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Thesis Title:

Improvement and support of the Management control system in DB Schenker Maintenance for the better use of Key Performance Indicators and Business Intelligence Reporting

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Declaration:

I hereby declare that I am the sole author of the thesis entitled "***Improvement and support of the Management control system in DB Schenker Maintenance for the better use of Key Performance Indicators and Business Intelligence Reporting"***. I duly marked out all quotations. The used literature and sources are stated in the attached list of references.

In Prague on 16 May 2014

Signature 

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Sublines

Master Thesis: Management Control Systems in the DB Schenker Maintenance Department

Improvement and support of the Management control system in DB Schenker Maintenance for the better use of Key Performance Indicators and Business Intelligence Reporting

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Abstract

Upon acknowledging the problems that the DB Schenker maintenance department had identified in the department, the company decided to embark on a new IT based management control system to remedy and solve the problems that the department was facing. The project titled 'Workshop Management System' would solve the main problem of a paper based workshop by encompassing all activates in maintenance and allowing for them to be coordinated digitally. The thesis took it upon itself to investigate the strengths and weaknesses of the management control system in place and then use the findings in the WMS project to foster an improved management control system through the implementation of WMS. The goal of the thesis is therefore to aid the company in improving the current management control system for better use of key performance indicators and Business intelligence reporting: such that WMS will be able to efficiently and adequately measure the performance of the maintenance department after it has been implemented.

In order to accomplish the goals set for the thesis, an analysis of the actual effectiveness of the management control system used by DB Schenker Rail maintenance was conducted according to Otley and Ferreira's 'Performance Management and Control Framework'. The results drawn from the framework were then taken and incorporated into the functional requirements of WMS. In addition to that the thesis then formed a Performance Management Tool (PMT), to be used in WMS to aid the management control system in tracking performance and fostering business intelligence. The PMT was formed by thoroughly investigating a particular department within maintenance to identify the main stages of importance in maintenance and their priority in measuring performance transparently and accurately. Following the formation of the PMT, the thesis also provided a blueprint to the functionality of the PMT within WMS and how it should be applied to other departments in order to ensure that both the management control system and the PMT are effective and efficient for the entire department.

As a result of the thesis, DB Schenker Rail maintenance is able to solve the problems identified in the department as well as address the inefficiencies found in the management control system, which were partially responsible for the challenges the company had initially faced. In addition, the company is able to manage, measure and evaluate performance on a real time basis through the PMT which gathers and comprehensively presents the important information in maintenance.

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ABBREVIATIONS

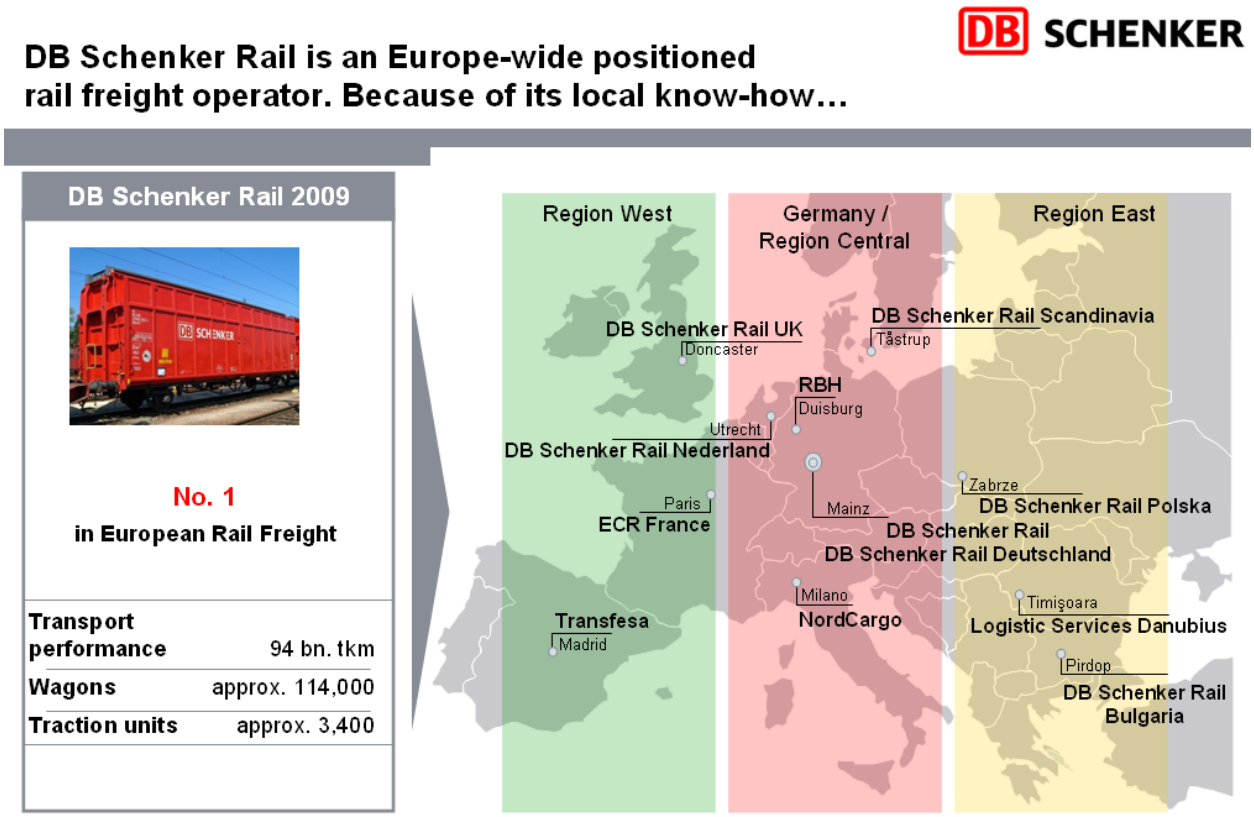
BI	Business Intelligence
DB SR	DB Schenker Rail (DB Schenker)
KPI	Key Performance Indicators
MCS	Management Control System
MM	Material Management
PMC	Performance Measurement and Controlling
PMT	Performance Management Tool
WMS	Workshop Management System

1 Chapter 1: Introduction

1.1 Current Situation in DB Schenker Maintenance

DB Schenker Rail (DB SR) is a leading global integrated logistics service provider and measured by transport volume, the largest rail freight company in Europe (Osborne, 2007). DB Schenker Rail is the only company to offer rail transport from a single source throughout Europe to business customers regardless of their industry. In the DB Schenker Rail network, around 5,000 freight trains service around 4,200 sidings and terminals (Rail Freight Portal, 2010). For example with end-to-end freight transport on the North-South axis from Scandinavia to Italy through a joint venture with DB Schenker Rail Scandinavia and a cooperation with Italian Nord-Cargo. Or with a wide range of services on the East-West axis with DB Schenker Rail UK, French subsidiary ECR and DB Schenker Rail Polska (DB Schenker, 2013).

Diagram 1A: DB SR Overview



Source: (DB Schenker Rail, 2014)

Maintenance is one of the services that DB Schenker Rail offers among its vast array of core products and services. In the network of service centers with wide-area coverage they offer a broad range of operational maintenance services on all electrical and diesel traction units and freight wagon models approved for use in Germany. It operates workshops in more than twenty locations, generally close to marshaling yards, for the maintenance of rail vehicles. In addition to this DB Schenker Rail provides maintenance services by mobile service teams, at especially reserved sidings, marshaling yards or directly on-site (DB Schenker Rail, 2014).

The goals of the company include: ensuring that the service centers make use of the most up-to-date maintenance technology, such that after a period spent at the workshop, the companies shunting service ensures that the vehicles will be promptly returned to the customer; carrying out scheduled servicing and inspection work, as well as dealing with disruptions, repairs and retrofitting; and handling short-term orders speedily (DB Schenker Rail, 2011).

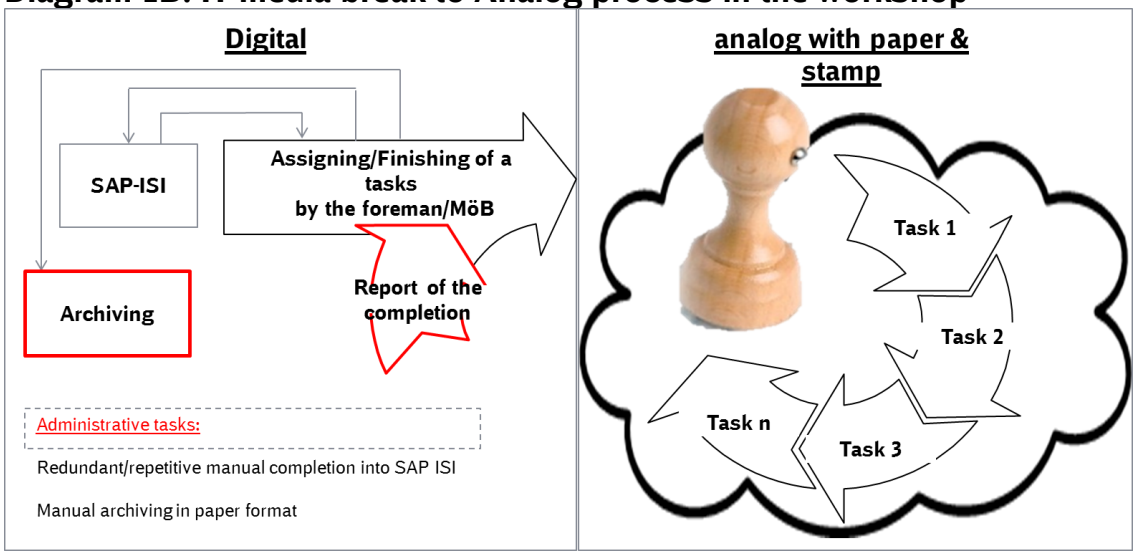
However DB Schenker's Maintenance department currently faces difficulties in its workshops as a result of a strained management control system (MCS). Because of the manner in which the current maintenance processes are structured the managers find it difficult to monitor and control the performance within the workshops, since there is an extended time difference between execution and evaluation of performance. For example, several activities and processes are completed manually through sheets of paper and verification stamps. Consequently there tends to be backlogs in work orders and workshop managers only realize the extent of the situation when all the documents have been duly processed. Please refer to diagram 1B.

Problems arise as well in material management as there is no real time inventory monitoring system such that vehicles then spend longer periods of time than necessary in the workshop awaiting the supply of the needed spare parts. In addition this causes minor adjustments and post-assignment requests in the workshop to consume lengthy periods of time before reaching completion- therefore long maintenance throughput times. Furthermore the manual system results in the redundancy of the workforce as there is a repetitive typing process in the input of process requirements, status updates and the results from completed orders into the existing system, SAP ISI. The shift and roster planning for maintenance personnel is done repetitively through excel and other similar mechanisms. Thus it is difficult to track the actual performance and/or time needed by the workforce to complete a vehicle's maintenance process and return it to function. More so the time needed for the planning of training phases of personnel needs to be taken into consideration. The maintenance processes are not yet harmonized across DB Schenker's workshops in Germany and the rest of Europe which makes monitoring and transparency difficult. In summary, the current management control system is no longer adequate to monitor and control the department effectively to ensure that its performance is aligned to the company's goals.

In light of the above described situation, DB Schenker Rail has decided to embark on a new project to improve the performance of its maintenance department. The company intends to introduce a new IT based system referred to as the Workshop Management System (WMS) by the end of 2014 (WMS will be discussed in chapter 4 of the thesis). WMS will be implemented as a management control system platform across all of the maintenance sub-departments in order to completely eradicate the paper trail in the organizations maintenance activities and to automate the input of data such that it only needs to be done once. Through WMS, DB Schen-

ker Rail hopes; to significantly reduce the time needed to bring a vehicle through a complete maintenance cycle- throughput time-; to better control the management of material such that the real time inventory status is provided at all times; to automatically (electronically) manage the training phases, shift and roster planning of personnel according to their qualifications; and fundamentally standardize the management control system for maintenance in all workshops, both in Germany and in its European subsidiaries.

Diagram 1B: IT media break to Analog process in the workshop



Source: (DB Schenker Rail, 2014)

Diagram 1B depicts the break from the IT media (SAP ISI) to a paper oriented workshop, where the maintenance tasks are consecutively executed, then the report is only sent back into the IT media (SAP ISI) only after all are completed. This leads to all the difficulties which were highlighted above. However, through WMS, this IT media break will be avoided and the tasks will be reported as they are individually executed (Shown in diagram 4A under the concept of WMS in chapter 4), consequently several of the above mentioned problems are then solved.

1.2 Objectives of Thesis

Initially, we will cover an analysis of DB Schenker's Management control system -in the maintenance department- its effectiveness and what influence the system emits on the behavior of the company (resources) to implement its organizational strategies. The thesis will therefore be investigating which, if any, inefficiencies exist in the company's control system. This is so that the company can establish a benchmark to use for the monitoring of the performance of the new management control system tool WMS in the future.

None the less, this thesis aims to support the implementation of the new Workshop Management System for the better use of BI reporting and KPIs as support to the overall management control system. WMS expansively covers and aims to improve the processes and activities that are involved in the maintenance process. In order for the project to be effective, it must include an efficient way for managers and department leaders to timely monitor, control and react ap-

propriately to the actual productivity of the individual craftsmen and the workshops as a whole. To that end, the thesis aims to analyze the processes and establish the most relevant measures to track the performance on a real time and up to date basis. The implementation of WMS will also include the creation of new steps and the termination of old and no longer relevant steps in the maintenance department. Consequently, the thesis aims to then reconcile the residual old processes with the new ones for WMS and establish the relevant KPIs to measure the overall processes.

As the goal of WMS is also to improve the overall performance in all of maintenance and its sub-departments, as well as to ensure a standardized performance control system in all workshops, the next objective of the thesis is to provide a performance management tool (PMT) as a foundation for DB Schenker maintenance to use BI reporting to achieve the standardized management control system in all of its workshops. The PMT will therefore be; a comprehensive write-up of the processes which were considered in selecting the relevant KPI measures to track performance; how the KPIs were established and in which systems to find further details for each of them respectively. In this way we form the foundation for BI reporting in WMS which should also lead us on a path to develop the predictive analysis capability of the control system. The result of this BI reporting is that a brief and standard formula of what and how the performance should be measured and interpreted for each individual process is created in one workshop but applicable to the rest of DB Schenker's workshops, in other words a single point of truth for all sub-departments in maintenance.

However due to time constriction and the size of the companies individual sub-departments, it is important to note that the paper will put focus on only one of the maintenance sub-departments, i.e. material management, for the in-depth analysis of the processes and selection of KPIs to generate the PMT. To ensure that the PMT will be functional and compatible in all sub-departments, the goal of the thesis is to provide a Blueprint to the performance management tool as well. Therefore only the processes and KPIs relevant to the material management department will be discussed in detail in this thesis and the PMT and Blueprint will be drawn according to the results and findings of this analysis. This is in order to ensure that the analysis is executed at a level deep and thorough enough to create a Blueprint that is not only theoretically applicable to all sub-departments in maintenance but also practically implementable even when the differences in departments are factored into consideration.

The thesis aims to further add value to the company's management process through questioning in a brief analysis which management control techniques and KPIs are pivotal to the company but are not in implementation as well as the improvements needed to those in place.

1.2.1 Central Questions

In this section, we will define the central questions which need to be addressed in order to meet the objectives of the thesis within WMS. As stated above the goal of the new management control system together with the thesis is to improve the overall performance of all maintenance departments in DB Schenker and establish a standard for management control applicable to all of its workshops. We also intend to create a PMT from the process of KPI selection and relevance; in such a way that a Blueprint can be adopted and used in other departments. Therefore to attain these goals we have asserted that the following central (key) questions should be addressed:

1. Which academic literature on Management control systems and BI reporting can be adopted to effectively improve the performance of DB Schenker's maintenance service?

2. How is the management control system in DB Schenker's maintenance department currently structured and where might a lack in efficiency arise?

3. What are the key management control system techniques and performance management systems that are lacking or need improvement (how can they be standardized for all workshops or do we need a new model)?

4. Are there any major differences in the maintenance processes in different workshops which can affect the applicability of a universal Blueprint?

5. What further actions should DB Schenker maintenance take in order to reach an optimal level of efficiency and performance control in the new management control system WMS?

1.3 Methodology

We will begin with a literature review on MCSs, and a brief explanation on the view the thesis takes on Business Intelligence (BI) reporting to form a foundation for the analysis of DB Schenker Maintenance's MCS as well as the goal to improve the BI reporting capability of the company and foster predictive analysis in maintenance.

Having completed the literature review, we commence the analysis of DB SR maintenance's existing MCS as a whole to understand how the organisation is structured and how the department functions.

As the Maintenance department is divided into 4 further sub-departments, we choose material management as the focus for the thesis and the development of the PMT and blueprint in which KPIs and BI reporting will be addressed. Therefore an analysis of the procedures in Material management will be made to determine which steps the blueprint will follow, adjust and use in its development.

The next stage will be the discussion of the WMS project which will be implemented in the maintenance department as the new MCS in Maintenance. The PMT and Blueprint are embedded in this project and will be based on the functionality of WMS.

Through the collection of information to this stage and the elaboration of the functionality of WMS, the concrete development of the PMT is done. At this stage, the strategy, goals, roles, processes and KPIs in Material management are then combined into a comprehensive template which is then known as the Blueprint. The formation of this blueprint will be in such a manner that it should be contingent in order to make it applicable to other departments with different strategies, goals, processes and KPIs: such that a different department to Material management will only need to substitute the above mentioned variables to be able to use the same blueprint to control the constituents of its department and measure the performance (explained in detail in Chapter 5.1).

Lastly, we investigate how the development of WMS, the PMT and the Blueprint has moved the company closer to predictive analysis, as well as draw conclusions and give recommendations of what future steps DB Schenker Maintenance should take to continuously improve its MCSs.

2 Chapter 2: Literature Review- Management Control Systems

Central question 1

Which academic literature on Management control systems and BI reporting can be adopted to effectively improve the performance of DB Schenker's maintenance service?

The purpose of this section is to provide a theoretical foundation for the analysis of DB Schenker's existing management control system in order to evaluate the presence of inefficiencies at a later stage. For the selection of textbooks, we will conduct a literature review which will be divided into 3 interconnected parts. As the aim of the paper is to help improve the management control system in DB Schenker maintenance for the better use of KPIs and BI reporting, the review will be focused on the overall topic of management control systems. The theory will be used to identify the importance and the relevance of the current management control system in DB Schenker maintenance to its performance as a department. This review will allow us to then identify which measures and structures to use in WMS in order to create a maintenance control system that is not only capable of improving the BI reporting capability but also fostering predictive analysis. While we are focusing on management control systems, it is to the benefit of the newly developed WMS and the thesis to include a brief explanation of our view on BI reporting as this is an integral objective of implementing the new control system as well.

Management control systems

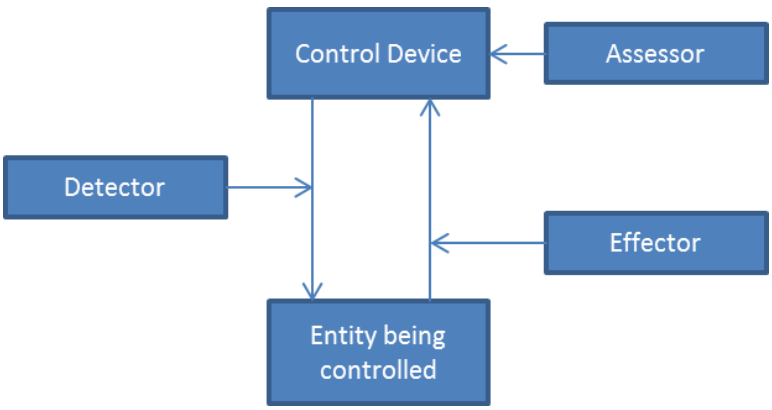
An in-depth review on all the available literature on a broad topic such as Management Control Systems is the best way to setup a foundation for a strong analysis on the current management control system in DB Schenker's maintenance department. However, this paper did not conduct an altogether primary research on the literature on Management Control Systems, but began instead by gathering information pointing to the most universally agreed upon important sources on MCS. As a result of this literature search, covering texts such as (Armesh, Dr. Salarzehi, & Dr. Kord, 2010), (Berglund & Rapp, 2010) and (Pock, 2007) we have found that the most suitable (for this thesis) and thorough research on management control literature was conducted by Erik Strauß in his dissertation, "The emergence of management control systems" (Strauß, 2011). His research comprised of a systematic review on the scope of literature, i.e. the amount and relevance of all texts on MCS. The systematic review was followed by an email survey among accounting academics as well as an online review of syllabi for courses covering MCS to enhance the reliability of his research. The email survey included accounting academics with specialization in cost accounting, managerial accounting and/or controllership from Hasselback's Accounting Faculty and Research Directory (Strauß, 2011). The initially contacted sample size was 1062 academics although only 74 successfully participated in the email survey for various reasons. In the survey, the respondents were asked to state and explain which text/ literature they found best and used as the most relevant text for MCS. The results of the research are shown in Appendix: Figure 1 of the thesis. Three points were awarded to each text book ranked first, two points to text books ranked second and 1 point to text books ranked third.

As can be seen from the results, respondents considered Merchant and Van der Stede (2003) as most relevant followed by Anthony and Govindarajan (2007) as second, and Simons (2000) as third: according to (Strauß, 2011). Therefore, this thesis takes these top three textbooks as the standard to establish a foundation for the analysis of DB Schenker's existing MCS and for the development of the PMT and the blueprint. We will therefore scrutinize the contextual differences of these sources and their perspectives on MCS and attempt to harmonize them. Such that a synthesis of the three sources should build a stable foundation for the praise and/or criticism to be made in regards to DB Schenker Maintenance's control system.

2.1 Management Control systems according to Anthony and Govindarajan

(Anthony & Govindarajan, 2007) in their book management control systems 12th edition put forth that Companies' strategies are either influenced by the management control systems or that the management control systems influence the strategies that emerge. None the less, they argue that regardless of the perspective, the Management control system (MCS) should focus on aiding the effective implementation of company's strategies. They assert that elements of MCS include strategic planning, budgeting, resource allocation, performance measurement, evaluation and reward, responsibility center allocation and transfer pricing. What is of particular interest to this paper is the "performance measurement and evaluation" aspect of Management control systems. Anthony and Govindarajan establish that a good control system must comprise of 4 basic control elements; a **Detector** – a device that gauges the actual proceedings and what is happening in the process that is being controlled; an **Assessor**- a device that determines the significance and relevance of the detectors results and compares them to a given standard or expectation of what should be happening; an **Effector-** a device which then takes the assessors findings and takes corrective action i.e. alters the behaviors or processes in the needed manner to bring them to the required performance; and lastly a **Communication Network**- devices which then connect and transmit information between the three above elements effectively to produce a functional control system.

Diagram 2A: Elements of a good MCS

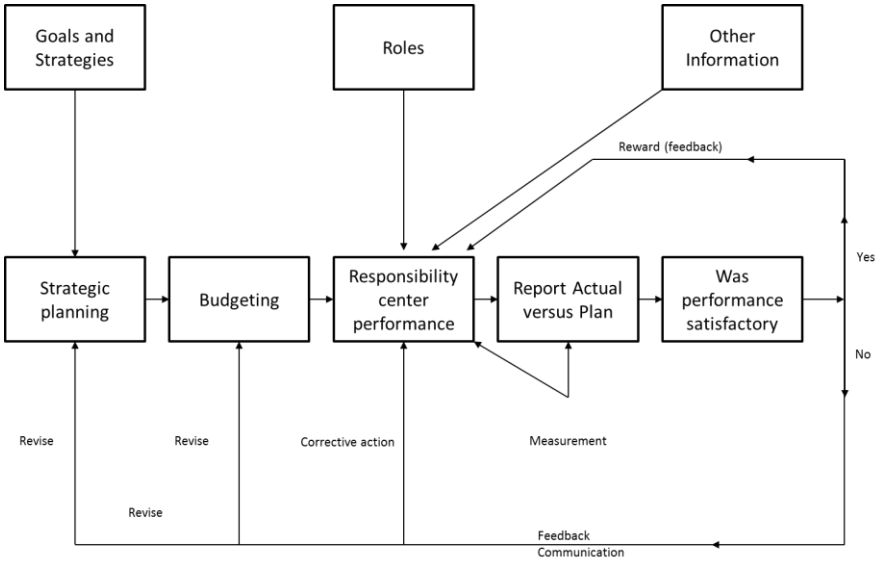


Source: (Anthony & Govindarajan, 2007)

This concept is useful for us to evaluate the efficiency of the given elements in DB Schenker's Maintenance management control system today. While it is clear that these elements are present, the difficulties reported today in the Maintenance department, reflect a possible ineffective communication of the elements causing them to have a challenge in timely monitoring and evaluating the performance of their maintenance processes.

Anthony and Govindarajan go on to define management control as a system which lies between strategy formulation and task control. They state that the planning process is more important in the strategy formulation phase, while the control process is more important for the task control phase, and that planning and control are of equal importance in the management control phase which lies between them. Defined, they say Management control is the process by which managers influence other members of the organization to implement the organization's strategies. They take the stance that management control systems should be designed and operated with the principle of goal congruence in mind, such that the organization can align not only the strategic goals with the operation in the departments but also the goals of the individual workers with the goals of the organization as a whole. MCSs encompass both financial and non-financial objectives, and through interactive control, can be used to indicate the need for new strategic initiatives. The major difference between management control and strategy formulation, is that strategy formulation is essentially unsystematic and includes relatively few people i.e. headquarters staff and senior management, while in contrast management control involves a series of steps that occur in a predictable sequence according to a fixed timetable, with reliable estimates. Further, it involves managers and their staff at all levels in the organization. This view of management control systems will also be considered in the analysis of the current management control system in DB Schenker maintenance as well as in the design of the PMT, blueprint and BI reporting foundation to be introduced in the new WMS. While Anthony and Govindarajan make a distinction between management control and task control- the process of ensuring that specified tasks are carried out efficiently and effectively-, it is still an integral part of MCSs and will be used to help the improvement of the maintenance departments performance through WMS. Anthony and Govindarajan provide a sketch of a formal control system (see diagram 1C) in which an organisation can oversee all its activities, and from this sketch a comparison to the system in use in DB Schenker Rail maintenance can be made.

Diagram 2B: Structure of a Formal Control System



Source: (Anthony & Govindarajan, 2007)

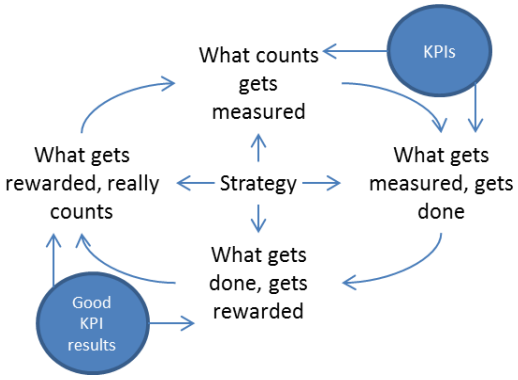
Anthony and Govindarajan also put emphasis on the allocation of responsibility centers- an organizational unit headed by a manager who is then responsible for the performance of that particular unit. There are four types of responsibility centers, namely expense, revenue, profit and investment centers. They argue that the nature of the unit should be used to determine the manner in which each organizational unit's performance should be measured. For instance an expense centers financial performance report should not be taken as a signal of its efficiency because the effect would be managers reducing expenses to be below budget but at the cost of output.

In terms of financial performance management, Anthony and Govindarajan have suggested variance analysis as the most suitable and transparent method to measure the performance of an organisational unit effectively. With this method, a company is able to control and monitor the cause and effects of each department's variation from planned budgets and expectations such that it becomes clearer where corrective action is required. The limitation of variance analysis however, is that it does not explain why a variance occurs and whether any steps have already been made to address a negative variance.

They do also mention that financial and nonfinancial measures need to be linked and adopted to have an effective management control system. They recommend the use of a balanced scorecard as one of the tools which can be used to achieve this. It is at this point that the key performances indicators come into effect. According to Anthony and Govindarajan a balanced mix of measures must be selected and a distinguished cause and effect relationship between the measures should be identified and monitored in order to translate the strategy into action. The creation and use of WMS intends to aid and improve the current relationships in the KPIs in

DB Schenker. To show the importance and interaction of the KPIs and strategies the author has adopted and slightly edited the diagram 1D shown below.

Diagram 2C: Interaction of KPIs and Strategy in MCSs



Source: (Anthony & Govindarajan, 2007), Edited by: Author

In summary, Anthony and Govindarajan find that regardless of whether the MCS influences or is influenced by the strategy, it should focus on the actual effective implementation of the set out strategy. They state that the elements of a MCS i.e. strategic planning, resource allocation, performance measurement and evaluation, and responsibility center allocation (to be used in determining the manner in which performance is measured) should all be well linked in order for the MCS to function effectively. In addition we noted that they put importance on the connection between the detectors, assessors, effectors and communication network for a good MCS. The thesis also notes that according to them, the MCS to be used in DB SR should allow managers to influence other members in the organisation to implement the strategies as optimally as possible while it should also be capable of indicating to the managers the need for new strategies. MCS according to Anthony and Govindarajan should involve managers and staff at all levels of the organisation, and the performance measures used should include both financial and non-financial aspects.

2.2 Management control systems according to Simons

According to the in-depth research by Erik Strauß, Simon's book titled Performance measurement and control systems for implementing strategy is among the top three preferred texts under the topic of Management control systems. In comparison to Anthony and Govindarajan, Simons forms an analysis of control systems with an informal system playing a bigger role in influencing the management control systems. The informal aspects of particular interest to this thesis are the five factors of human nature which need to be assumed and ascertained in order to have an effective control system (Simons R., 2000). According to Simons, these factors are namely assumptions that employees: 1. want to contribute to the overall success of the organisation, 2. choose to do right when it comes to their activities and tasks within the organisation, 3. like to be innovative, 4. strive to achieve the goals that are set, 5. want to do competent work. Although we realize that such assumptions may not hold true in all working environments/employees within an organisation, Simons argues that forming a base on these assumptions allows an organisation to form a control system that will not limit the potential of employees to be productive. For this reason, this thesis aims to make use of these assumptions in

generating a PMT and blueprint for performance measurement for DB Schenker. However the effectiveness of the system will not be limited to these assumptions in order to ensure that in situations of deviation or non-applicability of any of the above assumptions, the control system in WMS will still be functional and beneficial to the company. The managerial solutions in diagram 2D below will therefore be embedded in the PMT, such that WMS will be a control system adopting Simons' human nature assumptions as well as providing an environment in which employees are influenced to behave according to the assumed behavior.

Diagram 2D: The five factors of human nature for MCS

TABLE 14-2 Human Behavior, Organisational blocks and the Levers of Control

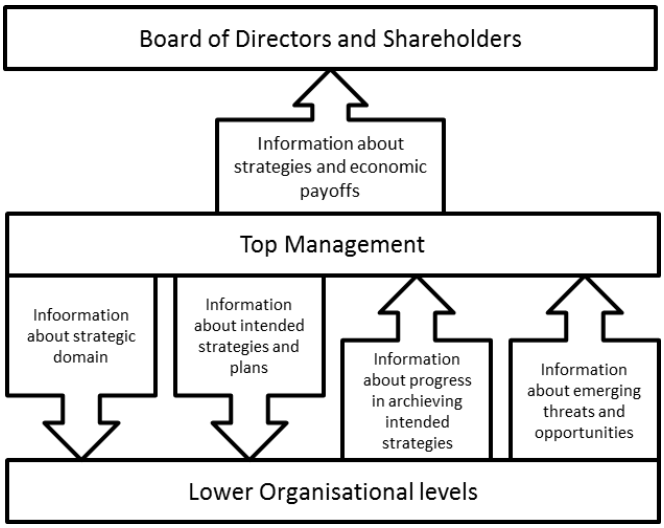
ORGANISATION MAN/WOMAN DESIRES TO	ORGANISATIONAL BLOCKS	MANAGERIAL SOLUTIONS	RELEVANT CONTROL LEVER
Contribute	Unsure of purpose	Communicate core values and mission	Beliefs system
Do right	Pressure or temptation	Specify and enforce rules of the game	Boundary systems
Achieve	Lack of Focus or resources	Build and support clear targets	Diagnostic control systems
Create	Lack of opportunity or afraid of risk	Open organisational dialog to trigger learning	Interactive control systems

Source: (Simons, 1995) (Simons, 2000)

Like Anthony and Govindarajan, Simons talks about the organisational structure of the company playing a significant role in the management control system. According to Simons, organisations should pay close additional attention to the structure, whether employees are grouped by function such as DB Schenker maintenance is or they are grouped according to specific market. At this stage, Simons puts forth that organisations should not only take into consideration the span of control- the number subordinates that each manager has- and the span of accountability- the range of performance measures that are used to evaluate a manager's achievements- but also the span of attention- domain of activities that are within a managers field of view for example, a narrow span of attention is limited to the managers direct activities and performance measures, while a wide span of attention not only includes both his activities and performance but also the external environment (customer satisfaction, changes in market expectations). He argues that putting too much pressure on managers to focus on their span of accountability and span of control, reduces their span of attention which may prove beneficial to the organisation in the short term but may cause detriment in the future. Consequently, we find this aspect on control systems important for the new PMT which will be implemented in DB Schenker Rail through WMS: to be wary of negatively affecting the managers and employees span of attention.

The primary purpose of performance measurement and control systems is to allow managers to move from only intuitive to informed (intuitive) management (Simons R., 2000). According to Simons, organisations which are capable of processing relevant information quickly can plan for the future, communicate direction and capitalize opportunities more efficiently. From this perspective, Simons' theory addresses DB Schenker's aim to achieve a maintenance department capable of predictive analysis. The importance of information communication through control systems to align with strategy is well depicted by Simons (diagram 2E), thus this thesis in using BI reporting as a part of the control system aims to deliver an efficient communication line in WMS as shown in diagram 2E below.

Diagram 2E: Effective Information communication in a control system



Source: (Simons R., 2000)

For this information exchange to be effective managers must be selective in choosing what to control and Simons like Anthony and Govindarajan, emphasizes the importance of understanding the cause and effect connection between the chosen measures of performance, such that information can be categorized into 5 categories i.e. information for decision making, information for signaling, information for external communication, information for education and learning and information for controlling. For this thesis however focus will be placed on information for decision making and controlling. In selecting performance measures, Simons argues as well that it is important to ensure that three tests are satisfied for every measure that is selected. The first test is: does the selected measure align with strategy? - Employees should be able to deduce the management's strategy from the measure with which they are evaluated. For example, when cost per unit is the selected measure or when quality failures are the selected measure. In the former the employee can assume that the strategy is cost advantage/leadership, while in the latter it could be premium quality or customer satisfaction. The second test is: Can it be measured effectively- ideally, measures should be objective, complete and responsive. The third test then asks: Is the measure linked to economic value- such that it

is more beneficial for managers to address a mix of indicators including leading indicators which allow for timely corrective action rather than only lagging ones which are only a report of what has already happened.

In summation of Simons' perspectives, the thesis has found that Simons believes informal controls play a bigger role in influencing MCSs, and argues that the five factors of human nature need to be considered. He puts forth that the organisational structure plays a significant part in a good MCS and that the span of accountability and control given to managers should not negatively affect the span of attention they can exert in their work. Simons explains that to form a good MCS, management should be selective of what they choose to measure and should differentiate the information they collect according to relevance e.g. information for decision making, information for controlling and/or information for signaling. He asserts that the quicker a MCS is able to process information for the future, the better the organisation is able to capitalize on opportunities. Lastly we found that he expresses the importance in measures being tested for alignment with strategy, having effective measurability and being economically valuable; being constituted by measures of both the leading and lagging type.

2.3 Management control systems according to Merchant and Van Der Stede

Management control systems according to Merchant and Van der Stede in their book Management Control Systems; Performance Measurement, Evaluation and Incentives, define management control systems as the back end to the management process (Merchant & Van der Stede, 2012). Like Antony and Govindarajan they put forth that MCSs are more about execution and strategy implementation than goal setting and strategy formulation. In fact, Merchant and Van der Stede argue that the knowledge of objectives is a prerequisite for any MCS while strategy formulation defines how organisations should use their resources to meet these objectives. They assert that MCSs then fall between the two (knowledge of objectives and strategy formulation) and focus on the execution. Their perspective is slightly different from Anthony and Govindarajan who instead argue that MCSs influence and/or are influenced by the strategy of a company. None the less, there are similarities in their theories in that the management control systems are needed in order to ensure that the organisation is moving towards the goals that they have set.

In analyzing Merchant and Van der Stedes' position on MCS, the thesis found that their perspective shares the views expressed by Anthony and Govindarajan- who view MCSs as a rubric which functions more effectively through formal controls- and the views expressed by Simons- who perceive MCSs as a rubric which functions more effectively through informal controls. While none of the authors (Anthony and Govindarajan or Simons) take an extreme stance in their views, Merchant and Van der Stede express in more detail the link between the formal and the informal controls and how they affect any MCS which is implemented in an organisation.

Merchant and Van der Stede begin by identifying three main overarching causes for problems in management control systems. Namely these problems are: i) Lack of direction, ii) Motivational problems and iii) Personal Limitations. They put forth that the lack of direction is a problem that stems from the employees not knowing what the organisation expects of them. Merchant and Van der Stede state that this is ultimately caused by the formal controls or lack thereof. From a survey they conducted, they stipulated that only 13% of non-management employees understand the value drivers of their business strategy: the cause of this being that organisational goals are not cascading down to all levels in the organisation. From this problem, the thesis deduced that Merchant and Van der Stede put importance on the formal controls of an organisation in the same way that Anthony and Govindarajan do. The paper will use the perspective in ensuring that the PMT is able to make clear and communicate the goals and expectations to the employees in order to avoid the lack of direction in DB SR maintenance.

On the other hand, the motivation problem arises mainly because of the (lack of informal controls) agency problems- that individual and organisational goals do not always coincide- within all organisations. They express that employees deliberately acting in their own interest at the expense of the organisation is one of the most common causes of problems in MCS. According to Merchant and Van der Stede, the Association of Certified Fraud examiners estimated that the typical organisation losses 5% of its annual revenue to this problem (Applied to the 2009 Gross World Product a total of $2.9 trillion!) (Merchant & Van der Stede, 2012). From this problem, Merchant and Van der Stede illustrated the importance of informal controls, such as hiring the suitable person for the organisation and also ensuring that the answers to the following questions about the company's employees are positively answered: will they work hard and consistently do what is expected of them? Will they pursue the organisations objectives in line with the strategy? Are they capable to do the job? (Merchant & Van der Stede, 2012). Not surprisingly, these questions coincide quite well with Simons' five factors of human nature, whose focus is on the informal controls as well: a strong point for the DB SR management and the thesis to take into consideration.

The last cause of problems in MCS as expressed by Merchant and Van der Stede is that of personal limitations. They argue that these causes can stem from a lack of formal or informal controls within an organisation. Personal limitations can be person specific, for example lack of aptitude, training or experience or they may be organisational specific, where jobs are not well designed/described causing even the most physically suitable and apt employees to burn out. Ultimately, Merchant and Van der Stede seem to express on overall view of MCSs that is focused on both formal and informal control systems.

When we look into more detail, at the actual theory behind MCS according to Merchant and Van der Stede, we find that, like Simons (who says companies which have a MCS capable of processing information for the future the fastest can capitalize on opportunities), they argue that a

good MCS is one that is future oriented and objectives driven; which supports the goal of the thesis to build a platform for predictive analysis in the maintenance department as well. In the first three chapters of their book, they cover several MCS aspects which encompass both formal and informal control systems. In the second chapter, they put forth the importance of Results Controls, which according to their definition, are controls to motivate the employees to produce outcomes that the organisation pursues. They state that a prominent example of results control is pay-for-performance. However, they argue that in a good MCS, the results controls do not specifically have to be monetary in nature but can encompass a variety of forms such as job security, autonomy, and promotions. Furthermore for the management control system to be effective, it should be formed in such a way to create meritocracies i.e. when rewards are given to the most talented and most hard working employees, rather than those with the longest tenure or social connections in the company. They point out that results controls in a good MCS should be tied closely to sound performance, and in that way will cause employees to be concerned about the consequences of their actions/decisions. This according to Merchant and Van der Stede creates a MCS that does not need the management to dictate to the employees what must be done but instead it empowers employees to act in the way they believe will best serve the company. For these reasons, the thesis believes the lining of performance measures in the same way within the PMT will serve DB SR maintenance in an extremely beneficial manner as well.

In chapter three, Merchant and Van der Stede talk about Action, Personnel and Cultural Controls, which are more of the informal controls which an organisation may use. Action controls involve ensuring that employees perform (do not perform) certain actions known to be beneficial (harmful) to the company (Merchant & Van der Stede, 2012). Action controls can be defined according to whether they are made to prevent or to detect and according to Merchant and Van der Stede can take any of four basic forms i.e. **behavioral constraints**- making it (almost) impossible for employees to do what should not be done, e.g., locks on desks, computer password, limits to access in some areas-, **pre-action reviews-** involve the scrutiny of the action plans of the employees being controlled**, action accountability**- involves holding employees accountable for the actions that they take, rewarding and punishing good or bad actions taken-,and **redundancy-** involves assigning more employees or verification equipment to a task than necessary.

Personnel controls build on employees natural tendencies to control or motivate themselves. These controls according to Merchant and Van der Stede serve three purposes i.e. i) help clarify expectations and make employees understand what an organisation expects of them, ii) ensure that each employee has the capabilities (e.g. experience, intelligence) and resources (e.g. information and time) to do a good job, iii) increase the likelihood that each employee will engage in self-monitoring. According to Merchant and Van der Stede again, these three purposes

can be implemented through a) selection and placement, b) training, and c) job design and re-sourcing. They put forth that finding the right person to do a particular job, training them and giving them both a good work environment and the necessary resources is likely to increase the probability that the job will be done properly.

Lastly, Cultural controls are designed to encourage mutual monitoring- a powerful form of group pressure on the individuals who deviate from group norms and values. According to them, cultural controls are embedded in written and unwritten rules that govern the employees' behaviors. They put forth that cultural controls can be formed in several ways including codes of conduct, group rewards, intra-organisational transfers, physical and social arrangements and the tone at the top.

According to Merchant and Van der Stede, all or only some of the above discussed controls can be applicable in the organisations but naturally, some controls are more suitable than others in various situations. However, while the Action, Personnel and Cultural Controls may be very effective and some may already be in use in DB SR, the thesis suggests this to be additional literature to be taken into consideration for further studies in the department, as the focus in the PMT is to aid DB SR to measure, monitor and evaluate the performance of the department: therefore these controls fall out of the PMTs current scope.

To summarize, Merchant and Van der Stedes' findings, we see that they also argue that MCS should focus on the implementation of the strategies set for a company. They put forth that the knowledge of objectives is a prerequisite for any MCS that is to function effectively. The thesis notes that Merchant and Van der Stede put importance on both the formal and informal controls in forming an intricate and optimal MCS. They argue that in order to fix or avoid problems in a MCS, we have to be aware of causes such as the lack of direction, motivational problems and personal limitations. Merchant and Van der Stede assert that a good MCS is one that is future oriented and objectives based; encouraging, motivating and empowering employees to act in a way that brings the company to its goals (results controls). Lastly they say controls should be used such that they align performance measures and rewards very closely to sound performance.

Business Intelligence (BI) reporting

As BI reporting is an integral part of the MCS and PMT that we wish to implement in WMS, the thesis has provided the brief paragraph below to clarify to what extent and in which capacity we view and wish to use BI reporting.

Business intelligence is a set of theories, methodologies, architectures and technologies that transform raw data into meaningful and useful information for business (Klein, 2012). It involves the multidimensional aggregation and allocation of processed information to respective departments as well as its comprehensive use and objectives. Furthermore through Business Intelli-

gence, organizations are able to run denormalization, tagging and standardization processes at a more efficient and transparent level, in a manner which fosters the optimization of routine procedures in the company (Accountable Software, 2014). Other components of BI reporting include: real time reporting with analytical alert; interfaces with unstructured data sources; group consolidation, budgeting and rolling forecasts (Klein, 2012). As will be further illustrated in this paper, key performance indicators are BI measures which are significantly important to the DB Schenker maintenance processes together with performance management (Accountable Software, 2014) (Klein, 2012).

Bi technologies provide historical, current and predictive views of business operations. The functions of which include reporting, business performance management and benchmarking. BI is sometimes used as a synonym for Competitive Intelligence because they both support decision making, however, it is important to note that if understood broadly that Competitive intelligence is a subset of Business Intelligence (Klein, 2012). Therefore taking this perspective on BI reporting the thesis hopes to enable DB SR maintenance to use some or all of the above described BI reporting tools in the department.

2.4 Synthesis of the views on MCS

The synthesis of the perspectives on MCSs discussed above helps us answer central question one. The thesis believes synthesizing the three perspectives will contribute to the formation of a sound MCS, PMT and Blueprint to be used in DB SR maintenance through WMS. Therefore the thesis aims to ensure that the PMT and blueprint created will enable the MCS in WMS to help management to focus on the implementation of strategy while also indicating when the need for new strategies arises. The thesis intends to provide a PMT that fosters the explicit formation and communication of goals throughout the department and involvement of all managers and employees at all levels within the organisational structure. We will also ensure that the PMT takes into consideration both financial and non-financial measures of both the leading and lagging type to optimize performance evaluation and measurement. Furthermore, the thesis will adopt the formal in as much as the informal measures to bring a balanced MCS to the department. The formation of the PMT and blueprint will be made in such a way that the five human nature assumptions according to Simons will be taken into consideration, while at the same time ensuring that the three main causes of problems in MCSs as described by Merchant and Van der Stede are addressed. In the formation of the PMT, all the elements of a good MCS will be taken into consideration together with the span of attention which is desired for the managers and employees. Last but not least, in the synthesis of the perspectives, the PMT will be future orientated and objective based to aid DB SR to seize opportunities as they arise.

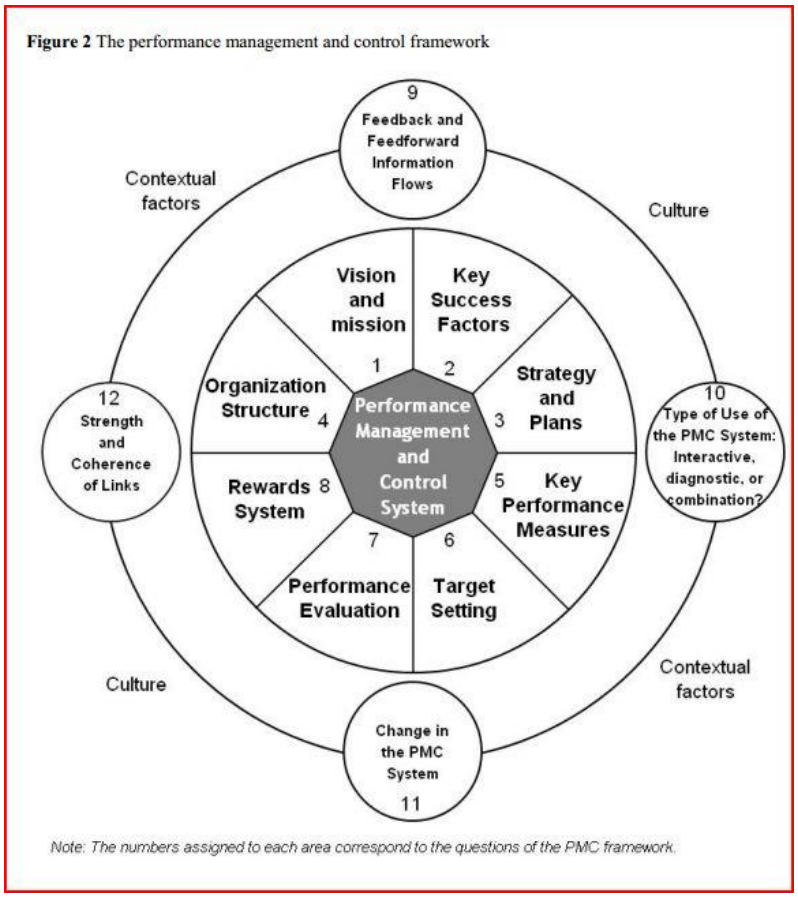
3 Chapter 3: Analysis of current Management Control System in DB SR

3.1 Analysis of the overall management control system in Maintenance

Central question 2:

How is the management control system in DB Schenker's maintenance department currently structured and where might a lack in efficiency arise?

Diagram 3A: The Performance Management and Control Framework



Source: (Otley & Ferrira, 2005)

To analyze DB Schenker Maintenance's current management control system, we will go through the Performance management and control (PMC) framework as proposed by David Otley and Ferreira. Two main frameworks were used for the innovation of the PMC framework by Otley and Ferreira. Initially (Otley D., 1999) framework was adopted as means of collecting relevant information, then structuring and presenting the material collected such that it focuses on a macro analysis of each company's control system. Then (Simons R. , 1995) levers of control' framework was employed as means of obtaining further insights into the design and functioning of the control systems observed. These two frameworks were selected on the basis of a literature survey, which indicated that they were general frameworks that focused on the operation of the whole of an organizational control system (Otley & Ferrira, 2005). As a result, the PMC framework is designed as a research tool to aid the description of the structure and operation of management control systems in organisations according to Otley and Ferreira. The PMC

framework shown above in diagram 3A comprises of 12 questions which the authors have found to enhance previous literature used in describing MCS in organisations and these 12 questions will be addressed individually in this thesis for the analysis of DB Schenker Maintenance's control system.

Like Robert Anthony and Govindarajan, and Merchant and Van der Stede, Otley and Ferreira put forth that all MCS should be well tied to the organisation strategy, in order to ensure that the measures chosen for performance monitoring are in line with the direction that the organisation as a whole aims to take. To that end, the first question in the PMC framework aims to ascertain the desired direction of the company, and therefore is as follows:

3.2 Vision, Strategy and Key success factors

1. **What is the vision and mission of the organization and how is this brought to the attention of managers and employees?**[1]

In order to answer the above question effectively, the vision and mission were taken from the company website: DB SR's vision and mission are stated as follows:

"Schenker Deutschland AG of tomorrow - **our vision:**

- We retain our position as the leading provider of integrated logistics services in the "Region Central Europe" (Germany, Belgium, the Netherlands, Switzerland).
- We achieve growth rates above market level and there with extend our competitive advantage consistently.
- We support DB Schenker in becoming the leading global supplier of integrated logistics services as engine of the worldwide DB Schenker network."

(DB Schenker Rail, 2011)

"Our self-conception and our aims - **our mission:**

- Our Mission is to provide innovative, high quality and cost efficient transport and logistics solutions which add value for both our customers and our shareholders.
- We thereby commit ourselves to motivated, highly educated staff - we remain the preferred employer in our industry.
- Within our scope we naturally respect the regulatory framework ("Compliance") and we commit ourselves to a sensitive handling of limited resources ("Green Logistics")."

(DB Schenker Rail, 2012)

The authors Otley and Ferreira include the question of an organisations vision and mission, as they rightfully put forth that they are an important element of a control systems design and use because they form part of the beliefs system of the organisation as supported by (Simons R. , 2000) and (Armesh, Dr. Salarzehi, & Dr. Kord, 2010). In addition the vision and mission can/ should be used to establish a clear link with strategy and performance measures (which should be defined/ selected in order for the organisation to actively move towards its intended objectives (Anthony & Govindarajan, 2007). It is important to note that DB Schenker Rail (DB SR) is a

[1] The question 'How is it brought to the attention of managers and employees?' will be answered under sub-question.

subsidiary of state-owned Deutsche Bahn; as the rail logistics industry has recently (in 2006) been made a free market (no longer government monopoly) through the non-discriminatory access to rail (Federal Railway Authority, 2008), DB SR now faces incremental competition in the industry. As now indicated in the vision and mission statements, the organisations values and belief system incorporates a focus on customer value, innovation and high quality as opposed to a more passive culture normally found in monopoly firms.

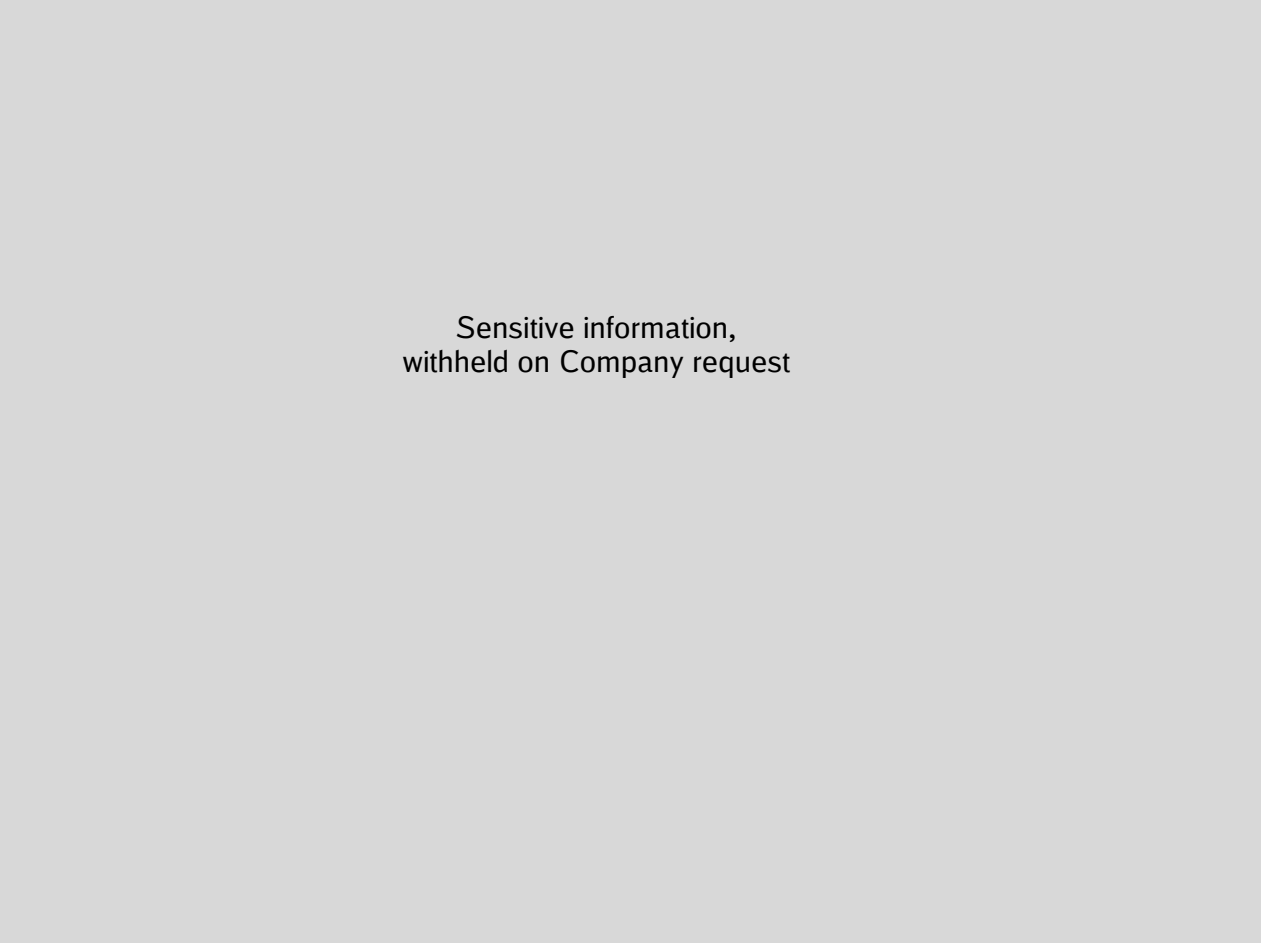
In addition, in line with Robert Anthony and Govindarajan who stress the importance of both financial and non-financial goals, the vision and mission show the use of multiple objectives which are both financial (added value for shareholders) as well as non-financial (highly educated staff, innovation and quality). DB SR aims to remain market leader and simultaneously achieve above market level growth rates and increase its competitive advantage among its overall goals, which have importance in so far as they are communicated and acted upon according to Simons, Merchant and Van der Stede, and Robert and Govindarajan. Thus a sound control system in will indicate a connection between these goals and the selected strategy, KPIs and key success factors as stated by (Pock, 2007) as well.

2. **What are the key factors that are believed to be central to the organization's overall future success and how are they brought to the attention of managers and employees?**[2]

Otley and Ferreira in their PMC framework formed question two to address the key success factors and question three to address the strategies and plans that the organisation will follow. However because DB SR has defined the success factors in relation to the strategy they have chosen, as seen in diagram 3B shown below, we will address question two and three simultaneously.

[2] The question 'How is it brought to the attention of managers and employees?' will be answered under sub-question.

Diagram 3B: DB SR's Strategy, Key Success Factors and the 'Schritt für Schritt' program



Source: (DB Schenker Rail, 2014), Edited by: Author

3. **What strategies and plans has the organization adopted and what are the processes and activities that it has decided will be required for it to ensure its success? How are strategies and plans generated and communicated to managers and employees?**[3]

As we can see from diagram 3B above, DB SR has divided its company strategy into four clouds which they aim to attain/sustain with a timeframe to 2020. We can see a clear link in DB SR's 2020 strategy to the established vision and mission, which include being market leader and top employer in the industry. In the first cloud of DB Schenker's strategy, we can note that DB SR wishes to be a profitable market leader in the industry and therefore has identified the key success factors for this to be a focus on cost reduction and an increase in productivity. The second cloud indicates the importance they place in the service they offer to customers as well as the quality at which it is delivered. In order for them to be successful in this respect, they have identified that security and credibility (on time delivery of trains and goods) are the key success factors. The next cloud which again is in line with their vision and mission expresses how DB SRs strategy illustrates the value placed on employees. In this strategic cloud, DB aims to not only remain the most favored employer but to be the biggest employer in the industry as

[3] The question '…generated and communicated to managers and employees?' will be answered under sub-question.

well. The key success factors for this goal are defined as maintaining employee satisfaction as well as creating a performance based culture within the organisation. In addition, DB SR has noted that they have to establish all round leadership performance rather than departmental leadership alone. The fourth and final strategic cloud focuses on the environmental aspect of the organisation. DB SR has the goal of being an ecological pioneer by 2020, by creating an innovative atmosphere for its employees and encouraging ideas surrounding sustainable development. Taking the four strategic clouds identified in DB SR, we can analyze the strategy according to Porter's generic strategies model and the Ansoff matrix referred to by (David, 2011) in his book Strategic Management, and deduce that DB SRs strategy is focused on cost leadership (cloud 1) through the use of market penetration (economies of scale) (cloud 2: same product same market), but without compromising the product quality and service (cloud 2) (David, 2011).

At this stage of our analysis, it is of importance to once again note that the goal of the thesis is to foster improvement in the management control system in the maintenance department of DB SR. Therefore having determined the overall vision, mission and strategy adopted by the organisation, we now move focus to the maintenance department, where we now continue the analysis in observing the compatibility of the goals, objectives and performance measures that the maintenance department has chosen in relation to the organisation strategy. Thus the subsequent questions addressed in the PMC framework will be answered from the maintenance department's scope. The first three questions of the PMC framework needed to be addressed at the organisational level as departments do not tend to set their own individual vision and mission statements in an organisation. In addition any departmental strategies set, in an effective company should be within the constraints of the organisation as a whole according to Simons, Anthony and Govindarajan. Therefore it was beneficial for the analysis to begin on the organisational level as this allows us to accurately analyze and offer improvement to the control system in maintenance if it deviates from the overall goals and strategies of DB SR as a whole.

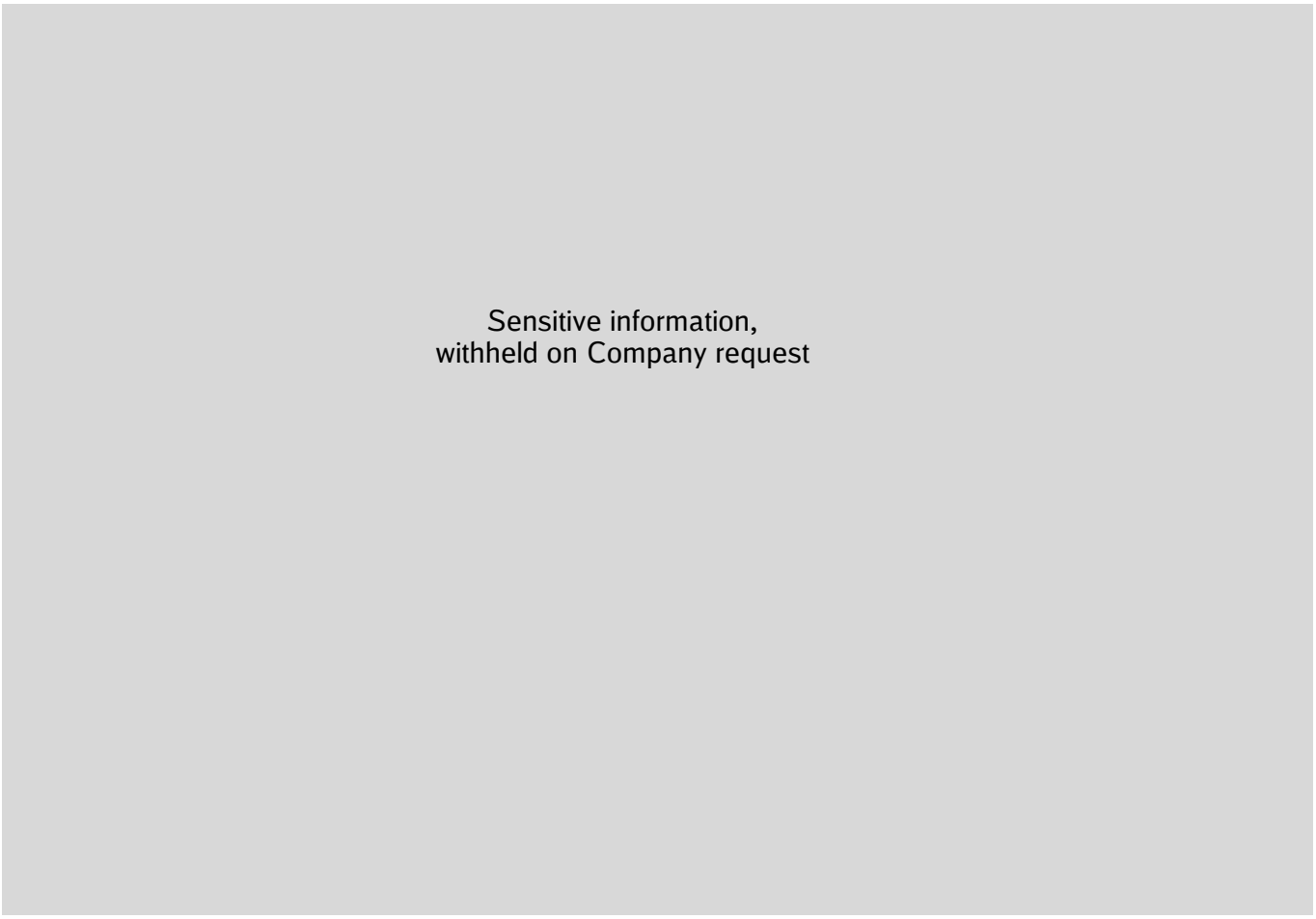
3.2.1 SUB QUESTION: How is it communicated to managers and employees?

Robert Anthony and Govindarajan, Merchant and Simons all put forth that the communication network in a control system should be pervasive in order to distribute the right information to the right managers or employees at the right time in order for the system to be effective: providing lag information- to allow for corrective action to be taken when needed, as well as to providing lead information- to avoid or prevent bad performance/undesired results. Taking heed from their argumentation, this thesis acknowledges that control systems are only as effective as their weakest communication link and the thesis has therefore deliberately answered the question of how goals, strategies and performance requirements are communicated in DB Schenker maintenance separately.

As will be seen later when answering question 4 of this PMC framework, DB Schenker has a very formal and well followed organisational structure, which determines the manner in which activities, responsibilities and strategies are assigned, set or communicated. The size of DB Schenker alone makes it difficult to incorporate non senior level management and employees in the strategy formulation exercises but it has implemented a structure in which both first level managers and employees are able to contribute to the direction and goals that are stipulated within their immediate spheres of activities and influence. The communication network in DB Schenker is formed in such a way that the board and senior management determine what the overall direction and strategy for the organisation should be and apply it on a top down approach. However, to enhance communication and avoid the agency problem within the company, respective boards and senior management, meet with first line managers, in this case the maintenance first line managers, and in an interactive manner (as recommended as well by (Armesh, Dr. Salarzehi, & Dr. Kord, 2010) and (Berglund & Rapp, 2010)) formulate a departmental strategy within the given targets.

In addition, DB Schenker has embarked on a program to further strengthen the communication of goals and targets to lower level employees through the "Schritt für Schritt" = Step for Step program (illustrated at the bottom of diagram 3B) (DB Schenker Rail, 2014). This program entails six simple steps which do not necessarily follow a chronological order. Step 1 is 'we the management' where the management as team forms a united understanding of what they want to achieve. Step 2 is 'Me and my work Station' where each employee, manager or not, lays out his objectives and intentions as a committed employee of DB SR. Step 3 is 'Us as a group/team' where the objectives of the group and their responsibilities are aligned and outlined in a team effort regularly. The fourth step is 'Us and our Service Centre.' In this step the management and employees then work together in constructively building their desires and goals for the service centers for which they are responsible as a team. Step five is 'Us and our region' Following the same logic, the region works together to form congruencies and adopt best practices from one another as far as possible. And naturally step six is then 'Us and our company'. The structure of the 'Schritt für Schritt' program in this way is to ensure strong communication ties throughout the organisation as recommended by (Theriou, Maditino, & Sevic) in their paper on MCS and strategy. In addition to build a team spirit where each individual employee feels valued within DB SR.

Diagram 3C: The Maintenance development plan



Source: (DB Schenker Rail, 2014)

One of the direct results of the interactive senior management- first line management meetings can be seen in the above depicted diagram 3C: the maintenance development plan 2013-2016. The overall goals that have been set in the maintenance department include the increase in vehicle availability, in particular faster completion of maintenance processes on locomotives which are important for the delivery of trains and goods (this is in line with the organisations strategy to achieve credibility), decrease unit costs and standardization- forming standards and individual processes (low cost strategy). Within these overall goals, we can note that DB SR maintenance has formed a maintenance strategy to meet the organisations Strategy. As shown in diagram 3C, they have identified four key factors for success and named them as follows: 1.0 Development of Maintenance structure (infrastructure), 2.0 Maintenance organisation, 3.0 Orientation of Core processes and 4.0 Management and management processes. Of particular interest is the placement of WMS as one of the objectives as this helps the reader to visualize the position and use of the thesis within the company. As we can see WMS is positioned as a goal under heading 2.0 Maintenance organisation. In essence, WMS will be an IT based control system aimed at controlling the communication of goals, performance and process evaluation within the maintenance department. This thesis provides added value by designing a performance management control tool and the blueprint, with KPIs and processes from the material

management sub-department: which should be applicable to all other sub-departments (see organisation structure under question 4); such that among its other functions, WMS will be the IT interface to manage and control the entire maintenance department based on a standardized blueprint formed from the thesis. In addition, the above outlined development plan will aid the formation of the PMT and blueprint as the selection of performance measures (KPIs) and how they will be communicated (BI reporting) will be partially drawn from it as well when the other departments are taken into consideration.

Now that we have established the relationship between the organisation strategy, and the goals and strategy set up in the maintenance department, we can move onto the next question, where we will investigate the influence that the organisational structure in maintenance has on managing and controlling performance.

4. **What is the organization structure and what impact does it have on the design and use of the performance management and control system? How does it influence and how is it influenced by the process of strategy implementation?**

Diagram 3D: The Sub-departments in Maintenance

Source: (DB Schenker Rail, 2014)

As illustrated in the above organisational chart, DB SR has a maintenance department that is divided into four sub-departments in a functional unit form. The overall maintenance department

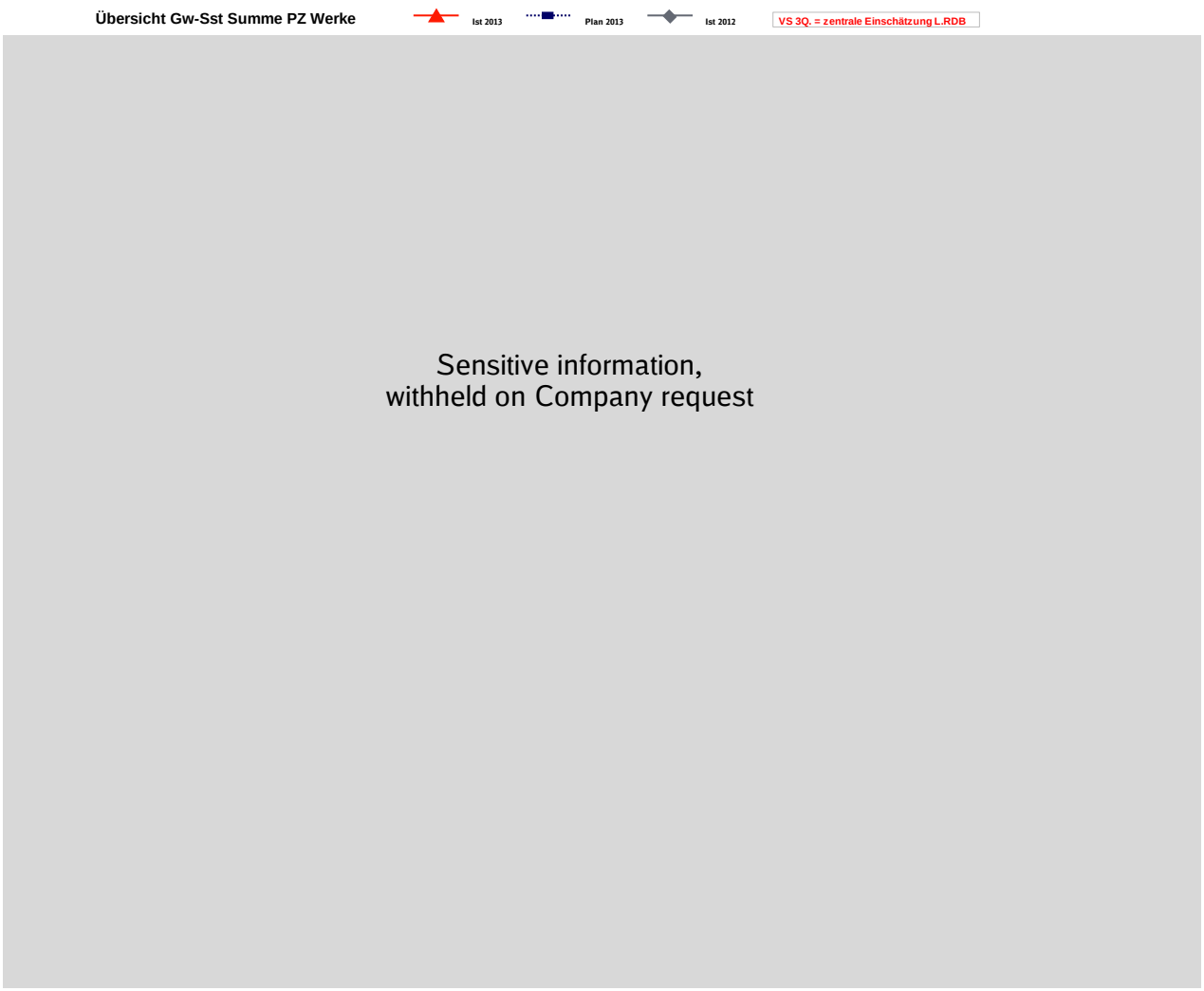
is headed by a member of the senior management (Mr Ketterl) who sits in the board meetings and participates in the organisational strategy formulation. It is under his management and instruction that the control system in maintenance becomes linked to the overall organisation. The strategy and organisational goals are received from the maintenance senior manager and first deliberated with the first line managers in maintenance to then formulate the departmental strategy as explained under question 2&3. The first line maintenance managers are therefore the individuals in charge of the four sub-departments of maintenance i.e. Technical management manager (Mr. Elkendorf), Performance planning and Control manager (Mr. Meng), Material Management manager (Mr. Tanner), Maintenance Quality manager (Dr. Westhoff). From the diagram 3D above, we are able to determine the roles and responsibilities of the first line management which can be seen as responsibility center allocation is encouraged by (Anthony & Govindarajan, 2007). This in itself is the platform from which the performance of these managers can be measured and monitored. The first line managers are responsible for the entire organisations maintenance workshops throughout the country. Thus the organisational structure has a great deal of influence on the control system in the maintenance department. It is, as well, of importance to state that the first line management then works together, and with the next layer in the organisation, i.e. regional leaders to assist in the effective on site management and communication in workshops. The regional leaders in turn work together, and with workshop managers as we go down the chain. Finally, we can see that the 'Schritt für Schritt' program is the control tool that the management is using to monitor and evaluate the individual performance of the lowest layer of employees within the workshops. This process is interactive, as the goals and targets used within the workshops (under Schritt für Schritt) and the continuously monitored dynamics within the workshop. In summary, one can argue that the organisation structure is close to the core of DB SR maintenance's management control system.

While the vertical functionality of the organisational structures influence on the control system is clear and easy to follow, the horizontal effects (as required by (Merchant & Van der Stede, 2012) of the organisational structure are not clear in DB SR. Indicating the first possible inefficiency in the MCS referred to in central question 2.

3.3 Key performance indicators, processes and feedback measures

5. What are the organization's key performance measures deriving from its objectives, key success factors, strategies and plans? How does the organization go about assessing and measuring its success in achieving them?

Diagram 3E: The main management KPIs in DB SR maintenance



Source: (DB Schenker Rail, 2014)

The above diagram 3E is of DB SR's KPIs that the maintenance department uses to measure and evaluate its performance. These eleven, are key measures selected and monitored by management regularly on a monthly basis. The maintenance management team meets roughly on the 15th of every month to deliberate on the performance and evaluate the cumulative performance of all of DB SR's workshops in the previous month. The performance measures were selected to represent each of the sub-departments in the maintenance overall department. In the diagram we see that the KPIs have been separated into three distinct groups, headlined: Availability/ quality, Cost/performance and Personnel: where 'availability/quality' are KPIs for the Material and Quality management departments, 'Cost/performance' are KPIs for the Performance planning and Technical management sub-departments, and 'personal' are KPIs which apply to all sub-departments about the employees. The conclusions made in the meetings as well as the actual graphs with the results is then circulated to the workshops again for the em-

ployees to personally reflect on their performance and to form an understanding of how or why the management team would have come up with the corrective measures that are then adopted after the point (DB Schenker Rail, 2014). It is unfortunate however that the key measures monitored are all of the lagging nature and that the performance is reflected upon at a rather late stage i.e. 15 days after the month inconsideration- which indicates another inefficiency in DB SR's MCS. None the less, to analyze the connection of these performance measures to the goals and objectives of the maintenance department, we formed a table with the list of the KPIs, what they measure and the goal to which they could relate.

Table: 3.1: The main management KPIs in DB SR maintenance

Sensitive information,
withheld on Company request

Source: (DB Schenker Rail, 2014), Edited by: Author

6. **What level of performance does the organization need to achieve in each of the areas defined in the above question, and how does it go about setting appropriate performance targets for them?**

As already mentioned before, DB SR is currently the industry leader in rail logistics in Germany and it has established that in order for it to remain the industry leader, the company must maintain a performance equal to or better than the previous year for each particular KPI. As a result, DB SR defines all its required KPI performance according to three factors i.e. Actual previous year (red line with triangle), planned current year (blue line with square) and Actual current year performance (grey line with rhombus/diamond shape) (please refer to the top of KPI diagram 3E above).

While this is the current system for setting performance targets in DB SR maintenance, it remains a question whether this system is still appropriate as the industry is no longer monopolized. In addition, this system of setting targets to meet last year's performance encourages slack and lack of development in the organisation as can be investigated by referring to (Reliability2.0, 2010) who examine KPIs in maintenance as well. In addition the exchange of information about these measures is carried out through multiple emails and telephone conferences which are cumbersome for management. This inefficiency in the MCS thus causes the employees and managers to have no incentive to be innovative or more efficient in their daily tasks (Reliability2.0, 2010).

As a result of this system and the liberalization of the industry, DB SR realizes that a new level of performance needs to be achieved that will aid the company to maintain its competitive advantage. The new level of performance should ensure that the high administrative costs due to the (manual) paper oriented state of completing core processes must be eliminated or reduced as far as possible, and that the transparency regarding the actual stage of completion of a vehicles' maintenance process is significantly increased. In addition better capacity management of resources i.e. personnel and material needs to be adopted in order to control the supply and delivery of vehicles to workshops to realize optimal resource utilization: (Bourne, Neely, & Platts, 2004) provide an academic perspective towards this concept as well. Supplementing the capacity management, the company asserts that they need a performance level which also provides for an overview of employee attendance and their qualifications within the workshops for the shift and labor planning. Furthermore, to improve quality, current regulations and work instructions need to be provided electronically in addition to the paper format which is available today.

Therefore as an improvement suggestion, this thesis proposes that the management should introduce additional benchmarks as performance targets to encourage continuous improvement as proposed in the kaizen management system, which is supported in (Smith, 2014) journal on leading and lagging measures and when to use them.

7. **What processes does the organization use for evaluating individual, group, and organizational performance? How important is formal and informal information and controls on these processes? What are the consequences of the performance evaluation processes used?**

As discussed earlier in the analysis, the organisation uses the 'Schritt for Schritt' program for individual and group performance evaluation. Further, Otley and Ferreira in this question aim to address the difference between the formal manner in which performance is evaluated i.e. KPIs and the 'Schritt für Schritt', versus the informal controls which senior management conveys as important as well. They argue that it is particularly important to distinguish between performance evaluation routines (often orchestrated by human resource function (Simons R. , 2000)) and those actually operated in practice by senior managers. In the case of DB SR maintenance however, there is a very small if any discrepancy between the formal and informal expectations from senior managers. The senior management attempts to evaluate performance as best possible through the formal channels such that the informal information is only to supplement the fulfillment of the expected formal performance targets. Consequently, the informal controls in DB SR maintenance should be strengthened as well to meet the recommendations from Simons and Merchant and Van der Stede.

In conclusion, the performance evaluation processes used are well detailed and clearly communicated to employees. However, while these evaluation processes may have been sufficient when DB SR was still a monopoly company, the literature indicates (Smith, 2014), (Anthony & Govindarajan, 2007), (Merchant & Van der Stede, 2012) and (Simons R. , 2000) that the processes need improvement today. This is because the formal evaluation processes are based on ensuring performance is maintained at a certain level (in a monopoly market with no competition) rather than ensuring that performance is improved in all areas possible for the company to reach its highest potential (in a competitive environment to gain and maintain a high competitive advantage).

8. **What rewards (both financial and non-financial) will managers and other employees gain by achieving performance targets (or, conversely, what penalties will they suffer by failing to achieve them)?**

Unfortunately, the analysis indicates that DB SR has very little rewards (either financial/ non-financial) which are directly linked to the achievement of performance targets within the company. Instead DB SR uses a state based system of reward, where employees are rewarded for their activities according to how long they are in the company or according to the standard of their education. A good example to explain this aspect is the fact that employees receive a bonus only in the event that the overall company has realized a profit which was significantly above the planned or expected profit for that particular year regardless of the individual employee or group performance. In addition, employees are awarded higher remuneration based on

the number of years that they are with the company, specifically, employees are given a percentage increase in salary every five years regardless of extraordinary performance or not.

On the other hand, DB SR has activity related performance rewards for managers which have a goal oriented contract (DB Schenker Rail, 2014). In this case, at the end of the year the managers in question are evaluated according to the percentage of goals they achieved and those they did not and their bonus is then calculated accordingly.

In relation to the non-financial rewards, the analysis has identified that in some cases where managers perform extraordinarily well, they are awarded with more responsibilities i.e. promotions, although this is normally done to internally fill new or recently open managerial positions and is not a direct award for performance.

9. **What specific feedback and feed-forward information flows has the organization devised for itself? What sort of feedback information flows have been created for monitoring current performance and bringing about adaptation of current behavior? What types of feed-forward information flows (if any) have been formulated to enable the organization to learn from its experience, to generate new ideas and to recreate strategies and plans?**

To address the question of feedback first, DB SR forms its strategy with the help of senior management and delivers it to the maintenance department in a top down manner. The senior management then receives feedback and also discusses the relevant strategies within the maintenance department in an interactive manner with the first line managers (DB Schenker Rail, 2014). In addition to this all feedback is encouraged within the organisation from both employees and managers; however the information flows are rigidly controlled through the organisational structure. Employees should report directly to their supervisors and should avoid bypassing the hierarchical order. As stated in the problem identification as well, one of the goals of WMS is to significantly reduce the amount of administrative tasks necessary in the workshops to allow workshop managers more presence on the workshop floor to have more interactive time with employees and receive feedback on a real time basis which they can also promptly respond to if possible. Furthermore, within the workshops themselves, management has recently begun using the 'Schritt for Schritt' program to encourage the employees to give feedback on their daily activities and status on the achievement of their targets as well.

The 'Schritt für Schritt' program is expected to go a step further as well and cater for feed forward possibilities within DB SR as well. The concept includes the adoption of the daily targets and feedback received from employees through 'Schritt für Schritt' into the formulation of overall goals, targets and strategy for the maintenance department as a whole as well. It should be noted however that the 'Schritt für Schritt' program is still at its initial stages and no feed forward has been executed to date.

10. What type of use is made of feedback and feed-forward information flows and to the various control mechanisms in place? Is use predominately diagnostic, interactive, or a combination of both?

Currently in DB SR, the aim of feedback information is to be used by management to monitor and diagnose the problem areas or processes within the maintenance department. Feedback information includes but is not limited to; the reporting on availability or lack of material when needed from the factory warehouse, the number of locomotives that are being held back in the workshops as a result thereof (DB Schenker Rail, 2014). While this feedback is identified to be important and the MCS in DB SR has a structure that encourages the submission and collection of feedback, there is a question on what use is made of the information to bring about solutions to any identified challenges (Merchant & Van der Stede, 2012). The current operation in the maintenance department allows for management to only meet once on the 15th of every month to evaluate the feedback that they would have received from the employees in the previous month (DB Schenker Rail, 2014). The feedback is summarized in a management report which is then discussed by the four first line managers. Unfortunately, this system of feedback use creates disadvantages such as delayed response/ corrective action to important problems and it also leaves the employees with no reassurance that their feedback is valued within the company. A system to actually monitor and track what use is made of the feedback information or how it is then adopted to actually make changes in the maintenance processes is yet to be identified.

11. How has the performance management and control system changed in light of the change dynamics of the organization and of its environment? What changes have occurred at the level of those systems in anticipation or response to such stimuli?

As already established, DB SR's environment has changed significantly since 2006, when the industry was opened to competition. Therefore in response to this question in the analysis, the management of DB SR maintenance argue that the creation and shift to an IT based system i.e. WMS, is a clear response that the organisation is making changes to its MCS as a result of the changes in its environment. As the market leader and largest company in the industry, it has been difficult for DB SR to adjust with the environment at a faster pace as the organisation history and culture had already sewn deep roots into their norms. None the less, the management realizes the necessity for the adjustment and transition to a more efficient MCS. Thus through WMS the maintenance management aim to change the MCS into a more real-time controlling system. In order to manage the department with a more developmental approach as opposed to the satisfactory approach they had adopted before.

3.4 Results and conclusions on Analysis of existing MCS in DB SR

12. How strong and coherent are the links between the components of the performance management and control system (as denoted by the above 11 questions)?

In the first four questions of the analysis we found that DB SR and DB SR maintenance have a very will linked strategy and that the targets and goals used in the maintenance department are formed based on the overall organisational strategy. This in addition to the communication between senior management and first line managers is a good sign of the coherence between the components in the four questions. In the next seven questions we analyzed the actual MCS in maintenance and found several times that DB SR maintenance's MCS, was well connected through its organisational structure and the 'Schritt für Schritt' program. The combined use of these tools allowed for DB SR to manage and control the maintenance department in a functional manner and with a clear allocation of management responsibility.

While the links depict a strong and coherent connection, it is also clear that the MCS has some inefficiency as well. The management control system illustrates a diagnostic nature and lacks a proactive or developmental component, or leading measures as Simons describes them. In addition, the performance measures selected have been mostly of the lagging nature, and the evaluation of the individuals or group performance was based on measures which are only to sustain the company's performance in relation to the previous years instead of adopting measures which internally motivate the organisation to improve, innovate and develop to its fullest potential, in the words of Merchant and Van der Stede, there is an apparent need for results controls.

Furthermore, although the organisation is structured well, the horizontal functionality of the organisational structure needs improvement in terms of definition and transparency. The analysis also reveals that the MCS only allows for the evaluation and controlling of performance at a relatively late stage in the maintenance department. In addition, the existing MCS in DB SR calls for strengthened informal controls as they are currently only used on a complementary basis. In terms of rewards and incentives, the thesis believes the company could seriously benefit from the literature recommendations, particularly according to Merchant and Van der Stede who touch on the topic of meritocracies.

Lastly, the analysis shows that DB SR's current MCS has an ineffective feedback system and that the feed-forward is still to be developed. The manner in which the feedback is done rigidly through the organisational structure makes it difficult to achieve top-down transparency in the department, and also makes it very difficult to have bottom-up development, innovation and/or strategy creation.

From this overview given by the PMC framework and the conclusions formed by the thesis, we can see on a fundamental level the causes and links to the difficulties that DB SR is facing as described in the introduction. In addition, we can comfortably conclude that the second central question has been adequately addressed and satisfactorily answered. Combining the challenges that DB SR maintenance faces as clearly described in the introduction, with the results of our analysis, we are able to move into a detailed guide and elaboration on WMS. The thesis aims to clearly lay out the functionality of WMS and to what extent it helps to reduce or eliminate the inefficiencies discovered in the existing MCS of DB SR and the difficulties it faces as a department. In addition as the goal of the thesis as stated several times now, is to aid the improvement of the MCS, following the section on WMS we will then conduct a detailed analysis of a specific sub-department- Material management within the maintenance department. Keeping the short comings identified through the PMC framework and the literature review in mind, we will thoroughly analyze the Material Management (MM) sub-department. The aim of the thesis is that through this sub department analysis, we are able to form a PMT and blueprint to be adopted through WMS in all other sub-departments to aid the successful improvement of the overall MCS in DB SR.

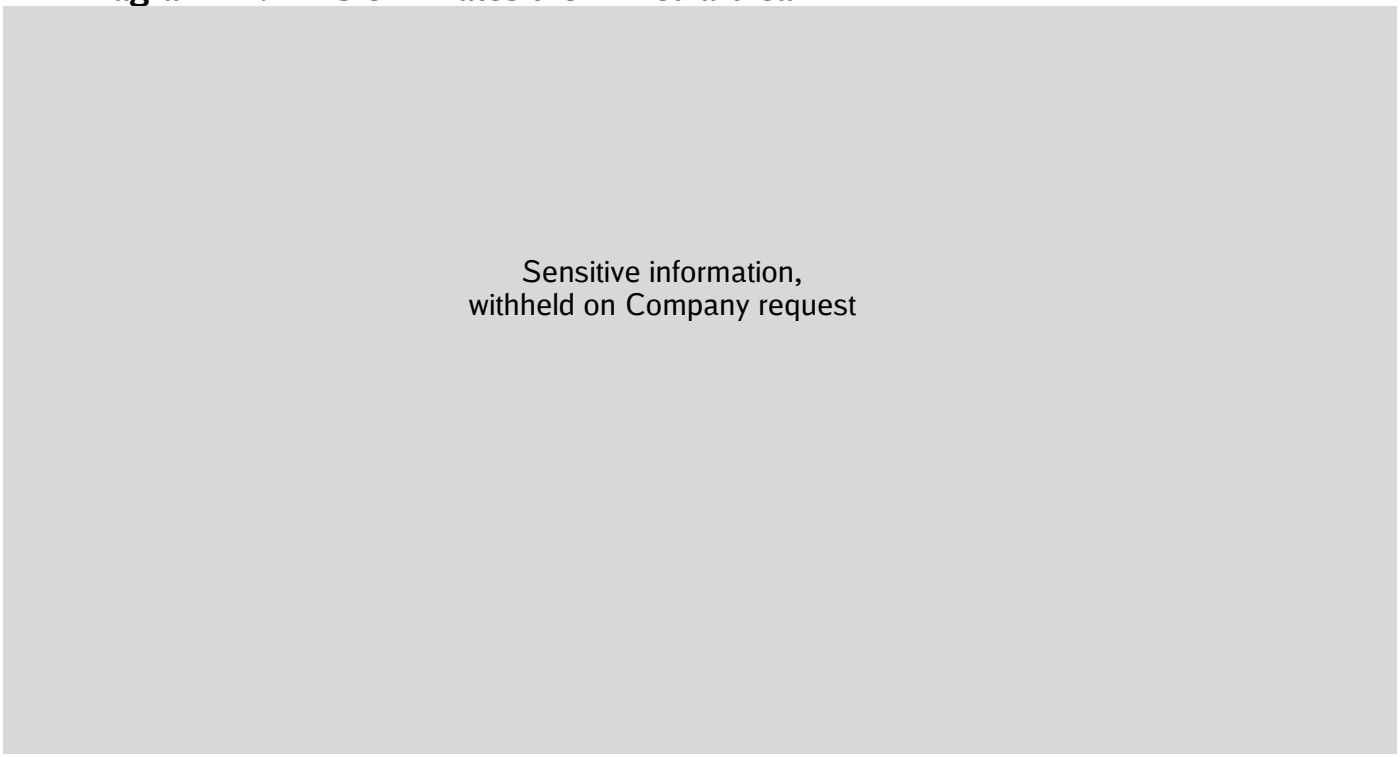
4 Chapter 4: Shift to an IT based transformational management control system

Central question 3:

> What are the key management control system techniques and process management systems that are lacking or need improvement (how can they be standardized for all workshops or do we need a new model)?

Before we delve into the detailed explanation of the concept of WMS, it is helpful to refer to diagram 1B shown in the introduction of the thesis to show the main motivation for embarking into the WMS project. In relation to that diagram, the diagram 4A below illustrates how WMS intends to solve the core problem of breaking from IT media to paper workshops.

Diagram 4A: WMS eliminates the IT media break



Source: (DB Schenker Rail, 2014)

The figure also depicts how WMS will be linked to several other relevant IT media in maintenance (Stand-alone systems marked in the red polygon), which will allow for further improvements to be made to the Management Control System. In addition to eliminating the break from IT media to a paper workshop, WMS has several goals aimed at solving the challenges described in the introduction and these goals are listed below. However it is important to note that the inefficiencies identified in DB SR's existing MCS are not all remedied by these goals stipulated for WMS. Therefore, the thesis adds value to WMS by innovating the PMT and the blueprint in such a way that the inefficiencies in the existing MCS will be resolved.

The goals of WMS are:

To decrease the processing time to improve vehicle availability through the time saved by removing focus from administrative activities and paper documenting.

To preserve and increase the competitiveness of DB SR by offering transparency to customers: they will receive a more exact time of when they will have their vehicles ready for operation again, allowing for better logistics planning for them.

To optimize the management possibilities within maintenance by creating a platform for improved capacity management and predictive analysis.

To foster improvement to the verification/conformity and audit responsibilities: therefore improving quality.

To establish a standardized user interface in maintenance, this can later be adopted on a European scope.

To create the possibility to prioritize maintenance orders according to strategic importance.

To achieve a true transparency in inventory status: in order to be able to discover situations of over and/or understocking.

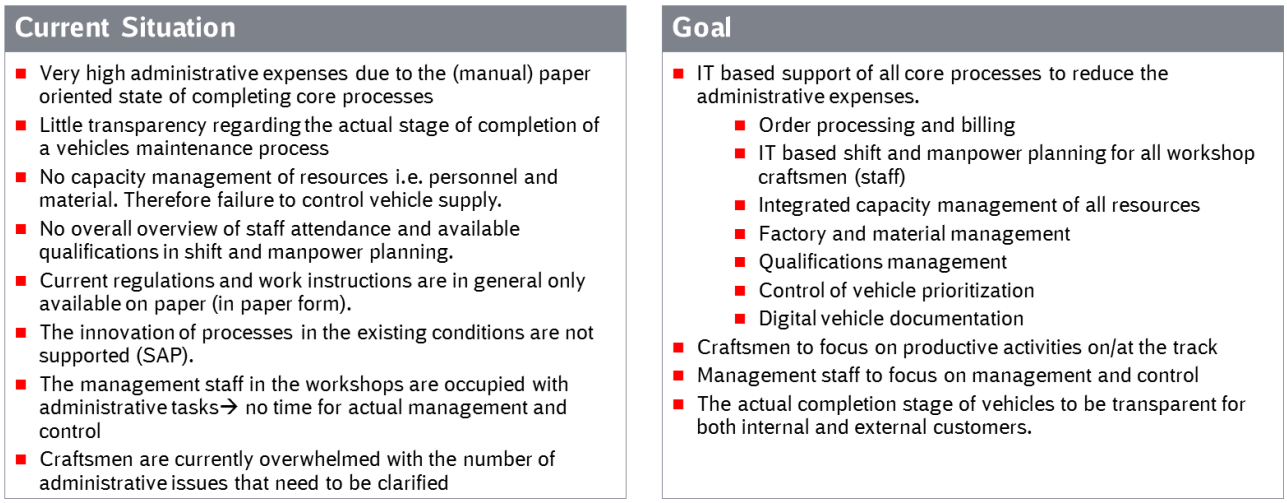
To provide a tool to the foreman to create a workload based schedule for his workers, an IT based shift and roster plan with the qualifications of employees to aid in assigning the tasks.

With this in mind, we can move into the explanation on the concept of WMS, after which we will look at the analysis of material management and form the PMT. The goal of the PMT is therefore to reinforce the functionality of WMS and to address the inefficiencies identified in DB SR's existing MCS.

4.1 The concept of the Workshop Management System

The Workshop Management System (WMS) is an IT based project which DB SR Maintenance has embarked on to address the problems in operations and performance which have been highlighted throughout this paper (diagram 4B depicting the summary of challenges and the goals of WMS is shown below) (DB Schenker Rail, 2014)

Diagram 4B: Summary of the Challenges and the Goals of WMS

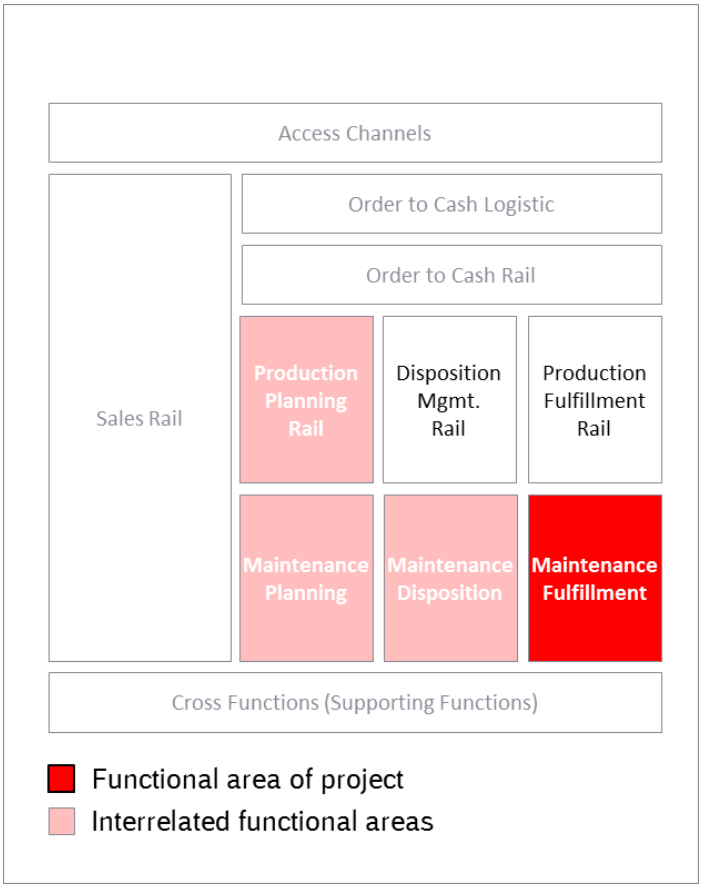


Source: (DB Schenker Rail, 2014)

As the challenges, which the maintenance department is facing, encompass all the sub-departments, the WMS project has a large scope and the functions which it must fulfill are vast, the concept of WMS will be explained from the broad perspective but specific focus will be put on the material management sub-department for the purpose of this thesis.

To foster a deeper understanding of the structure and scope of WMS in relation to DB SR as a company it is important for the reader to understand the functional domains in which WMS will operate. As noted before, the WMS project is intended to improve the operation and performance in the maintenance processes. However in order to accomplish this, one has to ensure that the planning and disposition stages before and after the actual fulfillment of maintenance have to be controlled and managed well in order to realize goals such as the increased vehicle availability. Therefore it is clear that other departments within DB SR need to be included in the administration of the project. For example closely related to maintenance is the Production Planning department, which is in charge of Fleet control and handles the disposition (allocation/ distribution) of wagons and locomotives to workshops. Diagram 4C below illustrates the structure of the entire company in relation to the areas in which WMS will be functional.

Diagram 4C: Functional areas of WMS in relation to DB SR



Source: (DB Schenker Rail, 2014)

Having clarified the functional area of the project, we now move into a deeper explanation of how WMS intertwines all interrelated functional areas/departments as well as the sub-departments such that a wide reaching and well-structured management control system is cre-

ated for the maintenance department to be able to realize its goals. In this section we also expound on the individual facets that will be controlled through WMS to illustrate the functions which will be engrossed by the system.

The Workshop Management System will be at the center of the maintenance department providing a platform where the requirements of both the maintenance headquarters and the individual workshops around Germany and the rest of Europe will be able to exchange information and manage the operations on a real time basis. In addition to this the WMS platform then provides a link between the maintenance and the production department such that the capacity available in the workshops will be made available to fleet control before any vehicles have been allocated. The result of this will be that the fleet management will be able to make well informed decisions about which vehicle should be delivered to which workshop depending on the under/over utilization in the respective workshops: thus leading measures are used to enhance their fleet controlling capabilities. More so it is important to note that the departments themselves use many different IT systems which are not always compatible to fulfill their tasks. Therefore WMS is then an interface between various standalone IT systems and makes it possible for the different IT systems to communicate instantly, allowing managers as well as employees of all related departments to be able to monitor and track their operations on one system regardless of the number of other IT systems that are in use. This not only improves the speed at which they will be able to execute their tasks but it also forms the basis on which relevant information is transferred across departments to make quicker decisions on interdependent variables thus in this respect meeting the recommendation from Simons and Merchant and Van der Stede to have a future oriented MCS. The links provided by WMS between the IT-technology, fleet management, the workshops and the maintenance headquarters is the center oval of the below diagram 4D provided.

Beginning with module development, we move our attention to the outer oval of the diagram 4D which is illustrating the actual functions that will be delivered through WMS.

Module development refers to the structure which the project will be set up in. Implementation of the project is done on a modular basis referred to as working packages and is divided into:

1. conception phase
2. pilot phase
3. roll-out phase

It is divided this way in order to gradually introduce the employees to the use of WMS module by module and to take into account experiences from the pilot phase of development. The pilot phase includes a test operation of WMS focusing on the workshops in Nürnberg and Maschen. The results are to be incorporated into the optimization of WMS from the wide range of feedback from the employees before the implementation phase. Furthermore a modular approach is taken as the project has a European scope as well. The intention is to make it possible for sub-

sidiaries to adopt modules selectively (e.g. adopting one module and leaving another) depending on the needs of their workshops. The modular form of the project will be clearly illustrated under the structure of WMS.

Learning system is WMS' function as a system that will incorporate e-learning into the maintenance organisation, such that training and tutorials can also be delivered to employees via the WMS tablets.

System networking as alluded to before, is the capability of WMS to connect different IT systems together and allow them to communicate on a real time basis.

The **Qualification level** function is that WMS will make a connection between the qualifications that are required to fulfill specific tasks in the maintenance process and the employees that will be present on each particular day. Such that management has an overview of the qualifications those employees have and which tasks they can allocate to them-primarily this atomizes the shift and labor planning.

Logic behind prioritization: from the real time connection between maintenance and production, both departments will be able to establish which vehicles need to be vs. which can be released sooner than others and made transparent for both internal and external customers. For example if a locomotive has first priority to leave the workshop (according to production) but the required material is not readily available (according to maintenance) this information is communicated faster between them as well as then to the customer. The departments can then make better and faster decisions about whether to forward the locomotive to the next workshop or wait for the material and priorities the remaining vehicles.

Providing rules and standards: refers to the depiction and presentation of rules and standards to employees 'on demand' via the WMS tablets.

Assert failure reporting: means that the system will be capable of tracking and keeping a historical record of the problems with assets within the workshops. This is to capture the employees' implicit knowledge about how the functionality and non-functionality of assets in the workshops.

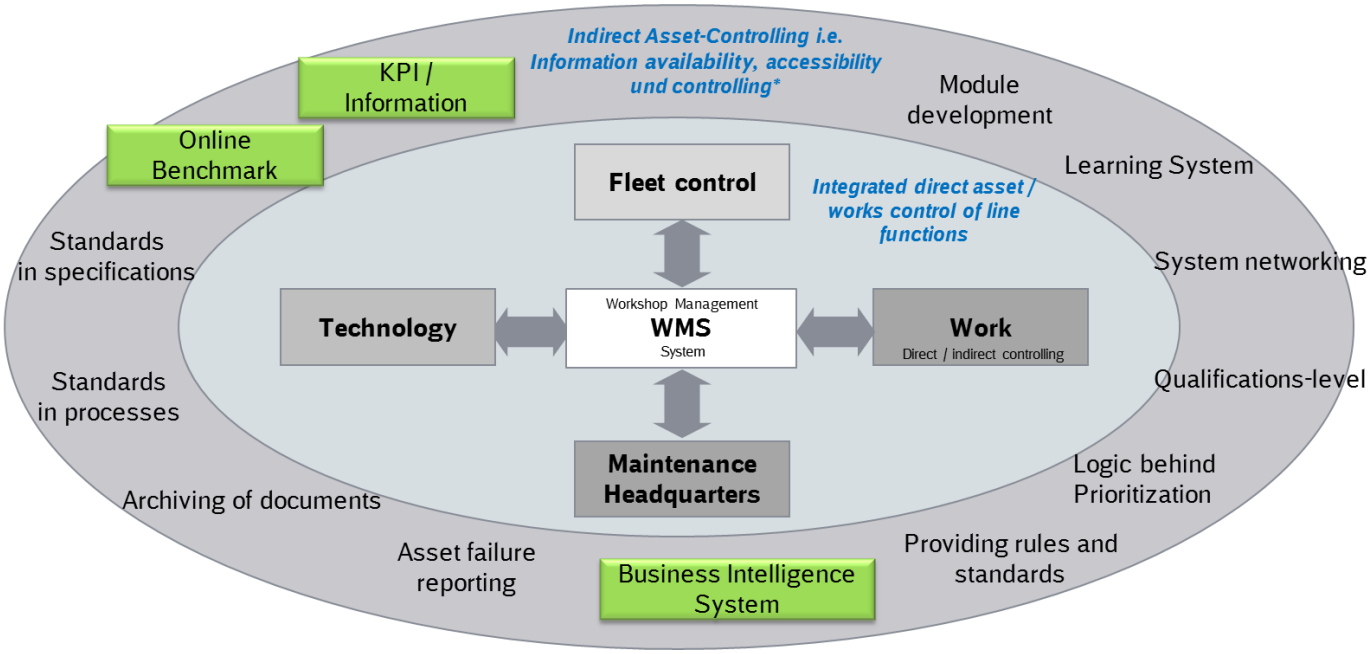
Archiving documents: to reduce the administration cost of paper documentation, all orders will then be archived electronically through WMS.

Standards in processes and **Standards in specifications** are both referring to the use of WMS on a European scope. The entire specifications and processes in maintenance will be provided in WMS in such a way that the department can be managed in a uniform manner across borders.

The three remaining functions of WMS are marked in the green rectangles to indicate to the reader that they are the specific functions of WMS investigated and provided for in this thesis.

4.2 The link between WMS and the PMT

Diagram 4D: The Functionality of WMS



Source: (DB Schenker Rail, 2014)

Business intelligence system: is the function provided by the PMT (BI) blueprint that will be developed by the end of the thesis. The standards in processes, the **KPIs** relevant to the processes and the **online benchmarks**, will be all connected to one another in the relevant manner and put onto one dashboard. The effect is that the blueprint becomes the portal through which the performance of the entire maintenance department can monitored through, such that the right information is provided to the right person at the right time. With all information connected and displayed on a dashboard through the PMT, the platform for predictive analysis is created.

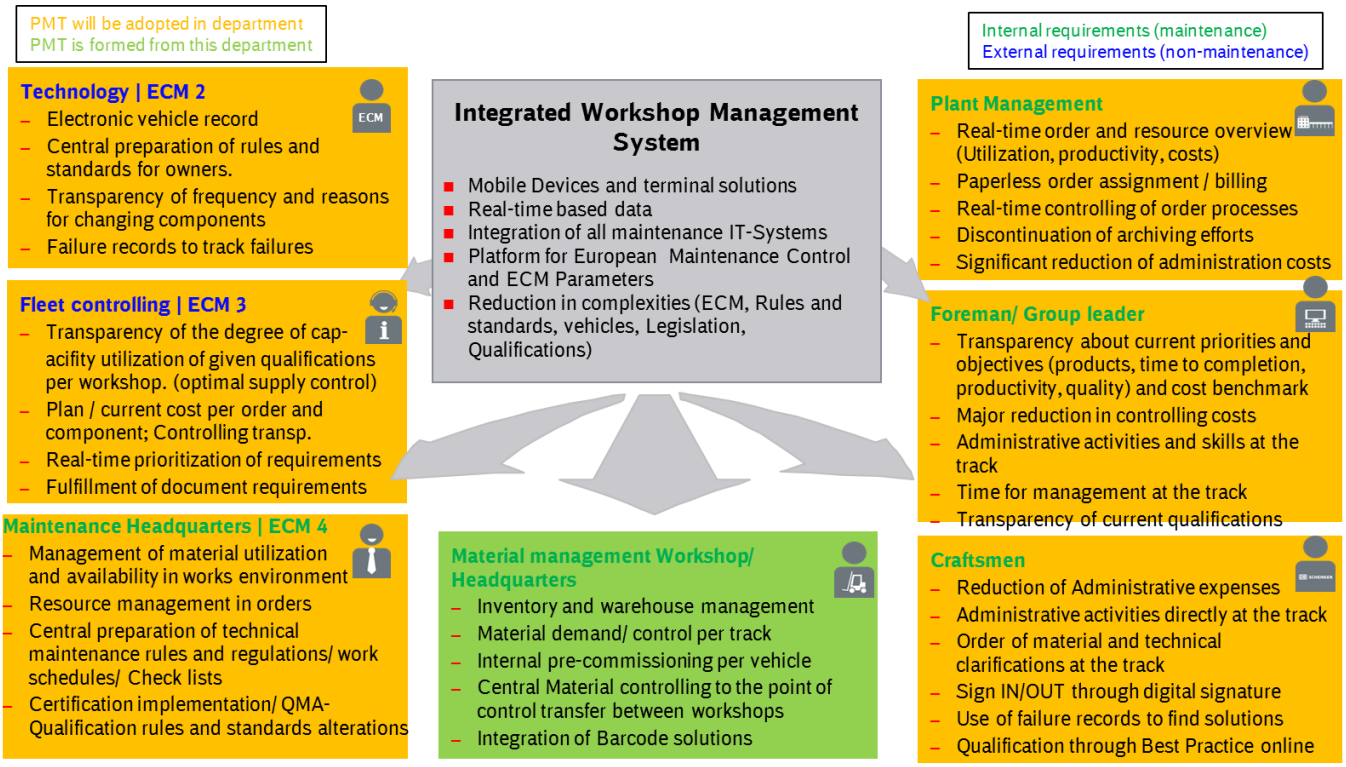
From the above information, we have established that the thesis is forming the blueprint to provide a performance management tool (PMT) for the MCS. The PMT is for the entire maintenance department as a whole but has been titled 'PMT and Blueprint' as the foundation for it is made primarily from the analysis and research in the Material management sub-department only. The name 'blueprint' is appropriate as the analysis and research methodology and steps from material management will be followed and executed in the other sub-departments, such that the same PMT will then be used to manage and control them all.

Having elaborated on how the management control system in WMS will connect the departments and provide several functions for the improved performance measurement and control in maintenance, the diagram 4E below has been provided to depict the areas of the functions which relate to maintenance and the areas of functions which relate to the other departments. Simultaneously, the diagram 4E shows how the PMT and blueprint will be developed in the material management and then to which other departments and sub-departments it will applied to,

making the PMT from the blueprint uniform and universally applicable to the maintenance department. In addition the design of the PMT and blueprint in this way allows for it to be adopted on a European scope and leaves room for necessary adjustments to be made when accommodating differences in the structure of subsidiaries and DB SR affiliates who will be granted access to use the PMT.

In diagram 4E, the blue coloured text indicates that it is a department external to maintenance while the green coloured text indicates that it is a sub-department within maintenance. The green background shows the department in which the PMT and blueprint will be formed and the orange back grounds indicate the departments and sub-departments that will adopt the blueprint from the material management analysis and research.

Diagram 4E: The formation of the PMT and Blueprint from Material Management



Source: (DB Schenker Rail, 2014)

As previously mentioned, WMS is developed in a modular structure referred to as working packages. The working packages have been made according to the goals and requirements that WMS is expected to meet. As a result, we can note that the working packages highlighted below are closely related to the departments that have been outlined above. WMS has a total of 10 working packages which after the successful implementation of the project, can be selectively adopted by the subsidiaries and affiliates of DB SR according to their individual requirements. As we can see the first working package is material management and the last working package is Business Intelligent reporting development.

The thesis is in-effect the last working package; however BI reporting development is not an independent working package as it is in actual effect the management and monitoring of the

performance realized in the first 9 working packages. Therefore working package 10: BI reporting development encompasses the data that is produced in the other working packages; cumulates it and then reproduces it in a comprehensive manner through the PMT and ensures that the information is delivered to the respective employees and managers in timely fashion to improve transparency and foster informed decision making.

Structure of WMS according to working packages

- **WP[4] A Requirements management**
  - WP A1 European subsidiaries
  - WP A2 Internal and External Customers
- **WP 1 Material management**
- **WP 2 Access rights according to defined Roles**
- **WP 3 Planning and execution of Maintenance activities**
  - WP 3.1 Task assignment and disposition
  - WP 3.2 Completion report and vehicle release
  - WP 3.3 Post-task-assignment
- **WP 4 Organize Personnel planning in Maintenance**
  - AP 4.1 Shift and labour planning I (short-term)
  - AP 4.2 Shift and labour planning II (long-term)
- **WP 5 Capacity management**
- **WP 6 Organisation of Documentation management in Maintenance**
  - WP 6.1 Preparation of base documents without an order
  - WP 6.2 Display of accompanying documents of an order
  - WP 6.3 Display of the vehicle history
- **WP 7 Integration of measurement and control devices**
- **WP 8 Electronic Archiving**
- **WP 9 Mobile Maintenance**
- **WP 10 Business Intelligence Report – development**

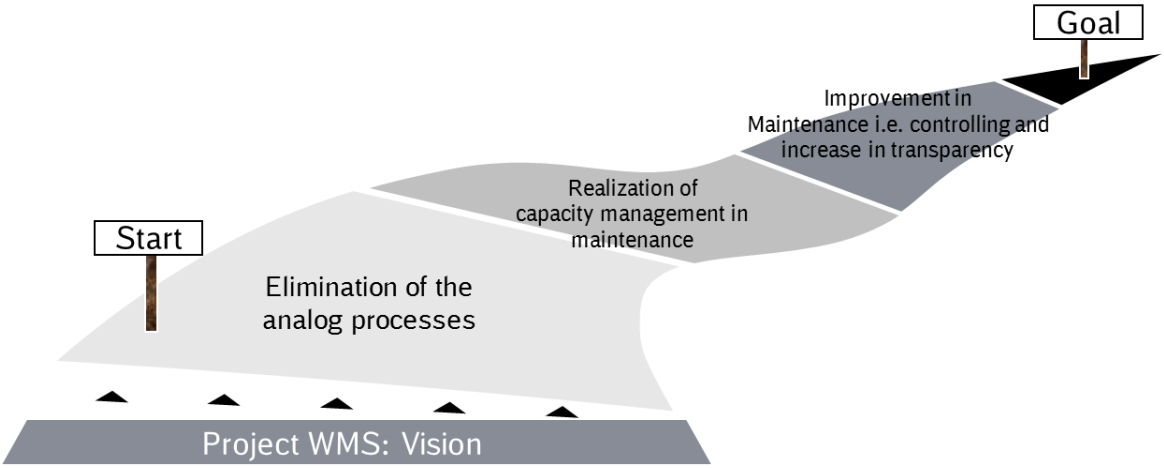
These 10 working packages encompass all the activities which will be covered by WMS and can serve as a simplified overview of range of the project. In addition, through the working packages, WMS makes a contribution to a competitive maintenance process and improved employee satisfaction which ultimately shows how it links with the overall company strategy as well. The use of IT technology has been repeatedly called for by the employees (improvement proposals in the context of step-by-step results of the employee survey). Therefore the implementation of WMS leads to an indication of appreciation of the workshop personnel by providing modern workplaces in maintenance; and serves as feedback to the employees. Additionally,

[4] WP = working package

WMS provides a user-friendly interface, which is a lot easier than SAP for the workshop employees to use and any possible problems of acceptance towards the new technology on the part of some employees are counteracted through specialized training workshops as well as the use of multipliers.

To summarize all the information about the WMS project has been put into a vision (diagram 4F) and together with the information provided about the concept of WMS central question three is therefore answered. This last section also explains what needs to be done by the domain owner in maintenance in order to sustain the management control system at a high level of performance and continue to improve.

Diagram 4F: WMS Vision



Source: (DB Schenker Rail, 2014) and Author

Continuous improvement to WMS

After realizing the successful implementation of WMS, the thesis puts forth that, further several steps need to be taken in order to sustain the management control system at top performance. When we consider the pace at which the world is changing and that the industries are becoming more and more dynamic (Foundrymag, 2004) who talk about this in their report on maintenance management, it serves as no surprise that without taking due sustenance measures, WMS will only be optimal for a short term period. In addition as the intention is to eventually apply WMS on a European scope, further action needs to be taken by the maintenance domain owner in Germany, as well as the domain owners in the subsidiaries and affiliates all over Europe. Therefore we assert the responsibility on the maintenance domain owner in Germany (hence forth domain owner) to ensure that the company changes with the environment and the necessary changes are made to the processes used in WMS as well. The domain owner is responsible for the establishment and continuous further development of the domain strategy towards DB SR 2020 strategy and the target picture 'New European Operating' in close collaboration with the relevant process owners. Again the domain owner is responsible for the alignment with the other domain owners (e.g. England/Poland) and the relevant functional management boards to ensure close collaboration between departments and to consult the boards in event of devia-

tions. The domain owner should also identify and define the business capabilities affected by changes, the involved process owners and the overarching target process in collaboration with the DB SR Information Technology (L.RVI 2) department. Therefore the domain owner is responsible for direct communication with L.RVI 2 for the domains, and oversees the consistency of target processes with regards to the New European operating model in terms of a clear assignment of new business/IT functions.

4.3 Analysis of the Material Management sub-department and formation of the PMT

Central question 4:

> Are there any major differences in the maintenance processes in different workshops which can affect the applicability of a universal Blueprint?

Having analyzed the management control system of DB SR maintenance as a whole and explained how WMS should significantly improve it; the next stage is to move focus to the material management sub-department, to form the concrete base for the formation of the PMT and blueprint. From the expected functionality and the wide scope of WMS, we can establish that many factors need to be investigated in all sub-departments individually, in order to have a blueprint that is all encompassing. In this paper we put forth that the investigations of the sub-departments will be constituted by the same main aspects, as they are all under the maintenance department and are all working to achieve the same end i.e. completing the maintenance of a vehicle and releasing it.

From the research and interviews conducted in the maintenance department, the paper has found that there are four common aspects which constitute every sub-department and are relevant to forming the blueprint. These are namely; i) **processes-** that are specific to each sub-department and must be executed, ii) **roles**- the individual employees responsible for the execution of these process as well as the individuals who are responsible for monitoring that these process are completed in the correct manner and that performance is up to par-, iii) **goals**- while each sub-department is working towards the same end, it still has its own smaller goals which help it to fulfill the end objective to the best of its performance. Lastly, the iv) **KPIs**- as each department is responsible for different processes, the KPIs that are measured in each department are clearly different as well. In summary we have established that in order to have a functional blueprint which can be used across all sub-departments, the blueprint must readily provide the information and answer the questions: what are the goals of the sub-department, which processes does the sub-department execute to fulfill these goals, who is responsible for executing them and how well were the processes executed: what is the performance level.

Goals in Material Management

Therefore the first step taken in the analysis of the material management sub-department was to investigate the goals in material management, and ensure that their use will be objectives based and future oriented as recommended in the literature (Navon & Berkovich, 2006) who

investigate the structure for an automated model for material management and control. In an interview with Mr. Jens Tanner (DB Schenker Rail, 2014), the head of material management in Germany, he stated that the foremost goal, from which all other goals stem from, is to always ensure that material is available around the clock for the progressive maintenance of the vehicles. He honestly stated that this is not always the case and in several instances vehicles are delayed in the workshop as a result of the lack of material. In addition to material availability, Mr. Tanner says it is to provide a clear inventory status, in order to facilitate internal transfer of material between workshops without jeopardizing the daily operations of either workshop. The interview with Mr. Tanner also revealed that the department aims to aid the highest possible quality in maintenance but with a low material cost; he said that where possible the workers attempt to repair as much material as possible before ordering new parts. From this interview, we can conclude that the material management department has three explicit goals which are: material management, inventory transparency and low material cost. The thesis will therefore incorporate these goals in the PMT and establish that the employees and managers can progressively work towards reaching them by having them consistently and constantly displayed…...

Processes in Material Management

To gather information and to analyze the processes in material management, the company's process portal was made use of (DB Schenker Rail, 2014). The process portal is the company's internal server where all the processes executed in the company are documented and made available for reference to every employee. In addition to that, interviews were conducted with Mr. Tanner as well as with Mrs. Corinna Lackmann (the vice to Mr. Tanner) (DB Schenker Rail, 2014) to verify the relevance and how up to date the processes were. (All the interviews which were relevant are provided in the appendix Figures F, G, H,I and J).The review of processes was also done to meet the recommendations according to Anthony and Govindarajan, and Simons, to find where leading measures as well as lagging measures can be best made use of to monitor the performance in fulfilling the processes.

On investigation of the processes, it was discovered that the processes for maintenance and material management were established over a decade and a half ago, naturally the consequence was that the processes were no longer up to date and did not accurately depict the steps which are conducted during the execution of the processes in material management today. In addition, in several places within the processes, roles and IT systems which no longer exist in the company today were still documented in the flow of processes. We will now go into a more detailed outline of the actual old processes that existed in material management before we move into the new processes we then created to be used in WMS.

Detailed investigation of existing processes in Material management

The overall maintenance process within DB SR are found under the heading **U07 Maintenance**. The first stage in the processes is the planning phase titled **U07.1 Maintenance planning and organisation**. Within this heading, the documented material management processes start from process **U07.1.2 Organize Material Management for Maintenance**. In this process it is documented that the planning and purchasing of material is done. Furthermore, it was revealed that in this stage the communication with partners and agreement on collective purchase was effected, however it was not represented in the process chart: thus the fault in this process being the lack of completion and transparency as recommended by Merchant and Van der Stede who state that the organisations expectations from employees should be clear and communicated.

After the planning phase in maintenance, they have **U07.2 Technical Management** stage, which is not investigated at this stage as it is not relevant to material management, therefore the next process comes under **U07.3 Execution of Maintenance.** Under this section of the maintenance processes, the processes related to material management begin under the title **U07.3.3.1 Preparation for Maintenance works execution**. According to the existing process chart, under this process, the first step identifies that material for the maintenance order needs to be gathered from the warehouse and made available to the craftsmen to fulfill their tasks. However under this step the IT systems identified are SAP ISI and EHD, however the use of the EHD system was discontinued by DB SR: reflecting how out of date the process is. In addition to this, the documented process lists 'an employee' as responsible for the completion of this task. While it is true, the term 'an employee' is rather ambiguous and makes it difficult for any sort of management control system to be able to identify which kind of employee completes the work. This illustrates the lack of informal controls as proposed by Simons and Merchant and Van der Stede, who ascertain that the right employee, trained and provided with the resources should be assigned to their work to ensure that they can do a good job, in addition the literature provided by (Piasecki, 2004) show that this is an indication that the organisation is in need of a warehouse management system. It is clear that the collection and provision of material will be conducted by a material clerk and therefore this should be depicted within the process as well. The same flaw is found in the next step of the process where material should be ordered in the event that there is a lack of it in the gathering stage. In this step, the ordering of material is done by the Service/Commissioning agents (MöBs) after it has been reported to them by the material clerk. However this is not put across in the existing process chart today. After this point, there are no further processes which explicitly lay out their connection to material management.

None the less we found that there are other processes such as material return process and handling material with warranty which are not documented with in the process portal. The result of this is we can only identify 2 processes related to material management in the process portal which are relevant to WMS while in actual fact there are processes which have simply been omitted. This could lead to information over looking or loss when performance is evaluated

higher up in the organisation (Piasecki, 2004). Appendix Figure 2 and Figure 3 provide the existing processes that were examined and discussed as they are illustrated in the process portal. To solve and remedy the problems identified here the thesis revises the processes in the next section and develops new processes which are congruent with the recommendations from the literature as well as functionally applicable to WMS and the PMT.

The new Material Management processes for WMS[5]

The analysis of the material management processes in maintenance reveals that they are out of date and are ambiguous when identifying the roles that a responsible for executing them, the next stage in formation of the PMT and Blueprint was to construct new processes for material management which are complete, relevant and up to date.

In close coordination with Mrs. Lackmann, and making reference to our literature including (Navon & Berkovich, 2006-automated model for material management and control), (Foundrymag., 2010- in Going beyond tracking: where they explain the inventory badge scanning to retrieve material) we then forged new processes and merged them where applicable with the old to create the processes that will be used in WMS. As WMS will create an improved capacity management by connecting the maintenance department with fleet control among other departments, a new stage in the material management processes was identified. With communication between the departments facilitated on a real time basis it becomes possible to inform the fleet management of the availability of material within the workshops before any particular vehicle is assigned to a workshop. In fulfilling this step, the thesis remedies some of the inefficiencies in the existing MCS by enabling the horizontal definition and functionality of the organisational structure, as communication will no longer be only vertical. In addition better feedback and feed-forward can be established when employees at the same level (involved in inter-dependent activities) in different departments can communicate and exchange relevant information. As a result, the process **MM01 Material availability before the allocation of Locomotives** was created.

MM01 Material availability before the allocation of Locomotives

- The locomotive has not yet been allocated to any particular workshop.

As Fleet management is responsible for the allocation of Locomotives to workshops, in this process, the Fleet management uses WMS to insert the model and serial number of the material that is required for the maintenance of the locomotive. In the event that the model and serial number for the material is not readily known, WMS has digitalized 6 ways in which the material number can be identified.

[5] The craftsmen will not be provided with WMS tablets; instead they have to confirm their activities on their supervisors and/or material clerks' tablets.

The material number can be:

1. chosen from the structured article list in WMS
2. manually inserted by the fleet management after research,
3. chosen from the previously used articles list,
4. chosen from the interface with the WeDoIt IT material program,
5. scanned from an existing material part,
6. selected from the defined Material kit available.

After the successful identification of the material number, the interface between WMS and SAP ISI then allows the Fleet management to access the inventory overview and thus the availability of material is seen. The material number needs only to be inserted once and the inventory overview can be viewed for any number of selected workshops by the fleet management.

- When the material is available in the 1st priority selected workshop, the Fleet management confirms the workshop and the information is sent through WMS as well to the Foreman and the service agents of the selected workshop to prepare and allocate the order to the craftsmen and material clerks.
- In the event that the material is not available in the 1st priority selected workshop, Fleet management then automatically receives information from WMS on two fronts i.e. if the material is in transit (some specific parts can be ordered and delivered within 24 hours as per company internal agreements) and which is the next nearest workshop where the material is available.
    - The head of material management and the foreman of the first priority workshop which did not have the material will be informed as well to foster knowledge management, prediction analysis and better capacity management in the future.

Process Figure 4 in the Appendix illustrates the flow of this process in a comprehensive manner.

MM02 Material availability before the allocation of wagons to the workshop

The next process that we created for Material management is **MM02 Material availability before the allocation of Wagons to the workshop**. However this process will not be explained in detail in this paper as it is identical to MM01, with the slight difference that rather than the Fleet management executing the check, the workshop foreman is responsible for wagons. This process can be viewed and compared to process MM01 from Figure 4b provided in the appendix.

Leading us then to the next inter-dependent processes **MM03 Material Availability after vehicle allocation** and **MM05 Material demand identification**. These two processes are linked as they run dependently on each other: in both processes MM03 and MM05, the vehicle (once the wagon or locomotive has been delivered we make no differentiation between them) has been allocated and delivered to a workshop. It is on arrival of the vehicle that the process MM05 begins. The process begins with a craftsman examining the vehicle for any additional damages which were omitted when the fleet management or foreman initially made a material request. Depending on the result of the examination, it is necessary to break process MM05 and go into

MM03 which is a material availability check after the vehicle is in the workshop. For clarity however, the processes are explained separately beginning with MM05 (Figure 5 corresponding to process MM05 is provided in the appendix).

MM05 Material demand Identification

- The vehicle has been delivered to the workshop and a craftsman conducts an examination of the vehicle to discover any previously unobserved repairs and material requirements that may be needed.

Open Warehouse[6]

- In the event of the completion of the examination and no additional material is required, there is no need to jump to process MM03. Instead as it is an open warehouse, the craftsman responsible for examinations (Exm-craftsman) informs the service agent and the foreman of the workshop, through WMS, that only the original damage exists. After receiving the notification, the service agent then informs the next craftsman responsible for executing the maintenance order (MO-craftsman) of which and where to locate the material in the warehouse. As will be explained in the process MM06, the MO-craftsman uses the Team leaders/ foreman's tablet to confirm through a digital signature that he collected and has the material readily provided to complete his tasks. The team leader/foreman must also use his digital signature on the WMS tablet to confirm the event.
- In the event that there is an additional material requirement after the examination of the vehicle, the need to jump to process MM03 occurs. The Exm-craftsman first informs the Foreman and service agent, that not only is the original material required but that more material for newly discovered damages is required. It is the foreman/service agent in this event that has to jump to process MM03 and conduct the material availability check after vehicle allocation. Depending on the results and decisions made in process MM03, the MO-craftsman is informed of which and where to collect the material for his tasks. Both the team leader/foreman and the MO-craftsman subsequently confirm the event on the tablet.

Closed Warehouse[7]

- In the event that the examination of the vehicle is complete and there is no additional material requirement, the jump to process MM03 is not required in the closed warehouse either. In this instance, the material clerk and the service agent receive the information that only the material for the original damage is required. The material clerk from this information knows which material to collect from his warehouse and transfer it to the point of exchange, where the respective MO-craftsman should receive it from him. The service agent uses this information to be alert of the status of the order. The material clerk informs the respective MO-craftsman when the material is readily provided and should be collected. When the exchange of material occurs, both parties must digitally confirm the event on the material clerks WMS tablet.
- In the event that there is an additional material requirement after the examination, the requirement to jump to process MM03 in the closed warehouse occurs as well. The material clerk receives the information from the Exm-craftsman that the original and additional material is required for the maintenance execution. In this event, the material clerk is responsible for completing the material availability check in process MM03. Again depending on the results from the MM03 process, the MO-craftsman is then informed by the material clerk that the material has been provided and should be collected from the

[6] The warehouse is open to all workers to collect the material they require and record it.
[7] The warehouse is managed by a material clerk. No other workers have the authority to collect material from it, and therefore he is provided with a tablet.

exchange point. Subsequently, the two parties confirm the exchange on the material clerk's WMS tablet.

MM03 Material Availability after Vehicle Allocation

- The vehicle has been delivered to the workshop and the foreman/team leader/ material clerk needs to determine the availability of additionally required material.

In completing this check for material, the same stage of inputting the material number as in process MM01 exists. Only in this instance the check is being done by the foreman/team leader or the material clerk and not the Fleet management.

As mentioned before, after the successful identification of the material number, the interface between WMS and SAP ISI then allows the individual access to the inventory overview and thus the availability of material is seen. The material number needs only to be inserted once and the inventory overview can be viewed for any number of selected workshops by the individual.

- In the event that the material is available, the individual jumps back into process MM05 and informs the MO-craftsman accordingly.

Process MM03 differs from processes MM01 and MM02 in that there are new decisions which need to be made in this process in the event that the material is not available.

Regardless of whether it is an open or a closed workshop, when the material is not available and the vehicle is already in the workshop, the information must be forwarded to the head of controlling in the respective workshop. The head of controlling in the workshop will then have to make one of three decisions before the maintenance process can continue and jump back into process MM05. The decision which needs to be made is one of the following:

1. Forward the vehicle to another workshop which has all materials without executing any repairs at all.
2. Repair the original damages for which material is available and then forward the vehicle to another workshop for the remainder of the repairs.
3. Repair the original damages for which material is readily available and then park the vehicle in waiting for the arrival of the additional material required.

From the description of processes MM05 and MM03, we see that they are dependent in that MM03 is a process which is designed to begin only in the event that process MM05 shows a result that additional material is required. Figure 5 in the appendix shows the actual flow and connection of processes MM03 and MM05. Figure 6 shows, the flow of process MM03.

The next stage relevant to material management, after a vehicle has been delivered to the workshop and examined for further damages, is the process of handling the return of excess material initially booked out of the warehouse. This process is MM07 Handling of excess Material and is presented in detail below.

MM07 Handling of excess material

After the completion of maintenance on a vehicle, it is possible that the craftsman discovers that excess material was booked out of the warehouse than was actually needed for him to complete the task. In this event the MM07 process needs to be completed.

- The MO-craftsman who has the excess material will use the team leader's/foreman's tablet to reverse the booking of the excess material from the warehouse. As this occurs, the material clerk (in the event of a closed warehouse) receives a notice that material has been booked back into the warehouse and should receive the material physically from the MO-craftsman at the point of exchange, and subsequently both parties confirm the return of material on the material clerk's tablet. In the event of an open warehouse, the MO-craftsman simply returns the material to the warehouse personally and confirms with the team leader/foreman.
- In order to prevent, repetitive back and forth movements of material and workers into and out of the warehouse for the same material, the process includes a possibility for a second MO-craftsman who needs the excess material in his working station, to book the material out of the warehouse before it has been physically returned (personally to the warehouse or) to the material clerk by the first MO-craftsman. The team leader/foreman receives information that the material that has been booked back into the warehouse by the first MO-craftsman is needed by a second MO-craftsman on a different vehicle. The foreman/team leader can then inform that second MO craftsman of the availability of the material he had awaited. The second MO-craftsman via the team leader/foreman's tablet can then directly rebook the material out of the warehouse again for himself. This way, the first MO-craftsman who initially had the excess material can simply hand it over to the second MO-craftsman, without the material actually having been physically transported back to the warehouse. However the exchange between the two craftsmen of the excess material must be confirmed by both parties on the team leader's/foreman's tablet.

Process MM07 is depicted in Figure 7 in the Appendix.

MM04 Post-task-assignment material availability

Another possibility however, is that after the maintenance of the vehicle has been completed, a new damage that was undiscovered during the examination of the vehicle. When this occurs and additional material is required, we have again asserted that a new process has to be taken into consideration as well. This process we called **MM04 Post-task-assignment material availability**. This process will none the less follow the same flow as in process MM03 material availability after vehicle allocation. This is because the steps to identify the availability of the material are identical, but the decisions which need to be met in the event that the post-task-assignment material is not available are slightly different. In process MM04, the decision which must be met by the head of controlling is from the following options:

1. Forward the vehicle directly to the nearest workshop which has the required post-task-assignment materials.
2. Park the vehicle, order and wait for the required post-task-assignment materials needed.

In addition, one should note that MM04 is different to MM03 in that it is independent to process MM05. Process MM04 can also be found in Figure 8 provided in the appendix.

The third possible event after the completion of the maintenance of a vehicle, which is not represented in the existing processes of material management, is dealing with old parts which are

returned to the warehouse, in particular, the parts which may still have a warranty which can be claimed. Thus we created the process MM08 handling of old parts which is explained in detail below.

MM08 Handling of Old parts.

First of all the digital ID of the individual who has asserted that an old part must be returned to the warehouse must be inserted into WMS.

- Depending on whether it is an open or closed warehouse, either the team leader/foreman or the material clerk will then open an order for the return booking of an old part into the warehouse. In this order, the material serial number is inserted and an 'A' will be added at the end of the number to indicate it is an old part. Thus WMS will then be able to automatically bring up the information/documents related to the old part which is being rebooked into the warehouse indicating if a warranty is still available on the part or not. If the warranty has expired, the material clerk or craftsman cleans and records all details about the part before it is then placed in the warehouse. The team leader/foreman, will also confirm the rebooking of the material back into the warehouse.
- In the event that the warranty is still available, the material clerk or team leader/foreman directly informs the head of controlling via WMS so that he may take the necessary actions to claim the warranty. Meanwhile the material clerk or craftsman clean and record all details about the material including that the warranty claim is in process. The material is subsequently placed in the warehouse awaiting replacement. The event is also confirmed on the WMS tablets of the material clerk or team leader/foreman.

When this is completed, the handling of old parts will have been done correctly. Figure 7 in the appendix shows the processes (the beginning of MM04) MM07 and MM08 as well: as they can occur parallel to each other. The processes are shown in this manner as one or maybe all of them may occur simultaneously after the maintenance of a vehicle is completed.

At this stage in our analysis and formation of the new processes required for material management in maintenance, only one process remains. The process **MM06 Material Provision and Preparation** has been presented last as it is a process which can occur in every stage where any material needs to be provided, whether it is before, after or during maintenance.

MM06 Material Provision and Preparation

This process will always be executed whenever the material availability check was conducted and found successful. The process MM06 begins as material is being removed from the warehouse.

<u>Open warehouse.</u>

- In the event that material being collected from an open warehouse, the MO-craftsman collects the material according to the instruction from the service agent or team leader/foreman and following the 'First in First out-Principle.' After collecting the material from the warehouse, the MO-craftsman books and confirms the provision or preparation of material on the team leader/foreman's tablet.

<u>Closed warehouse</u>

- In the event that it is a closed warehouse, the material clerk collects the required material from the warehouse according to the 'First in First out-Principle' as well. The material clerk then books the material out of the warehouse on his WMS tablet and transports the

material to the point of exchange. On booking the material out of the warehouse, the MO-craftsman who is in need of the material which is being prepared and provided is informed that he should go to the point of exchange to pick up the material from the material clerk. Subsequently the MO-craftsman and the material clerk both confirm the exchange of material on the material clerk's WMS tablet.

For this process, it is necessary for all workshops to accordingly define where the point of exchange is in order for both parties to be present timely for the exchange of material to avoid any time being wasted when one party waits for the other. The process MM06 is shown in Figure 9 which can be found in the appendix.

After much review and revision of the processes the thesis was satisfied that the entire relevant processes in material management were covered correctly and in completion: such that the old and the new processes have been fully reconciled to fully represent all tasks which are present in material management in maintenance. In addition the constant checking and confirming of activities on the tablets allows for constant feedback, and possible feed-forward between all employees and managers.

In conclusion, the analysis of processes in material management generated a total of 8 material management relevant processes. In order of occurrence these are namely:

1. **MM01 Material availability before the allocation of Locomotives**
2. **MM02 Material availability before the allocation of wagons to the workshop**
3. **MM05 Material demand Identification**
4. **MM03 Material Availability after Vehicle Allocation**
5. **MM07 Handling of excess material**
6. **MM04 Post-task-assignment material availability**
7. **MM08 Handling of Old parts**
8. **MM06 Material Provision and Preparation**

Conveniently and coincidentally, in forming the necessary processes to be used in WMS the thesis indirectly formed and identified the roles that are relevant to material management: thus establishing a basis for the informal controls according to Simons, Merchant and Van der Stede to be implemented. None the less, the next section explains the roles important for material management in more detail as analyzed by the thesis.

Roles in Material Management

From the analysis of processes, we have already identified several roles which are involved in material management. These roles are namely, the craftsman, the material clerk, the team leader/foreman and the service agent. What was clear at this stage however was that these roles would only be useful in managing and controlling the workshops on a workshop to workshop basis rather than on the European level as is desired. Therefore in the thesis we put focus

on all the roles necessary to form a European level Management Control system for DB SR maintenance.

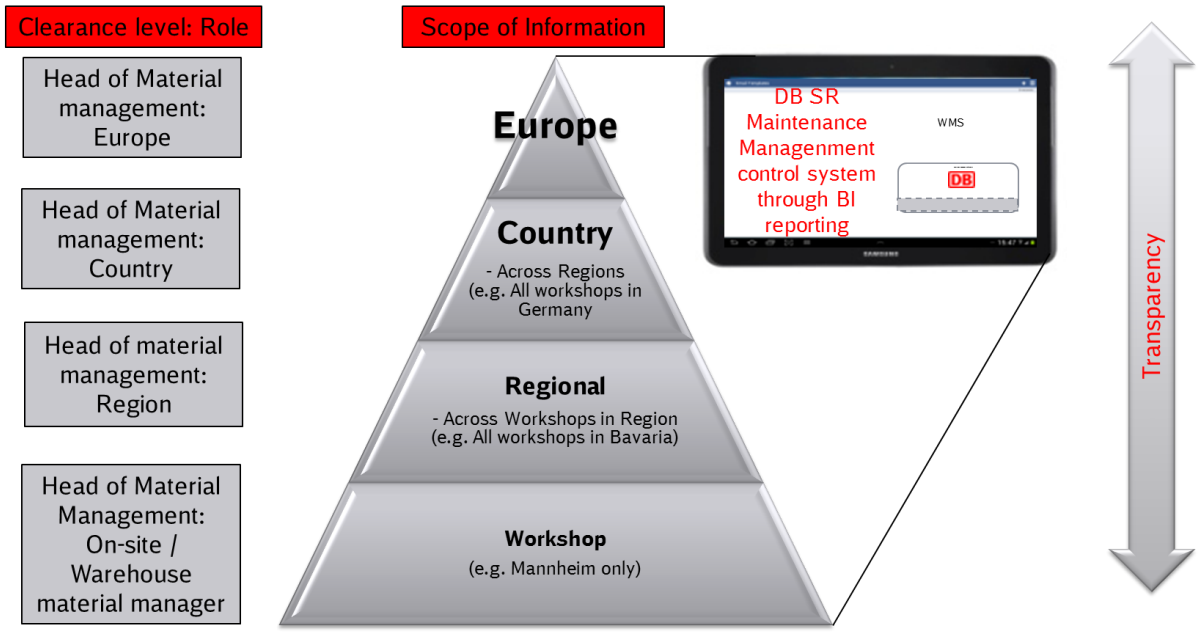
The thesis therefore put forth that if each workshop has the first four roles which are identified in the above paragraph, then there is a need to have an additional role which will be in charge of all the activities of material management as a whole in each individual workshop. So that through him the performance of the material management department as whole can be measured and monitored effectively. As a result the paper suggested that the role of Head of Material Management: On Site to be formed for the purposes of WMS administration and not necessarily to have it represented in the organisational structure of DB SR. The thesis next asserted that in order to have a connection between workshops to improve the possibility of better capacity management and predictive analysis; it would be of great benefit to have a connection between all the workshops at different levels. As a result the author made the suggestion that in addition to the head of material management on site, a Head of material management: Region be added. He would have the role to monitor and evaluate the performance of all the workshops within a region of any particular country. Such that the information he has access to will allow him to better control and inform for example the Fleet management that one workshop is being over utilized and another under-utilized, and what material is in most demand. The end effect would be the possibility to control which and the amount of material that should be kept in stock in each workshop within that region to fully optimize the utilization of the respective workshops in that region.

Furthermore, the thesis applied the same logic to the next level in the hierarchy. This led to the creation of the Head of Material management: Country. As the head of material management in the country, he would have access via WMS, to all the workshops within his particular country. Consequently, he would be responsible for monitoring which regions are performing better than others and to investigate why. He would also be able to identify which regions are being less utilized than others and to find solutions to material issues on a country scale. The last role that the paper found to be important and therefore created was that of Head of Material management: Europe. The head of material management Europe, would therefore, via WMS, have the access to all information about material management on a European scale. He is then ultimately the overall head of material management for DB SR maintenance. His responsibilities would include monitoring and evaluating the performances of the different countries across Europe according to the goals set by these countries. He would also have to identify reasons for differences as well as select best practices, distribute them among the company as a whole and not on a country basis only. This then makes the administration of maintenance on a European level very possible and significantly more transparent. In addition, the possibility for European wide capacity management is open if these roles are adopted respectively into all the other departments and sub-departments as the PMT and blueprint suggest.

After the formation of these roles, it was important to make sure that they were acceptable not only in Germany, but also in the subsidiaries and affiliates of DB SR as a company. Therefore, telephone conferences were held with the subsidiaries in Poland and England. The participants in the telephone conference included Mr. David Straffon, the Parts Service Manager from England, Mr. Sebastian Pilorz, the Head of Procurement in Poland, Mr. Alexander Ritzer, the Head of the WMS project, Mrs. Lackmann, the Material management expert in Germany and myself. The conference was a success as all the parties were satisfied with the concept and the responsibilities assigned to the newly created roles. The protocols to the conference calls can be found in the appendix in Figures A and B, together with Figure C which displays a list of possible remaining stakeholders which will be incorporated at a later stage. Thus in material management, the thesis managed to add 4 new roles that had not been previously present in the department.

As these roles are the key to a European level management control system, the thesis asserted that they have, according to each level in the hierarchy a different clearance level for information. Unfortunately as one may have already noted from the processes, not all roles in material management will have an individual WMS tablet to work with (in particular craftsmen), however the new roles have been all accepted and because of the level of their importance will all have tablets. The table on the next page summarizes the overall roles that we now have for material management that should be used in WMS and the description of their activities as agreed upon with England and Poland. In addition to that, diagram 4F has been provided below to visually depict how the roles will be used in the new management control system through WMS and the PMT.

Diagram 4G: The relevance of the Roles in the PMT



Source: Author

Table 2[8]: The Description of the Roles in the PMT[9]

Role in material management Department	Function in Material management	Description of responsibilities and activities relevant to WMS
Head of Material Management: Europe	Monitoring material management and performance in Europe	Receives standardized dashboard visualization: displaying the overall material management processes in Europe. She/he compares the results with/against the past, plan, and desired goals set by each country within Europe and also investigates the reasons for the differences in on-site, regional and national performance to find/adopt best practice.
Head of Material management: Country	Monitoring material management and performance in the respective Country	Receives standardized dashboard visualization: displaying the overall material management processes in the country. She/he compares with/against the past, plan, and desired goals set by each region and also investigate the reasons for the differences in on-site and regional performance to find/adopt best practice.
Head of Material management: Region	Monitoring material management and performance in the respective region.	Receives standardized dashboard visualization: displaying the overall material management processes in the region. She/he compares with/against the past, plan, and desired goals for the region and also investigates reasons for the differences in on-site performance to adopt best practice.
Head of Material Management: On-site/ Warehouse (Material) manager	Monitoring material management and performance in the Warehouse	Receives standardized dashboard visualization: displaying the overall material management processes and activities in the warehouse. She/he compares with/against the past, plan and the desired goals in the warehouse and identifies areas that need to be improved.
Foreman/ Team leader/ Service agent	Team management in the warehouse. Assigning and completing material orders in the warehouse	Receives information about the vehicles assigned to the workshop and 'pick lists' of the necessary materials. Assigns 'pick lists' to a material clerk or craftsman. Confirms fulfilled execution of 'pick lists' in WMS/SAP.
Material clerk	Material organisation and supply	The material clerk receives materials pick lists for the maintenance orders in progress. Picks up the necessary materials in the warehouse and delivers them to the exchange point, to hand it over to a craftsman. The material clerk immediately posts the issued materials in WMS/SAP, using either his tablet or a terminal.
Craftsman	Material organisation and supply	When there is no material clerk, a craftsman takes up this role as well. The craftsman picks up all materials necessary for the maintenance in progress from the warehouse. The craftsman immediately posts all issued materials in WMS/SAP, using his foreman's tablet.

[8] Source: Author

[9] THESE ROLES ARE FOR THE ADMINISTRATION OF THE WORKSHOP IN WMS (they do not particularly represent the Organisational Structure of the Department)

The KPIs in Material Management

Now that the thesis has established what the goals, processes and roles in material management are; for use in WMS, the next stage is to investigate what KPIs need to be generated to measure the processes that have been newly created as well as to investigate the KPIs that were already used in material management. Noting that Antony and Govindarajan together with Simons have emphasized the importance of measures which are both financial and non-financial, leading and lagging, we will first investigate the existing KPIs as provided by Mrs. Lackmann as the main KPIs in material management. We also referred the work by (Wardhaugh, 2004) on useful ´key performance indicators for maintenance, to aid in identifying new KPIs and/or where they would be needed in Material management. In the investigation of these KPIs we aim to assign them as far as possible to the processes which generate them. Following this we will make an investigation on the new KPIs.

During the investigation and identification of the new KPIs, the paper will directly sort and organize the KPIs according to the processes which they will be measuring as well as the roles that will be responsible for the execution of the processes, such that we create a link between the goals, all the KPIs (old and new), the processes and the roles responsible for them. This then forms the strong foundation of our Performance Management Tool PMT/ (BI) Blueprint. This link between the four aspects (goals, roles, processes, KPIs) that we identified to be common in all departments and sub-departments also forms the plausibility of the blueprint in that, if the same steps we have taken in this thesis are taken for other departments, the performance management tool will be applicable to them all.

The Old/existing KPIs in Material management

After corresponding with material management expert in DB SR Germany, Mrs. Lackmann, the paper was easily able to identify the main KPIs used in material management. Mrs. Lackmann worked closely with Mr. Tanner the Head of material management Germany and developed a list of KPIs of priority 1 and KPIs of Priority 2. This list of KPIs and their descriptions is provided in the Table 3 below. This same list of KPIs was then taken as the standard KPIs in material management and used by the thesis in telephone conference calls with Poland and England. The KPIs were discussed at the same time that the roles were agreed upon and thus the protocols provided in the appendix reflect the discussion of the KPIs as well. To no surprise there is not much difference in what are considered important KPIs for material management and in how the subsidiaries run their workshops in comparison to DB SR Germany. As a result the KPIs were also all successfully agreed upon. In addition to the protocol, a KPI template is provided in appendix Figure D, to illustrate how all KPIs should be descriptively handled in order to prevent any misunderstandings or mismatches when using them in WMS and the PMT.

Table 3: The Description of the KPIs in Material Management

Sensitive information,
withheld on Company request

Source: (DB Schenker Rail, 2014) and Author

As we can see from the table, there are five KPIs of priority 1 and seven KPIs of priority 2 that the thesis received from Mrs. Lackmann. Consequently, the paper focused on the 5 KPIs of 1st priority and assigned them all respectively and as far as possible to the processes which generated them. The first KPI material availability naturally belongs to processes MM01, MM02, MM03 and MM04 as well. The next two KPIs which refer to parked vehicles were assigned to processes MM03 and MM04 accordingly. The KPI material expenditure was not assigned to any particular process as expenditure of material could occur in many several ways which may not be directly connected to the processes which we have highlighted as material management relevant in WMS so far, for example the use of gloves by employees is recorded in material expenditure however it is not directly connected to the processes which we have developed for material management in WMS. Thus we have the fifth and last KPI which we focused on which

is Inventory/material turnover. This KPI we assigned to the process MM06 Material provision. The paper asserts that this process generates the KPI and best monitors it because all material is noted and recorded in the material provision process and for that reason it automatically shows the inventory turnover rate in the workshop. Although the thesis was not able to assign all five of the priority one KPIs for material management to the processes that were created the 4/5 success level can still be noted as satisfactory for the functionality of the PMT and Blueprint. In addition in the next section, we provide more KPIs for use in the blueprint. None the less, the KPIs provided so far do well in representing both financial and non-financial measures.

The New KPIs for material management

In investigating for new KPIs in material management, the paper asserted that the department already had identified all the important KPIs needed which were unrelated or related o processes. Therefore the thesis took the stance that the analysis of the newly created processes themselves and what needs to be measured from them, would automatically generate the new KPIs needed in material management controlling and performance measurement. Thus we began the analysis from process MM01.

MM01 Material availability before the allocation of Locomotives

Unfortunately, this section has to be censored as it contains a significant amount of sensitive information and has been withheld by DB Schenker Rail maintenance.

MM02 Material availability before the allocation of wagons to the workshop

As already mentioned before, process MM02 is identical to process MM01 except for the fact that it deals with wagons rather than locomotives. As a result, we created and assigned the same KPIs to this process as in process MM01, however they have been named KPI MM02 'a', KPI MM02 'b' and KPI MM02 'c' accordingly. Figure 4b in the appendix.

MM05 Material demand Identification

The process MM05 is one which is linked to the process MM03. The thesis has found that to measure any KPI in this process would not be beneficial to the management rather it would be redundant as the more relevant and critical information is acquired by measuring the instances in the process MM03. For this reason the thesis puts forth that no KPI will be assigned to the process but leaves it open for further investigation, in case the management may find events of interest for which they would like a KPI to be generated.

MM03 Material Availability after Vehicle Allocation

MM07 Handling of excess material

MM04 Post-task-assignment material availability

MM08 Handling of Old parts.

MM06 Material Provision and Preparation

Table 4: The Description of KPIs in the PMT

Sensitive information,
withheld on Company request

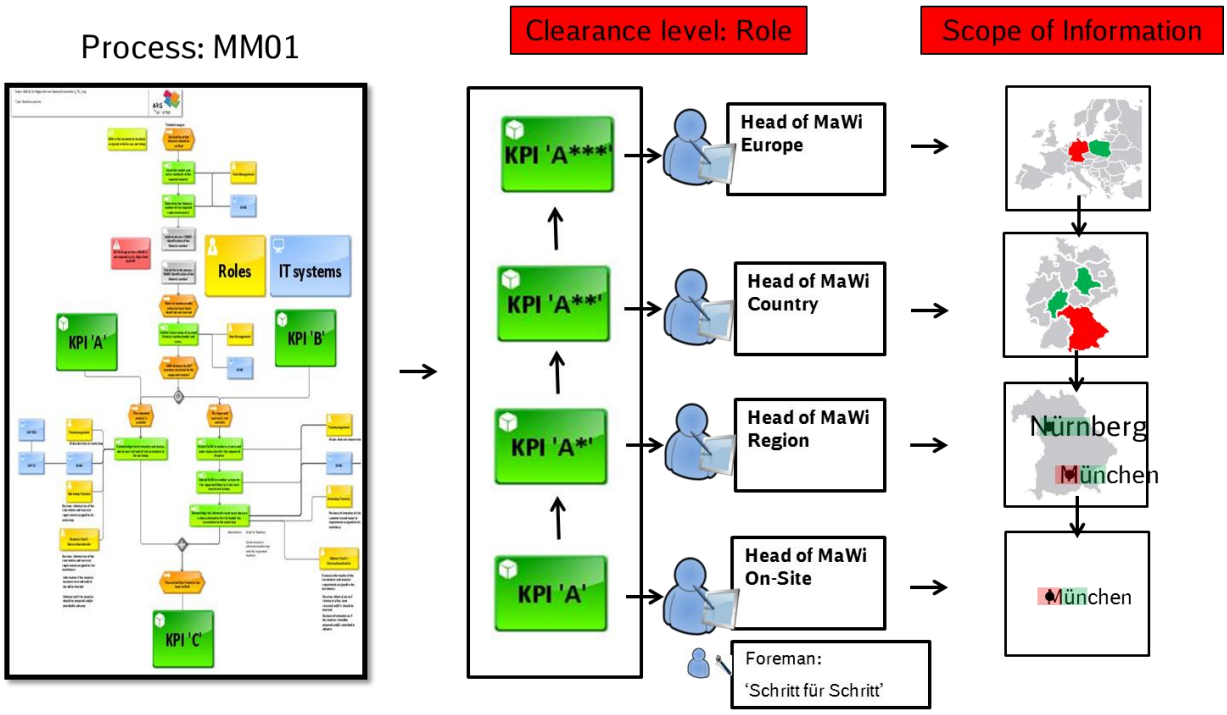
Sensitive information,
withheld on Company request

Source:Author

If we refer to the diagrams for the processes provided in the appendix again, we will note that the roles have also been appropriately indicated and assigned to the processes to which they belong. In addition the analysis of which IT systems are used in material management was done but not included in the thesis in detail, as it was a rudimentary activity of interviews with Mrs. Lackmann where she simply stated for the benefit of the thesis which system was used in which process. None the less the paper wishes to inform that the analysis was made and as WMS will also have interfaces to these systems, the stand alone IT systems relevant to material management were also identified and allocated appropriately to the processes.

In conclusion, at the end of our detailed analysis of material management, we have formed a strong base for the blueprint which is to be used as the standard Business intelligent (BI) performance management tool in DB SR maintenance through WMS. The diagram 4H provided below is to serve as a summary of the result of this analysis, to show the connection between the four aspects plus the stand alone IT systems and how they are interlinked creating the Performance Management Tool. Thus the thesis defines the ***Performance Management Tool*** as a management control system component intricately connecting the organisation as a unit, according to the goals and strategy, processes, IT systems, and roles to manage, measure, monitor and evaluate performance with in an organisation through the provision of KPIs and other relevant information comprehensively with the use of business intelligence.

Diagram 4H: Summary of the results from the Analysis: The PMT



In the diagram, we can see the process MM01 depicted on the left, with the KPIs roles and IT systems allocated respectively to the processes according to where they are relevant. Then we have the KPI MM01 'A' used as an example of how the different roles have access to it. However we should note the asterisks next to the KPI which indicate the scope of information the

different roles receive about the same KPI. In this case we see that the head of material management on site views the KPI 'A' which does not have an asterisk next to it. This means he only can see KPI 'A' with the details of his particular workshop. In the next role, the head of material management in the region, views the same KPI 'A' but it has an asterisk next to it. This is to indicate that the head of material management: region, can view the same KPI as his subordinate and in addition to that the KPI for other workshops in that region. In this case the diagram shows as an example that the region is Bavaria and thus the head of material management: On site will only see the KPI 'A' for his workshop in Munich, while the head of Material management can see the KPI 'A' for both Munich and Nuremberg, which are the two workshops in the entire region. From this logic, the rest of the diagram explains how the PMT for the management control system in WMS is formed to give improved transparency and control for the management of DB SR.

As the analysis of the material department has been done in a very thorough and detailed manner and yet still in a broad enough way for the variables to be applicable to other departments, the thesis has formed a performance management tool that is applicable to WMS and the maintenance department as a whole. Thus a table of general requirements is shown below to continue to ensure that it is applicable to all departments. The fourth central question is therefore positively answered and we are able to move into the next chapter where a universal blueprint will be developed and explained.

Table 5: General requirements (GR) of the PMT to function in WMS

Requirement	Description of Application
GR-1	Provide access to information according to predefined roles
GR-2	Allow customized presentation of information for mobile and stationary platforms
GR-3	Provide real time/ pop-up information on deviating KPIs
GR-4	Interface between BICC and WMS to receive the information founding the KPI data

Source: Author

5 Chapter 5: Innovation of the Management Control Blueprint

The work in the thesis so far has been all building up to form the PMT and the management control blueprint. From the analysis of the existing management control system in DB SR as a whole as well as in maintenance, we were able to establish what the company is doing well and what the company needs to improve. From this analysis as well we were able to piece together the strategy and goals that the maintenance department follows in relation to DB SR as an entire company. As rightfully put by the authors in the literature review, the strategy and goals are the corner stones to the management control system a company uses. Thus the thesis considered them to be important for the blueprint that will be formulated in this section.

In addition, the analysis of the existing management control system revealed that DB SR has a control system that is heavily dependent on the organisational structure of the company. While there are informal communication channels in the company, the paper found that the formal communication channel is well respected and made use of in DB SR, such that managers and employees know the channels to follow when interacting with each other and the manner in which performance is evaluated was clear as well. Therefore, the thesis asserted that the organisational structure would also be a reasonable and sound base on which the blueprint could be formed. And the horizontal function of the organisational structure could be developed by applying it to the other departments.

When the KPIs in DB SR maintenance were analyzed in chapter 3, the paper found that the KPIs were not allocated to processes and neither were they used to aid the direct measurement of individual performance with in the company. None the less the KPIs were present and used by top management in making decisions. The challenge discovered however, was that the KPIs were generated and presented to the top management relatively late, such that the KPIs became a source to review the past rather than aid the activities of management in the immediate and long term future. To this end, the thesis puts forth the use of KPIs in the PMT on a more timely i.e. real time basis as well as in supplementing the measurement of performance for both groups and individuals.

Taking these conclusions and others from the analysis of the existing management control system in DB SR, the thesis went into a detailed analysis of the material management sub-department in maintenance to deepen the foundation and accuracy for the PMT and blueprint. In the analysis of material management, the paper was able to evaluate and amend the processes in material management, such that the processes became relevant and represent the actual flow of material management activities in the maintenance department. Furthermore, the thesis was able to allocate and assign the roles, the KPIs and stand-alone IT systems, which will be coordinated through WMS in the future, to the processes which had been updated. Con-

sequently an intricate connection was made which formed the PMT -which increases transparency of the entire process flow for material management on a European scale.

The thesis argues that the combination of all these analyses into one concrete block of comprehensive information will allow for an optimal management control system to function in DB SR maintenance. Coupled with WMS, the performance management tool fosters business intelligence as all the relevant information needed to evaluate the performance of individuals and groups in the maintenance department will be made readily available to managers in a timely manner. As mentioned before, the right information will be provided to the right person, at the right time. Therefore well informed decision making in maintenance is made possible.

From these analyses, the thesis creates the Blueprint for performance measurement control in DB SR maintenance. The blueprint will be followed in other departments to make them compatible with the PMT in WMS and therefore all measureable through business intelligence. In effect, the Blueprint is then instructions to other departments, as to what must be done, analyzed, evaluated and reconciled in order for the performance of the departments to be measured effectively and optimally in WMS.

5.1 The Blueprint

The other departments and sub-departments in DB SR maintenance are advised to follow the five steps provided in this blueprint in order to ensure that performance will be measured, monitored and evaluated most effectively and optimally through the Performance Management Tool in WMS.

Goals and strategies

Before attempting to use the PMT, the thesis recommends that the department evaluate itself in relation to the goals and strategies of DB SR as a whole. For example, DB Schenker Rail currently has the DB SR 2020 Strategy which it aims to achieve. The department should ensure and clearly state, its own internal goals and strategy to follow in order to aid the entire company to reach its objective. This is the first recommendation from the thesis as it became clear during research that DB SR because of its size, at times does not operate as a single unit, with incongruence between departments and sub-departments arising at times.

In addition, laying out the internal goals and strategy for each individual department is important when reconciling the new processes and KPIs with the old to use in WMS. Naturally management will select different processes and KPIs of interest depending on the target goals that are set.

Processes and Activities

After the internal goals and strategies of the department are laid out, the thesis asserts that an evaluation on the activities and processes that are carried out by the department be made. At

this stage, it is expected that the processes will be made up to date and documented in such a way that every significant and relevant activity be described as specifically and clearly as possible so they need not be explained to new employees for example. This is to ensure the applicability and functionality of the PMT on the European scale. If the processes and activities are made completely clear, then the processes all over Europe in maintenance will become uniform and a standard will be created. In addition the documentation of the processes should be made according to how each process interacts with WMS tablets.

Management and Roles

Following the explicit layout of the processes, for the PMT to be able to measure individual performance together with group performance, the respective and responsible roles must be indicated within the processes. For example in the material management process, the material clerk is indicated as responsible for the provision of material. Therefore the role material clerk is indicated directly next to the process. In addition to indicating the roles responsible for completing activities and processes in the department, it is important to indicate the managers who will be responsible for monitoring and evaluating the performance of the department. In the material management analysis an example of this manager is the head of material management: On site. It is important for all departments to clearly sate these roles, in order to avoid questions of who is responsible for what. As Anthony and Govindarajan put it, allocation of responsibility should be clear.

Stand-alone IT systems

The thesis also recommends the clear identification of all the stand alone IT systems that are used within the department. This is in order for the employees to have an overview of the systems which have an interface to WMS and those that do not. In addition it is also important in the European arena, as the same tasks may be completed using different systems in different countries. Having the stand alone IT systems identified aids the employees to complete their respective tasks in WMS easier, knowing when to break to another system and when not to.

Performance and KPIs

The last step recommend by the thesis for the departments to follow is in regard to the KPIs. Naturally the departments have existing KPIs which they use to measure the performance in the department. However in addition to this, the paper encourages a review of the KPIs used to date and a re-evaluation, where the predictive capability of the KPIs be considered. The department needs to move focus to the future, and what actions to take based from the KPIs rather than using the KPIs to evaluate how good or bad performance was in the past. In addition, the KPIs should also be created and allocated to the processes and individuals which generate them. Again this is in order to measure performance of both individuals and groups, and for (quicker problem identification, as well as clarity as to who deserves a reward for exceptional

performance') responsibility allocation and results controls as recommended by Merchant and Van der Stede.

When these steps have been taken, the paper argues that all the required information for the management to measure and monitor performance for the department will have been provided. The information is then handed in to the Business Intelligence Competence Center department in the company, so that the information will be made readily available for management to access it on the PMT through WMS. The blueprint and PMT diagram 5A is provided below to show exactly how the blueprint leads to the (BI) Performance Management Tool which is used in WMS, when applied to all other relevant departments which should be controlled by this management control system. The blueprint can be compared to diagram 2B provided by (Anthony & Govindarajan, 2007) to show how it forms a formal control system in DB SR maintenance

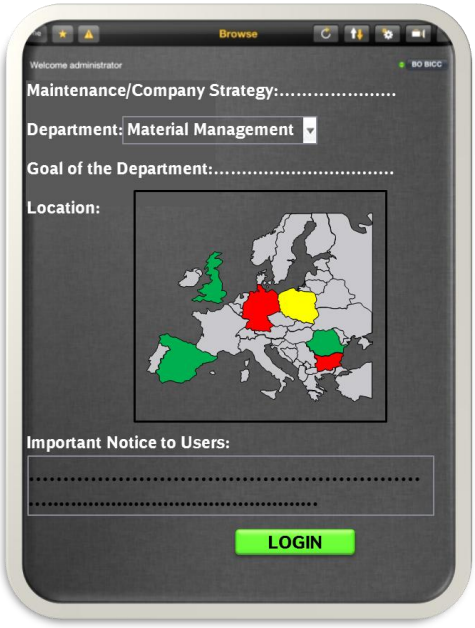
Diagram 5A: The Blueprint

5.2 Dashboard view of the PMT Blueprint

The thesis in this section has taken the PMT ant the blueprint as explained above with the information gained from the analysis made in the material management department and put it together to give a visual depiction of the PMT, for the benefit of DB SR management and for the reader. The dashboard view illustrated in this section is not the final and exact art in which the PMT will be presented through WMS. However all the information illustrated and presented here will be shown in WMS. The purpose of this section is to illustrate comprehensively how the performance management tool has been designed to function.

The dashboard views provided will be for the four top roles created for material management i.e. from the head of material management: On site, to the head of material management: Europe.

Diagram 5B: Login Dashboard



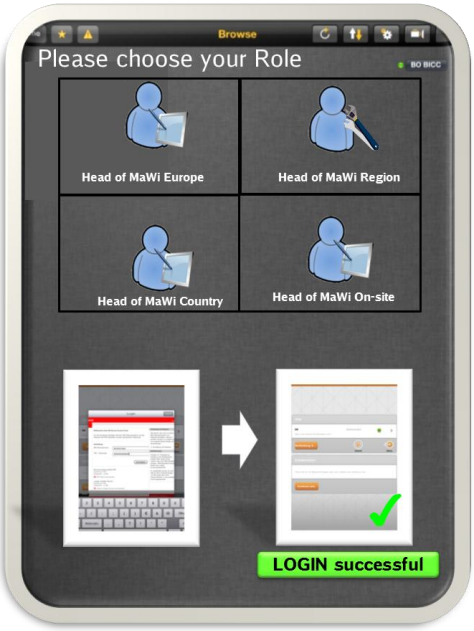
The tablet view provided diagram 5B on the left, is the first page of the tool where the manager is expected to login into the PMT in WMS. This dashboard has been presented to illustrate how the goals and strategies investigated in the blueprint are relevant in the PMT. The final version will be made according to the DB Corporate style.

The company's strategy or the maintenance strategy will be fixed on this login view in order to ensure that all employees are always kept aware of the overall aim and objectives. In close connection to strategy as the thesis has put forth are the internal goals that all departments should clearly layout. Consequently after selecting the relevant department in the PMT, the internal goals set by the departments are then displayed on the tablet as well. That way, when the individual finishes his login, he has been reminded of the company's direction, the maintenance strategy to get there and the goals in his department for which he is responsible to fulfill in getting the company to reach its targets. The thesis believes that a constant reminder to the employees of these aspects will lead to an automatic recall of what is expected of them and it will ensure that they are always thinking of ways to improve in order that the goals are reached. In addition the thesis asserts that the European map should be included in this login to the PMT to also give all employees a general idea on how the company is performing as a whole. The green red and yellow colors in the image function as a traffic light, indicating good, bad and intermediate performance respectively. Lastly on this page, for the management control system to be as optimal as possible, the domain owner can display important information which he wants all employees to be aware of.

After going through all this information and the manager has clicked on login, the next view shown, as we can see in the diagram 5C on top right of the next page, requires the user to insert his role and credentials to gain the access to information which his particular role is entitled to view. This view is to further explain the already mentioned aspect of scope of information. As the information which will be provided by the performance management tool will be very sensitive and confidential, the departments and management should have clearance levels and securities to ensure that the company's critical information is not carelessly handled. Therefore in the

image because material management was the focus of the thesis, we have taken those roles as example for this illustration. As it may be difficult to read from the image, the options available to the user in this case are head of material management: Europe,

Diagram 5C: Dashboard Roles

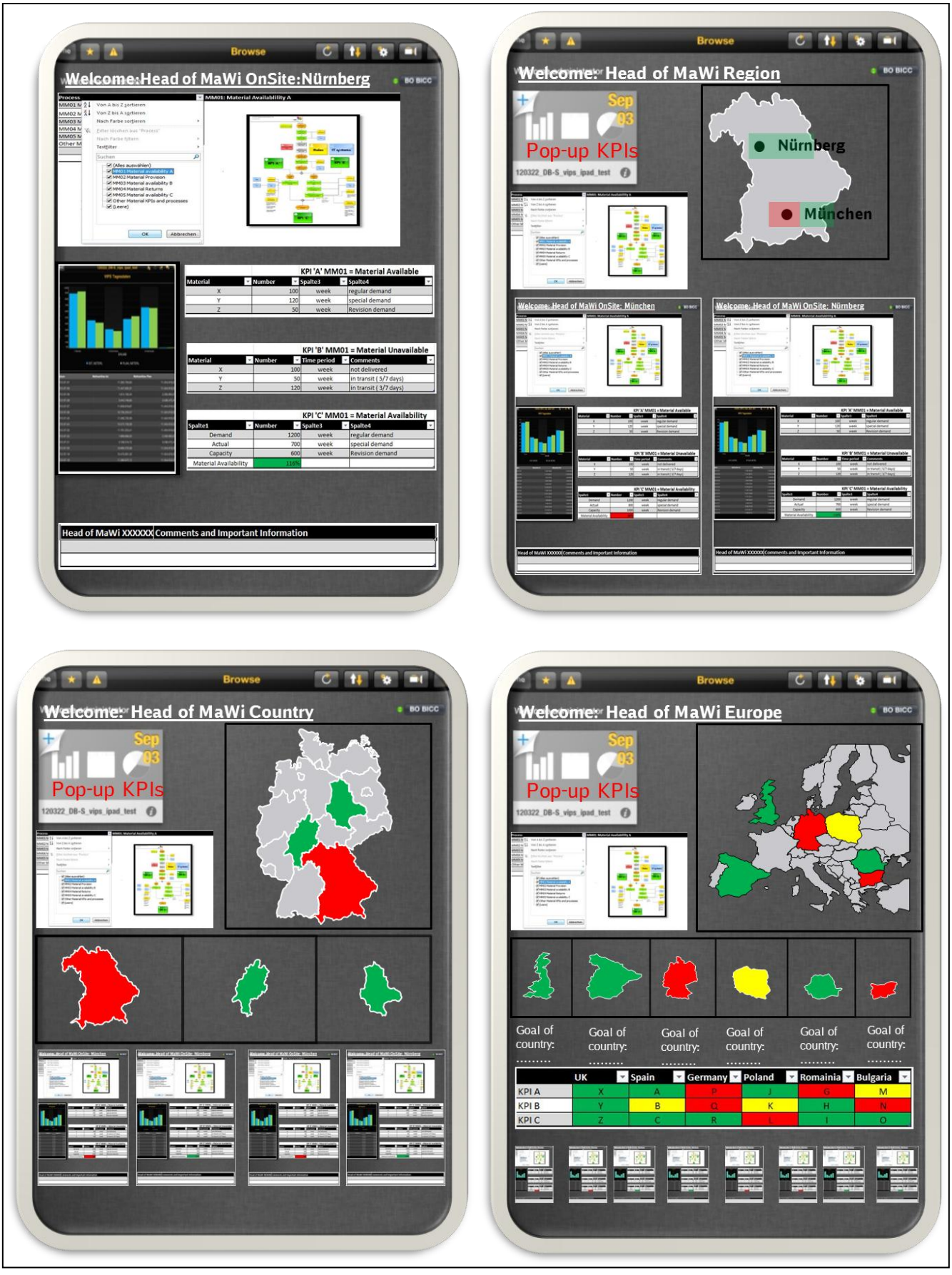


head of material management; Country, head of material management: Region and lastly, head of material management: On site. As we will see in the next images, the scope of information available to these different roles is adjusted accordingly as we go up the hierarchy.

Diagram 4D with the four dashboard images shown below has been made to illustrate to the reader the differences in views that the different roles will have. For the head of material management: On site, as explained before, the dashboard shows that he will only be able to select and view the KPIs, processes and roles that are under his supervision within his particular workshop- Nürnberg. The head of material management: Region will be able to view that information for the entire region for which he is responsible in this case the example shows that he will view the information regarding the two workshops i.e. the one in Nuremberg and the one in Munich. The head of material management: Country, as we can see in the dashboard, then views all the information regarding all the regions within the country for which he is responsible. In this case we see that three regions in Germany have been taken as an example. Lastly, the dashboard view for the head of material management: Europe has been provided. As illustrated, he has access to all workshops in all countries. The countries shown in the image have also been taken as an example for this presentation.

Consequently the MCS created by the thesis through WMS and the PMT resembles the elements of a good MCS (refer to diagram 2A) in that we have: an **Entity being controlled**- DB SR Maintenance (in this case material management), a **Control device**- The PMT, a **Detector**- WMS, an **Assessor**- the PMT using the KPIs allocated, the **Effector**- Managers responsible and responding to the information from the PMT and the **Communication Network**- WMS connecting the managers, employees, IT stand-alone systems and the PMT all together i.e. Business Intelligence

Diagram 5D: Dashboard views from different roles



From the dashboard views provided, we are able to provide the table 5 below, which depicts the IT functional requirements that the thesis believes WMS should have in order for it to function compatibly with the PMT.

5.3 Analysis of movement towards Predictive Analysis and Capacity Management

Central Question 5:

> What further actions should DB Schenker maintenance take in order to reach an optimal level of efficiency and performance control in the new management control tool WMS?

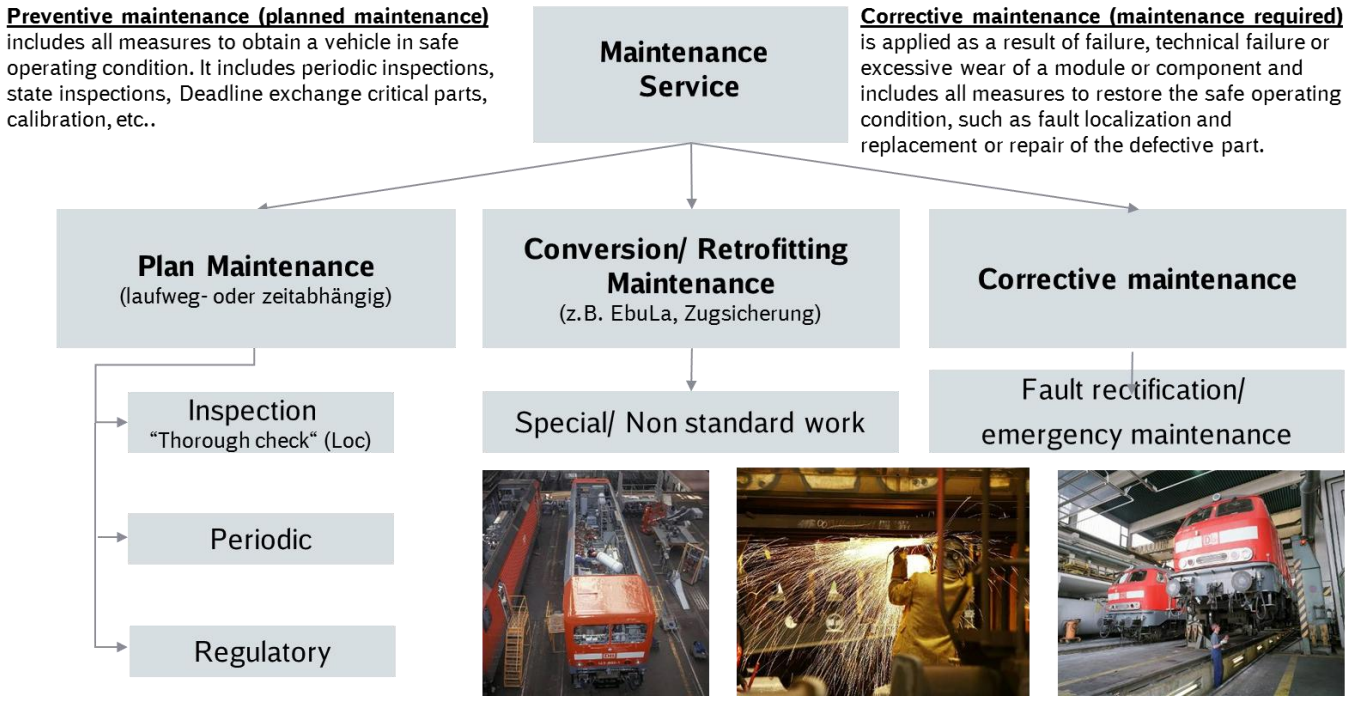
As we have stated on several occasions in the thesis, the goals of DB SR maintenance include: achieving an improved capacity management, an improved maintenance processes controlling and predictive analysis (in the same way as referred to by (Olavsrud, 2013)) for the department. Therefore, in this section the thesis puts forth the actions that will supplement the new management control system that has been innovated. The thesis conducted a thorough analysis of material management to form the blueprint and the PMT that will be used within management and controlling in WMS of the department.

From the PMT created, the thesis argues that platforms for predictive analysis and capacity management have been formed; however, this platform will only be fully functional when the aspects of the other departments and sub-departments are taken into consideration and are applied to the PMT. For example, the knowledge of material availability in workshops in advance is not adequate for the fleet management to make well informed decisions about which workshop is best to deliver a vehicle to. The other aspects which need to be taken into consideration for effective capacity management are for example, the availability of personnel and infrastructure in the workshops. It would be ineffective for the fleet management to deliver a vehicle to the workshop based on material availability only to discover at a later stage that the workshop lacks the personnel or infrastructure to deal with a particular damage that needs to be repaired.

In addition, predictive analysis would then be possible after collecting data, evaluating how many employees were required in the past to attend a particular maintenance requirement, the number of times the same maintenance requirement occurred in the same workshop etc. then using this information for example to predict which maintenance requirements will occur in the following months (days, years), which qualifications will be needed and the number of employees. Consequently, the thesis puts forth that for the company to realize functional platforms of predictive analysis and capacity management, it must apply the PMT broadly across its departments and ensure that the managers of the respective departments are in regular communication and contact, exchanging information on their respective results and performances per department, such that the end decision for example will allow feet management to allocate a vehi-

cle to a workshop which has the required material, infrastructure and personnel available at the same time, and the predictive planning to take this into consideration as well. (Moya, 2007) provides helpful and comprehensive work in the 'Model for the selection of predictive analysis techniques, which the thesis recommends DB SR to take into consideration as well.

Diagram 5E: Definition of Maintenance Categories

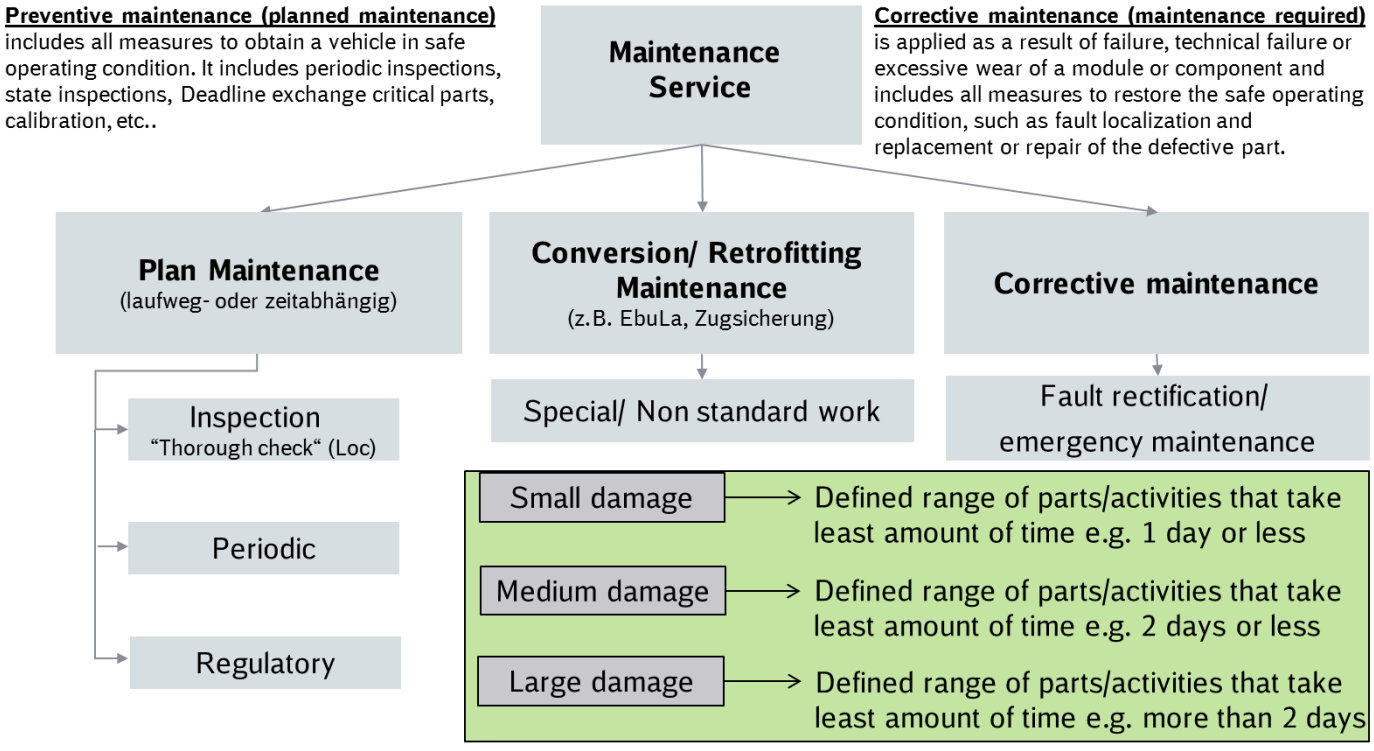


More so, to further the movement towards capacity management and predictive analysis the thesis encourages DB SR maintenance to increase the depth of the categories that they have formed for maintenance activities. Currently, there are three major distinctions between the maintenance activities that occur in the workshops. As shown in the diagram 5E above, the maintenance categories are, planned maintenance, retrofitting maintenance and corrective maintenance. The planned maintenance includes all activities in maintenance to obtain a vehicle to safe operating conditions, while corrective maintenance includes all activities in maintenance which are a result of a vehicle failure. The conversional or retrofitting maintenance covers all activities in maintenance which are non-standard or special conditions which cause the need for maintenance procedures to be fulfilled. While the categories in themselves are clear and effective to distinguish which maintenance is to be carried out, the thesis argues that the categories could be improved by differentiating large, medium and small maintenance requirements with in the categories.

While this possibility may be limited in planned maintenance, the other two categories would benefit significantly from this distinction. For example corrective maintenance covers a variety of activities, from repairing damages in the engine, mounted wheels or vehicle springs, to much smaller elements such as injection valves, joints and gaskets. When the distinction is made on vehicle entry, it will be more transparent to mangers and customers, for example how long the

maintenance of a vehicle will take based on the classification of the damage with in the category. Diagram 5F is provided below to explain the concept more clearly. After determining the category of each vehicle entering maintenance, the thesis suggests that the department can differentiate the maintenance requirements based on a replacement parts list. For example the material management department characterizes parts into: A parts (most expensive, most important/ most regularly required in maintenance) B parts (of middle importance and expense) and C parts (cheapest and rudimentary parts in maintenance) (DB Schenker Rail, 2014). Therefore if the parts are characterized in a similar manner within the entire department i.e. grouping the parts which need the least amount of time to repair to those that need the most amount of time to repair, a predictive analysis can then be undertaken through the PMT to investigate the total amount of time needed to repair a vehicle in relation to the composition of maintenance parts needed. Diagram 5F together with the conclusion therefore bring the thesis to an end and provide the answer to the fifth (and last) central question needed to successfully fulfill the goals of the thesis.

Diagram 5F: Refined definition of Maintenance Categories



Source: Author

6 Chapter 6: Conclusion

To conclude the thesis, we will review the activities and steps that were taken to help improve the management control system in DB SR Maintenance, for the better use of KPIs and BI reporting. The thesis began by evaluating the current situation in DB SR both internally and externally. We established that DB SR is one of the largest rail logistics companies in Europe and is performing at an international standard with subsidiaries and affiliates all over Europe. Internally the thesis identified that the maintenance department in DB SR is facing difficulties in efficiency, stemming from a strained management control system. As a result of the MCSs structure, the management faced challenges in timely monitoring and controlling the performance within the workshops. A further challenge identified was the break from IT media to analog processing of maintenance activities which resulted in high administrative tasks and paper stacking which removed the focus of employees and management from the productive work on the tracks/vehicles and also lead to backlogs in work orders. More so, the existing situation reflected that the department suffered from a workforce redundancy because of the repetitive typing of process requirements, status updates and results into the existing IT system, SAP ISI. In addition, in the evaluation of the current situation in DB SR maintenance, the thesis established that the lack of real time monitoring and representation of inventory on hand lead to the delay of maintenance activities: waiting for the supply of material. Lastly, the lack of harmonization in the maintenance department across the German and other European workshops proved to be a problem in the management control system as well, as the transparency of performance in the department was limited.

In light of the problems evaluated, DB SR embarked on the Workshop Management System WMS project to address the issues. Through WMS, DB SR aimed to completely eradicate the paper trail in the workshops and automate the input of data such that it would only be done once to eliminate the workforce redundancy and reduce the amount of administrative tasks that employees and management would otherwise have to focus on. In addition, through WMS, the company hoped; to significantly reduce the amount of time needed to bring a vehicle through a complete maintenance cycle; to monitor the status of inventory on a real time basis; and to fundamentally standardize the processes in all maintenance workshops in Germany and the rest of its European subsidiaries; in order to increase transparency and to ensure that the management control system would be effective on a European level.

To that end, the thesis took it upon itself to help improve and support the new management control system in WMS. While the thesis had several goals, the ultimate goal of the thesis was to provide an efficient tool for management to timely monitor, evaluate and control the performance within the workshops- by analyzing the maintenance processes and establishing the relevant measures to track performance within WMS- in terms of KPIs and BI reporting; in ef-

fect, the thesis aimed to create a performance management tool in WMS. In addition, another goal of the thesis was to reconcile the differences between the existing maintenance processes and the processes created for maintenance for the implementation of WMS, such that, the overall processes would be compatible and could then be applied to the performance measurement tool. It is important to note that the activities and processes in maintenance are vast and wide, and the paper could not adequately investigate them all individually. Instead to ensure that the performance management tool (PMT) would be functional, another goal of the thesis was to create a blueprint for the PMT, so that if all steps of the blueprint were followed, the maintenance processes would be compatible and measurable through the PMT. Furthermore, through the PMT, the thesis aimed to create a platform for predictive analysis and BI reporting in maintenance.

Therefore, to achieve the desired goals of the thesis, five central questions were established and answered in the course of thesis. The questions and answers were as follows:

1. Which academic literature on Management control systems and BI reporting can be adopted to effectively improve the performance of DB Schenker's maintenance service?

In answering this question, the thesis included a literature review where the top hundred academic sources on management control systems were considered and the best three were taken for analysis. The best sources were quoted as Merchant and Van der Stede (2003), Robert Anthony and Govindarajan (2007) and Simons (2000). Following the considerations and the recommendations from the literature, the first key question was answered.

2. How is the management control system in DB Schenker's maintenance department currently structured and where might a lack in efficiency arise?

We then conducted an analysis of the existing management control system in DB SR, according to the performance measurement and control (PMC) framework provided by Otley and Ferreira (2005). The results of the framework contributed to the formation of the PMT in the thesis, as the framework brought out the strengths of the existing management control system which could be further adopted in WMS and the PMT, while it also helped the thesis identify the exact areas within the maintenance management control system which caused the difficulties described in the introduction. For example, the framework proved that the organisational structure in the company is firm and well respected; such that the thesis used it as well to form the basis for allocation and evaluation of responsibilities within the PMT, while on the other hand we discovered that there were inefficiencies in the MCS as it included only lagging measures, weak informal controls, and poor feedback and feed-forward systems among others. Therefore the second key question was answered.

3. What are the key management control system techniques and process management systems that are lacking or need improvement (how can they be standardized for all workshops or do we need a new model)?

After the in-depth analysis of the existing management control system in DB SR maintenance, we introduced the concept of WMS as an IT based management control system and the scope of its functionality. We illustrated the link formed by WMS in all the sub-departments of maintenance and the communication it enables between managers of different sub-departments. In completing this chapter of the thesis, we managed to answer the third key question as WMS addressed the key management control system techniques and process management systems that were lacking in DB SR's existing MCS. In addition the creation of the PMT in the following chapter supplemented to WMS as the residual inefficiencies in DB SR's MCS were remedied by the PMT.

4. Are there any major differences in the maintenance processes in different workshops which can affect the applicability of a universal Blueprint?

From the elaboration of the concept of WMS and the interdependency of departments, the importance of the PMT was brought out more concretely and how it is to function across different working packages within WMS. Consequently, we were able to move into the next stage of the thesis where we conducted the detailed analysis of the material management sub-department of maintenance; which we used to form the prime foundation for the PMT as set out in the goals of the thesis. In this analysis, it was established that there are four common aspects in the departments and sub-departments of maintenance, namely: roles, processes, KPIs and the goals. Consequently, the inefficiencies in the existing MCS of DB SR were remedied, as feedback and feed-forward capabilities were created, both leading and lagging measures were made use of and roles were defined for the better use of informal controls. The answer to the fourth key question set for the thesis was that there are no foreseeable significant differences that could hinder the applicability of the blueprint and the PMT.

5. What further actions should DB Schenker maintenance take in order to reach an optimal level of efficiency and performance control in the new management control system WMS?

Having formed the concrete PMT from the analysis of material management, the next chapter of the thesis described the blueprint which is to be followed in all other departments which wish to implement the PMT as described in the thesis. Together with the blueprint, the thesis also provides dashboard views of the PMT in order to illustrate the importance of the steps which are to be followed in the blueprint as well as to present how the PMT forms the platforms for predictive analysis and BI reporting. Therefore at the end of the chapter we were able to layout the further

actions that the thesis believes DB SR should take in order to continuously move towards predictive analysis, capacity management and successful BI reporting. Thus bringing the thesis to conclusion and simultaneously answering the fifth and last key question that had been set.

6.1 Overall Resolutions

As rightfully planned in the introduction of the thesis, the successful fulfillment of the 5 key questions resulted in the thesis meeting its goals. The performance management tool as a platform for predictive analysis and BI reporting was created. Through the analysis and reconciliation of the existing processes in material management with the new ones that were created for the implementation of WMS, the thesis was also able to define a blueprint that is applicable to maintenance as a whole.

The thesis shows that the successful implementation of the PMT and WMS will remove the strain on the management control system in DB SR maintenance, and prevent the break from IT media. The progress on processes during maintenance will all be reported on a real time basis through the digitally managed workshop created in WMS. Together with the PMT created by this thesis, the managers will be able to measure, monitor and evaluate performance in the workshops better, as the time difference between execution and evaluation of performance is automated through the PMT; such that the right people are informed at the right time, about any deviations from desired performance automatically through the PMT on the WMS tablets. The problems of long through-put times and post-assignment-tasks have been solved: the release of vehicles and improvement in vehicle availability has been facilitated in the thesis, by the PMT for example which allows the real time monitoring of inventory and WMS which provides communication with the other departments involved in maintenance. Consequently, the workforce redundancy is cut down as the repetitive typing process is no longer necessary; the managers and employees' focus can be turned to their actual activities on the track and in the workshops as they have less administrative tasks to focus on.

The inefficiencies identified in the existing MCS of DB SR have also been well addressed in the thesis, and remedied partially through WMS and partially through the PMT. The implementation of WMS will bring about the use of not only lagging measures but leading ones as well to DB SR maintenance, and the PMT by forming a platform for predictive analysis makes the new MCS to be objectives based and future oriented. The PMT made use of not only the vertical functionality of the organisational structure but also defined and used the horizontal function as well through the blueprint which instructs other departments how to make use of the PMT to foster communication across departments horizontally and make interrelated decisions on capacity management, for example, possible. In addition, DB SR maintenance should no longer

experience challenges in timely feedback or feed-forward, as the PMT and WMS allow real time communication between all users of the system, making information on employees feedback or their discoveries on future strategies the company can take, regularly available.
Lastly, the provision of the blueprint gives a foundation of understanding for any other departments or subsidiaries that intend to use the PMT and as a result, the maintenance processes are more transparent and can be harmonized all over Germany and the rest of Europe.

6.2 Limitations and Possible Future Studies

While the thesis conducted the analyses as best possible it is still apparent that the results drawn from the literature review were dependent on three texts, even though they are highly recommended. Thus the thesis was limited to the ideas and perspectives that were delivered by the selected authors.

In addition, the thesis was also limited by a time constraint which made it challenging to analyze all the sub-departments in the maintenance department in order to guarantee that the PMT would be 100% applicable to the entire department. Instead, the analyses were limited to the material management sub-department alone. None the less the thesis argues that the analyses were done at a level deep enough to assert with a reasonable degree of certainty that the PMT will indeed be applicable to all the sub-departments in maintenance.

For future studies, we recommend that DB SR investigate the incentives and rewards system in the MCS. As already elaborated, the thesis believes the existing MCS lacks adequate incentives for employees as performance is only rewarded on a group basis rather than individually as proposed by Merchant and Vander Stede when referring to meritocracies. Thus further studies could be made to investigate to what extent the lack of incentives and rewards affects the performance of the maintenance department as a whole.

Lastly, while the Action, Personnel and Cultural Controls may be very effective and some may already be in use in DB SR, the thesis suggests this to be additional literature to be taken into consideration for further studies in the department, as the focus in the PMT was to aid DB SR to measure, monitor and evaluate the performance of the department, focus was put instead on results controls. Therefore these controls fell out of the PMTs scope. The further studies could therefore investigate how the bygone controls can be effectively incorporated and used in the PMT and WMS.

6.3 Recommendations

As the thesis has made use of the most highly recommended literature on management control systems and conducted a thorough analysis of the MCS in DB SR, it has found that DB SR can take further measures to continuously improve on the MCS in the company. The thesis finds for example that supplementing the PMT with variance analyses constantly would significantly increase the value of information they can draw from it. As stated by Anthony and Govindarajan variance analysis can be seen as the most suitable and transparent method to measure the performance of an organisational unit effectively. Therefore, it would be beneficial for DB SR to ensure that the information collected and gathered in the PMT should be monitored according to how it varies from a standard point and to train employees to be able to identify why this variance occurs and to solve the problems causing negative variances.

Although the thesis conducted as broad an analysis as timely possible, the focus was mostly on evaluating, monitoring and controlling performance in maintenance. Therefore DB SR is recommended to ensure that the elements of MCSs are well linked to ensure efficiency. As Merchant and Van der Stede state that the elements of a MCS i.e. strategic planning, resource allocation, performance measurement and evaluation, and responsibility center allocation (to be used in determining the manner in which performance is measured) should all be well linked in order for the MCS to function effectively.

Also the thesis recommends for DB SR to distinguish the information it will draw from the PMT as proposed by Simons: information for decision making, information for signaling, information for external communication, information for education and learning and information for controlling, should all be distinguished in order to allow the company to process information as fast as possible.

In conclusion, the thesis believes that the research was a success and that the goals of the thesis were all achieved. The thesis acknowledges that it faced some limitations from the number of literature that was used and the constraint on time. However, the final result of the thesis shows that the PMT was successfully developed and the blueprint allows it to be applicable to all the other departments and sub-departments in maintenance. The thesis found that the inefficiencies discovered in the MCS were solved by the PMT and WMS and that the performance evaluation, monitoring and measurement can now be optimally and easily done by the management. All in all the strain on DB SR's existing MCS is relieved through the implementation of the workshop management system and the performance management tool.

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9 Appendix

Figure A: Protocol- Conference call with England Subsidiary

DB SCHENKER **Rail**

DB Schenker Rail AG
Region Central
Instandhaltung (L.RDB 4)
Rheinstraße 2
55116 Mainz
www.dbschenker.com

Conference protocol from 11.04.2014

Clarification on the Future material management roles in WMS and the common KPIs used in Material Management

Participants:
Mr. Ritzer, Mrs. Lackmann, Mr. Straffon, Mr. Bozena, Mr. Persidis, Herr Takaendisa.

Facilitators:
Takaendisa, Ritzer, Lackmann.

Place/time:
Mainz, Headquarters
10:00 – 10:45

Protocol scope:

1 Page
Appendix:
None

L.RDB 4
Issued on: 11.04.2014
Issued by: Dominic Takaendisa

Nr.	Contents/Actions	Responsible	Dead-line	Status
1.	The roles suggested as standard for European material management in WMS were agreed upon and accepted by Mr. Straffon (Parts Centre Manager DB SR UK).	Takaendisa	-	I
2.	The KPIs suggested as standard priority 1 and 2 for European material management in WMS were agreed upon and accepted by Mr. Straffon (Parts Centre Manager DB SR UK).	Takaendisa	-	I
3.	Agree on Roles suggested as standard for European material management in WMS with Mr. Pilorz (head of procurement DB SR Poland).	Takaendisa	KW 16	A
4.	Agree on KPIs suggested as standard for European material management in WMS with Mr. Pilorz (head of procurement DB SR Poland).	Takaendisa	KW 16	A
5.	An additional KPI of priority 2 should be defined relating to: Material taken from non-functional vehicles and used in the fulfillment of maintenance on other (functional) vehicles.	Takaendisa and Lackmann	KW 17	A
6.	Any further questions or comments will be addressed to Mr. Ritzer and/or Mr. Takaendisa.	-	-	I
7.	The documents containing the Roles and KPIs agreed upon can be received from Mr. Ritzer and/or Mr. Takaendisa upon request.	-	-	I

Source: Author

Figure B: Protocol- Conference call with Poland Subsidiary

DB SCHENKER

Rail

DB Schenker Rail AG
Region Central
Instandhaltung (L.RDB 4)
Rheinstraße 2
55116 Mainz
www.dbschenker.com

Conference protocol from 11.04.2014

Clarification on the Future material management roles in WMS and the common KPIs used in Material Management L.RDB 4

Issued on: 14.04.2014

Issued by: Dominic Takaendisa

Participants:
Mr. Ritzer, Mrs. Lackmann, Mr. Pilorz, Herr Takaendisa.

Facilitators:
Takaendisa, Ritzer, Lackmann.

Place/time:
Mainz, Headquarters
10:00 – 10:45

Protocol scope:

1 Page

Appendix:
None

Nr.	Contents/Actions	Responsible	Dead-line	Status
1.	The roles suggested as standard for European material management in WMS were agreed upon and accepted by Mr. Pilorz (Head of Procurement DB SR PL).	Takaendisa	-	I
2.	The KPIs suggested as standard priority 1 and 2 for European material management in WMS were agreed upon and accepted by Mr. Pilorz (Head of Procurement DB SR PL).	Takaendisa	-	I
3.	Define and establish a KPI of priority 2 for efficiency, based on speed of material provision/employee	Takaendisa and Lackmann	KW 16	A
4.	Clarify on the definition of the KPI 'Scrap material' for use in WMS as a priority 2 KPI.	Takaendisa And Lackmann	KW 16	A
5.	Establish the KPI 'Quality of Material Requirement Planning' as a priority 1 KPI for Poland	Takaendisa and Lackmann	KW 17	A
6.	The role of 'Head of Material management: Region' for Poland will be further discussed by Mr. Pilorz and Logistics manager.	Pilorz	KW 17	A
7.	Any further questions or comments will be addressed to Mr. Ritzer and/or Mr. Takaendisa.	-	-	I
8.	The documents containing the Roles and KPIs agreed upon can be received from Mr. Ritzer and/or Mr. Takaendisa upon request.	-	-	I

Source: Author

Figure C[10]: Stakeholders for the WMS project

Company	Country Head	Head of Production	Head of Maintenance	Head of IT
DB SR CH	Martin Brunner	Martin Brunner	-	-
ECR France	Marc Bizien	Michel Didier	Jean-Francois Caubet	-
DB SR Scandinavia	Gottfried Eymer	Gottfried Eymer	Stig Bang-Mortensen	-
Transfesa	Bernd Hullerum	Julian Gacimartin	Oscar Lazaro	-
DB SR Bulgaria	Liubomir Garchev	Liubomir Garchev	-	-
RBH	Gerhard Hartfeld	-	-	-
DB SR Polska	Christian Schreyer	Michael Hetzer	Fabian Amini	Dariusz Kasprzyk
DB SR Romania	Eduard Iancu	Eduard Iancu	Mircea Mihailov	-
Cobra	André Kalvelage	André Kalvelage		-
DB SR Nederland	Aart Klompe	Arno van Deursen	Paul Rossou	-
DB SR Industrial	Alain Thauvette	Stephen Hill	Steve Wilkinson	-
MEG	Jürgen Sonntag	-	Sebastian Bernhard	-
NordCargo	Enrico Bellavita	Giorgio Spadi	Jacopo Mauri	-
DB SR UK		Andrew Byrne	Steve Wilkinson	Doug Pennel

[10] Source: (DB Schenker Rail, 2014) and Author

Figure D: KPI Template for universal use

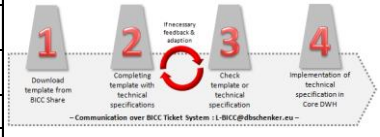
KPI Template (Access Layer) of Core DWH

Short description / Task of template: Definition of a Key Performance Indicator (KPI) in the Access Layer. Please send the template to: L-BICC@dbschenker.eu or L-BICC@deutschebahn.com (The BICC ticket system is obligatory for processing the request).

KPI Template (Core DWH, BICC of DB Schenker Rail)			
Responsible Owner	< xxx > < xxx >	Department	< xxx > < xxx >
Responsible within BICC	< xxx > L-BICC@dbschenker.eu	Department	< xxx > < xxx >
KPI name / description			
Scenario (plan, actual, forecast)			
Business definition			
Formula for calculating the KPI			
Boundary conditions and exceptions of the calculation instructions			
Unit of measurement			
Time reference / granularity of KPI			
Is the KPI based on another KPI? If yes, what are the base key performance indicators?			
Is the KPI summable? If yes, what kind of calculations is applicable (sum, avg, min, max, ...)?			
Is it possible to use the time dimension for aggregation?			
Which areas / departments are working with the KPI?			
By what dimensions is the KPI evaluated?			
At what aggregation level (granularity) of the respective dimension is the KPI stored?			
Is there an access protection for the KPI? If yes, what kind of protection is requested?			
Is the access protection for all levels of aggregation equal?			

Modifcation History of Template			
Version	**Date**	**Modification Note**	**Name / Department**
0.9	23.03.2012	Initial Definition & Coordination	Logica Project Team
1.0	01.08.2012	Acceptance by BICC	DB Schenker Rail BICC

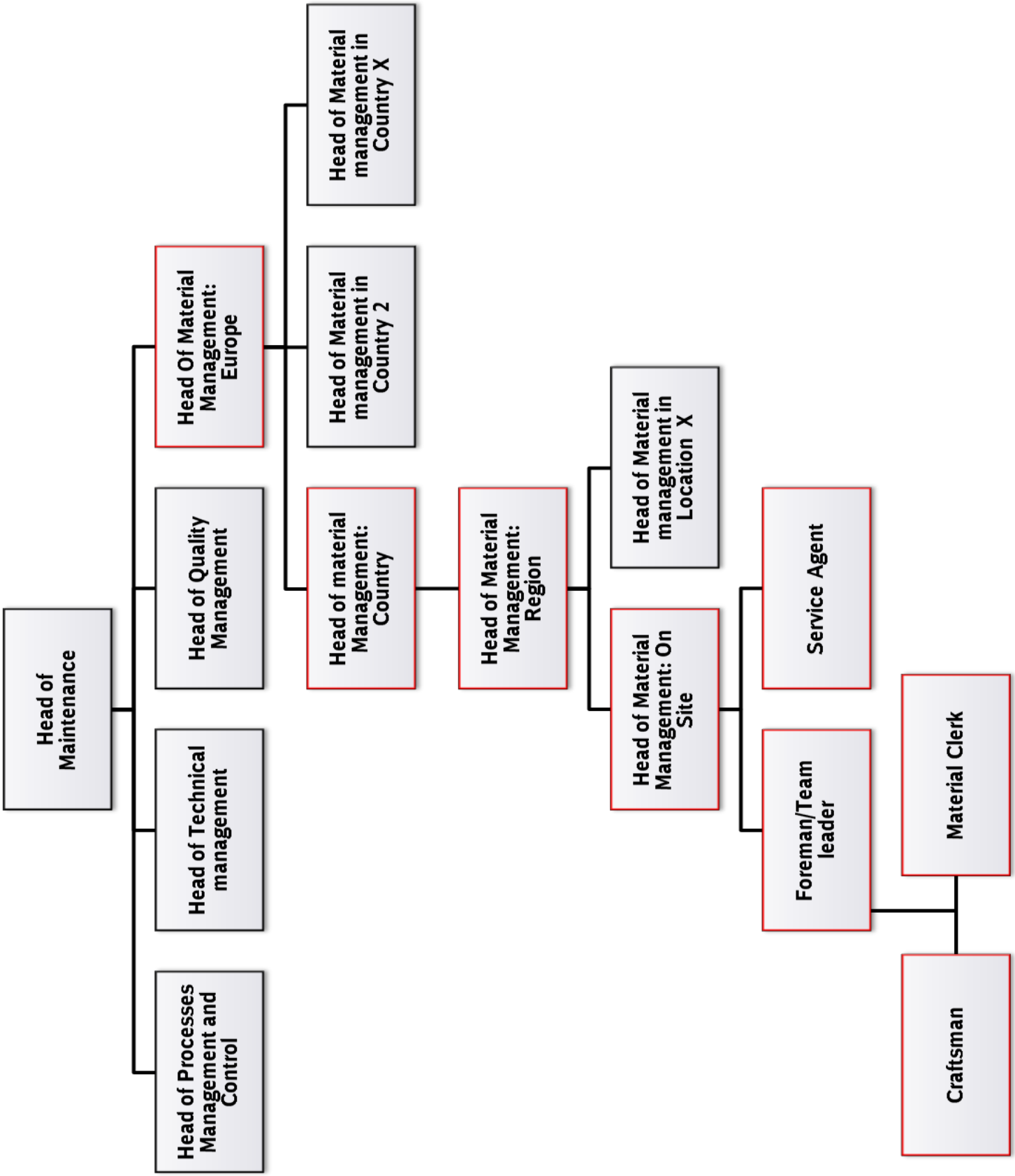
Templates process flow within in BICC



Document Code: ALKTEV1DBICCSCHENKER

Source: (DB Schenker Rail, 2014)

Figure E: WMS Maintenance Organogram



Source: Author

Figure F: Interview with Head of warehouse and Material management Nürnberg

Protocol from 25.03.2014

DB Schenker Rail AG
Region Central
Instandhaltung (L.RDB 4)
Rheinstraße 2
55116 Mainz
www.dbschenker.com

Clarification on the Material warehouses in Nürnberg, the processes and the roles L.RDB 4
Issued on: 2.05.2014
Issued by: Dominic Takaendisa

Place/time:
Nürnberg
10:00 – 16:45

Protocol scope:

1 Page
Appendix:
None

Participants:
Mrs. J. Truch, Mrs. K. Truch,
Mr. Takaendisa.

Facilitators:
Takaendisa, J. Truch.

Nr.	Contents/Actions
1.	Order billing
2.	Roles in the warehouse and workshops and their responsibilities (i.e. material clerk, service agent, team leader, foreman and craftsman)
3.	Inventory management (through comparison of two sheets of paper)
4.	Administration responsible for opening orders, material purchase, material and order billing/invoicing
5.	IT systems in use (SAP ISI and SAP R3K)
6.	Classification of materials into A,B and C parts

Source: Author

Figure G: Interview with controlling department

Protocol from 13.01.2014

DB Schenker Rail AG
Region Central
Instandhaltung (L.RDB 4)
Rheinstraße 2
55116 Mainz
www.dbschenker.com

Clarification on controlling departments
Role on KPIs and performance measurement
L.RDB 4
Issued on: 2.05.2014
Issued by: Dominic Takaendisa

Participants:
Mr. B. King
Mr. Takaendisa.

Facilitators:
Takaendisa, Mr. B. King

Place/time:
Mainz, Headquarters
15:00 – 16:00

Protocol scope:

1 Page
Appendix:
None

Nr.	Contents/Actions
1.	▮ Many IT pre-systems and individual development of KPIs for measurement (SAP ISI, SAP R3K, TM1, Excel
2.	▮ Many individual standalone IT systems, related but uncoordinated and should be looked into
3.	▮ Management is well informed of well executed activities and good performance
4.	▮ Many possible filters exist before all information is available to controlling but data sources are consistent.

Source: Author

Figure H: Interview with Material management expert in Headquarters

Protocol from 18.03.2014

DB Schenker Rail AG
Region Central
Instandhaltung (L.RDB 4)
Rheinstraße 2
55116 Mainz
www.dbschenker.com

Agreement on Material management Processes proposed by thesis
L.RDB 4
Issued on: 2.05.2014
Issued by: Dominic Takaendisa

Participants:
Mrs. Lackmann, Mr. Ritzer
Mr. Takaendisa.

Facilitators:
Takaendisa

Place/time:
Mainz, Headquarters
9:45 – 10:45

Protocol scope:

1 Page
Appendix:
None

Nr.	Contents/Actions
1.	▮ Process must allow repetitive retrieval of material form the warehouse possible
2.	▮ Provision of material to point of exchange (i.e. point of exchange = in front of vehicle or in front of warehouse?) Point should be defined according to workshop
3.	▮ Several IT systems/ interfaces in use behind SAP ISI and SAP R3K (i.e. MMBE, ME2M, MD04
4.	▮ Some replacement materials are available can be ordered and delivered with 24 hours according to agreement with DB 'Fahrzeuginstandhaltung'
5.	▮ Which number of workshops should WMS display to fleet management before allocation of vehicles
6.	▮ Open or closed warehouses?
7.	▮ The interaction of the roles and processes for efficiency, security and quality
8.	▮ Acceptance of the processes according to the above parameters

Source: Author

Figure I: Interview with material management expert in the Headquarters

Protocol from 21.03.2014

DB Schenker Rail AG
Region Central
Instandhaltung (L.RDB 4)
Rheinstraße 2
55116 Mainz
www.dbschenker.com

Agreement on Material management
KPIs proposed by thesis
L.RDB 4
Issued on: 2.05.2014
Issued by: Dominic Takaendisa

Participants:
Mrs. Lackmann, Mr. Ritzer
Mr. Takaendisa.

Facilitators:
Takaendisa

Place/time:
Mainz, Headquarters
9:45 – 10:45

Protocol scope:

1 Page
Appendix:
None

Nr.	Contents/Actions
1.	▮ Mondays, gathering of KPIs for the department from SAP R3K and SAP ISI and comparing with previous week
2.	▮ Commenting and deliberating on possible causes for deviations
3.	▮ Wednesdays, telephone conferences with all relevant service agents and managers of the other workshops
4.	▮ Agreement of some proposed KPIs for the new processes
5.	▮ Deliberation with Mr. Tanner on some of the proposed KPIs (i.e. predictive material availability KPI etc.)
6.	▮ Provision of priority 1 and 2 KPIs from Mrs. Lackmann

Source: Author

Figure J: Interview with Head of Material management Headquarters

Protocol from 13.02.2014

DB Schenker Rail AG
Region Central
Instandhaltung (L.RDB 4)
Rheinstraße 2
55116 Mainz
www.dbschenker.com

Material management overview and key aspects to WMS
L.RDB 4
Issued on: 2.05.2014
Issued by: Dominic Takaendisa

Participants:
Mr. Tanner, Mr. Hausner
Mr. Takaendisa.

Facilitators:
Takaendisa

Place/time:
Mainz, Headquarters
10:45 – 11:45

Protocol scope:

1 Page
Appendix:
None

Nr.	Contents/Actions
1.	▮ Goals in material management
2.	▮ Points of interest from WMS
3.	▮ Important aspects to measure (i.e. time between ordering of materials and its availability in the workshop. Reservation of material, delivery time, Link to interface CO24-missing parts list.
4.	▮ WMS access to delivery time appointments and link to service agents
5.	▮ Traffic light concept of KPIs in material management
6.	▮ Important KPIs to consider (i.e. material availability, Order status, vehicles out of order needing material)
7.	▮ WMS should connect vehicle entry to material orders, measure post assignment tasks in relation to overall time needed to complete order.
8.	▮ Material connection to infrastructure and employees qualifications.
9.	▮ Prioritizing wagons: establishing the importance of lacking parts in relation to vehicle priority
10.	▮ History of material use on orders, use, reservations, bookings and on any given vehicle

Source: Author

Figure K: Interview with Head of Controlling

Protocol from 20.02.2014

DB Schenker Rail AG
Region Central
Instandhaltung (L.RDB 4)
Rheinstraße 2
55116 Mainz
www.dbschenker.com

Controlling department information
L.RDB 4
Issued on: 2.05.2014
Issued by: Dominic Takaendisa

Participants:
Mr. Werner
Mr. Takaendisa.

Facilitators:
Takaendisa

Place/time:
Mainz, Headquarters
10:05 – 11:00

Protocol scope:

1 Page
Appendix:
None

Nr.	Contents/Actions
1.	Number of times management meets to discuss KPIs and performance
2.	Discussion on improvements to performance tracking
3.	Supply of overall KPIs in all of Maintenance, including management decision making KPIs in maintenance
4.	Regularity of important KPIs (i.e. weekly, monthly etc.)
5.	Problem of completed work but not reported and typed back into stand-alone IT systems, difficult to measure on it.
6.	TM1 data bank and related software very relevant to controlling department- Link to WMS
7.	WMS should connect vehicle entry to material orders, measure post assignment tasks in relation to overall time needed to complete order.
8.	Material connection to infrastructure and employees qualifications.
9.	Prioritizing wagons: establishing the importance of lacking parts in relation to vehicle priority
10.	History of material use on orders, use, reservations, bookings and on any given vehicle

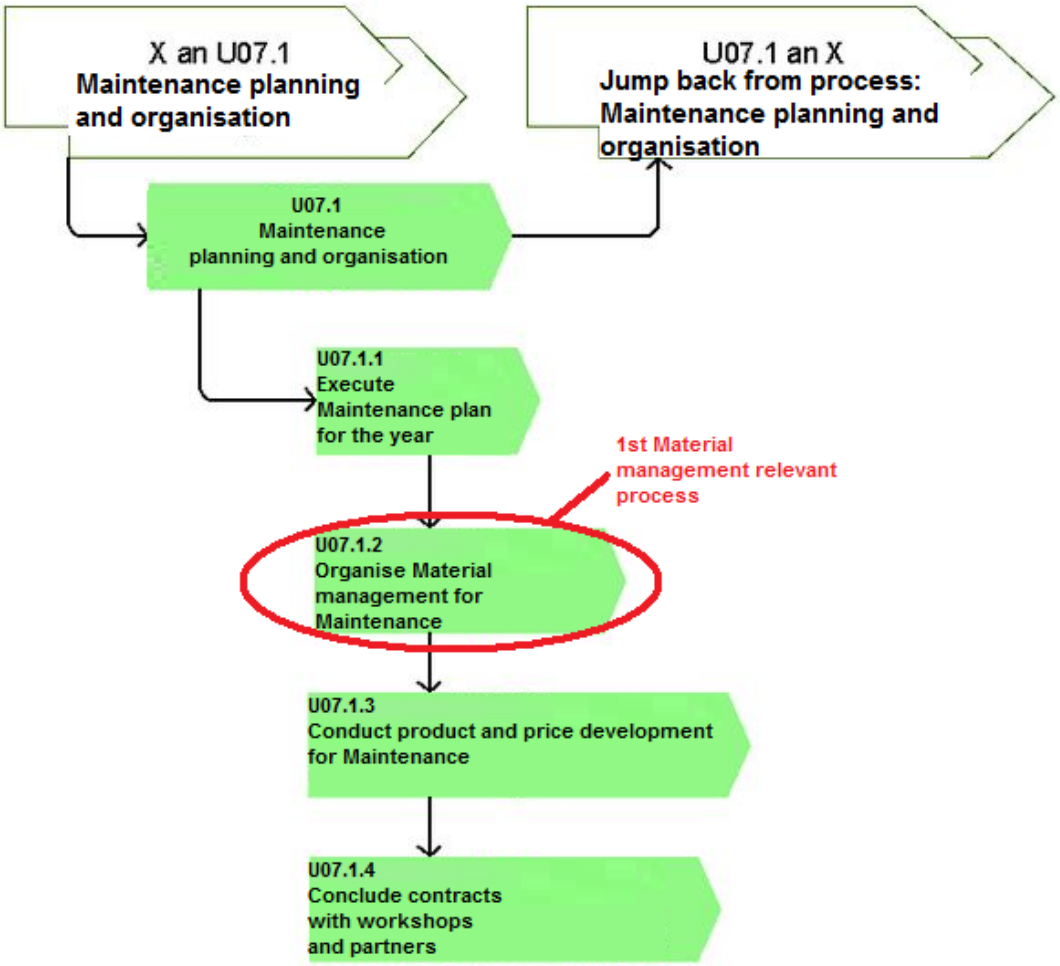
Source: Author

Figure 1[11]: Results from e-mail Survey for relevant literature

Author(s)	Title	Ed.	Year	Experts			Total	
				1st rank	2nd rank	3rd rank	Points	Rank
Merchant and Van der Stede	Management Control Systems	2nd	2003	18	14	2	84	1
Antony and Govindarajan	Management Control Systems	12th	2007	18	9	7	79	2
Simons	Performance Measurement and Control systems for Implementing Strategy	1st	2000	12	11	7	65	3
Horngren, Foster, Datar, Rajan and Ittner	Cost Accounting	13th	2008	4	1	2	16	4
Zimmerman	Accounting for Decision Making and Control	6th	2008	2	2	1	11	5
Emmanuel, Merchant and Otley	Accounting for Management Control	2nd	1990	1	3	1	10	6
Atkinson,Kaplan, Matsumura and Young	Management Accounting	5th	2007	1	3	0	9	7
Demski	Managerial Uses of Accounting Information	2nd	2008	2	0	0	6	8
Macintosh	Management Accounting and Control Systems	1st	1995	1	1	0	5	9
Hilton	Managerial Accounting	6th	2008	1	0	1	4	10
Merchant	Modern Management Control Systems	1st	1997	1	0	1	4	10
Anthony	Planning and Control Systems	1st	1965	1	0	0	3	11
Dorf and Bishop	Modern Control Systems	11th	2007	1	0	0	3	11
Ewert and Wagenhofer	Interne Unternehmensrechnung	7th	2008	1	0	0	3	11
Gordon	Managerial Accounting	6th	2005	1	0	0	3	11
Hopper, Northcott, and Scapens	Issues in Management Accounting	3rd	2007	0	1	1	3	11
Sandoe, Corbitt, and Boykin	Enterprise Intergration	1st	2001	1	0	0	3	11
Solomons	Divisional Performance	1st	1965	1	0	0	3	11
Vancil	What kind of Management Control Do you need?	1st	1973	1	0	0	3	11
Allen, Brownlee, Haskins, Lynch, and Rotch	Cases in Management Accounting and Control Systems	4th	2004	0	1	0	2	12
Anderson and Post	Management Information Systems	4th	2005	0	1	0	2	12
Anthony and Young	Management Control in Nonprofit Organisations	7th	2003	0	0	2	2	12
Senge	The Fifth Discipline	1st	2006	0	1	0	2	12
Anthony, Hawkins, and Merchant	Accounting: Texts and Cases	12th	2006	0	0	1	1	13
Christensen and Feltham	Economics of Accounting	1st	2005	0	0	1	1	13
Garrison, Noreen,and Brewer	Managerial Accounting	12th	2007	0	0	1	1	13
Maciariello and Kirby	Management Control Systems	2nd	1994	0	0	1	1	13
Maher, Weil, and Stickney	Managerial Accounting	10th	2007	0	0	1	1	13
Merchant	Rewarding Results	1st	1989	0	0	1	1	13
Shank and Govindarajan	Strategic Cost Management	1st	1993	0	0	1	1	13
Smith	Performance Measurement and management	1st	2005	0	0	1	1	13
Turban, Aronson, Liang, and Sharda	Decision Support and Business Intelligence Systems	8th	2008	0	0	1	1	13

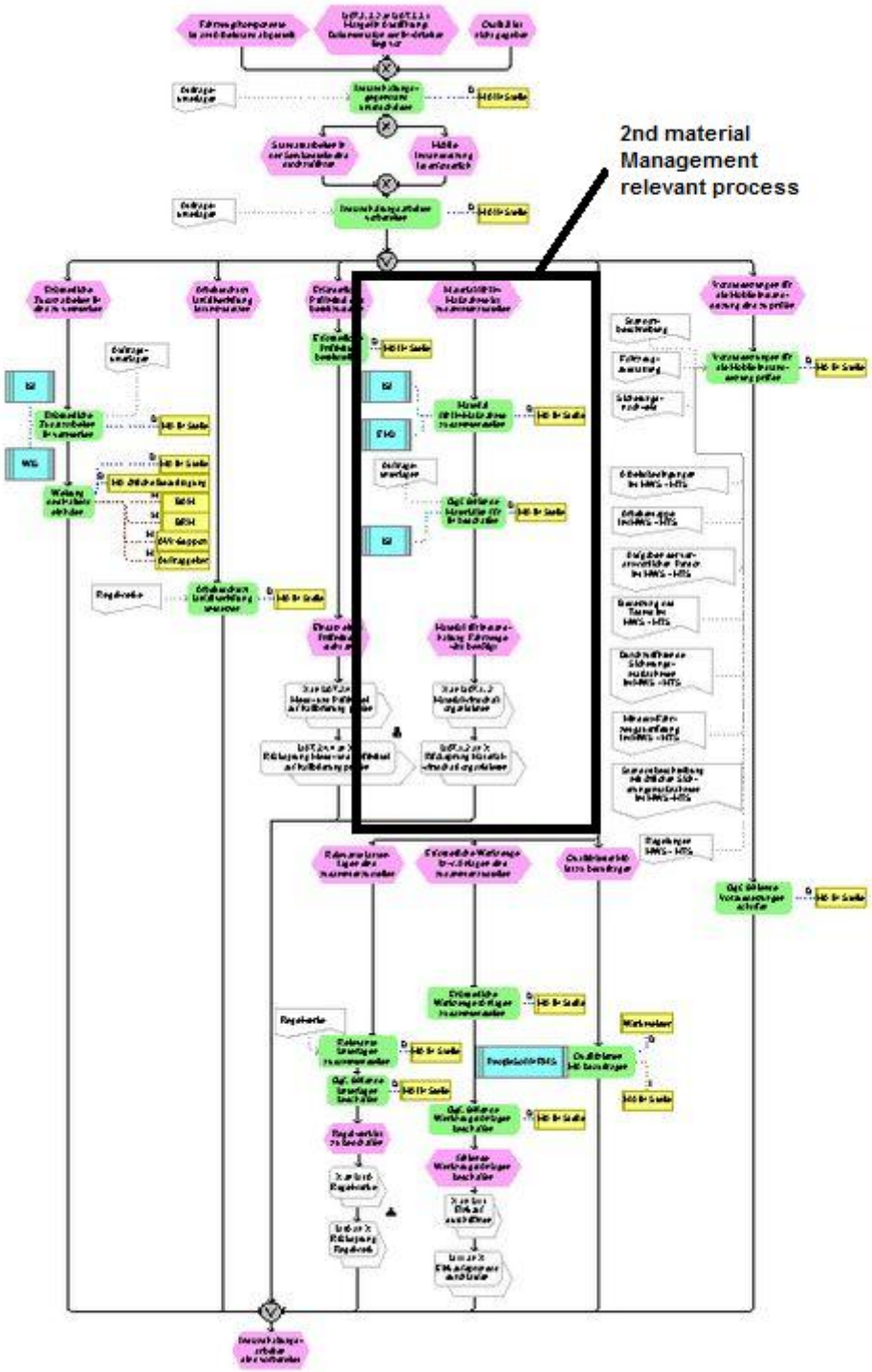
[11] Source: (Strauß, 2011)

Figure 2[12]: First Material management relevant process- Old processes



[12] Source: (DB Schenker Rail, 2014)

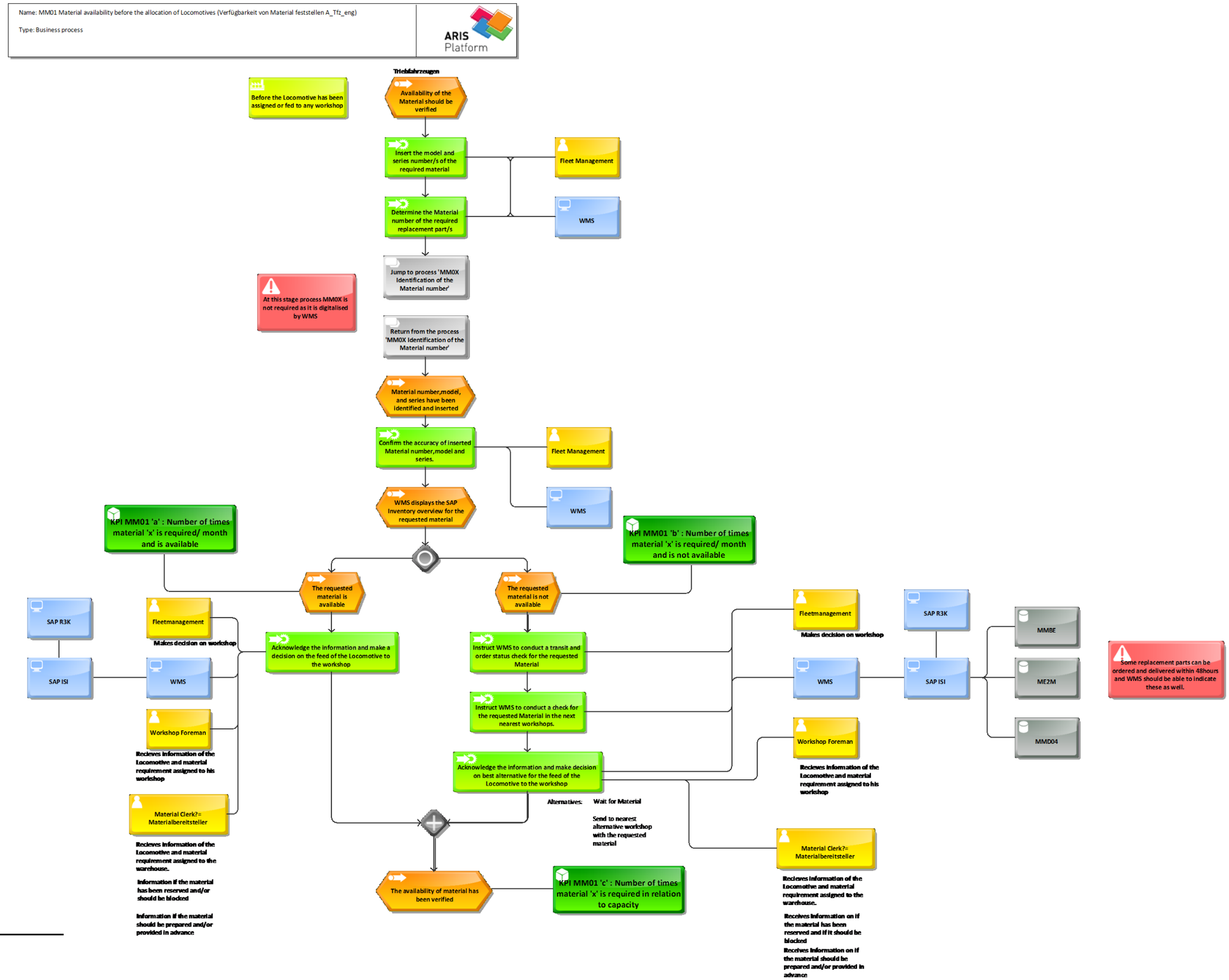
Figure 3[13]: Second Material management relevant process: Old Processes



The processes provided on the following pages which are relevant to material management, can be read by zooming into the page. (Relevant only to the digital version of the thesis)

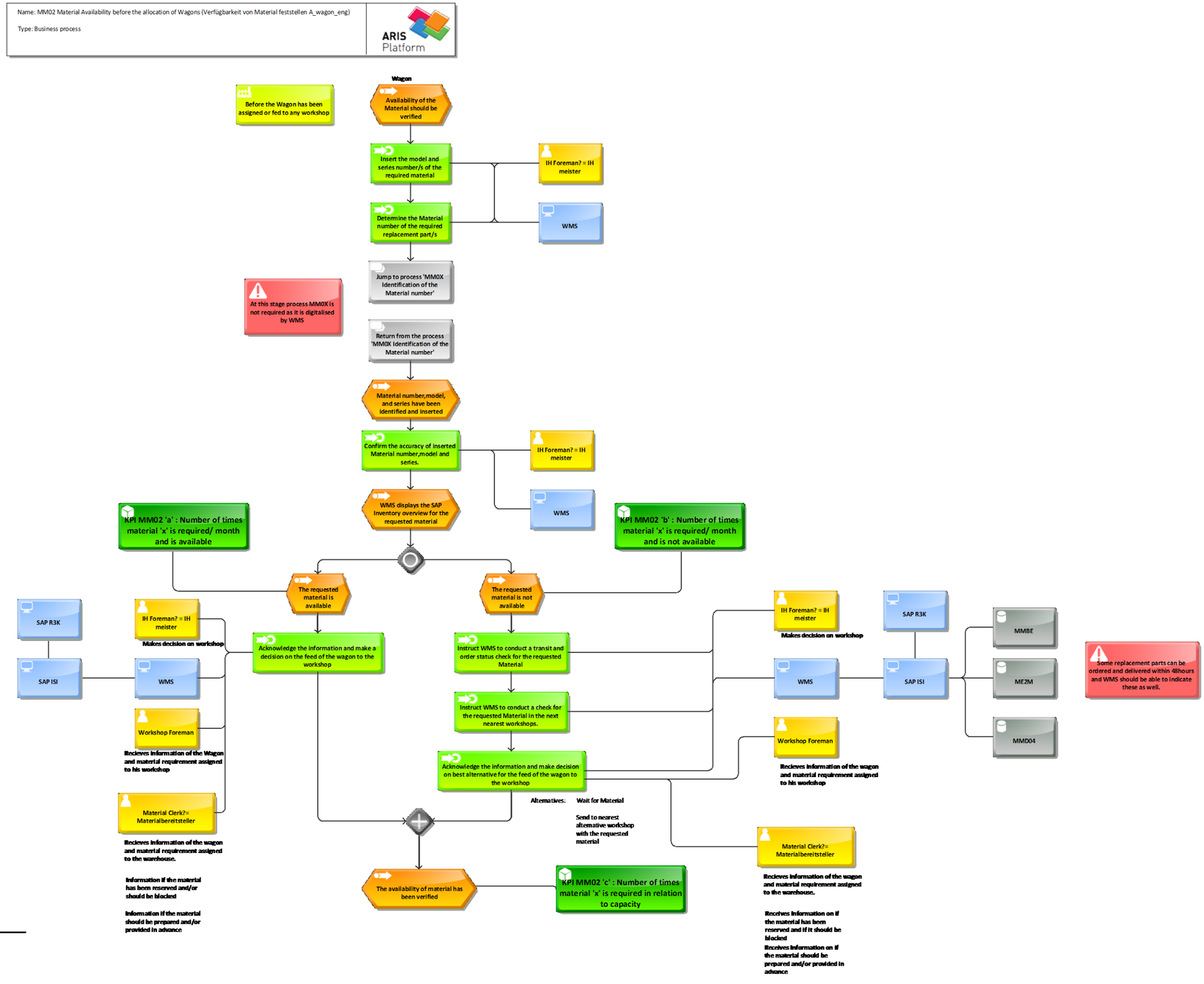
[13] Source: (DB Schenker Rail, 2014)

Figure 4[14]: MM01 Material availability before the allocation of Locomotives



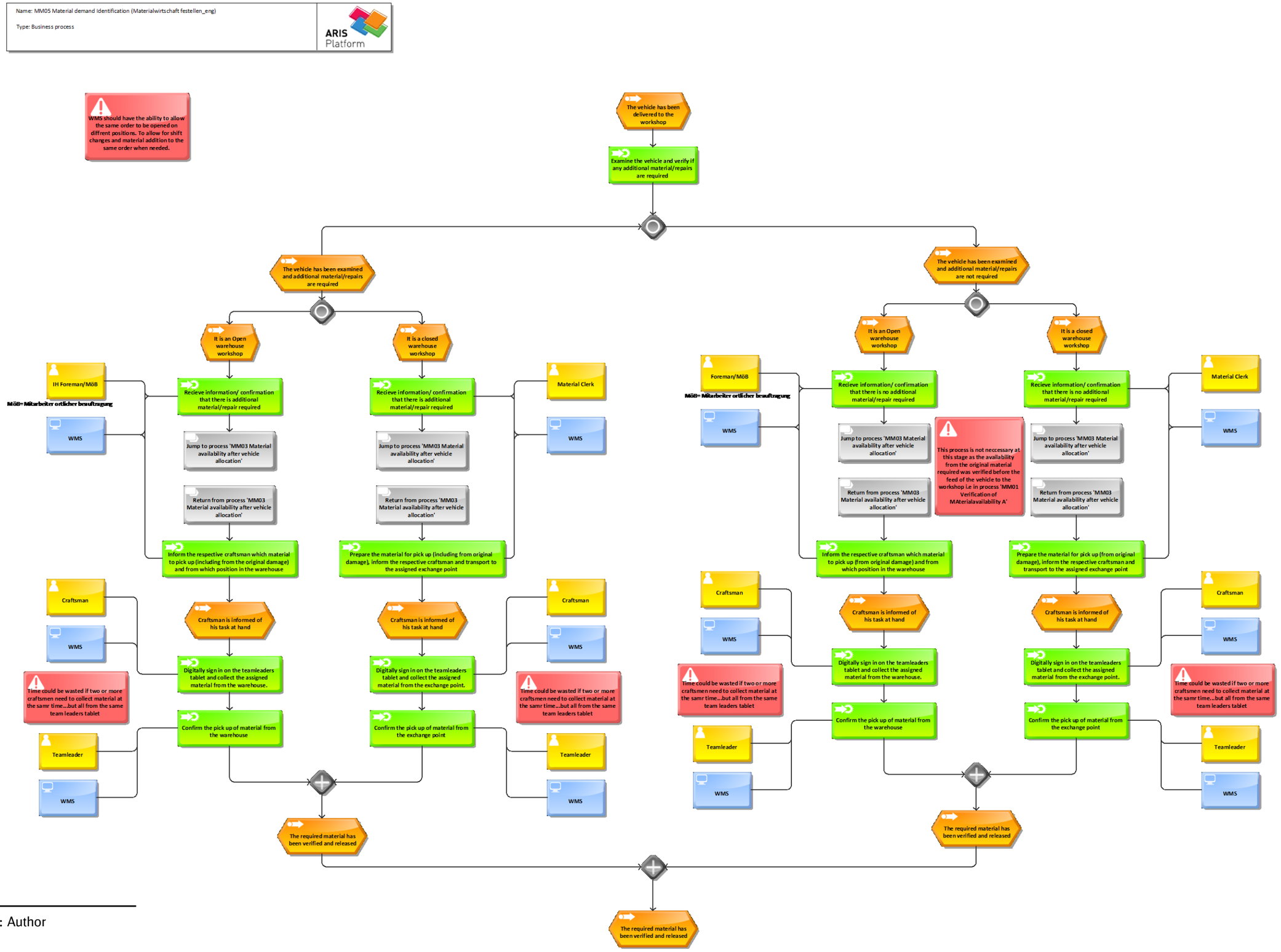
[14] Source: Author

Figure 4b[15]: MM02 Material availability before the allocation of wagons



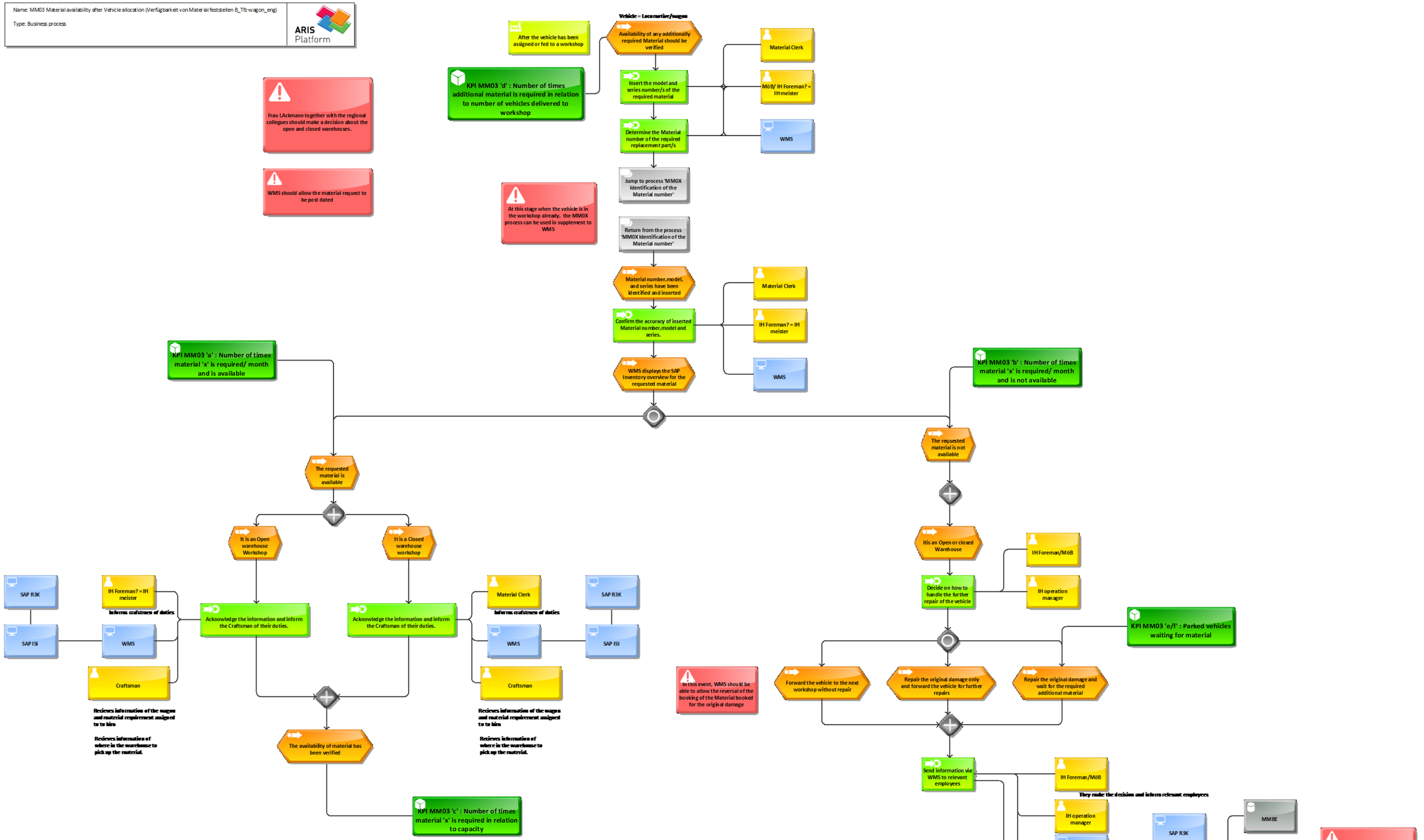
[15] Source: Author

Figure 5[16]: MM05 Material demand Identification



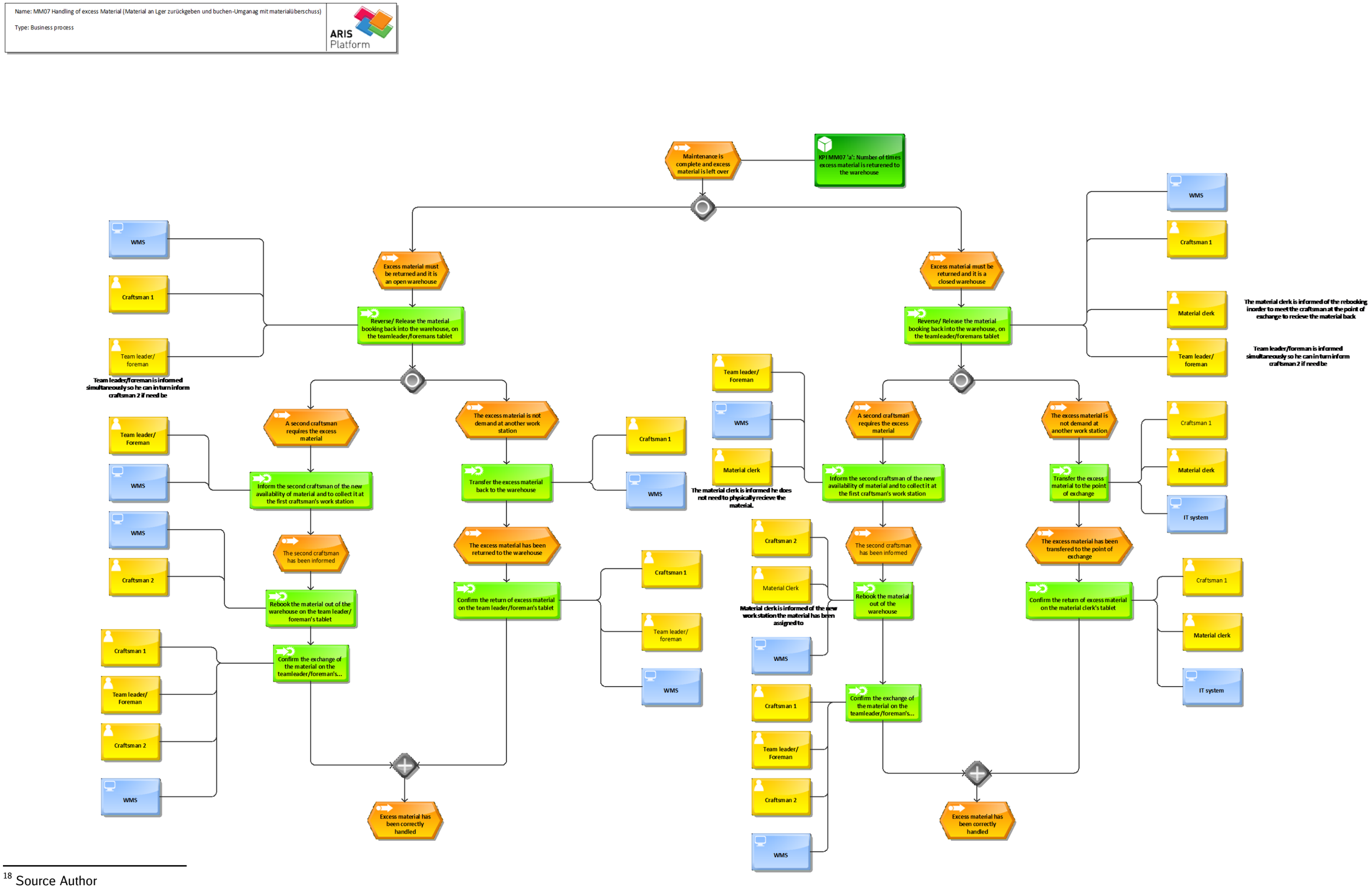
[16] Source: Author

Figure 6[17]: MM03 Material availability after vehicle allocation



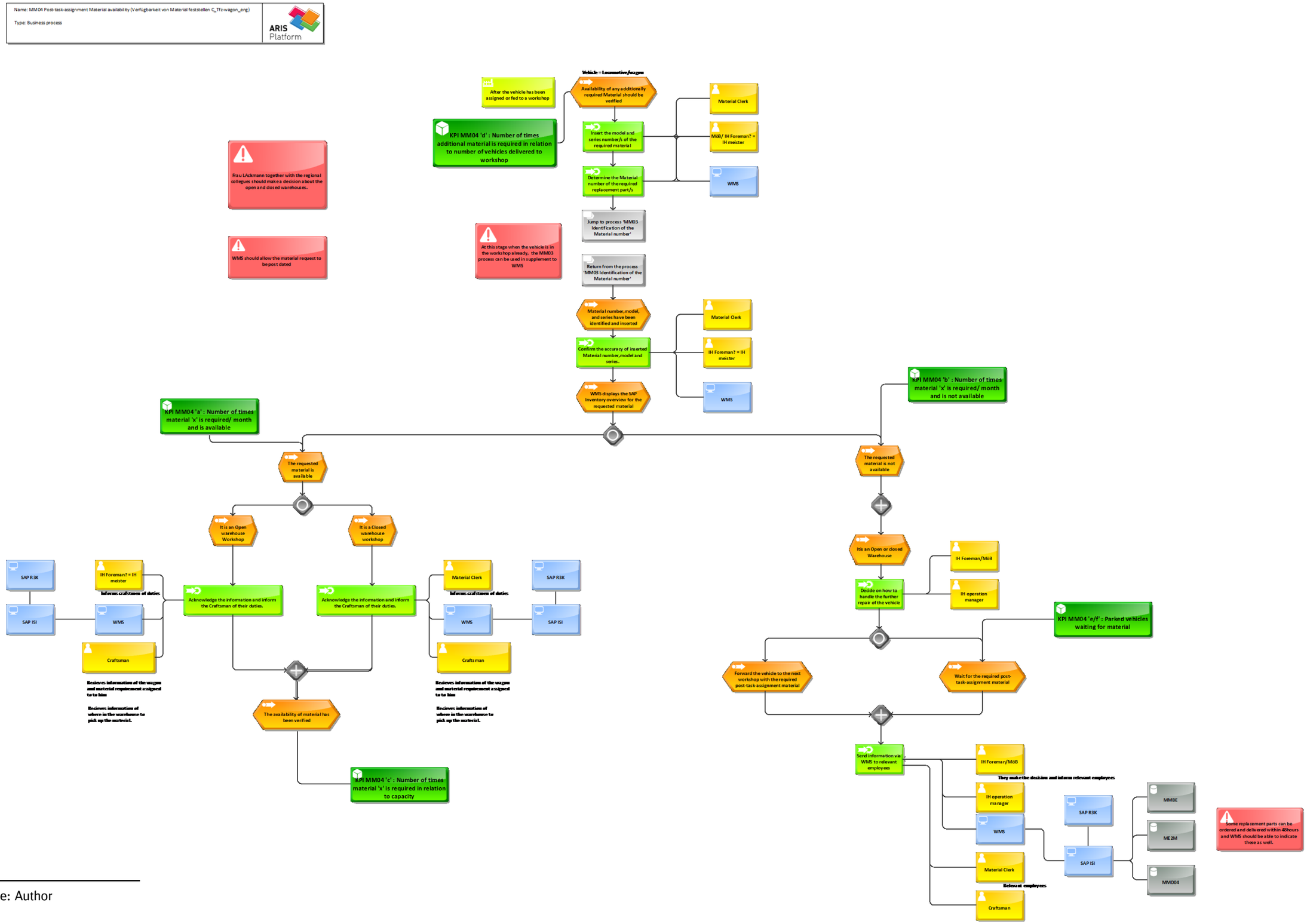
[17] Source: Author

Figure 7[18]: MM07 Handling of Excess Material



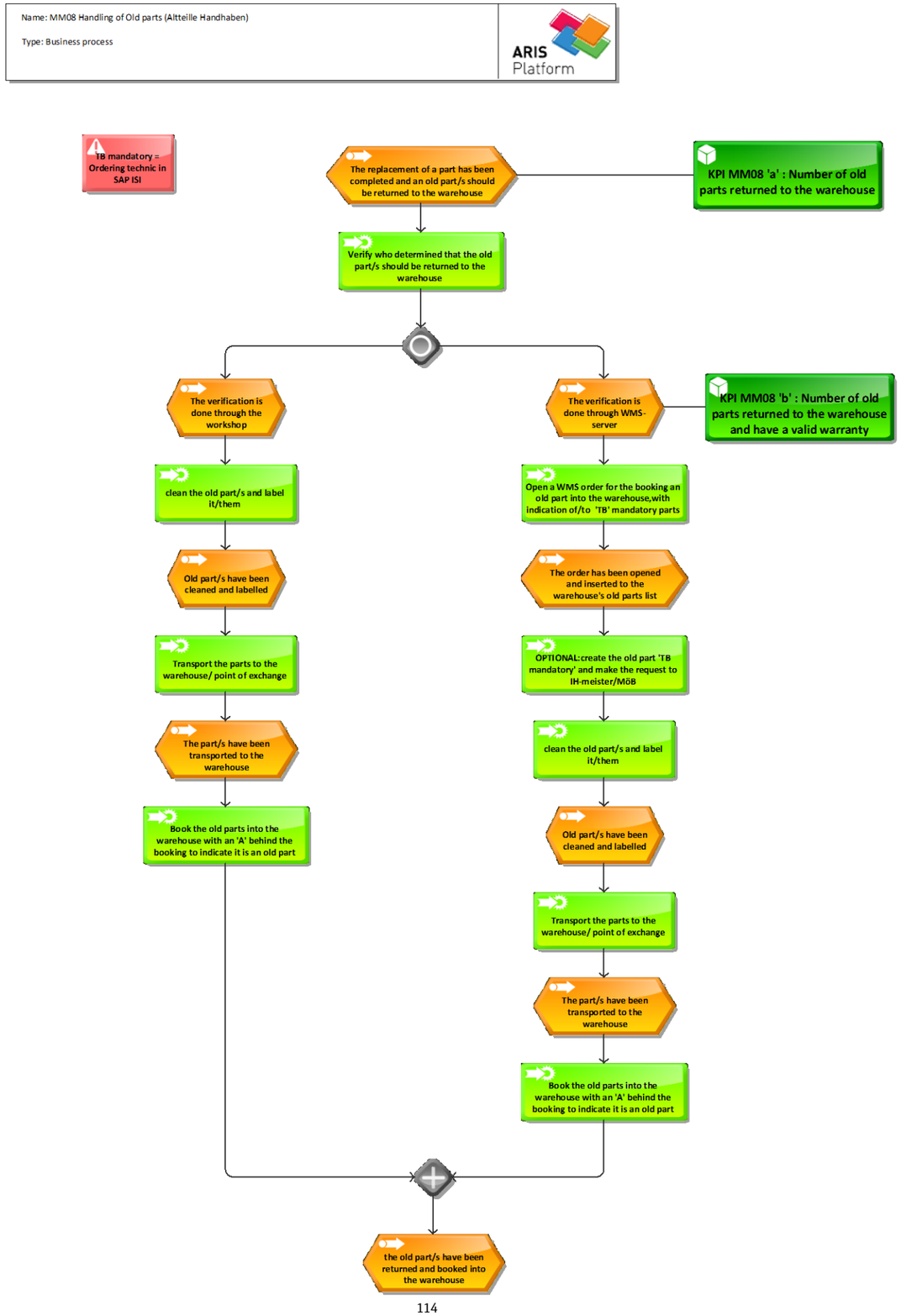
[18] Source Author

Figure 8[19]: MM04 Post-task-assignment Material availability



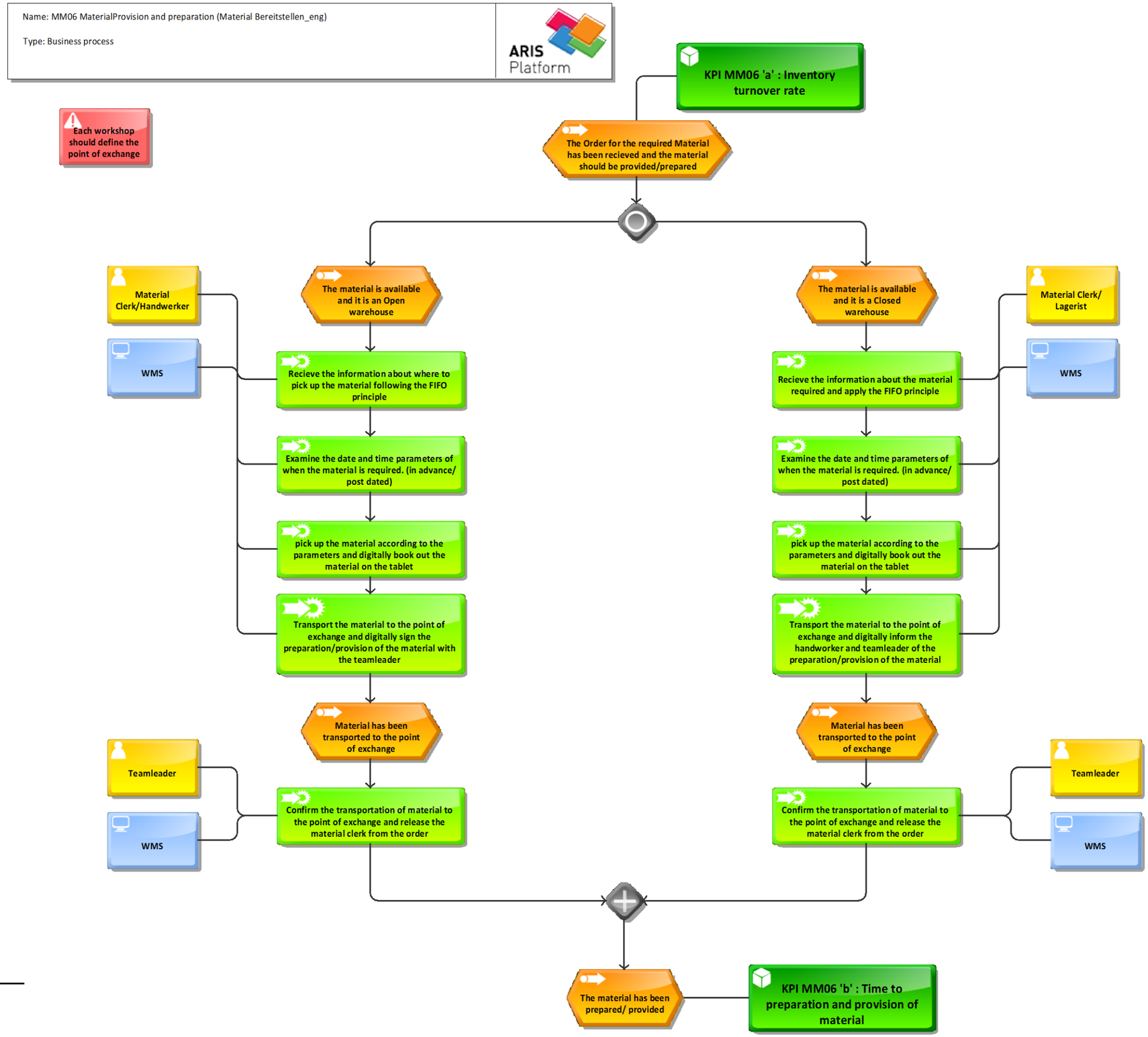
[19] Source: Author

Figure 9[20]: MM08 Handling of Old Parts



[20] Source: Author

Figure 10[21]: MM06 Material Provision and Preparation



[21] Source: Author