ZFSC)	sS1.1 Schedule product deliveries
Differences are reconciled (SAP action: ZFOC)	
Receive vehicle production confirmation from Brazil (SAP Action: ZVPN)	sM2.3 Produce and test
Complete vehicle background check and valuation (SAP Action: ZREA)	
Purchase order created on system (SAP action: ZCPO)	sM2.6 Release finished product to deliver
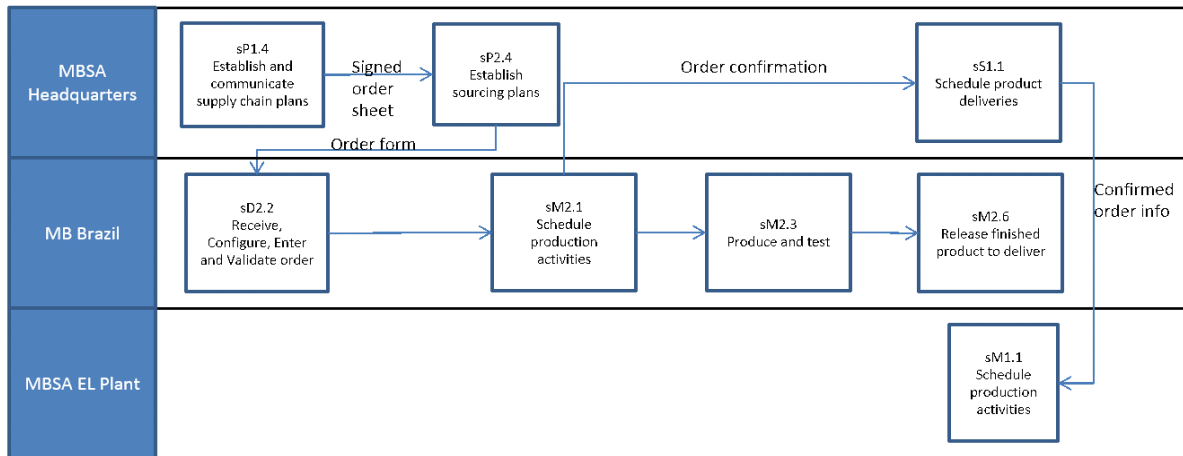
Figure 13: Ordering process workflow diagram

Receiving Process

The receiving activities are detailed in the first column of table 2. These activities are carried out by the various parties including the logistics specialist at MBSA, Bidvest as well as the production planning team at the MB EL plant. The accompanying workflow diagram displayed in figure 14 uses the SCOR level 3 processes to illustrate the sequence of activities involved in the receiving process.

Table 2: Receiving process description

Receiving Process:	
Process Description	**SCOR Description**
Receive packing list and invoice from MB Brazil via courier	sD2.11 Load product and generate shipping documents
Use engine number from invoice to update chassis information on system. (SAP action: ZVDU)	sS1.3 Verify product
Verify invoice (SAP action: ZINV)	
Receive shipping advice from MB Brazil via email	sD2.11 Load product and generate shipping documents
Enter shipping information onto system (SAP Action: ZSHP)	sD2.12 Ship product
Shipping advice used to schedule chassis assembly at MB EL plant via TRP system	sM1.1 Schedule production activities
Shipping advice, clearing instruction, invoice and waybill sent to Bidvest for call freight clearing	sE8.1 Monitor regulatory entities
Goods received at the local port. Portnet sends EDI PGOR message to notify MBSA.	sS1.1 and sS1.2 Receive product
Goods verified by Bidvest	sS1.3 Verify product
Receive PGOR message (SAP action: ZGOR)	sS1.4 Transfer product
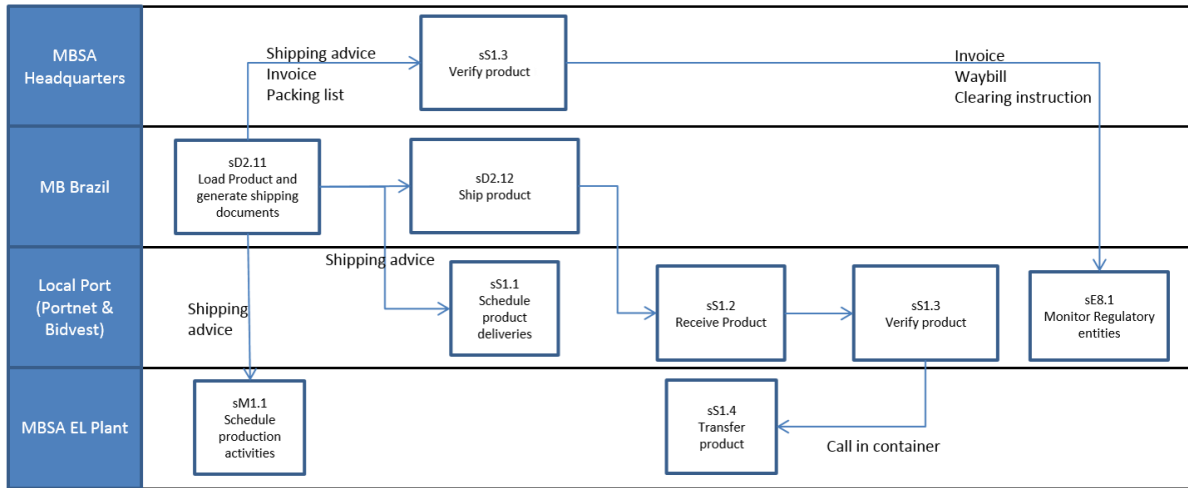
Figure 14: Receiving process workflow diagram

Assembly Process

The assembly process is detailed in the first column of table 3 and the related SCOR level 3 processes are listed in the second column. The process is quite simple and the activities are carried out by the production planning team at the MB EL plant. The simplicity of this process is exhibited in the workflow diagram in figure 15.

Table 3: Assembly process description

Assembly Process:	
Process Description	**SCOR Description**
System automatically generates order number for the plant (SAP action: ZSC1)	sM1.1 Schedule production activities
System releases order (SAP action: ZPRL)	
Units sequenced for production (ZRSQ)	
Containers are called into plant (SAP action: ZCKD)	sS1.4 Transfer product
Assembly process is started (SAP actions: ZVRV, ZSCI)	sM1.3 Produce and test
Plant updates chassis component information e.g. transmission number etc. (SAP action: ZVDU)	sM1.5 Stage product
Unit assembly completed/VPC (SAP action: ZSCC)	
Unit is introduced onto the eNatis system – Legal Requirement (SAP action: ZNAK, ZSPT, ZVSX, ZVMD)	sE8.1 Monitor regulatory entities
Delivery instruction sent to CVDS (SAP action: ZIDI)	sM1.6 Release product to deliver
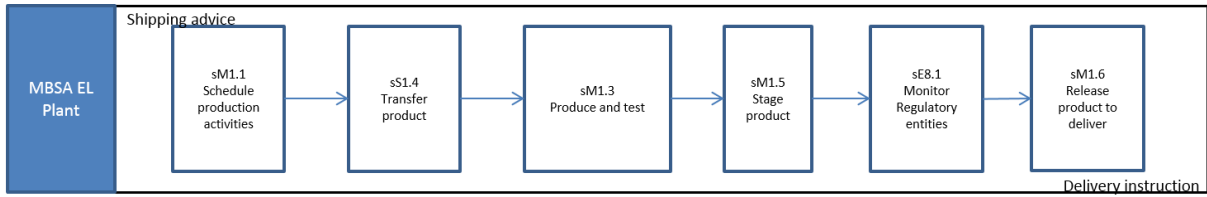
Figure 15: Assembly process workflow diagram

Delivery Process

Although the delivery process is further categorised into three sub-processes, each of the delivery types follow a similar set of activities. Each of the deliveries involve the same key players, i.e. MBSA headquarters, MB EL plant, DataDot, CVDS and Eagle Trans. The delivery instruction specifies the recipient of the delivery which can be either the Denel storage yard or the bodybuilder. This section details the activities for each delivery type and the related workflow diagram.

Table 4: Delivery to storage yard process description

Delivery of MB stock units from MB East London Plant to Denel Storage yard:	
Process Description	**SCOR Description**
CVDS receives delivery instruction via VTS system	sD1.2 Receive, enter and validate order
Sends request to DataDot, via email, to complete DataDot on ordered units - Legal requirement	sE8.1 Monitor regulatory entities
Schedule delivery	sD1.3 Reserve inventory and determine delivery date
Notifies subcontractor, Eagle Trans, of delivery instruction via phone/email	sD1.7 Select carriers and shipment rate
Eagle Trans collects units from MB Plant, collection note completed (SAP action: ZVHC)	sD1.8 Receives product from source or make
Vehicle despatched (SAP action: ZVIT)	sD1.12 Ship product
Vehicle arrives at Denel storage yard and units scanned into system, delivery note completed (SAP action: ZVAX)	sD1.13 Receive and verify product by customer
Unit awaits allocation	sS1.2 Receive product
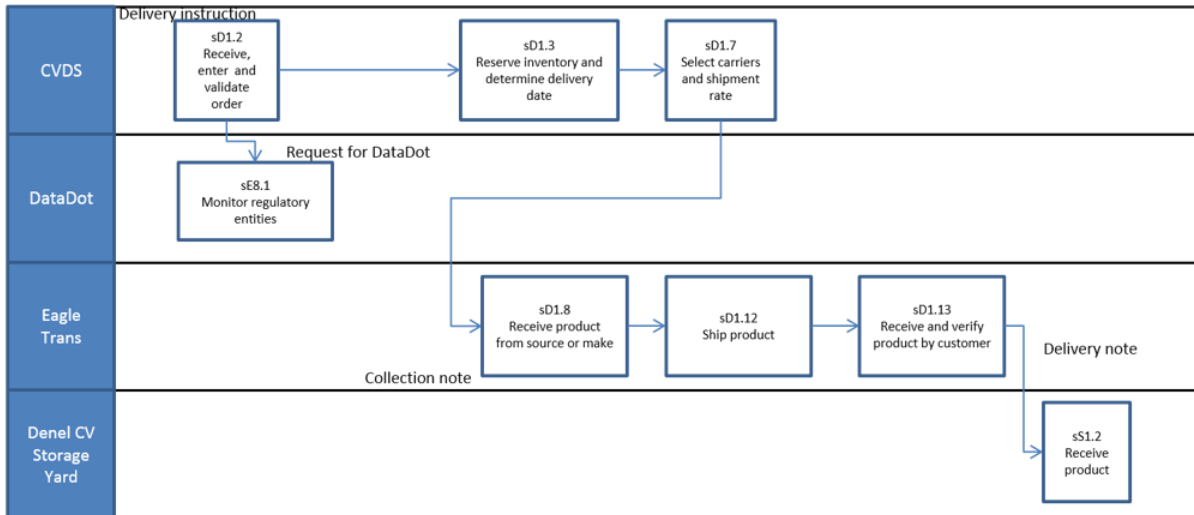
Figure 16: Delivery to storage yard workflow diagram

Table 5: Delivery to bodybuilder process description

Delivery of MB joint stock units and ordered units from MB East London Plant to bodybuilder (Marcopolo)	
Process description	**SCOR description**
CVDS receives delivery instruction via VTS system	sD1.2 Receive, enter and validate order
Sends request to DataDot, via email, to complete DataDot on ordered units - Legal requirement	sE8.1 Monitor regulatory entities
Notifies subcontractor, Eagle Trans, of delivery instruction via phone/email	sD1.3 Reserve inventory and determine delivery date
Schedule delivery	sD1.7 Select carriers and shipment rate
Eagle Trans collects units from MB Plant, collection note completed (SAP action: ZVHC)	sD1.8 Receives product from source or make
Vehicles despatched (SAP action: ZVIT)	sD1.12 Ship product
Vehicle arrives at bodybuilder, delivery note completed (SAP action: ZVAX)	sD1.13 Receive and verify product by customer and sS2.2 Receive product
Unit information captured manually at body builder	
Bodybuilder schedules production of body	sM2.1 Schedule production activities
Requested body completed and fitted onto chassis	sM2.3 Produce and test
Delivery arranged between bodybuilder and MB dealer	sM2.6 Release finished product to deliver
Body builder delivers unit to dealer	sD2.12 Ship product
Unit received at dealer	sS2.2 Receive product
Unit is MIB released on the eNatis system (SAP action: ZRMC)	sE8.5 Obtain licence
Sales card captured by dealer (SAP action: ZECU)	sD2.15 Invoice
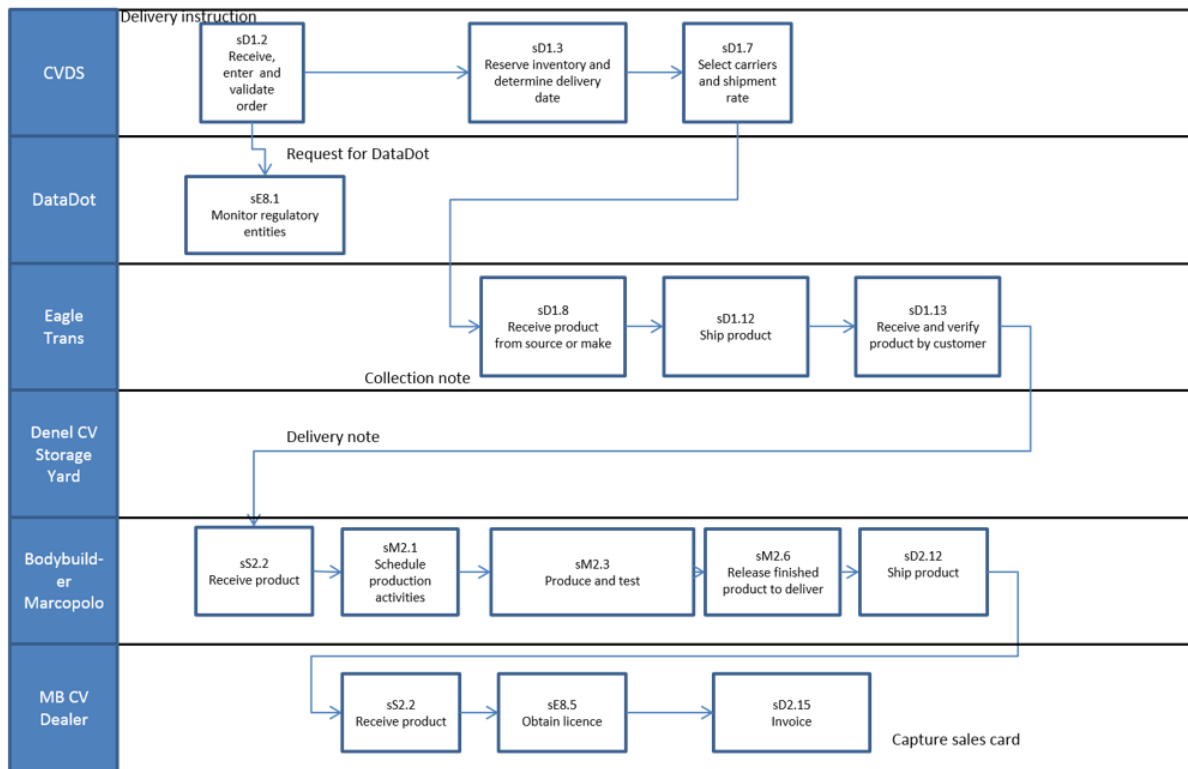
Figure 17: Delivery to bodybuilder workflow diagram

Table 6: Delivery from storage yard to bodybuilder process description

Delivery of ordered units from Denel storage yard to bodybuilder (Marcopolo) /MB CV dealer	
Process Description	**SCOR Description**
Order received, promise date updated (SAP action: ZPDD)	sD2.2 Receive, enter and validate order
Order verified for financial release (ZFRR, ZFIR)	
System automatically creates delivery order and invoice (SAP action: ZDEL, ZBIL)	
Unit updated on eNatis system to MIB controlled (SAP action: ZNAK, ZVMD)	sE8.1Monitor Regulatory entities
CVDS receives delivery instruction via VTS system	sD2.7 Select carriers and shipment rate
CVDS collects units from Denel storage yard (SAP action: ZVHC)	sD2.8 Receive product from source or make and sS2.4 Transfer product
Vehicles despatched (SAP action: ZVIT)	sD2.12 Ship product
Vehicle arrives at Bodybuilder /dealer (SAP action: ZDLD)	sD2.13 Receive and verify product by customer and sS2.2 Receive product
Unit information captured manually at body builder / dealer	

Bodybuilder schedules production of body	sM2.1 Schedule production activities
Requested body completed and fitted onto chassis	sM2.3 Produce and test
Delivery arranged between bodybuilder and MB dealer	sM2.6 Release finished product to deliver
Body builder delivers unit to dealer	sD2.12 Ship product
Dealer receives unit	sS2.2 Receive product
Unit is MIB released on the eNatis system (SAP action: ZRMC)	sE8.5 Obtain licence
Sales card captured by dealer (SAP action: ZECU)	sD2.15 Invoice
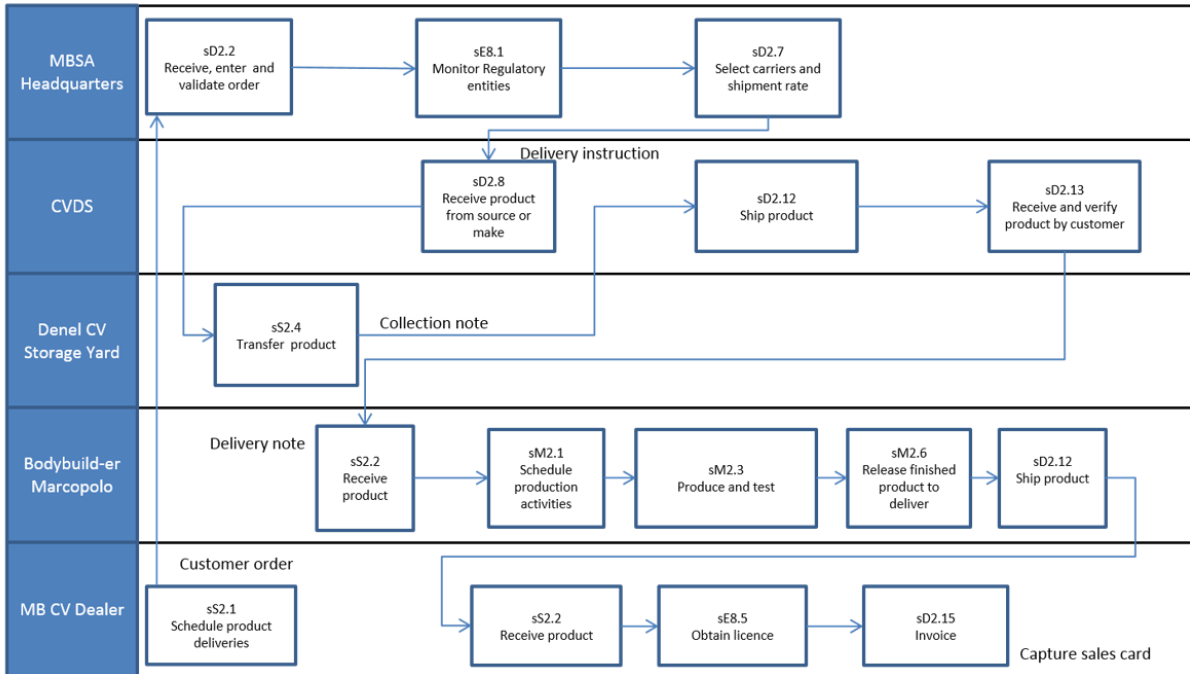
Figure 18: Delivery from storage yard to bodybuilder workflow diagram

3.3   Application of the General Visibility Model

The next step is to apply the general visibility model to the process. This model is used to identify the areas where the visibility needs to be improved. The four visibility processes; capture data, interconnect data, extract intelligence and interrupt decisions will be applied within each of the sub-processes of the MB Bus supply chain described in the previous section.

Capture Data

This step involves identifying the processes where information needs to be captured. For this project, the most important data to be captured is from the material flow and the information

flow. This includes activities such as the production and receiving of units from the material flow and the capturing and validation of orders and delivery information. This information is essential for planning and executing supply chain activities. These steps are marked with a red triangle in the workflow diagrams found in figures 19-24.

Interconnect Data

The next step is determining which data needs to be interconnected or transmitted throughout the supply chain. This step is important as often data from one partner needs to be translated into a form which is applicable to the next partner. The different partners tend to use different systems and methods for data capturing and usually not all available information is relevant to each partner. In the MB Bus supply chain this occurs at many points in the process.

The MB Brazil plant uses order information from MBSA to plan their production schedules. They in turn provide MBSA with their production schedules and shipping information. MBSA then uses this information to determine expected delivery schedules. The delivery schedules are then sent to the plant where this information is used to determine a production schedule. The delivery companies also need to use the delivery instructions sent from the plant in order to determine their delivery schedule. The bodybuilder also uses the delivery and order information to plan their production schedule. The areas of data interconnection are illustrated in figures 19-24 by means of a blue pentagon.

Extract Intelligence

In this step, valuable information based on the previously identified data interconnections is extracted from the process. This is usually in the form of order schedules, delivery schedules, production schedules, shipping documents, receipts, service agreements and promise dates. This information is essential in determining how well the process is performing. Schedules can be compared to actual system performance to determine areas of concern.

For this supply chain order schedules, delivery schedules, production schedules and delivery dates in the sub-processes have been selected as areas where intelligence can be extracted. These processes are indicated in figures 19-24 through means of a yellow plus sign.

Interrupt Decisions

This final step uses the intelligence extracted from the previous step to improve decisions and processes in the areas of concern. This could be in the form of determining alternate methods for performing activities or finding ways to improve current methods.

The application of this step shows the main areas for decision interruption are; the sourcing activities between MBSA and MB Brazil, the selection of a carrier and the communication between the bodybuilder and MBSA headquarters. This is indicated in figures 19-24 with a

green star. This section provides a brief discussion of these areas and will be the focus of the solution design phase.
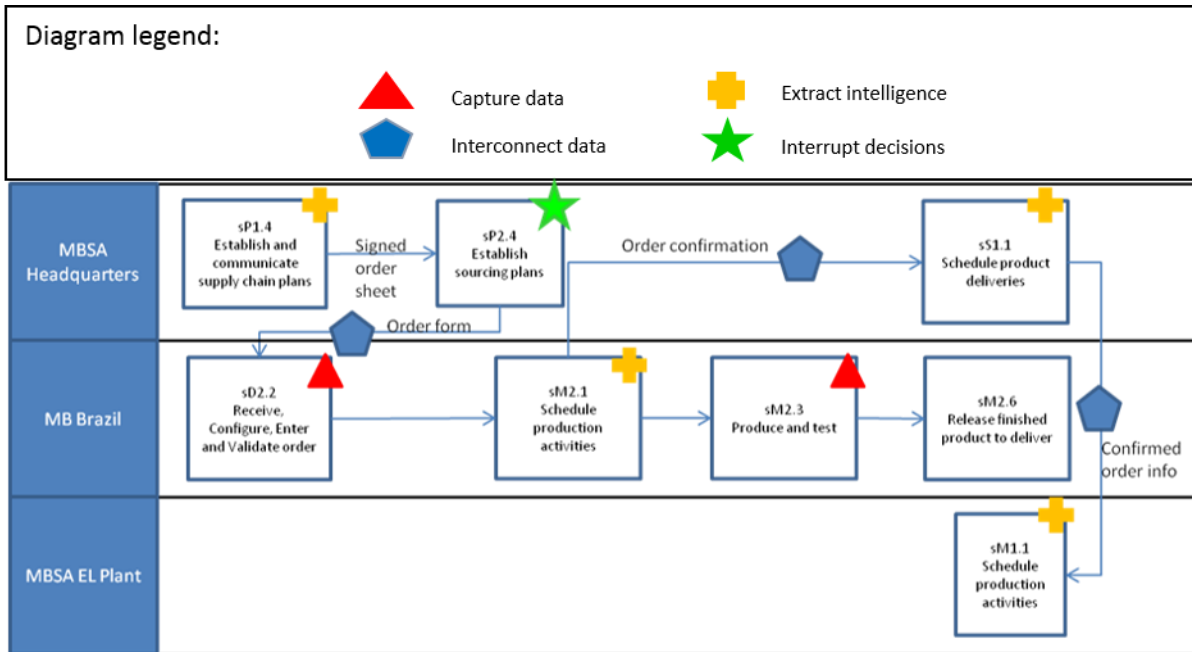
Figure 19: Ordering process - visibility model

Figure 19 illustrates that sourcing from MB Brazil is an area of concern. The shipping advice and other required information is often not received timeously causing delays in the MBSA's expected delivery and production scheduling processes. This lack of communication may be improved by exploring the capabilities of the current SAP system and common servers used by both MB Brazil and MBSA. This suggestion will be further explored in chapter 5.
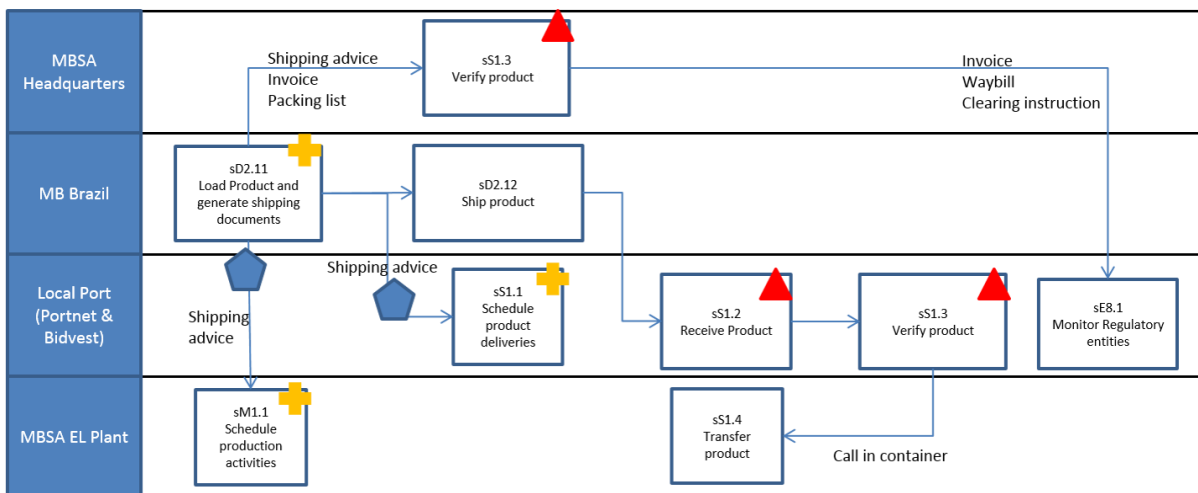
Figure 20: Receiving process - visibility model

Figure 21: Assembly process - visibility model
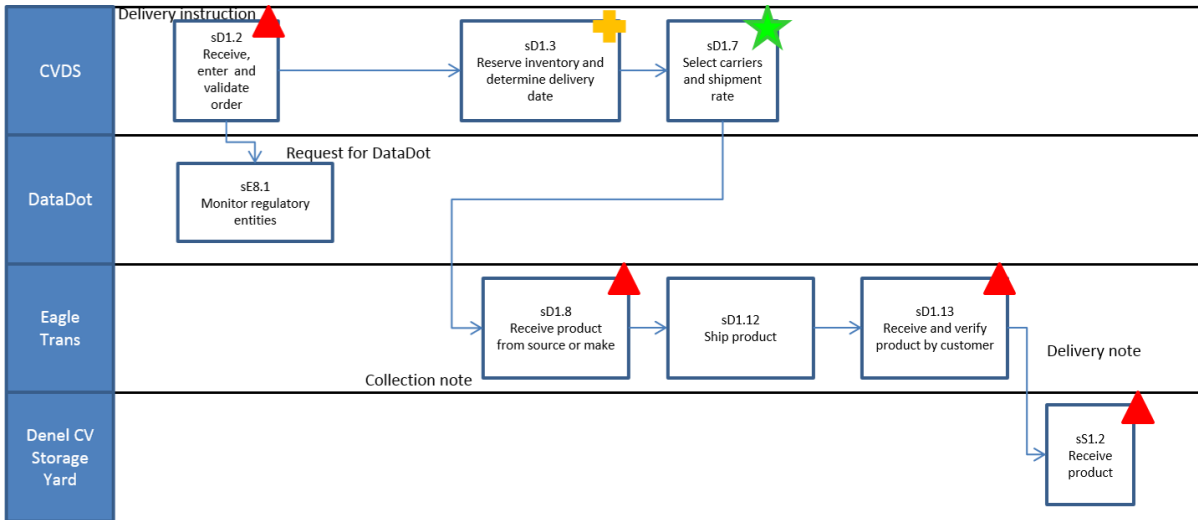
Figure 22: Delivery to storage yard - visibility model

From figure 21 and 22, it is clear that the carrier performance is a problematic area with regards to visibility. Due to the fact that CVDS subcontracts the transporting of the chassis, MBSA is not always able to track the status of the chassis deliveries. Currently, MBSA will have to contact CVDS to find out the status of the delivery and CVDS in turn have to contact Eagle Trans to get this information. It may be necessary to select a new carrier with suitable capabilities in order to improve traceability in this area. A 3PL selection will therefore be conducted in the solution design phase.
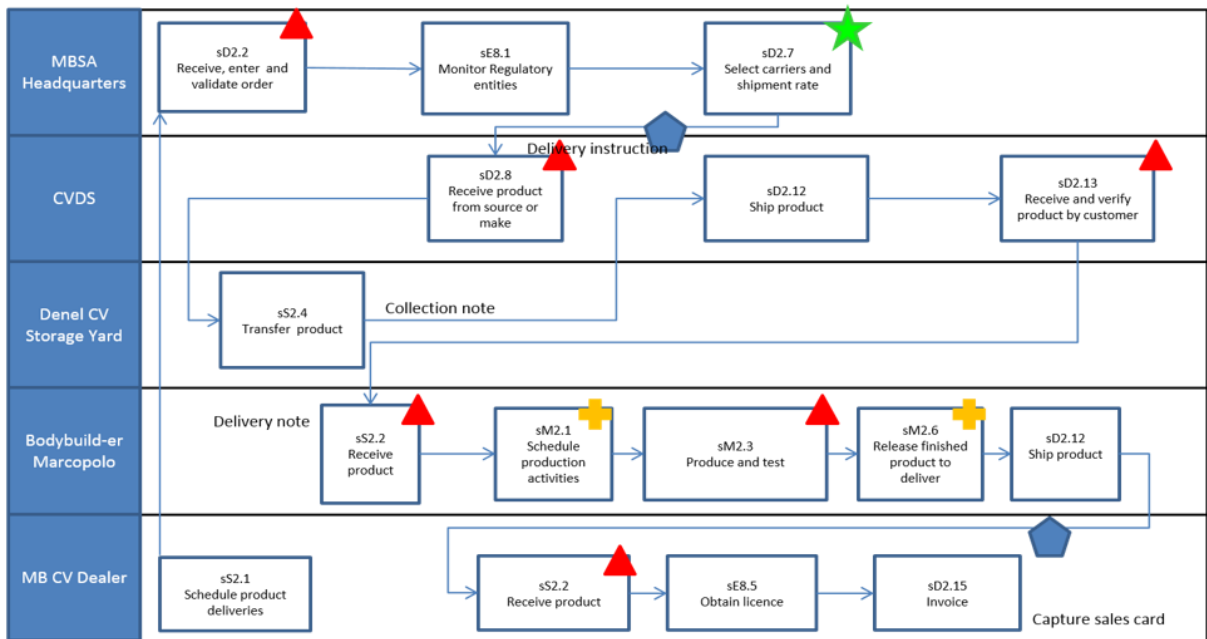
Figure 23: Delivery to bodybuilder - visibility model
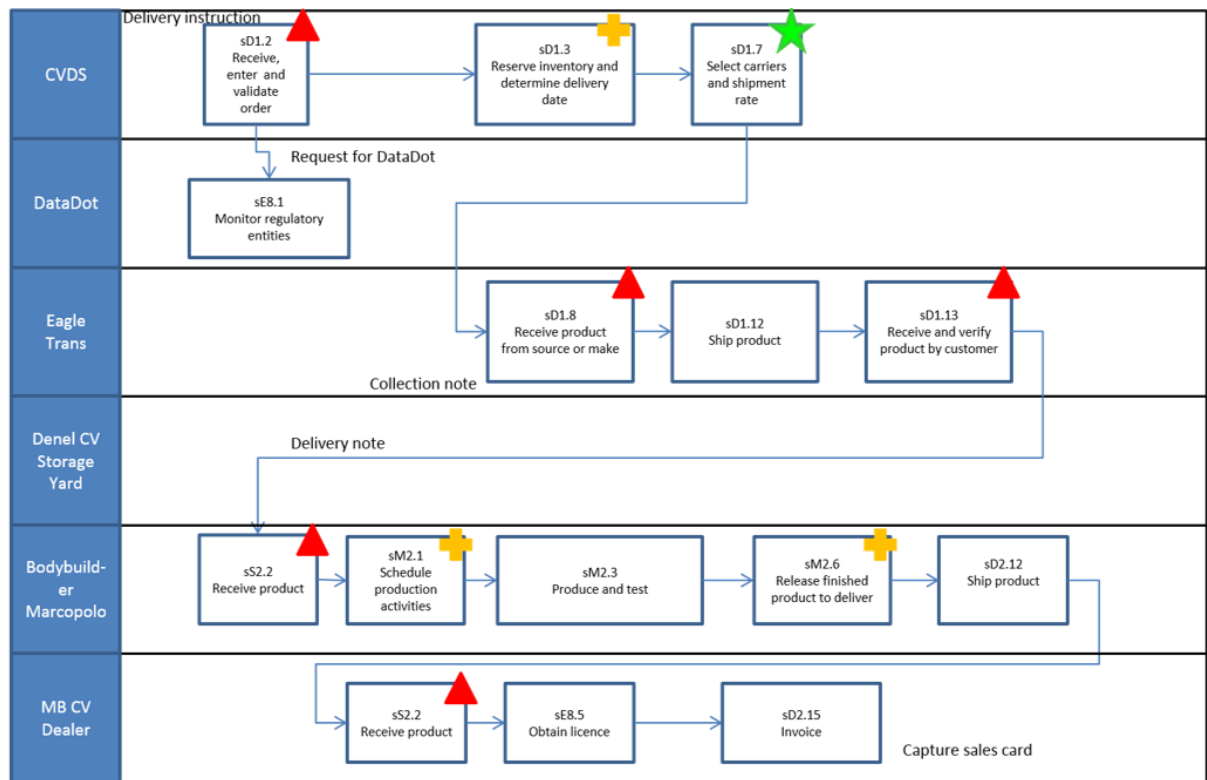
Figure 24: Delivery from storage yard to bodybuilder - visibility model

Communication between the bodybuilder and MBSA is another area where visibility is lacking. There are many instances where a chassis has been delivered to the bodybuilder but the delivery is not timeously recorded by the bodybuilder, resulting in time wasting enquiries from both parties. Once chassis are at the bodybuilder, MBSA is not notified of the progress of the bus throughout the production. This uncertainty causes delays in the sales planning for the

team at MBSA. Therefore a standard procedure of communication must be established between MBSA and the bodybuilder. This may involve using a simple checklist to ensure that the necessary information is being shared between MBSA and the bodybuilder or alternatively the use of a server or shared system can provide the same function. It may also be necessary for the chassis to be equipped with identification tags to facilitate the required tracking. All possible solutions will be further explored in chapter 5.

3.4   Concluding Remarks

This chapter deals with the thorough analysis of the entire MB Bus supply chain. An initial description of the current process is given to explain the system logic and the data involved. The process is then categorised to simplify the analysis that follows.

SCOR modelling techniques are then used to map all the processes involved in the MB Bus supply chain. The next step involves applying the general visibility model to the mapped processes. This process allows for easy identification of areas with poor visibility.

The communication gap between MB Brazil and MBSA will be explored and common systems currently in use will be investigated to develop a better communication plan. A benchmarking exercise will be carried out using applicable metrics. A 3PL selection will be conducted to address the visibility deficiencies during chassis transportation. A standard procedure will then be developed to enable effective communication between the bodybuilder and MBSA. Finally, overall process visibility may be improved by additional technology or IT solutions, which will be explored in the solution development phase.

Chapter 4: Metrics Development and Benchmarking

4.1 Current Metrics

The first task of this phase is to investigate the current metrics in place and determine the usefulness of these metrics in measuring the level of visibility in the MB Bus supply chain. These metrics are acquired from the supply chain manager, who uses the same metrics to measure the performance of all the product supply chains within the commercial vehicle department. Table 7 lists the current metrics and their explanations.

Table 7: Current Metrics

Process	Current Metric	Explanation
Sourcing process (Ordering And Receiving)	Factory Order Accuracy	This metric is used to check that all orders from the signed off order sheet have been confirmed and placed on the SAP system within the same month. $$\frac{(\textbf{Number of orders confirmed on SAP for the month})}{(\textbf{Number of orders on order sheet for the month})} \times \textbf{100}$$
Assembly process (at MB EL plant)	Truck Plant on Time	This metric is used to measure the production at the MB EL plant to ensure all vehicles are assembled on time. The number of vehicles produced later than, earlier than and on the planned date are recorded. $$\frac{(\textbf{Number of vehicles produced on time per month})}{(\textbf{Total number of vehicles produced per month})} \times \textbf{100}$$
	Plant Plan vs. Actual	This metric is used to measure the production planning of the MB EL plant. The planned number of vehicles to be produced per month is measured against the actual number of vehicles produced per month. $$\frac{(\textbf{Number of vehicles produced per month})}{(\textbf{Number of vehicles planned for production per month})} \times \textbf{100}$$
Delivery process (Transport / Carrier)	Carrier on Time	This metric is used to check that the carrier delivers the vehicles to the required bodybuilder or storage yard within the agreed upon time. $$\frac{(\textbf{Number of vehicles delivered on time per month})}{(\textbf{Total number of vehicles delivered per month})} \times \textbf{100}$$
Overall process	On Time to Dealer	This metric is used to measure the number of orders/vehicles that are completed and delivered on time to the dealers for each month. The number of vehicles delivered late is also recorded. $$\frac{(\textbf{Number of vehicles delivered on time to dealer per month})}{(\textbf{Total number of vehicles delivered to dealer per month})} \times \textbf{100}$$

Table 7 lists the current metrics according to the process each metric represents. The Factory Order Accuracy metric measures the accuracy of the sourcing process; the Truck Plant on Time and the Plant Plan vs. Actual metrics measure the performance of the assembly process; the Carrier on Time metric measures the performance of the carriers during the delivery process and the On Time to Dealer metric indicates the efficiency of the overall process. Each of these metrics are explained in table 7 and the relevant formula used to calculate each metric is provided. The metrics are measured on a monthly basis and are expressed as a %.

The explanations in table 7 indicate that majority of the current metrics do not measure the visibility in the supply chain and are more focused on measuring the output of the various activities involved. The only metric found to be valuable for representing the level of visibility, is the Factory Order Accuracy metric. It was also noted, from discussions with the supply chain manager, that the On Time to Dealer metric is currently not being measured for the bus department as there is too much variation in the cycle time. There are also no metrics in place to measure communication between the partners. Therefore, it is necessary to develop a new set of metrics to provide more accurate insight regarding visibility within the supply chain.

4.2 Metrics Development

The development and selection of metrics to be used for measuring the performance of a supply chain should be closely linked to the strategy of the supply chain. The MB Bus supply chain is focused on providing customers with a quality product that meets all their requirements. According to the SCOR framework, this is indicative of strategy based on reliability and responsiveness (SCC, n.d.). The focus of this project, visibility, is an underlying factor that supports both these aspects.

The metric development commences with holding a meeting with the relevant staff to obtain their input in determining a new set of visibility metrics. The input from the staff is vital at this stage as they provide insight into metrics which will be practical, helpful and maintainable for future use. A total of three qualitative and quantitative metrics make up the final metric selection. These metrics are a combination of those used currently by the company, derivations of the SCOR metrics and derivations of the communication score card metric developed by Bill Quirke (Starry Blue Brilliance, 2013). The three metrics are explained below.

4.2.1 Factory Order Accuracy

This metric is currently being measured by the MB Bus department and is useful in determining the level of visibility between MBSA and the supplier MB Brazil. This metric measures the accuracy of the orders being placed. The monthly order is confirmed at the FRM which takes place during the second or third week of each month. The confirmed order is filled in on the order sheet, signed off by the relevant managers and emailed to MB Brazil. MB Brazil uses

this order to plan the chassis production four months in advance. MB Brazil then sends an order confirmation to MBSA who confirms the order volume and provides an expected production date. The logistics specialist in the bus department at MBSA then enters each of the vehicles confirmed in the order confirmation onto the SAP system. At the end of the month, the supply chain manager checks that the number of chassis placed on the SAP system is equal to the number of chassis recorded on the order sheet for that month. Measuring the accuracy of the orders placed gives significant insight into the efficiency of this ordering process.

As this metric is already being measured, the required data is readily available. The calculation for this metric, expressed as a percentage, is given in table 7 and repeated in figure 25.

$$Factory\ Order\ Accuracy = \frac{Number\ of\ orders\ placed\ on\ SAP\ per\ month}{Number\ of\ orders\ recorded\ on\ the\ order\ sheet\ for\ the\ month} * 100$$

Figure 25: Factory Order Accuracy Metric

4.2.2 Production Cycle Time

Order Fulfilment Cycle Time is one of the applicable metrics listed in the SCOR framework. This metric is used to measure the responsiveness of the supply chain. The metric is calculated by measuring the time taken to fulfil an order. This metric was then adapted to develop a metric more suitable to the processes involved in the MB Bus supply chain.

Currently the total cycle time of bus production varies significantly. This is due to the many activities involved during the production, which are carried out by various partners at different locations. The amount of control MBSA has over the external partners, such as the body builders, is limited and thus they cannot impose cycle times on these partners. However, the production of the bus chassis is an internal process and thus the cycle time can and should be measured. This cycle starts from the time the chassis CKD kit has been produced at the MB plant in Brazil and ends when the chassis has been fully assembled and completed at the MB EL plant. A 90 day approximation has been assigned to this process but this cycle is not being measured at the moment.

The Production Cycle Time metric will measure the number of days used for the production of the chassis so as to ensure the 90 day approximation is being adhered to. The required data will be obtained from the SAP system. The calculation for this metric is given in figure 26.

$$Production\ Cycle\ Time =$$

$$Staging\ time\ at\ MB\ Brazil + Shipping\ Time\ from\ Brazil\ to\ local\ port$$
$$+\ Production\ Time\ at\ MB\ EL\ plant$$

Figure 26: Production Cycle Time Metric

4.2.3 Communication Efficiency

Efficient communication between partners in the supply chain is one of the key factors towards ensuring a high level of visibility and partner collaboration. Echoing the work of Billy Quirke (2013), Bieniek (2013) suggests that to ensure successful communication, effectiveness of this communication should be measured (Starry Blue Brilliance, 2013). Furthermore, Bieniek (2013) has developed a communications score card based on the framework designed by Quirke. This score card focuses on measuring four aspects, namely; efficiency of the communication channels, effectiveness of the actual communication, the impact of the communication on behaviour and lastly the impact the communication has on the business. These aspects are then measured in terms of the required outcomes, agreed upon measurement methods and the actual outcomes. Each of the aspects is then given a rating according to how well they perform against the measures (Starry Blue Brilliance, 2013). Bieniek's communication score card can be found in appendix B.

Using Bieniek's (2013) score card as an example, a customised communications score card and metric was developed for the MB Bus supply chain. Instead of measuring four different communication aspects as Bieniek's has, this score card uses only one metric, i.e., the communication efficiency, to measure the overall communication between MBSA and each of its partners. The score card records the channels of communication for each partner as well as the required information from each partner. The communication efficiency rating is then allocated based on how well the information actually received adheres to what is required. It also takes into consideration the efficiency of the communication channels in sharing the required information between partners. This score card is illustrated in figure 27 along with its rating scale.

	Supplier	MB East London Plant	3PL / Carrier	Bodybuilder	Customer/ Dealer Front End	Total (Rating)
Channel/s of Communication						
Required Outcome / Information						
Communication Efficiency (Rating)						20

Communication Efficiency Rating:
1 - Does not meet required outcome
2 - Marginally meets required outcome
3 - Meets required outcome
4 - Exceeds required outcome

Figure 27: Communication Efficiency Metric

As illustrated in figure 27, the columns of the score card display each of the partners in the supply chain. The rows are used to record the communication channels and required information from each of the partners. The last row is used for recording the communication efficiency metric, where a rating is recorded for the overall communication of each partner.

To be efficient, the communication between partners must be on time, in the correct format and contain the correct and useful information. However, to a large extent, the staff is expected to use their discretion and experience in determining the efficiency level of communication, thus the metric can be considered a qualitative measure. This metric is then quantified by using a scale of 1 to 4. The scale is explained in figure 27. The ratings for each of the partners communication is then totalled to give the overall supply chain a final rating out of 20. This can then be used as an indication of the overall communication efficiency for the supply chain and can also be used to compare against the other supply chains in the department.

4.3 Internal Benchmark

The newly formulated set of metrics is then used to benchmark the performance of the MB Bus supply chain. It was decided that an internal benchmark would be the most appropriate

for this exercise. Following the recommendation of the supply chain manager, only the MB Van supply chain is used for benchmarking against the MB Bus supply chain. The reason being, the MB Van supply chain follows a similar process to that of the MB Bus. Additionally, the supply chain manager justifies this recommendation by relying on his knowledge and previous experience which has shown that the MB Van supply chain displays a high level of visibility.

4.3.1 Van Process Description

The first task is to understand the process involved in the MB Van supply chain. As this supply chain is not the focus of the project, only a brief outline of the process is given. The process follows much of the same process detailed in the MB Bus supply chain found in section 3.1. This outline highlights the main differences between the MB Van and MB Bus processes. This is illustrated in table 8.

Table 8: Van Process Description

Process	Description	Differences to Bus
Ordering Process	Orders for vans are formulated on a monthly basis. Orders are then sent to the MB Plant in Germany where the vans are produced as a FBU vehicles. These orders are sent directly via the SAP system.	The ordering process for vans does not require an emailed order to be sent first. Orders are placed directly on the SAP system, without having to wait for email confirmations from the factory in Germany.
Receiving Process	Vans are sent to the local port in East London much in the same way as the bus process. Clearing and customs are also handled in the same way.	Vans are received as a FBU vehicles and not as a CKD kit.
Assembly Process	The vans are received already assembled and so only minor part fitments and legal requirements are done at the MB EL plant.	Only minor parts are fitted to the vans at the MB EL plant whereas the entire bus chassis is assembled at this plant.
Delivery Process	The MB Van division uses two carriers to transport the vans to storage yards and the bodybuilders. The carriers are designated according to areas. Vans are delivered on road, meaning the vehicles are driven to the designated destinations.	Vans are driven to points of delivery while the bus chassis have to be delivered on a low bed truck. There is also only one carrier contracted for bus delivery.

4.3.2 Data Gathering

The next task is to measure the selected metrics for both MB Van and MB Bus which involves gathering the relevant data for each metric.

Factory Order Accuracy

The data for this metric is obtained from the supply chain manager as this is one of the metrics he is currently measuring. Data from the 2013 to 2014 period is used for this benchmark.

Production Cycle Time

The required production cycle time data is extracted from the SAP system for both MB Van and MB Bus. A random sample of 50 bus orders and 50 van orders, completed during the 2013 to 2014 period, is selected for the benchmarking.

Communication Efficiency

The ratings for the Communication Efficiency metric are gathered from the staff involved in the bus and van supply chain. The communication score card illustrated in figure 27 was completed by the staff and the metric ratings extracted from this form.

4.3.3 Score Card

Once all the relevant data had been collected and sorted, a score card representing the resulting metrics was developed to illustrate the performance of both the MB Bus supply chain and the MB Van supply chain. The final score card is given in figure 28.

Metric	Score	
	MB Bus	**MB Van**
Factory Order Accuracy	82%	100%
Production Cycle Time	70 Days	43 Days
Communication Efficiency	12/ 20	15 / 20

Figure 28: Score Card

From the benchmark it is clear that the MB Van performance dominates the MB Bus performance across all three metrics. This result indicates that there is a clear visibility problem within the bus division. The benchmark has also helped to identify areas in which the MB Bus supply chain can improve, possibly by implementing practices being used in the MB Van department.

MB Van achieved a perfect score of 100% for the Factory Order Accuracy metric whilst MB Bus achieved a score of 82%. The difference in score indicates that there is a lack of effective information sharing between MB Brazil and MBSA and that there is much room for improvement on the part of MB Bus. The differences in the order processes between MB Bus

and MB Van is one of the main reasons for the superior performance of the MB Van and MB Bus can benefit from implementing the methods used by MB Van.

The Production Cycle Time metric shows that both MB Van and MB Bus have an average cycle time that is far below the approximated cycle time of 90 days. This indicates that the 90 day approximation is inaccurate and should be reviewed. The reason for the MB Van cycle being far shorter than the bus is that the minimal fitting activities taking place at the MB EL facility are far less complex than the assembly processes of the bus. Chapter 5 will feature a more accurate cycle time for the MB Bus.

From the difference in the Communication Efficiency ratings, it is clear that the MB Van supply chain displays better communication than the MB Bus supply chain. This is likely attributed to the more automated information sharing being displayed in the MB Van department as well as the quality of the information that is being shared. It follows that the communication within MB Bus can be improved by adapting the methods used in the MB Van supply chain.

4.4 Concluding Remarks

This chapter deals with analysing the current metrics in an attempt to measure the performance and visibility within the supply chain. The analysis indicates that the current metrics do not sufficiently measure the level of visibility which leads to the development of a new set of metrics.

New metrics are developed from the company's current metrics as well as metrics adapted from various sources. Following the manager's recommendation, these metrics are then used in an internal benchmark against the MB Van supply chain.

The results show that the MB Van outperforms the MB Bus supply chain in terms of supply chain visibility. The suggestion to adapt the methods and activities currently being used in the MB Van supply chain will be considered in the solution development phase found in chapter 5.

Chapter 5: Solution Development

This chapter describes the process of developing a multifaceted solution necessary for improving the overall visibility of the MB Bus supply chain. The solution is divided into various components to address each of the areas of concern highlighted in chapters 3 and 4. These components include; a proposal to implement service level agreements (SLAs) between MBSA and its supply chain partners; a 3PL selection using the AHP tool; an improved process that focuses on information sharing and communication activities; and the development of an Excel tracking tool to compliment the improved process. The process is mapped using the SCOR tools to illustrate the improvements. Lastly, a brief best practice analysis is provided.

5.1 Service Level Agreements

From the analysis conducted in chapter 3 and 4, it has become apparent that one of the key reasons for the seemingly inefficient communication and low visibility within the MB Bus supply chain is the lack of well documented SLAs. Parish (1997) describes SLAs as an important agreement between a service provider and the customer. Parish (1997) goes on to emphasise the importance of having SLAs in place to ensure service requirements are defined and measured accordingly. Thus, the first step of the proposed solution entails the review and development of SLAs between MBSA and the relative supply chain partners. However, developing multiple SLAs for the MB Bus supply chain falls beyond the scope of this project, but will be addressed in the future. This project will detail the main requirements and recommendations that should be included in the agreements.

5.1.1 Supplier SLA

Currently the ordering process is reliant on the staff's knowledge of the process flow. After some investigation it was found that the activities involved in the ordering process have not been documented. The only contract in place between MBSA and MB Brazil is a general sales and purchase agreement developed by Daimler AG, which is used for all procurement activities at MBSA. No documentation exists to explain the requirements and responsibilities of both MB Brazil and MBSA during the ordering process. As the ordering process is an area of major concern, it is essential that an agreement detailing these requirements be put into place.

The key requirements are aimed at structuring the ordering process and increasing the visibility are defined using the feedback from several interviews with the staff at MBSA. This report only details the requirements related to the areas that display the most ambiguity and delays. The SLA should include other requirements such as delivery times, production times and related activities.

Order Confirmation Lead Time

Order Confirmation Lead Time refers to the time taken by MB Brazil to send an email order confirmation. It is measured from the date an order is emailed through to MB Brazil until MB Brazil sends the email order confirmation to MBSA. Currently this time varies between 2 to 52 days. It is necessary to standardise this lead time as the variation causes major delays in the planning of MBSA.

The lead times of orders placed between January 2014 and July 2014 are analysed to determine the average lead time, which was found to be 30 days. When deciding upon a standard lead time, it is also necessary to specify a reasonable time for variability. Based on the lead time confirmation data as well as past experience of the supply chain manager, a variability of 3 days was suggested. This 30 day lead time with a 3 day variability should be proposed to MB Brazil as the standard lead time and as one which should be agreed upon and adhered to. Penalties or other follow-up actions should also be defined for lead times exceeding the agreed upon time frame.

Order Deadlines

Presently, MB Brazil provides MBSA with an order deadline by which all emailed orders need to be sent through. The monthly order is used by MB Brazil to plan production of chassis CKD kits four months in advance. However, these deadlines do not always tie in with the planning and performance measuring methods of MBSA. When an order deadline falls within the last few days of the month, MB Brazil will fail to send MBSA an order confirmation within the same month. This then reflects poorly on the Factory Order Accuracy metric measured by MBSA. It also delays the production planning of the MB EL plant.

The deadlines for order placement should be re-evaluated taking into consideration the agreed upon order confirmation lead time as well as the planning requirements of both MBSA and MB Brazil. Assuming a 30 day order confirmation lead time, order deadlines should be set closest to the 1st of each month. This will allow sufficient time for MB Brazil to confirm orders within the month. It will also allow MBSA to confirm its production planning and correctly reflect its monthly performance with regards to the Factory Order Accuracy metric. Again, penalties or other reasonable actions for placing orders later than the agreed upon time should be stipulated.

Shipping Advice

Currently, there is an undocumented understanding in place between MBSA and MB Brazil. MB Brazil is expected to send MBSA the shipping advice, in terms of a waybill or bill of lading, approximately two days after the orders have been shipped. Too often this advice is not sent timeously to MBSA, causing a delay in the production planning at MBSA as well a delay in

the clearing processes. To avoid this, a set time should be agreed upon by which MB Brazil must send the shipping advice to MBSA. The consignment is shipped approximately 15 days after the vehicles have been produced and MB Brazil, the consignor of the shipment, will always receive the shipping advice within 2 days of the ship having left Brazil. Thus, a reasonable time for receiving the shipping advice is 17 days with a variation of 3 days. Appropriate follow-up actions and penalties should be agreed upon to ensure this agreement is withheld.

Automated Orders

As a long term solution, MBSA should propose that the orders for busses be placed in the same manner as the order for vans are placed. Orders should be placed directly on the SAP system and confirmation should occur automatically, eliminating the need to first email an order and await confirmation before ordering on the SAP system. However, this may require numerous improvements on the supplier's side and will take a longer time to negotiate and implement.

5.1.2 Bodybuilder SLA

MBSA does not take ownership of the body and the bodybuilder is paid directly by the customer. For this reason, there is currently no service agreement in place between MBSA and the bodybuilder. However, the relationship between MBSA and the bodybuilder remains important when attempting to increase the visibility through the MB Bus supply chain. For this reason it is suggested that an informal agreement between MBSA and the bodybuilder be put in place in an attempt to improve the performance of both parties. This agreement must address the following key issues.

Promise dates

When the bodybuilder has received a chassis that has been ordered by a customer, the bodybuilder must provide MBSA with an expected date of completion. Based on previous experience with the bodybuilder, this date should be set approximately 6 to 8 weeks from the start of production.

Progress reports

The bodybuilder must provide MBSA with weekly reports detailing the progress of each of the orders. This can be sent in the form of a spread sheet detailing the status of the chassis, including the date the chassis was received, the date production was started and the date production will be completed. The bodybuilder must also communicate any problems that may arise such as parts shortages and employee or industry strikes.

5.1.3 Carrier SLA

Currently, the SLA in place between the carrier and MBSA is a generic agreement used for all vehicle carriers within the department. Due to the unique delivery requirements of the bus chassis, it is recommended that a customised SLA for the transport of busses be developed. A meeting was held with members of the supply chain department, the MB Bus product department and the procurement department, to define the key points of the bus chassis SLA. These differentiating key points are discussed below.

Collection and Delivery Requirements

The carrier is required to collect and deliver the chassis from and to points stipulated by MBSA. The carrier must carry out an inspection on collection and delivery of the chassis according to a chassis checklist and all observations must be noted.

Handling Specifications

The bus chassis must be handled according to the specifications set out in the Daimler AG Operations Manual. This includes the procedure for loading and unloading the vehicle so that no damage is caused to it. The carrier is also required to cover certain parts of the vehicle during transit. This includes the steering column and all electrical components on the vehicle.

Transportation Lead Times

The majority of the chassis will be transported from the MB EL plant to the storage yard and bodybuilders in Gauteng. Based on previous experiences, MBSA poses a lead time of 3 days for this transportation with a variability of 1 day to allow for unexpected delays.

Infrastructure/Equipment Requirements

The carrier is required to deliver the vehicle off-road. A low bed truck must be used for all chassis transportation. Each of the carrier's vehicles must be fitted with a tracking device and the carrier must be able to inform MBSA of the location of the vehicle at any point during the delivery. The carrier must inform MBSA of the type of technology used to facilitate this tracking. The carrier must also inform MBSA of the system it uses and its ability to interface with the MBSA SAP system.

These are the key requirements that a potential carrier must satisfy before being awarded the carrier contract. At this point, it is also important to determine a method for selecting the best carrier if there are multiple carriers found to satisfy these requirements. Section 5.2 addresses the proposed method for this selection.

The SLA requirements and cycle times mentioned in this section is used to develop a tracking tool as part of the improved process for the MB Bus supply chain. This will be detailed in section 5.3.

5.2 Carrier Selection

Unlike the case of the supplier, there are numerous carriers available to provide the chassis transportation service. For this reason, a carrier selection will be used to determine the best available carrier to meet the MB Bus transport requirements with a focus on increasing the overall visibility.

The selection process starts with sending out a Request for Quotation (RFQ) to all suitable 3PL providers. The 3PL providers capable of meeting the requirements stipulated in the SLA then send through quotations and proposed solutions for the bus transportation. Once all this information is received, an AHP tool can be used to make the final selection.

As the carrier selection is not the main component of the solution, an existing AHP template designed by Kruger, (2012) will be used instead of developing a new template. The focus of this activity will be on the applicability of the AHP method in selecting the carrier that will provide the best visibility for the delivery process involved.

Three possible carriers are considered in the selection. Due to the confidentiality of the information required in this selection process, the carrier names and actual information cannot be published in this report. A realistic example is used here to explain the process that is followed. The tool with the AHP results can be found in appendix C.

Selection Criteria

The first step of the AHP is to determine the defining criteria that will be used to rate the carriers. As many of the requirements have been explicitly defined in the SLA, it was decided that the criteria used here will focus on increasing the visibility in the supply chain. The four selected criteria are explained below.

Cost

Although the cost does not directly affect the level of visibility within the supply chain, it is naturally one of the biggest aspects in selecting a carrier. The rates of the carrier must be competitive and inclusive of all costs associated with the movement of the chassis. Lower rates are considered most favourable.

Capacity

This criterion considers whether the selected carrier has adequate capacity to move the required volume of chassis. The size of the carrier's fleet and its ability to adapt to fluctuating volumes are an important part of this criterion. It also considers whether the carrier subcontracts the actual transportation to another company. Experience with the current carrier proves that subcontracting contributes to limited visibility and brings about added complexity to the process. Carriers with sufficient in-house capacity will be given preference.

Technology

This is one of the more important criteria in attempting to increase visibility. The carrier must be running an operating system that can directly interface with the SAP system used by MBSA. This is to ensure that delivery instructions can be transmitted automatically. This criterion also considers the tracking device and technology used by the company and how efficiently real-time information on the vehicles can be received. Preference will be given to carriers with the best technology and systems in place.

Communication

The communication criterion deals with the carrier's willingness and ability to communicate with MBSA. It takes into consideration the means of communication as well as the efficiency of the communication. It is important that the carrier be able to communicate with MBSA in case of system downtime or any other issues that may occur. It also considers the carriers ability to communicate with the driver of the delivery vehicles at all times.

Criteria Pairwise Comparison

The next step involves a pairwise comparison of these criteria to determine the weight that should be assigned to each of the criteria. This is done by comparing each of the criteria to every other criteria to determine which of the two is most important. The AHP uses a quantitative scale to compare each of the criteria and then allocates weights accordingly. The scale ranges from 1 to 9, where 1 indicates both criteria being equally important and 9 indicates that the first criterion is absolutely more important than the second. This results in criteria with higher importance being allocated higher weights. This scale is illustrated in figure 29.

The ratings to be given in the comparison are a result of a discussion with the supply chain manager and the relevant staff members involved in the MB Bus supply chain. The following conclusions yield from this discussion:

- The cost criterion is of greater importance than all other criteria except the technology criterion. This is because the main goal of this selection is achieving a high visibility level, thus having a system that can interface with the MBSA system is of equal importance to having a reasonable rate.
- It follows that the technology criterion is of greater importance than all other criteria except the cost. Again, the technology criterion is the main driver of ensuring high visibility and must be given preference.
- The communication criterion is of greater importance than the capacity criterion as good communication facilitates the visibility in the supply chain.

- The capacity criterion is given the least importance as this aspect is focused on whether or not the carrier subcontracts the transport. However, as long as the communication and Technology criteria are met, carriers that subcontract transportation can also be accepted.

These conclusions form the basis of the pairwise comparison and can be viewed in figure 29.

Criteria i	Greater than	Criteria j	Rating
Cost	>	Capacity	5
Cost	>	Technology	1
Cost	>	Communication	2
Technology	>	Capacity	7
Communication	>	Capacity	3
Technology	>	Communication	2

Value Scale
1 -> Objectives i and j are of equal value
3 -> Objective i is weakly more valuable than alternative j
5 -> Objective i is strongly more valuable than alternative j
7 -> Objective i is very strongly more valuable than alternative j
9 -> Objective i is absolutely more valuable than alternative j

Figure 29: Criteria Pairwise Comparison

The ratings in figure 29 reflect the results of the discussion with the relevant staff. As illustrated, cost is considered to be more valuable than capacity and communication and thus is given a rating of 5 and 2 over these respective criteria. Cost and technology are considered to be of equal importance and is given a rating of 1. Technology in turn, is also more important than capacity and communication and is given a rating of 7 and 2 respectively. Lastly, communication is considered to be minimally more important than capacity and is therefore given a rating of 3. These ratings are then used to allocate weights to each of the criteria. The allocated weights are shown in figure 30.

Criteria	Allocated Weight
Cost	0.36
Capacity	0.06
Technology	0.39
Communication	0.19

Figure 30: Criteria Weight Allocation

These weights are derived from the ratings given in figure 29. The ratings are converted to a 4x4 matrix form for easier calculation. The four criteria are listed in the rows and columns. The columns are totalled and each entry is divided by the respective column total to give a probability. These probabilities are then added to give a final weight allocation to each criteria (Excel AHP Template, Appendix 3). Figure 30 shows that the technology criterion has been given the highest significance with a weight of 0.39. The capacity criterion has the least significance with a weight of 0.06.

Alternative Pairwise Comparison

A pairwise comparison with respect to each criterion is then conducted for the alternative carriers. Each carrier is compared to every other carrier with regards to each of the criteria. This comparison is based on the information provided by the carriers. This data is shown in table 9.

Table 9: Carrier Data

		Carrier 1	Carrier 2	Carrier 3
COST	Delivery Rate (EL to Gauteng)	R10 500	R12 000	R11 500
CAPACITY	Subcontracts?	Yes	No	No
	No. of chassis delivered per day	4	4	4
TECHNOLOGY	Efficiency of system interface and tracking technology	2	2	3
COMMUNICATION	Means of communication	Email,phone	Email, Phone	Automated system messages, Email, Phone
	Efficiency	1	2	3

Efficiency rating used for technology and communication:

1 – Minimally meets requirements, Low efficiency

2 – Meets requirements, Medium efficiency

3 – Exceeds requirements, High efficiency

From the data in table 9, the following conclusions can be drawn:

- Carrier 1 performs the best with regards to cost, whilst carrier 2 has the lowest performance.
- Carrier 2 and 3 perform equally well with regards to capacity whilst carrier 1 displays a weaker performance.
- Carrier 3 has the best performance with regards to technology, whilst carrier 1 and 2 perform equally well.
- Carrier 3 has the best performance with regards to communication, whilst carrier 1 exhibits the weakest performance.

The pairwise comparison for the alternative carriers is conducted based on these conclusions and can be viewed in figure 31.

Criteria	Alternative i	Greater than	Alternative j	Rating
COST	Carrier 1	>	Carrier 2	5
	Carrier 1	>	Carrier 3	4
	Carrier 3	>	Carrier 2	3
CAPACITY	Carrier 2	>	Carrier 1	3
	Carrier 3	>	Carrier 1	3
	Carrier 3	>	Carrier 2	1
TECHNOLOGY	Carrier 1	>	Carrier 2	1
	Carrier 3	>	Carrier 1	5
	Carrier 3	>	Carrier 2	5
COMMUNICATION	Carrier 2	>	Carrier 1	3
	Carrier 3	>	Carrier 1	7
	Carrier 3	>	Carrier 2	4

1 -> Alternatives i and j are of equal value
3 -> Alternative i is weakly more valuable than alternative j
5 -> Alternative i is strongly more valuable than alternative j
7 -> Alternative i is very strongly more valuable than alternative j
9 -> Alternative i is absolutely more valuable than alternative j

Figure 31: Alternative Pairwise Comparison

The ratings in figure 31 reflect the information provided in table 9 and the subsequent conclusions. The ratings show carrier 1 has the best performance with regards to cost. Carrier 2 and carrier 3 are rated equally valuable in terms of capacity and are both more valuable than carrier 1. Carrier 3 shows the best performance with regards to technology and is given a rating of 5 over both carrier 1 and 2. Carrier 3 also exhibits the best performance with regards to the communication criterion and is reflected in the ratings. These ratings are then used to allocate a weight to each alternative carrier with regards to each of the criteria. These weights are shown in figure 32.

Criteria	Alternative	Allocated Weight
COST	CARRIER 1	0.67
COST	CARRIER 2	0.10
COST	CARRIER 3	0.23
CAPACITY	CARRIER 1	0.14
CAPACITY	CARRIER 2	0.43
CAPACITY	CARRIER 3	0.43
TECHNOLOGY	CARRIER 1	0.14
TECHNOLOGY	CARRIER 2	0.14
TECHNOLOGY	CARRIER 3	0.71
COMMUNICATION	CARRIER 1	0.09
COMMUNICATION	CARRIER 2	0.21
COMMUNICATION	CARRIER 3	0.70

Figure 32: Alternative Allocated Weights

Figure 32 shows that carrier 1 has the best performance with regards to cost and is given a weight of 0.67. This is calculated by multiplying the initial weight allocated to the cost criterion with the rating of carrier 1 with regards to the cost criterion. This method is used for all the allocated weights shown in figure 32. Carrier 2 and 3 are given an equal weighting of 0.43 with regards to capacity indicating these are equally valuable. Carrier 3 exhibits the best performance with regards to technology as well as communication and is given ratings of 0.71 and 0.70 respectively. These calculations are shown in the AHP excel template in appendix C.

The final weighting of each alternative carrier is calculated in two steps. The first step consists of multiplying the weight allocated to each criteria by the weight allocated to the alternative with regards to the respective criteria. This is then summed to find the final weight for each alternative. The formulae for this calculation can be found in the AHP excel template. Consequently, the alternative with the highest score is considered to be the best carrier. In this case, carrier 3 is allocated a final weight of 0.5203 and is selected as the new carrier. The results are shown in figure 33.

Figure 33: Final Alternative Weights

The selection of a new carrier, i.e. Carrier 3, plays an important role in improving the processes in the supply chain. As Carrier 3 does not subcontract the delivery, the activities involved will differ from the original supply chain activities. The effects of this new selection will be shown in the improved process detailed in section 5.3 and in the to-be process maps found in section 5.4.

5.3 The Improved Process and Tracking Tool

The main focus of the solution is on improving the process and activities within the MB Bus supply chain to ensure effective communication and improved visibility. These improvements are based on the conditions to be included in the new SLAs as well as the new carrier selection discussed in section 5.1 and 5.2 respectively. The new process, which is categorised according to the initial four sub-processes described in chapter 3, is detailed in section 5.3.2. The main improvements come from additional information capturing activities and the implementation of a newly developed tracking tool.

5.3.1 Tracking Tool

An order tracking tool, in the form of a spread sheet, is developed using Microsoft Excel to facilitate this new process. The development of this tool begins with review of the entire supply chain process and flagging each activity which provides information regarding the progress of the chassis. The first identified activity is the monthly FRM and the confirmation of the orders. The important information to note related to this activity is the confirmed order details. The next significant activity is the emailing of orders to MB Brazil. The important information from this activity is the date the order was sent. Similarly, the important information relating to each significant activity is assimilated in this way. The spreadsheet is then designed to record all of this information in a manner that follows the flow of the process.

The tool serves as a simple yet efficient way to manage all communications between partners and track the progress of the bus through the supply chain. Currently, ordering activities prior to order confirmation as well as correspondence from supply chain partners are not reflected on the SAP system. This is one of the core reasons for the variability and lack of visibility throughout the supply chain. Therefore creating a simple tracking tool for the purpose of recording all significant activities and communications is a crucial starting point for achieving the goal of higher visibility within the supply chain. This tool initiates the recording of the order information finalised in the monthly FRM. The order number is used to track the order throughout the supply chain process. The tracking tool is categorised into the four sub-processes, i.e., ordering, receiving, assembly and delivery. In addition, provision is made for the recording of the bodybuilding activities. The activities taking place at the bodybuilder are not currently recorded by the supply chain department. However the bus product team at MBSA uses a tracker to record bodybuilder activities for government tender orders, but does not share this information with the supply chain department. The use of this tracking tool will ensure bodybuilding activities are recorded for all bus orders and will lead to the integration of the supply chain department with the bus product department. This tool will also considerably improve communication and information sharing between MBSA and the bodybuilder.

The tracking tool will serve as single record from which, the status and progress of each order can be easily tracked from the time the order is formulated, up until the bus has been completed at the bodybuilder. This format also provides an easy way of ensuring that cycle and lead times defined in the SLAs are adhered to by each of the relevant supply chain partners. If a lead or cycle time has exceeded the agreed upon time, the relevant cell will be highlighted initiating a follow up action, in the form of either an email or phone call. In turn, if a change in lead or cycle time is observed, the recorded data can be used to justify the updating of the conditions in the SLAs with the relevant partners.

The tracking tool will be managed by the logistics specialist responsible for the MB Bus supply chain. The tool must be updated daily or as the information is received in order to keep the tracker up to date and relevant. Any adjustments based on information received from the supply chain partners can be easily recorded on the spreadsheet and thus ensure that the information reflected in the tracker is always accurate.

As a long term solution, an automated tool based on this template must be developed with the help of the IT department. The current capabilities of the current SAP system must be investigated to determine if this is possible and other Business Intelligence software should be considered. An automated tracking tool will allow follow up actions, such as emails, to be sent automatically via the system and will also eradicate the need to duplicate records in the

SAP system as well as in the tracker. This will lead to more accurate reporting and measurement of the MB Bus supply chain and ultimately a higher level of visibility.

The implementation and intended use of this tracking tool is included in the improved process description. The description has been divided into the sub-processes which is explained in section 5.3.2.

5.3.2 Improved Process Description

This section details the activities of the improved process. The process is categorised into the ordering, receiving, assembly and delivery sub-processes. The delivery sub-process is further split into three categories to explain each type of delivery and also details the information that must be recorded during the bodybuilding activities. Each of the processes are described in detail, focusing on the activities related to the new tracking tool and the intended improvements. Each process description is followed by the relevant section of the Excel tracking tool.

Ordering Process

The conditions discussed in the SLAs greatly influence the improvement of this process. The process starts with recording the order number in the form of a model code and production month. The dates of the correspondence are then recorded as well as the dates of the Brazil production which forms part of the ordering process. Table 10 details the activities involved in the ordering process.

Table 10: Ordering Process Description

Ordering Process Description:
FRM meeting to discuss order volumes and trends to be held by the 31st of each month to finalise orders for the next month.
Receive signed order sheet from FRM meeting.
Complete order form and email to MB Brazil by the 1st of each month.
Record date of emailed order in the order tracking tool.
The tool will generate an expected date of order confirmation based on a 30 day lead time and 3 day variation.
If the expected confirmation date has passed, the cell will turn red indicating that a follow up email must be sent to MBSA asking for the order confirmation.
Receive order confirmation from MB Brazil via email and record date on the order tracking tool.
The spread sheet calculates the order confirmation lead time. A lead time that exceeds 33 days will be highlighted in red. This can then be used to monitor the supplier's performance.
Confirmed order is entered onto the SAP system using the commission number (same as order number on the Daimler AFAB system).
Record commission number on order tracking tool.
System creates a VMS number for internal tracking (SAP Action: ZCRE).

System links commission number to VMS number (SAP Action: ZCOM).
Record VMS number on order tracking tool.
System confirms order (SAP action: ZFOC).
Unit is made available on system (SAP Action: ZMVA).
Generate expected receipt report to send to MB East London plant for production planning.
Record expected date of Brazil production on order tracking tool.
Unit is frozen on system to check order details are correct. Interactive Difference Report is generated (SAP actions: ZFSN, ZFSC).
Differences are reconciled (SAP action: ZFOC).
Receive vehicle production confirmation from Brazil (SAP Action: ZVPN).
Record production date on order tracking sheet.
The spread sheet then calculates the Brazil production time.
Complete vehicle background check and valuation (SAP Action: ZREA).
Purchase order created on system (SAP action: ZCPO).

				ORDERING PROCESS	
Production Month Order/Model	Email Order to Brazil	Expected date of confirmation	Order confirmation	Confirmation Lead Time	Commission Number
0500RSD2436	2013/11/12	2013/12/12	2013/12/19	37	2467587014
1726MAN	2014/02/17	2014/03/19	2014/03/13	24	2467587046
1726MAN	2014/02/17	2014/03/19	2014/03/13	24	2467587052
VMS Number	Order placed on SAP	Estimated Production Date (Brazil)	Vehicle Produced Date (ZVPN)	Brazil Production Time	
2843246	2014/01/13	2014/02/05	2014/03/06	29	
2891299	2014/03/17	2014/03/20	2014/04/26	37	
2891305	2014/03/17	2014/03/30	2014/04/29	30	

Figure 34: Order Tracking Tool - Ordering Process

Figure 34 shows an example of how the ordering process section of the tracking tool will be used. An important function of this section of the tracking tool, is the prompting of follow up activities. If required information is outstanding, the relevant cell will turn red indicating that the logistics specialist must email or call MB Brazil to request the needed information or determine the reason for the delay. This information is then updated on the tracking tool. This ensures that the ordering process does not suffer from unnecessary delays and will lead to a better understanding and working relationship between MBSA and MB Brazil.

Receiving Process

This process starts by recording the date the packing list and invoice is received and ends when the order arrives at the local port. The improved communication and activities are attributed to the conditions discussed in the relevant SLAs. Table 11 details the activities involved in the receiving process.

Table 11: Receiving Process Description

Receiving Process Description:
Receive packing list and invoice from MB Brazil via courier and record date on order tracking sheet.

Use engine number from invoice to update chassis information on system. (SAP action: ZVDU)
Verify invoice (SAP action: ZINV)
Order tracking tool generates expected date of shipping advice, based on a 2 week lead time from the date of receiving the invoice.
If expected date for receiving shipping advice has passed, the cell will turn red indicating that a follow up email must be sent to MB Brazil as well as the shipping company (Safmarine) to request the shipping advice.
Receive shipping advice from MB Brazil/ Safmarine via email and record date on order tracking tool.
Enter shipping information onto system (SAP Action: ZSHP)
Record expected date of delivery and expected date of arrival on the order tracking tool.
The tool will calculate the time taken for the order to move from production to the ship.
Shipping advice used to schedule chassis assembly at MB EL plant via TRP system
Shipping advice, clearing instruction, invoice and waybill sent to Bidvest for call freight clearing
Goods received at the local port. Portnet sends EDI PGOR message to notify MBSA.
Record actual date of goods received in order tracking tool.
The tool will calculate the shipping time for the order.
Goods verified by Bidvest.
Receive PGOR message (SAP action: ZGOR).

			RECEIVING
Packing List & Invoice Received ▾	**Expected Date of Receiving Shipping Advice** ▾	**Shipping Advice Received** ▾	**ETD** ▾
2014/03/11	2014/03/23	2014/03/22	2014/03/21
2014/05/01	2014/05/13	2014/05/12	2014/05/08
2014/05/04	2014/05/16	2014/05/15	2014/05/08

PROCESS			
Production to Ship Time ▾	**ETA** ▾	**Chassis received at local port** ▾	**Shipping Time** ▾
15	2014/04/05	2014/04/07	17
12	2014/05/31	2014/06/02	25
9	2014/05/31	2014/06/02	25

Figure 35: Order Tracking Tool - Receiving Process

Figure 35 illustrates how the receiving process section of the spread sheet will be used to facilitate this process. This section of the tool, along with the improved process activities, serves as a means to ensure that communication between MBSA and MB Brazil is timeous and accurate. This plays a major role in improving the collaboration between MBSA and MB Brazil and ultimately improving the visibility of this leg of the process.

Assembly Process

Table 12 details the assembly process that occurs at the MB EL plant. The main activities of the process remains the same as the initial process detailed in chapter 3. The only addition is the use of the tracking tool.

Assembly Process Description:
System automatically generates order number for the plant (SAP action: ZSC1).
System releases order (SAP action: ZPRL).
Units sequenced for production (ZRSQ).
Record expected date of chassis production the tracking tool (PDD).
Containers are called into plant (SAP action: ZCKD).
Assembly process is started (SAP actions: ZVRV, ZSCI).
Plant updates chassis component information e.g. transmission number etc. (SAP action: ZVDU).
Unit assembly completed/VPC (SAP action: ZSCC).
Record date of chassis production and vehicle sign out on the order tracking sheet.
The tracking tool will calculate the production time at the MB EL plant.
The production cycle time will be calculated based on the data entered. As mentioned in chapter 4, the previous cycle time is inaccurate and will be replaced with a 70 day cycle time with a 3 day lead time. Thus, if the production cycle time exceeds 73 days, the cell will be highlighted in red.
Unit is introduced onto the eNatis system – Legal Requirement (SAP action: ZNAK, ZSPT, ZVSX, ZVMD).
Delivery instruction sent to Carrier 3 (SAP action: ZIDI).

The most important aspect of this section is the automatic calculation of the Production Cycle Time metric. This metric is used to measure the visibility of the MB Bus supply chain as described in chapter 4. The tool will be used to easily track this metric and note any changes in the agreed upon time. Figure 36 shows how the tracking sheet is used to record the significant dates and determine the cycle times.

ASSEMBLY PROCESS			
PDD (East London)	Vehicle Signed out of EL (ZSCC)	EL Production Time	Production Cycle Time
2014/08/12	2014/08/05	120	152
2014/08/05	2014/07/29	57	94
2014/08/07	2014/07/31	59	93

Figure 36: Order Tracking Tool - Assembly Process

Delivery Process

Table 13 details the delivery process from the MB EL plant to the Denel storage yard. The main difference in this improved process stems from the activities between the newly selected Carrier 3 and MBSA. The subcontracting activities have been removed which has thus simplified the process. In addition, the collection delivery dates are recorded on the tracking tool providing a convenient method of tracking the status of the chassis as well as measuring the performance of the carrier. This holds true for all three delivery types detailed in this section. Figure 37 illustrates the use of the tracking tool in this process.

Table 13: Delivery Process Description (MB EL to Denel Storage Yard)

Delivery Process Description (MB East London Plant to Denel Storage yard):
Carrier 3 receives electronic delivery instruction.
Sends request to DataDot, via email, to complete DataDot on ordered units - Legal requirement.
Schedule delivery.
Carrier 3 collects units from MB EL plant, collection note completed (SAP action: ZVHC).
Record date of vehicle collection in the order tracking tool.
Vehicle despatched (SAP action: ZVIT).
Vehicle arrives at Denel storage yard and units scanned into system, delivery note completed (SAP action: ZVAX)
Record date of vehicle arrival on the order tracking tool.
Unit awaits allocation.

DELIVERY PROCESS		
Date of vehicle collection ▾	Date of vehicle arrival at storgae yard ▾	Date of vehicle arrival at bodybuilder ▾
2014/08/13	2014/08/14	
2014/08/08	2014/08/10	
2014/08/12	2014/07/08	

Figure 37: Order Tracking Tool - Delivery Process

Table 14 details the delivery process from the MB EL plant to the bodybuilder and also includes the activities occurring at the bodybuilder. As with the delivery to the storage yard, the main improvement is the selection of Carrier 3 which has simplified the activities involved. The delivery process section of the tracking tool shown in figure 37 is used to record the collection and delivery dates of this process.

Table 14: Delivery Process Description (MB EL Plant to Bodybuilder)

Delivery Process Description (MB East London Plant to Bodybuilder):
CVDS receives electronic delivery instruction.
Sends request to DataDot, via email, to complete DataDot on ordered units - Legal requirement.
Schedule delivery.
Carrier 3 collects units from MB Plant, collection note completed (SAP action: ZVHC).
Record date of vehicle collection on the order tracking sheet.
Vehicles despatched (SAP action: ZVIT).
Vehicle arrives at bodybuilder, delivery note completed (SAP action: ZVAX).
Unit information captured manually at body builder.
Record date of arrival on order tracking sheet.
Bodybuilder provides MBSA with body number used for tracking the chassis and body through production at the bodybuilder. This number is recorded on the order tracking sheet.
Bodybuilder schedules production of body and provides MBSA with a committed body completion date.

Record the committed body completion date on the order tracking sheet. If this date has passed, the cell will turn red indicating that a follow up email must be sent to the bodybuilder to determine the progress of the body production and adjust the completion date accordingly.
Receive weekly progress reports from bodybuilder and update the order tracking sheet accordingly. This section of the tracking sheet is used to record the activities completed during the bodybuilding process.
Requested body is completed and fitted onto bus chassis.
Inspection carried out by MBSA product specialist and date recorded on order tracking sheet.
Record completion date on order tracking sheet.
Delivery arranged between bodybuilder and MB dealer.
Body builder delivers unit to dealer.
Unit received at dealer.
Unit is MIB released on the eNatis system (SAP action: ZRMC).
Sales card captured by dealer (SAP action: ZECU).

The other crucial improvement begins when the chassis has arrived at the bodybuilder. Following the recommendations discussed in the SLA with the bodybuilder, the tracking tool provides a means of recording the weekly progress of the units at the bodybuilder. It also links the VMS number used by MBSA with the body number used by the bodybuilder which helps with the tracking of the unit whilst at the bodybuilder. Figure 38 illustrates the bodybuilder section of the tracking sheet and how it will be used to record these activities.

					BODYBUILDER PROCESS
Body Number	Chassis Prep start	Structure Completed	Panelling Completed	Painting Completed	Final Finishing
B2356	2014/06/20	2014/06/25	2014/06/30	2014/07/05	2014/07/10
B2357	2014/06/21	2014/06/26	2014/07/01	2014/07/06	2014/07/11
B2358	2014/06/22	2014/06/27	2014/07/02	2014/07/07	2014/07/12

Bodybuilder committed completion date	Quality Inspection Date	Bus Completion date	Bodybuilder Cycle Time
2014/07/09	2014/07/11	2014/07/11	21
2014/07/10	2014/07/12	2014/07/14	23
2014/07/11	2014/07/13	2014/07/19	27

Figure 38: Order Tracking Tool - Bodybuilder process

The activities taking place at the bodybuilder have been categorised and are shown in the bodybuilder section of the tracking tool. On a weekly basis, the progress of each of the chassis at the bodybuilder must be recorded on the tracking sheet, by entering the date each activity has been completed for that chassis. In this way, the communication and information sharing between MBSA and the bodybuilder will noticeably improve leading to increased overall visibility.

The third delivery, from the storage yard to the bodybuilder, closely follows the delivery process from the MB EL plant to the bodybuilder. The difference is that here, chassis are

transported from the Denel storage yard. The delivery activities and activities at the bodybuilder remain the same and the process is described in table 15.

Table 15: Delivery Process Description (Denel Storage Yard to Bodybuilder)

Delivery Process Description (Denel Storage Yard to Bodybuilder):
Order received, customer promise date updated (SAP action: ZPDD).
Order verified for financial release (ZFRR, ZFIR).
System automatically creates delivery order and invoice (SAP action: ZDEL, ZBIL).
Unit updated on eNatis system to MIB controlled (SAP action: ZNAK, ZVMD)..
Carrier 3 receives electronic delivery instruction.
Carrier 3 collects units from Denel storage yard (SAP action: ZVHC).
Record date of vehicle collection on order tracking sheet.
Vehicles despatched (SAP action: ZVIT).
Vehicle arrives at Bodybuilder /dealer (SAP action: ZDLD).
Unit information captured manually at body builder / dealer.
Record date of vehicle arrival on order tracking sheet.
Bodybuilder schedules production of body and provides MBSA with a committed body completion date.
Record the committed body completion date on the order tracking sheet.
Receive weekly progress reports from bodybuilder and update the order tracking sheet accordingly. This section of the tracking sheet is used to record the activities completed during the bodybuilding process.
Requested body is completed and fitted onto bus chassis.
Inspection carried out by MBSA product specialist.
Record completion date on order tracking sheet.
Delivery arranged between bodybuilder and MB dealer.
Body builder delivers unit to dealer.
Dealer receives unit.
Unit is MIB released on the eNatis system (SAP action: ZRMC).
Sales card captured by dealer (SAP action: ZECU).

This completes the proposed supply chain process for MB Bus. The improved process highlights the importance of efficient communication and information sharing between the supply chain partners. Emphasis is placed on the timeliness and accuracy of these activities in effecting a positive change in the overall visibility of the MB Bus supply chain. The next step is to map this process using the SCOR mapping tools which will be illustrated in section 5.4.

5.4 To- Be Process Maps

This section deals with the process maps for the improved supply chain activities. However, there are minimal changes to the initial process flow hence only diagrams that differ to those developed in chapter 3 are shown here. The main difference between the as-is process and the to-be process is the new carrier as this new carrier does not subcontract to other carriers.

5.4.1 To-Be Geomap

The geomap remains the same as the as-is process and is therefore not shown.

5.4.2 To-Be Thread Diagram

The to-be thread diagram in figure 39 illustrates the simplification of the supply chain by removing the subcontractor and all related activities. The delivery instructions are sent directly to Carrier 3 who in turn transports the vehicles without having to reschedule this delivery with the subcontractor. This provides MBSA with a better view of the delivery process.
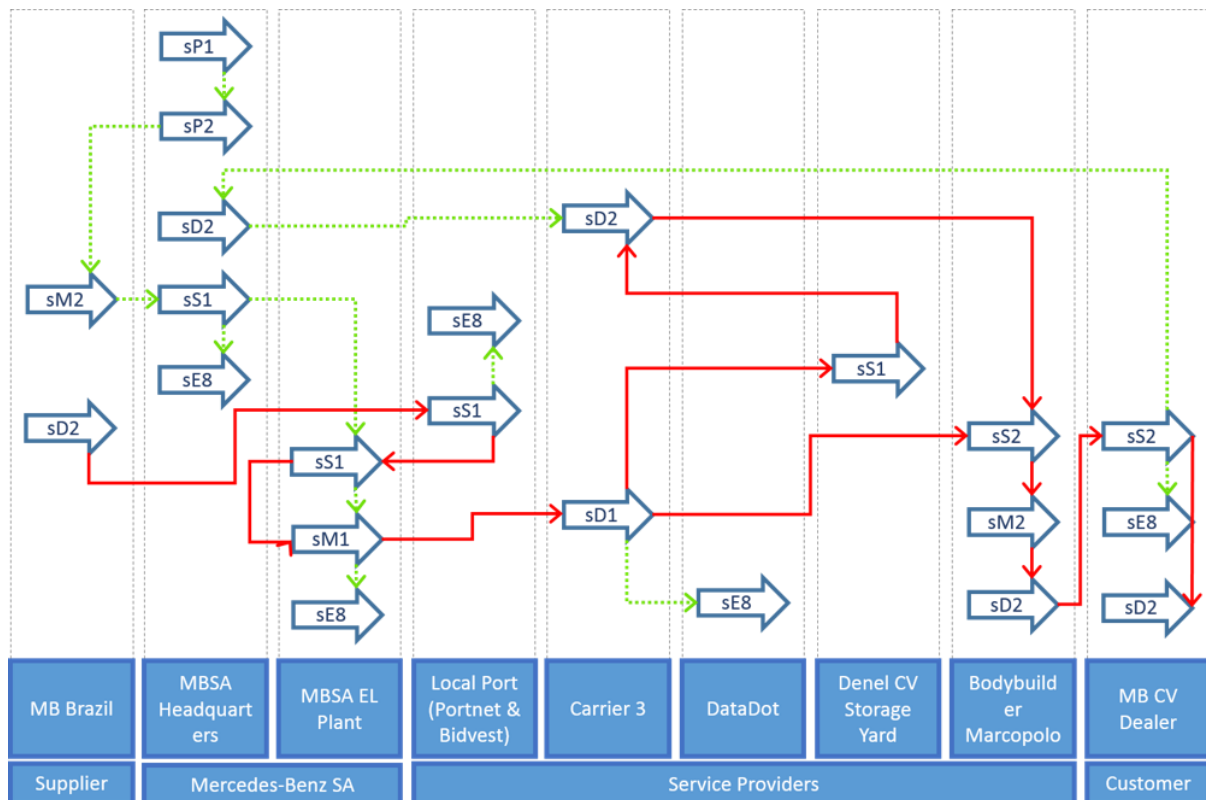
Figure 39: To-be Thread Diagram

5.4.3 To-Be Workflow Diagrams

The delivery process workflow diagrams are the only diagrams that differ from the as-is workflow diagrams. Therefore these are the only workflow diagrams that will be illustrated in this section.

Figure 40 shows the activities involved in the delivery to the storage yard process. The significant difference here is the change in carrier which results in a simpler workflow. All delivery related activities are now carried out by a single carrier, Carrier 3.
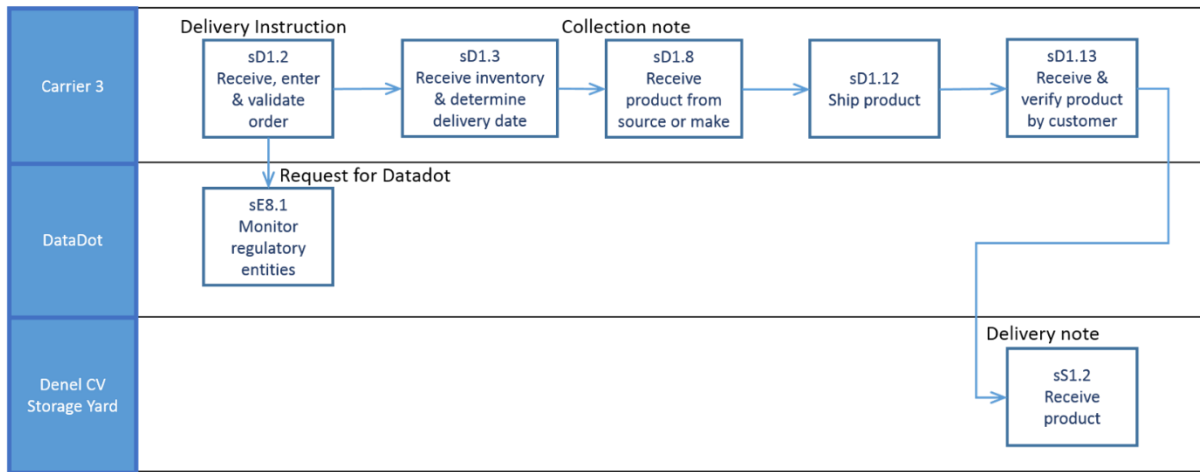
Figure 40: To-be delivery process to Denel storage yard

The to-be delivery process from the MB EL plant to the bodybuilder is shown in figure 41. The most obvious difference is the change   of carrier. Carrier 3 is responsible for all delivery activities which has consequently changed the process flow.
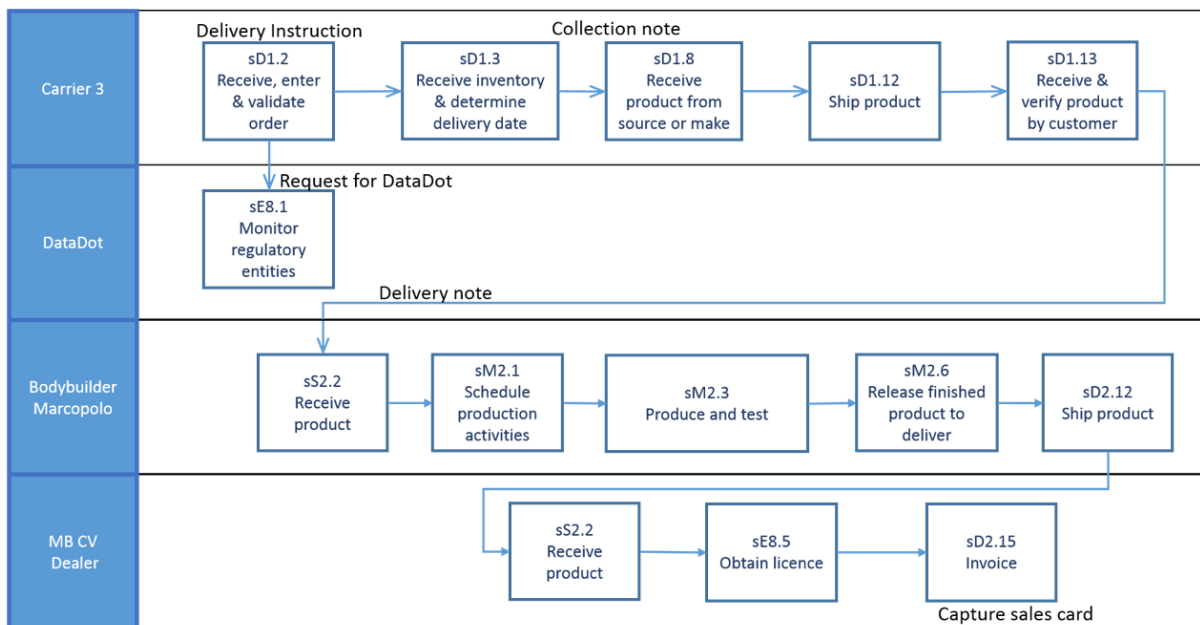
Figure 41: To-Be delivery process to Bodybuilder

The process illustrated in figure 42 remains the same as the initial as-is process found in chapter 3. The only difference as mentioned in the previous two delivery processes, is the new carrier selection.
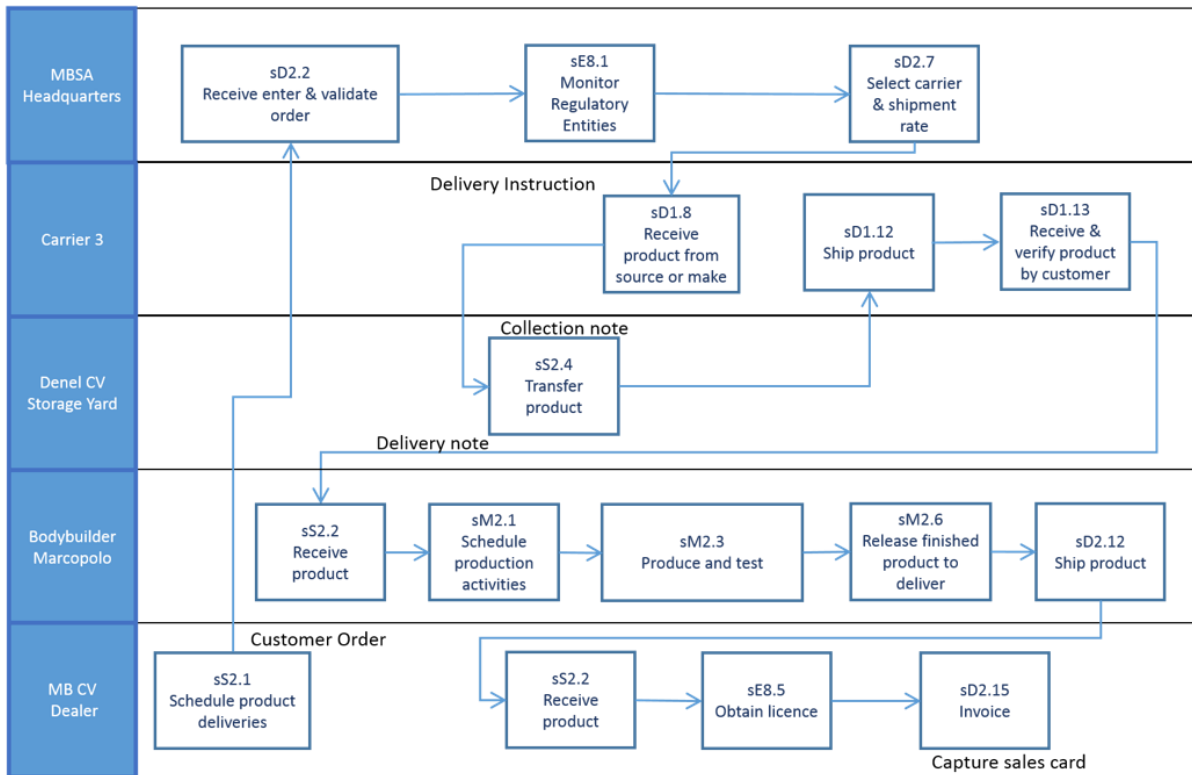
Figure 42: To-be delivery process from Denel storage yard to bodybuilder

It is evident from the minimal changes of the process maps that solution is not focused on redesigning the process flow of the supply chain but rather on improving the activities within the supply chain. It is important that this solution be validated to determine its usefulness and ability to achieve the goal of higher visibility within the supply chain.

5.5 Solution Validation

As this project does not include the implementation of the solution, the validation is limited to discussions with the supply chain manager and staff. The following comments yielded from these discussions:

- The relative staff members consented that it would be beneficial to implement SLAs between the various partners on the supply chain. This will be further discussed with other necessary departments such as the legal department to draw up suitable SLAs for the process.
- The result of the AHP carrier selection was approved by the staff. However, this will be compared to processes used in the procurement department for selecting a carrier as they use different criteria and methods. The results will then be compared to determine which selection has the best impact on the supply chain.
- The staff also approved of the improved process and order tracking sheet as it serves as a central platform to track order progress. The manager suggested adding a

summary sheet for this tracker to enable him to quickly evaluate the cycle times, which would allow a holistic overview of the performance. The tool will be further validated by inputting past data to evaluate its usefulness. This is explained in section 5.5.1.

5.5.1 Tracking Tool Validation

An effective way to validate the working of the tracking tool is to populate the tool with past order data. Ten orders are randomly selected from the 2013 to 2014 period and their relevant data gathered. This data assimilation is a tedious task as it requires pulling information from various sources such as the SAP system, emails and other disconnected spreadsheets. Data relating to the ordering process is found in order spreadsheets and the email inbox of the bus logistics specialist. The receiving process data is retrieved from the SAP system as well as emails sent to the logistics specialist. The required data relating to the assembly and delivery processes is obtained from the SAP system. It is not possible to get the data for the bodybuilding activities as these activities have not been previously recorded, although the manager undertook that this data will be recorded going forth.

The data is then entered in the respective fields of the order tracking tool. This task proves the tracking sheet follows a logical flow and easily allows the progress of the order to be tracked. The populated tracking tool can be found in appendix D.

Once the tracking tool has been populated, the average cycle and lead times are automatically calculated. These times have not been previously measured but are important in pinpointing areas of poor performance. The summary of the lead and cycle times allow the manager to immediately see which areas need improvement and provide significant backing for decision-making.

From the selected data, the tracking sheet (Appendix D) shows the average confirmation lead time is 33 days which is acceptable based on the agreed upon lead time of 30 days with a variability of 3 days. The average production cycle time of 80 days is noticeably longer than the suggested time of 73 days which indicates that this process needs to be investigated to determine the reasons for these longer timeframes. This provides an example of how the tracking tool can be used to diagnose problem areas within the process.

Overall, the tracking tool provides a comprehensive method to record all relevant data for each bus order. The tool easily links the varying reference numbers for the chassis used throughout the process so that the progress tracking becomes simple and effective. The staff and manager agree that this tool, in conjunction with the SLAs and carrier selection, will considerably increase the visibility in the MB Bus supply chain and will be implemented in the future.

5.6 Best Practice Analysis

The final component of the solution consists of a brief best practice analysis based on the SCOR recommended best practices. It is necessary to review these practices as there are many other methods available for improving the visibility in a supply chain. However, a further detailed investigation into these practices must be conducted if they are to be implemented in the future.

This brief analysis begins with identifying the main processes that need to be improved. This has been identified in chapters 3 and 4 where it was found that the ordering process is one of the major areas of concern. Ordering falls under the sourcing process domain within the SCOR framework. For this reason, the sourcing process within the SCOR framework is the first process to be reviewed to identify best practices that could potentially improve this area.

Best Practice 42: Regular Review of Procurement Terms and Conditions

This practice entails the regular review of the terms of the procurement contract in place with the supplier. The review can be conducted monthly, quarterly or annually, depending on the nature of the business (SCC, 2012). The practice is focused on improving both the collaboration with the supplier and the impact of inventory within the supply chain (SCC, 2012). Proper supplier collaboration will provide superior order fulfilment and increased capacity utilisation benefitting both customer and supplier (Sahay, 2003).

Implementing this practice within the MB Bus supply chain will be useful as it will provide the supplier, MB Brazil, with a clearer understanding of the needs of MBSA and any changes that may occur. This will allow for better planning at MB Brazil. It will also force MBSA to regularly monitor the performance of the supplier and address key issues. This ensures the strategic goals of both MB Brazil and MBSA are aligned, thus bringing maximum benefit to both parties.

Overall Supply Chain Visibility

The other applicable best practices are focused on increasing the overall visibility throughout the MB Bus supply chain. There is a strong trend of implementing relevant technology and information systems to achieve this. Two of the most appropriate practices are reviewed here.

Best Practice 159: Electronic Data Interchange

The SCOR reference framework (SCC, 2012) defines this practice as the exchange of work flow related documents through standard electronic messages. These documents include orders, order confirmations and invoices. It allows for easy sharing of documents between companies but can also be used within a company. EDI requires both parties to agree on the format of the information shared. It also requires that the equipment used by both parties are synchronised to facilitate this interchange. This service is commonly provided by third parties

specialising in this field. This practice has numerous benefits including cost and time saving, improved customer service and the elimination of repetitive activities (SCC, 2012).

Although MBSA currently makes use of an EDI system, the practice does not extend over all the activities within the supply chain. The ordering processes, for example, can greatly benefit from using EDI. This would eradicate the need to manually send emails and await email confirmations. EDI would also be useful when communicating with the bodybuilders, ensuring that necessary information is received timeously. A further study of this practice and its applicability to these activities within the MB Bus supply chain should be conducted in the future in order for this practice to be implemented.

Best Practice 153: Barcoding/RFID
The SCOR reference model (SCC, 2012) describes barcoding as the practice of adding machine readable labels to products for the purpose of tracking a product and reading its related information. RFID (Radio Frequency Identification) is the predominant trend in this practice.

The RFID practice consists of attaching a data tag to a product, from which the data can be automatically captured as it passes by a reader device (Niederman, 2007). The infrastructure requirement for the RFID implementation consists of tags, readers, Reader Network Controllers (RNCs) and software applications (Krishna, 2007). The tag is made up of a microchip that is connected to a small antenna. The reader transmits a radio frequency (RF) signal, to which the tag responds with another RF signal containing the product information (Krishna, 2007). In this way, data is captured automatically and more accurately. This provides an efficient means of tracking the location of the product throughout the supply chain. It will also provide better visibility within the supply chain, resulting in better inventory management (Niederman, 2007). The other benefits of implementing RFID include accurate real-time information, long-term cost savings and less manual work (RFID Arena, 2013).

Implementing RFID in the MB Bus supply chain would considerably increase the visibility of the chassis throughout the system resulting in more accurate planning and better customer service. The supply chain manager would have full knowledge of the location of the chassis as well as the extent of its progress throughout the production. However, this would require cooperation from all of the partners in the chain, starting from the supplier, which may incur high costs that are not practical for the company and its partners. A complete feasibility study must be conducted before implementing this practice at MBSA.

Best Practice 126: Supply Chain Visibility System

According to the SCOR framework, this practice places focus on cultivating collaboration between the partners in a supply chain by using a system that is available to all partners (SCC, 2012). This system allows suppliers to see requirements and align their planning with that of the customer. It also eases the information sharing of the partners and ensures all partners have access to the necessary information.

This practice appears to be very useful to the MB Bus supply chain as there are numerous partners using different systems and the integration of these partners and their systems is essential in achieving overall visibility. There are many products available that can be used to achieve effective integration. A further analysis of the current SAP system should first be carried out to determine its capability of attaining this system integration. Other products such as Qlikview (Qlikview, n.d.) and RapidResponse (Kinaxis, n.d.) should also be considered in this endeavour.

5.7 Concluding Remarks

This chapter details the development of a potential solution to overcome the visibility issues experienced by the MB Bus department. The solution proposes implementing SLAs between the partners in the supply chain and then using these new conditions as a guide for the improved process. An AHP selection is also conducted to choose a new carrier.

The improved process focuses on improved communication activities. An order tracking tool is used to facilitate the new process. This process and tracking tool has been validated by the supply chain manager and relevant staff. The to-be process is mapped with the SCOR process maps and finally a best practice analysis is conducted which concludes the solution development phase.

Chapter 6: Conclusion and Recommendations

Supply chain visibility is considered to be a vital component of a successful supply chain. The MB Bus supply chain suffers from poor visibility, which is due to multiple factors in their supply chain. Primarily, the lack of communication between the different facets of the supply chain poses the greatest issue. To overcome this, all the partners in the supply chain must be considered in terms of their roles and their contribution to the flow of the supply chain.

The initial analysis of the as-is state reveals three key areas where increased visibility is crucial. The communication lag between MBSA and MB Brazil, the limited capability of the current vehicle carrier as well as the inefficient communication between MBSA and the bodybuilders must be addressed in the potential solution.

Expanding the problem investigation, the current metrics are found to have little relevance to measuring the visibility of the supply chain, leading to the development of a new set of metrics. The newly developed metrics are used in this project to conduct an internal benchmark and further indicate areas of improvement.

The findings from the initial analysis are used to develop a solution to overcome the visibility issues. The solution comprises of several components including: negotiating SLAs with the relevant partners, selecting a new carrier to compliment a higher visibility level and designing an improved process flow with a focus on additional communication activities. An order tracking sheet is designed, using Microsoft Excel, to facilitate this new process. The future implementation of the suggested solution will require further investigation and expansion of these components.

The SLA requirements in this report are discussed largely from a supply chain perspective. Implementing these SLAs will require members of the bus product department, sales department, procurement department and the legal department to be included in the negotiations with the respective supply chain partners.

In the future, an automated tracking tool based on the Excel tracking tool should be designed and integrated with the current SAP system. This will allow messages and follow up actions to be automated thus speeding up the communication of the process in an attempt to increase the visibility. Integrating this tool with the SAP system will also decrease the amount of work or data input that is duplicated. If necessary, other Business Intelligence software can also be considered for the integration of the tracking tool.

Lastly, best practices from the SCOR framework are evaluated to determine the most applicable practices for increasing visibility. This evaluation indicates a strong trend towards

implementing technology which is focused on increasing visibility levels. RFID, EDI and supply chain visibility systems are briefly evaluated but a thorough feasibility study must be completed to determine the worth of implementing these solutions in the future.

To conclude, the visibility issues afflicting the MB Bus supply chain can be improved by refining the process flow and amending the communication activities between the supply chain partners. A simple tracking tool and the implementation of suitable technology are amongst the various tools that will result in more efficacious work flow, better information flow and higher overall visibility for the MB Bus supply chain.

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Appendix A: Industry Sponsorship Form

Department of Industrial & Systems Engineering
Final Year Projects
Identification and Responsibility of Project Sponsors

All Final Year Projects are published by the University of Pretoria on *UPSpace* and thus freely available on the Internet. These publications portray the quality of education at the University and have the potential of exposing sensitive company information. It is important that both students and company representatives or sponsors are aware of such implications.

Key responsibilities of Project Sponsors:

A project sponsor is the key contact person within the company. This person should thus be able to provide the best guidance to the student on the project. The sponsor is also very likely to gain from the success of the project. The project sponsor has the following important responsibilities:

1. Confirm his/her role as project sponsor, duly authorised by the company. Multiple sponsors can be appointed, but this is not advised. The duly completed form will considered as acceptance of sponsor role.
2. Review and approve the Project Proposal, ensuring that it clearly defines the problem to be investigated by the student and that the project aim, scope, deliverables and approach is acceptable from the company's perspective.
3. Review the Final Project Report (delivered during the second semester), ensuring that information is accurate and that the solution addresses the problems and/or design requirements of the defined project.
4. Acknowledges the intended publication of the Project Report on UP Space.
5. Ensures that any sensitive, confidential information or intellectual property of the company is not disclosed in the Final Project Report.

Project Sponsor Details:

Company:	Mercedes - Benz (SA)
Project Description:	Analysis & improvement of the Mercedes-Benz (SA) Bus supply chain
Student Name:	Tasneem Mukadam
Student number:	28001967
Student Signature:	*(signature)*
Sponsor Name:	Richard Stewart
Designation:	CV Supply Chain Manager : Mercedes-Benz SA
E-mail:	richard.p.stewart@daimler.com
Tel No:	012 6775733
Cell No:	0762400309
Fax No:	
Sponsor Signature:	*(signature)*

Appendix B: Bienieks's Communication Scorecard

Integration Communication Scorecard

Measures

Aspects	Required Outcomes	Measurement Method	Actual Outcomes	Rating
Efficiency of Channels	80% associates to access Integration News Portal on Intranet	Integration News Portal Hit Count Report; Internal Communication Survey; Town Hall Survey	80% associates accessed Integration News Portal on Intranet	3
Effectiveness of Communication	70% associates to understand the overall Integration strategy	Internal Communication Survey; Town Hall Survey	7 out of 10 associates showed understanding	3
Impact on Behavior	2% increase in client satisfaction of their service team	Current client satisfaction metrics; Internal Communication Survey	2% increase in client satisfaction score	3
Business Impact	3% increase per year in sales	Current sales report metrics	1% increase in one month	4
			Mean Score	3.25

Rating Scale
1- Did not meet required outcome
2- Marginally met required outcome
3- Met required outcome
4- Exceeded required outcome
5- Far exceeded required outcome

Appendix C: AHP Excel Template

Criteria Pairwise Comparison

	cost	capacity	technology	communication					Criteria Weights	
cost	1.00	5.00	1.00	2.00	0.37	0.31	0.38	0.38	0.36	
capacity	0.20	1.00	0.14	0.33	0.07	0.06	0.05	0.06	0.06	
technology	1.00	7.00	1.00	2.00	0.37	0.44	0.38	0.38	0.39	
communication	0.50	3.00	0.50	1.00	0.19	0.19	0.19	0.19	0.19	
	2.70	16.00	2.64	5.33				CI / RI =	0.0040	Acceptable

Value Scale:

1 -> Objectives i and j are of equal importance
3 -> Objective i is weakly more important than objective j
5 -> Objective i is strongly more important than objective j
7 -> Objective i is very strongly more important than objective j
9 -> Objective i is absolutely more important than objective j

Alternative Pairwise Comparison with respect to cost

Alternative Weights		Carrier 1	Carrier 2	Carrier 3
0.67	Carrier 1	1.00	5.00	4.00
0.10	Carrier 2	0.20	1.00	0.33
0.23	Carrier 3	0.25	3.00	1.00
CI / RI = 0.0750	Acceptable	1.45	9.00	5.33

Intermediate Matrix

0.69	0.56	0.75
0.14	0.11	0.06
0.17	0.33	0.19

1 -> Alternatives i and j are of equal value
3 -> Alternative i is weakly more valuable than alternative j
5 -> Alternative i is strongly more valuable than alternative j
7 -> Alternative i is very strongly more valuable than alternative j
9 -> Alternative i is absolutely more valuable than alternative j

Carrier 1 better than Carrier 2

Carrier 1 better than Carrier 3

Carrier 3 better than Carrier 2

with respect to : cost

Alternative Pairwise Comparison with respect to capacity

Pairwise Comparison Matrix

Alternative Weights		Carrier 1	Carrier 2	Carrier 3
0.14	Carrier 1	1.00	0.33	0.33
0.43	Carrier 2	3.00	1.00	1.00
0.43	Carrier 3	3.00	1.00	1.00
CI / RI = 0.0000	Acceptable	7.00	2.33	2.33

Intermediate Matrix

0.14	0.14	0.14
0.43	0.43	0.43
0.43	0.43	0.43

1 -> Alternatives i and j are of **equal value**
3 -> Alternative i is **weakly more valuable** than alternative j
5 -> Alternative i is **strongly more valuable** than alternative j
7 -> Alternative i is **very strongly more valuable** than alternative j
9 -> Alternative i is **absolutely more valuable** than alternative j

3.0	3.0	1.0
Carrier 1 / Carrier 2	Carrier 1 / Carrier 3	Carrier 2 / Carrier 3

Carrier 2	Carrier 3	Carrier 3
better than	better than	better than
Carrier 1	Carrier 1	Carrier 2

with respect to :

capacity

Alternative Pairwise Comparison with respect to technology

Pairwise Comparison Matrix

Alternative Weights		Carrier 1	Carrier 2	Carrier 3
0.14	Carrier 1	1.00	1.00	0.20
0.14	Carrier 2	1.00	1.00	0.20
0.71	Carrier 3	5.00	5.00	1.00
CI / RI = 0.0000	Acceptable	7.00	7.00	1.40

Intermediate Matrix

0.14	0.14	0.14
0.14	0.14	0.14
0.71	0.71	0.71

1 -> Alternatives i and j are of **equal value**
3 -> Alternative i is weakly **more valuable** than alternative j
5 -> Alternative i is **strongly more valuable** than alternative j
7 -> Alternative i is **very strongly more valuable** than alternative j
9 -> Alternative i is **absolutely more valuable** than alternative j

1.0	5.0	5.0
Carrier 1 / Carrier 2	Carrier 1 / Carrier 3	Carrier 2 / Carrier 3

Carrier 1	Carrier 3	Carrier 3
better than	better than	better than
Carrier 2	Carrier 1	Carrier 2

with respect to :

technology

Alternative Pairwise Comparison with respect to : communication

	Alternative Weights		Carrier 1	Carrier 2	Carrier 3
		Pairwise Comparison Matrix			
	0.09	Carrier 1	1.00	0.33	0.14
	0.21	Carrier 2	3.00	1.00	0.25
	0.70	Carrier 3	7.00	4.00	1.00
CI / RI =	0.0281	Acceptable	11.00	5.33	1.39

7.0

3.0

4.0

Carrier 1 / Carrier 2

Carrier 1 / Carrier 3

Carrier 2 / Carrier 3

Carrier 2 better than Carrier 1

Carrier 3 better than Carrier 1

Carrier 3 better than Carrier 2
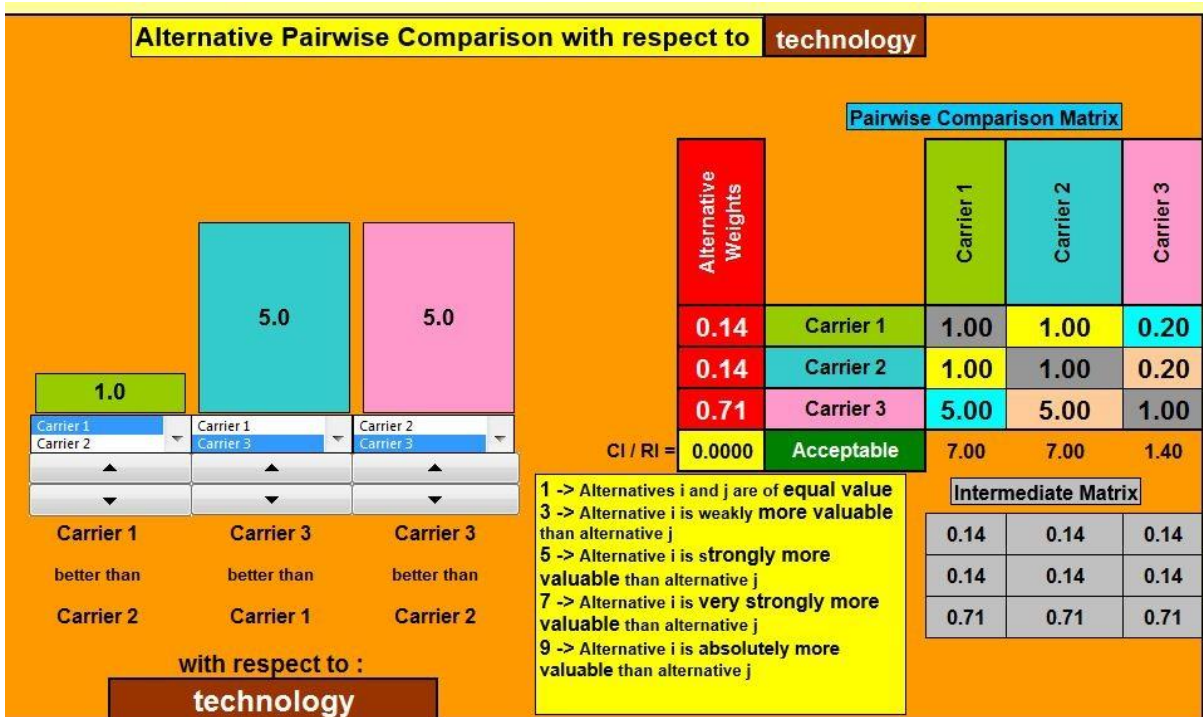
with respect to :
communication

1 -> Alternatives i and j are of **equal value**
3 -> Alternative i is **weakly more valuable** than alternative j
5 -> Alternative i is **strongly more valuable** than alternative j
7 -> Alternative i is **very strongly more valuable** than alternative j
9 -> Alternative i is **absolutely more valuable** than alternative j

Intermediate Matrix

0.09	0.06	0.10
0.27	0.19	0.18
0.64	0.75	0.72

Objective Hierarchy

Select Carrier

	cost	capacity	technology	communication
Weight	0.3591	0.0633	0.3903	0.1873

CI / RI 0.0040

	cost	capacity	technology	communication
Carrier 1	0.6651	0.1429	0.1429	0.0853
Carrier 2	0.1038	0.4286	0.1429	0.2132
Carrier 3	0.2311	0.4286	0.7143	0.7014
CI / RI =	0.0750	0.0000	0.0000	0.0281

Final Alternative Weights

Carrier 1	Carrier 2	Carrier 3
0.3196	0.1601	0.5203

83

Appendix D: Tracking Tool Validation

ORDERING PROCESS

Production Month Order/Model	Email Order to Brazil	Expected date of confirmation	Order confirmation	Confirmation Lead Time	Commission Number
0500RSD2436	2013/11/12	2013/12/12	2013/12/19	37	2467587014
1726MAN	2014/02/17	2014/03/19	2014/03/13	24	2467587046
1726MAN	2014/02/17	2014/03/19	2014/03/13	24	2467587052
1730MAN	2014/02/17	2014/03/19	2014/03/13	24	2467587056
1730MAN	2014/02/17	2014/03/19	2014/03/13	24	2467587082
1730AUTO	2013/11/12	2013/12/12	2013/12/19	37	2367588223
1726MAN	2013/11/12	2013/12/12	2013/12/19	37	2467587003
1726MAN	2013/07/31	2013/08/30	2013/09/24	55	2367588213
1730AUTO	2013/10/15	2013/11/14	2013/11/16	32	2367588207
1730AUTO	2013/10/15	2013/11/14	2013/11/18	34	2367588238
0500RSD2436	2013/10/15	2013/11/14	2013/11/18	34	2367588245

VMS Number	Order placed on SAP	Estimated Production Date (Brazil)	Vehicle Produced Date (ZVPN)	Brazil Production Time
2843246	2014/01/13	2014/02/05	2014/03/06	29
2891299	2014/03/17	2014/03/20	2014/04/26	37
2891305	2014/03/17	2014/03/30	2014/04/29	30
2891309	2014/03/17	2014/03/30	2014/04/30	31
2891287	2014/03/17	2014/03/20	2014/04/25	36
2843221	2014/01/13	2014/02/03	2014/03/01	26
2843228	2014/01/13	2014/02/05	2014/03/06	29
2771341	2013/10/28	2013/11/10	2013/12/04	24
2843203	2014/01/13	2014/01/05	2014/01/28	23
2843212	2014/01/13	2014/01/05	2014/01/29	24
2843189	2014/01/13	2014/01/06	2014/01/30	24

RECEIVING

Packing List & Invoice Received	Expected Date of Receiving Shipping Advice	Shipping Advice Received	ETD
2014/03/11	2014/03/23	2014/03/22	2014/03/21
2014/05/01	2014/05/13	2014/05/12	2014/05/08
2014/05/04	2014/05/16	2014/05/15	2014/05/08
2014/05/05	2014/05/17	2014/05/12	2014/05/08
2014/04/30	2014/05/12	2014/05/11	2014/05/08
2014/03/06	2014/03/18	2014/03/17	2014/03/01
2014/03/11	2014/03/23	2014/03/22	2014/03/11
2013/12/09	2013/12/21	2013/12/20	2013/12/26
2014/02/02	2014/02/14	2014/02/13	2014/02/07
2014/02/03	2014/02/15	2014/02/18	2014/02/07
2014/02/04	2014/02/16	2014/02/15	2014/02/15

PROCESS

Production to Ship Time	ETA	Chassis received at local port	Shipping Time
15	2014/04/05	2014/04/07	17
12	2014/05/31	2014/06/02	25
9	2014/05/31	2014/06/02	25
8	2014/05/31	2014/06/02	25
13	2014/05/31	2014/06/02	25
0	2014/04/05	2014/03/27	26
5	2014/04/05	2014/03/27	16
22	2014/01/07	2014/01/09	14
10	2014/03/02	2014/03/07	28
9	2014/03/02	2014/03/07	28
16	2014/03/09	2014/03/10	23

ASSEMBLY PROCESS			
PDD (East London)	Vehicle Signed out of EL (ZSCC)	EL Production Time	Production Cycle Time
2014/08/12	2014/08/05	120	152
2014/08/05	2014/07/29	57	94
2014/08/07	2014/07/31	59	93
2014/08/06	2014/07/30	58	91
2014/08/01	2014/07/21	49	87
2014/07/17	2014/05/02	36	62
2014/07/17	2014/05/05	39	60
2014/06/14	2014/02/25	47	83
2014/05/04	2014/03/17	10	48
2014/06/20	2014/03/17	10	47
2014/05/02	2014/04/08	29	68

DELIVERY PROCESS		
Date of vehicle collection	Date of vehicle arrival at storgae yard	Date of vehicle arrival at bodybuilder
2014/08/13	2014/08/14	
2014/08/08	2014/08/10	
2014/08/12	2014/07/08	
2014/08/13		2014/08/15
2014/07/23		2014/07/28
2014/05/15	2014/05/19	
2014/05/16	2014/05/19	
2014/03/19	2014/03/14	
2014/04/30	2014/05/02	
2014/04/10	2014/04/11	
2014/04/25		2014/04/30

Bus Tracker Summary	
	Average Time in Days
Confirmation Lead Time	33
Brazil Production Time	28
Brazil Production to Ship Time	11
Shipping Time	23
Arrival in EL to Vehicle Produced Time	47
Production Cycle Time (ZVPN to ZSCC)	80