Value Engineering

Master in Product Design Engineering

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Master's internship report held under the guidance of Doctor Fábio Simoes, Professor of the Higher School of Technology and Management of the Polytechnic Institute of Leiria.

Leiria, August 2019.

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Sincerely,

Eduardo Cerda Tolentino

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Abstract

MAN Truck and Bus AG is a leading international provider of commercial vehicles as well as well-known producers of diesel and natural-gas engines. This report focuses on the products manufactured in MAN Nuremberg assembly plant, which produces a wide variety of engines designed and developed for different applications for customer needs. As any other company in the industry, MAN has high expenses while producing their engines.

In response for this need, the PKO+ project was born. This project follows the VE ideology of improving the value of the goods or products by reducing the cost of the raw material, seeking of low cost suppliers, optimizing the product with or without customer perception, supply chain optimization, etc.

VE techniques have been applied to coordinate properly the communication between the different departments involved in this project.

The basics of this project and the starting process can be found in this report. These foundations consist of generating a support team, establishing long term targets, and processes to achieve such targets.

At the end, the results from period January 1st 2019 to August 1st 2019 are shown in this report.

Keywords: Value Engineering, Diesel Engine, Natural-Gas Engine, PKO+, Supply Chain Optimization, Cost Reduction.

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List of Acronyms

Value Engineering (VE)

Horse Power (hp)

Low Cost Countries (LCC)

Cross-Functional Teams (CFTs)

Nuremberg (NUE)

Exhaust Gas Recirculation (EGR)

Selective Catalytic Reduction (SCR)

Bill of Materials (BOM)

Produkt Kosten Optimierung Plus (PKO+)

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Chapter 1

Introduction

A main concern of any company is how to improve profit and reduce its costs, since any cost reduction is directly correlated to profit. The problem is how to carefully get rid of unnecessary costs since these ones cannot impact customers loyalty or reduce products quality[1]. For this reason, companies need to implement new and improved methods to reduce inessential expenses, and PKO+ shows how to achieve this. It describes a variety of tools and techniques used by the value engineering department to coordinate activities between the departments involved such as logistics, quality, engineering design, purchasing, controlling and validation, finance, and more.

Since MAN Truck and Busses announced that by year 2023 the company should reach a target saving of millions of euro, this cost reduction project was created to help in the process. This report describes the steps followed for PKO+ and the conclusions obtained during the internship period. PKO+ is a complex project, for that reason is necessary a full team organization.

Cost reduction is the easiest way to increase profit, and it is possible by removing wasteful elements from design and internal processes. Keeping in mind that quality or service cannot be sacrificed. The selection of a cost reduction target is key, since cost reduction in the long term cannot undercut a company, but the opposite, it makes sure to pare away not profitable expenses[1].

The main objectives of PKO+ is to save large amounts of money in a long term period and the product optimization of the series product. For that reason, this report is structured in a way that the reader can understand the company vision as well as the methodologies and tools used in the VE department. Afterwards, the activities performed in the internship are described to finally let the reader know the obtained conclusions.

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Chapter 2

MAN Truck & Bus AG

The intention of this chapter is to relate the reader with MAN, Nuremberg plant products and how the value engineering department can support such a big project as it is PKO+.

2.1 MAN Engines

MAN is recognized for being efficient producers of diesel and gas engines in performance ranges that goes from 50 hp to 2.000 hp. MAN develops, manufacture and sell pioneering products of excellent quality for different applications, assembly situations and load profiles. This translates into products that have been developed, modified and tested precisely. This company relies on the latest technology and sophisticated components from large-scale production. Whether product applications can be for commercial vehicles, power generation and co-generation, or drives for agricultural machinery, rail, water, or special-purpose vehicles for customized solutions.

The assembly plant that focuses on engineering development and production of engines is located in Nuremberg, Germany. Place where all the Powertrain PKO+ project takes place. Within a total plant surface of 355,253 squared meters.

However, Powertrain PKO+ focuses on the three most fabricated engines with commercial vehicles purposes, which are: D08, D20 (soon replaced by D15), D26, and external engines, mainly for marine applications. These models starts with a "D" since this letter stands for "Diesel", meaning that PKO+ is putting effort only in this type of engines.

MAN Engines			
On-Road & Strategic Cooperations	Off-Road	Power	Marine
Bus	Agriculture	Diesel	Pleasure
Special-purpose vehicles	Industry		Commercial
Component	Railway	Gas	Auxiliary

Table 2.1: Market Segment
(Source: MAN Internal Documents)

2.1.1 D08 Engine

This type of engines have an inline type of 4 or 6 cylinder, depending on the model D0834 or D0836, respectively. These engines are designed mainly for on-road applications such as busses and special purposes vehicles, for example street sweepers, airport busses, trolley busses, fire engines, etc.

Power ranges varies depending on the model. For example, D0834 has a power range of 37-162 kW and a displacement of 4,6 liters. Meanwhile, model D0836 power range varies from 56-251 kW, with a displacement of 6,9 liters.

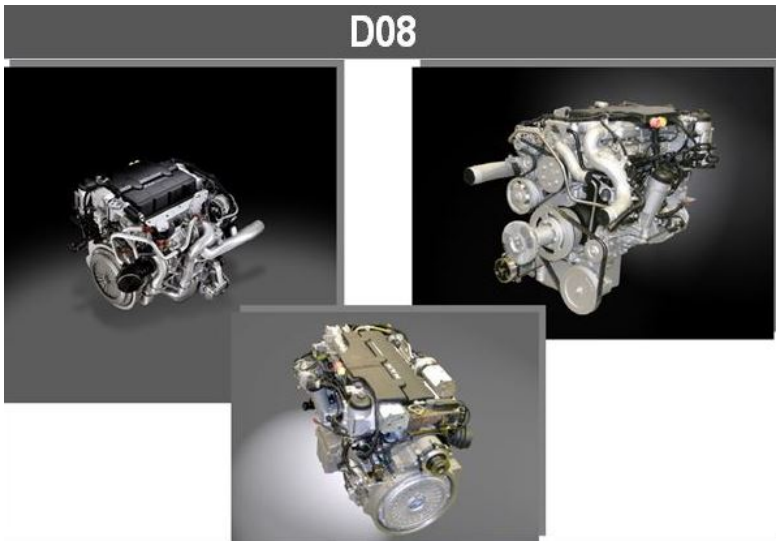

Figure 2.1: D08 Engines
(Source: MAN Internal Documents)

2.1.2 D20 Engine

The D20 model is a 6 cylinder engine used for off-road applications such as, agriculture (tractors, harvesters, cutters and crushers), industry (construction equipment, commercial machinery), and railway (rail cars, locomotives, metro).

Power range for this type of engine can vary between 118 kW to 328 kW and a displacement of 10,6 liters.

2.1.3 D26 Engine

The heavy duty engine model is the D26. It is a 6 cylinder engine that is used not only for on-road and off-road applications, but also can be used in marine applications.

D26 has a 12,4 liter displacement and a power range that goes from 140 kW - 588 kW.

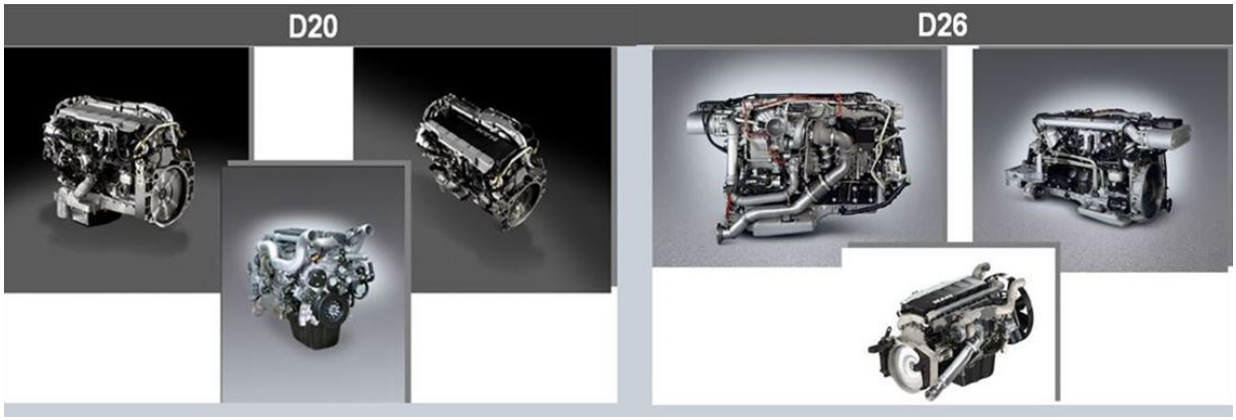

Figure 2.2: D20 & D26 Engines
(Source: MAN Internal Documents)

The table below (Table 2.2) offers a brief summary of MAN engine ranges:

MAN Engine Ranges

	Series	Type Inline	Displacement in L	Power range in kW	On-Road	Off-Road	Power	Marine
	D0834	4-cylinder	4.6	37 – 162	✓		✓	
	D0836	6-cylinder	6.9	56 – 251	✓		✓	
	D20	6-cylinder	10.6	118 – 328		✓		
	D26	6-cylinder	12.4	140 – 588	✓	✓	✓	✓

Table 2.2: MAN Engine Ranges
(Source: MAN Internal Documents)

2.2 Value Engineering

Value Engineering is an organized effort directed at analyzing the function of goods and services for the purposes of achieving basic functions at the lowest overall costs, consistent with achieving essential characteristics.

The goal of the value engineering department is to utilize the materials in the most economical way to better the most economical project. VE is a team effort, requiring contributions from all disciplines. All of these parties have a interest in common, which is to improve the product so that the entity can be more successful[2].

In other words, VE is a process using multi-disciplined teams to review projects and standards to identify high costs functions with improvement potential. The teams follow the VE plan to establish an optimum value for selected functions[2].

PKO+ has assigned the Value Engineering team as responsible for internationalization, de-contenting, product cost optimization and voice leader to coordinate all the parties involved in the project.

2.2.1 VE Methodology[2]

VE can look at ways to utilize resources (people, time, money, material) better and still accomplish the same function. In fact, behind VE there is a powerful methodology to problem solving, reduce costs, improve quality and performance, and maintain intended functions[2].

General: Before actual work begins, a foundation should exist consisting of good human relations, teamwork, and management support so that an effective interaction can take place and work can focus on specifics.

Information: Secure facts, determine costs, and fix costs on specifications and requirements.

Function: Define the function, evaluate functions relationships, and identify costs for these functions.

Creativity: Establish positive thinking and develop creative ideas in a team setting.

Evaluation: Refine and combine ideas, establish costs on all ideas, develop function alternatives, and evaluate by comparison.

Development: Develop and present proposals that resolve the study issues and motivate to action.

Implementation: This is the phase of the job plan in which the proposal is implemented and the product is improved by acceptance of the VE recommendations.

2.3 Synergies Between MAN Group

Business firms in many industries currently pursue the realization of synergies with high priority to increase corporate performance. The main advantages of a cross-functional synergy are the raise of efficiency in the products as well as the reduction of components cost. In addition to these advantages, companies focus on achieving profitable corporate growth by collaboration across their international business. For many companies is a way of growth in their saturated markets[3]

Strategic management have recognized and emphasized the importance of synergies for decades. Synergies are the prime rationale for alliances and for international firms. However, the realization of synergies into a coherent whole is costly and require resources, for that reason, it needs to be properly managed[3].

According to the definition, cross-functional synergies exist if the net present value of the combined firms is greater than the sum of the net present values of the individual firms. Therefore, from the perspective of a corporate manager, every cross-business activity that increases the net present value of the combined firms leads to cross-business synergies.

For PKO+, these alliances are essential because companies can join together to get some cost reduction savings. To have a better approach on MAN Truck and Bus synergies, it is important to know that MAN is a sub-company from the Volkswagen Group. The Volkswagen group comprises twelve brands from seven European countries.

To illustrate, figure 2.3 show these brands.

Figure 2.3: Volkswagen Group
(Source: MAN Internal Documents)

It is true that the Volkswagen Group is huge and is one of the main automotive influences worldwide. Inside this group you can find important brands like Volkswagen, Audi, Seat, Skoda, Bentley, Bugatti, Lamborghini, Porsche and Ducati. However, these brands are not really good alliances when referring to MAN since the structure of a car is totally different as the interface of a truck or bus.

In the other hand, TRATON is the truck and bus group created by Volkswagen. This group is conformed by brands like MAN, Scania, MAN Latinamerica, and RIO. Recently, has made a new alliance with Navistar. TRATON aims to become a global champion of the commercial vehicle industry and drive the transformation of the logistic sector[4].

TRATON leads the truck market in the European and Brazilian sectors and considerably increased unit sales by 13.7%. The name TRATON stands for tradition, transport, transformation, tonnage, among other meanings[4].

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Chapter 3

Product Cost Optimization (PKO+)

PKO+ comes from the German meaning of Produkt Kosten Optimierung Plus, which means, "Product Cost Optimization, Plus" and it is a cross-functional cost management program to intensify the identification and realization of cost potential for serial products in a long term. It need to be taken seriously since it involves a lot of resources and has really big targets. The main categories under PKO+ are product cost optimization, internationalization, de-contenting, and supply chain optimization. It is important to clarify that PKO+ do not include new product development but only current production.

3.1 Business Goals

The main goals of the PKO+ project are:

- Money savings in a long term period

- Product optimization of series product

In order to reach these objectives it is necessary that all the parties involved joint responsibilities, and most important is that all the cost reduction ideas are not judged. Every idea needs to be challenge and everything need to reach top management and have a top priority.

3.2 Targets

The aim of MAN Truck and Bus is to save a high quantity of millions of euro in the period of 5 years. However, for the first year (2019), the target is 4,65 bigger compared with the savings obtained in 2018, from which, Nuremberg's engine plant, in charge of the powertrain system has to double the savings in comparison with 2018.

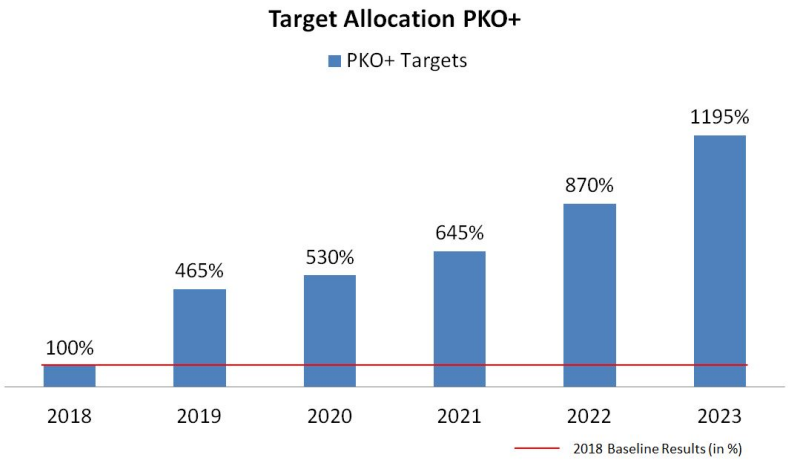
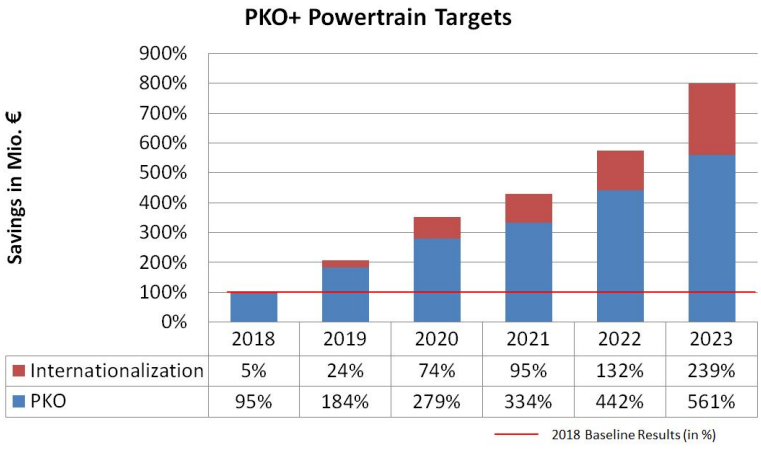


Figure 3.1: PKO+ Targets - Whole Project
(Source: MAN Internal Documents)



	2018	2019	2020	2021	2022	2023
Internationalization	5%	24%	74%	95%	132%	239%
PKO	95%	184%	279%	334%	442%	561%

Figure 3.2: 2019 PKO+ Powertrain Targets
(Source: MAN Internal Documents)

3.3 PKO+ Classification

3.3.1 PKO

This term refers to the continuous process of obtaining the best pricing/cost with no impact or reduction of scope of the product and ensuring the customer satisfaction scores are maintained. Some common practices to achieve PKO targets can be:

1. Identify potential by:

-Benchmarking

-Reference calculation

2. Reductions such as:

-Implement new technology

-Internal sourcing to LCC

-Optimizing existing parts

3.3.2 Internationalization

Internationalization in PKO+ means the seeking of new low cost suppliers in low cost countries, for instance, China, India, Mexico, Brazil, among others. It can be considerably cheaper to get parts done in low cost countries and pay importation fees rather than producing parts in Europe.

Currently a wide range of MAN products are made in Germany and the intention is to start sourcing more parts to LCC. To achieve this task it is necessary to be in constant communication with the purchasing team to close negotiations with the new prospect suppliers.

It is not easy to accept new suppliers in MAN. They need to meet all legal requirements and to migrate from one supplier to another a lot of validation tests need to be done.

The first phase to achieve 2019 goals is to source only the parts that do not require testing. At this point is not feasible to source parts like the cylinder block or the crankshaft for the short period time. In the other hand, bearings and other common parts are a good way to begin.

3.3.3 Decontenting

Decontenting can be understand as the removal of features in the engine with customer perception in order to sell it more cheaply. This is a though task, however, it is possible to gather all the engine engineers together and some external support experts to deeply talk about components that can be sold separately as options.

There is also a term called "reductive decontenting" in which the objective is to reduce the weight of many components to get an overall engine weight reduction.

For example, if the engine gets lighter, that translates to smaller brakes, smaller shocks, better fuel consumption performance, and cheaper shipping costs. At the end, the overall vehicle and process gets benefited by applying reductive decontenting.

3.3.4 Supply Chain Optimization

SCO is the reduction of cost regarding supply chain. Nowadays, supply chain has become a very complex system of people, processes and technologies[5].

To reach the targets, MAN is forced to optimize its supply chain process taking in consideration that this process needs to remains lean, manages costs, and capable to respond fluctuations[5].

3.4 Tandems

The meaning of Tandem in this context refers to the group of experts from the purchasing and engineering department. There exist one Tandem per engine category, which are the following: Tandem D08, Tandem D15, Tandem D26, and Tandem Cross-Functional Components. To achieve a successful result for PKO+, these Tandems need to be supported by validation, controlling, quality and production & logistic.

3.5 Product Examination

It is necessary to understand the product and know where the team is positioned. Support from the different members to get design details and engineering drawings are going to be crucial. Another important task is the coordination between the PKO+ team and the benchmark department to disassemble the engine and observing the sequence.

In today's competitive market, customer requirements on engine product functionality are increasing. Better fuel performance, higher power, faster acceleration, lower noise, and longer reliability life are a few examples. On the other hand, the supplier industry is trying to provide engine manufactures with advanced or luxury components, but it may not be financially viable at all.

There is a pressing need for system cost integration and control during engine development in order to design the least expensive product while meeting customer requirements. Although cost reduction opportunities exist in almost all engine components, there are main aspects that drive a high product cost, for example, emissions compliance, fuel economy improvement, and advanced features[6].

3.5.1 Introduction to Diesel Engines

In principle, a diesel engine is a type of compression-ignition engine using diesel fuel. According to emission standards and engine applications, diesel engines are classified as on-road, off-road and stationary. The on-road applications include trucks, buses and automobiles. The off-road applications include marine, agricultural, industrial and locomotive[7].

The American Automotive Manufacturers Association emissions certification methods for on-road applications, diesel engines are classified as heavy duty, medium duty, and light duty. Heavy duty applications include trucks, buses, certain off-road vehicles, marine engines, generator sets, etc. Light duty applications include passenger cars, sport utility vehicles and light trucks, like some pick-up trucks[7].

The American Automotive Manufactures Association divide these classifications in 8 classes, which can be seen in Table 3.1:

	Vehicle weight	Classification
Class 1	<6000 lbs GVW	Light-duty (LD) trucks
Class 2	6001–10,000 lbs GVW	Light-duty (LD) trucks
Class 3	10,001–14,000 lbs GVW	Light-duty (LD) trucks
Class 4	14,001–16,000 lbs GVW	Medium-duty (MD) trucks
Class 5	16,001–19,500 lbs GVW	Medium-duty (MD) trucks
Class 6	19,501–26,000 lbs GVW	Medium-duty (MD) trucks
Class 7	26,001–33,000 lbs GVW	Heavy-duty (HD) trucks
Class 8	>33,000 lbs GVW	Heavy-duty (HD) trucks

Table 3.1: Truck Classes according their general weight
(Source: American Automotive Manufactures Association)

According to different fuel injection methods, diesel engines are classified as direct and indirect injection. By air charging method, diesel engines are divided as naturally aspirated, mechanically supercharged and aerodynamically turbocharged. By cooling medium, diesel engines are divided into water-cooled and air-cooled. According to the after-treatment technology diesel engines can be classified into EGR (exhaust gas re-circulation) engine, non-EGR engine, SCR (selective catalytic reduction) engine, and non-SCR engine.

Comparison between diesel engines and gasoline engines

Understanding the fundamental characteristics of diesel engines is very important for engine system design and powertrain technology assessment. Compared to gasoline engines, diesel engines have the following advantages:

Advantages
Low fuel consumption and low CO2 emissions
High power
High torque at low speeds and better drivability
Low carbon monoxide and hydrocarbons

Table 3.2: Diesel Engine Advantages[6]
(Source: Own Elaboration)

However, there are several design challenges for diesel engines compared with their gasoline counterparts as follows:

Disadvantages
Higher smoke due to combustion
Lower exhaust temperature due to lean burn combustion
Higher noise from fuel injection
Heavier engine weight
Higher cost
Lower engine rated speed

Table 3.3: Diesel Engine Disadvantages[6]
(Source: Own Elaboration)

The above challenges are important system characteristics of diesel engines although they are inherently unfavorable. The best is to enhance the advantages of diesel engines and minimize, or at least not to increase, the disadvantages.

Main parts of a diesel engine

The main components of this type of engine are listed in Table 3.4

However, components like the aftertreatment, turbocharger, EGR system, fuel injectors, cylinder heads, piston, piston rings and the crankcase have a high impact regarding major cost increase for low emission engines.

Each of the mentioned items has a heavy weight on overall engine product cost. If each of them is not planned and controlled carefully, the entire engine will be at a risk of high cost. In diesel engine design there is a need to plan the integrated cost roadmap and to coordinate the cost structure.

Main Parts of a Diesel Engine	
Cylinder Rod	Rigid structure that keeps the cylinders in an appropriate alignment.
Injection Pump	Responsible for the fuel pressurization at the moment of injection.
Cylinders	Pipes where the pistons slide up and slide down inside.
Cylinder Head	Delimits with the piston the combustion chamber volume.
Oil Carter	Rigid structure situated at the inferior part of the engine which allows the lubrication system to feed the engine mobile elements.
Piston	It assures a tight blockade between the combustion chamber and the block. When the piston is submitted to the gases pressure, it transmits the explosion force to the connecting rod through its shaft.
Connecting Rod	Transmits the force exerted by the piston when the mixture air-fuel burns.
Crank Shaft	Transforms the alternated movement of the pistons in rotating movement and transmits the engine power for the gearbox, which relays for the wheels.
Flywheel	Maintains the uniformity of the rotation movement of the winches tree, assuring the constant speed of the crank shaft.
Valves	Each cylinder has an admission valve where the mixture to be burnt enters and an expulsion valve to leave the burnt gases escape.
Camshaft	Responsible for opening and closing the valves.

Table 3.4: Main Parts of a Diesel Engine[8]
(Source: Own Elaboration)

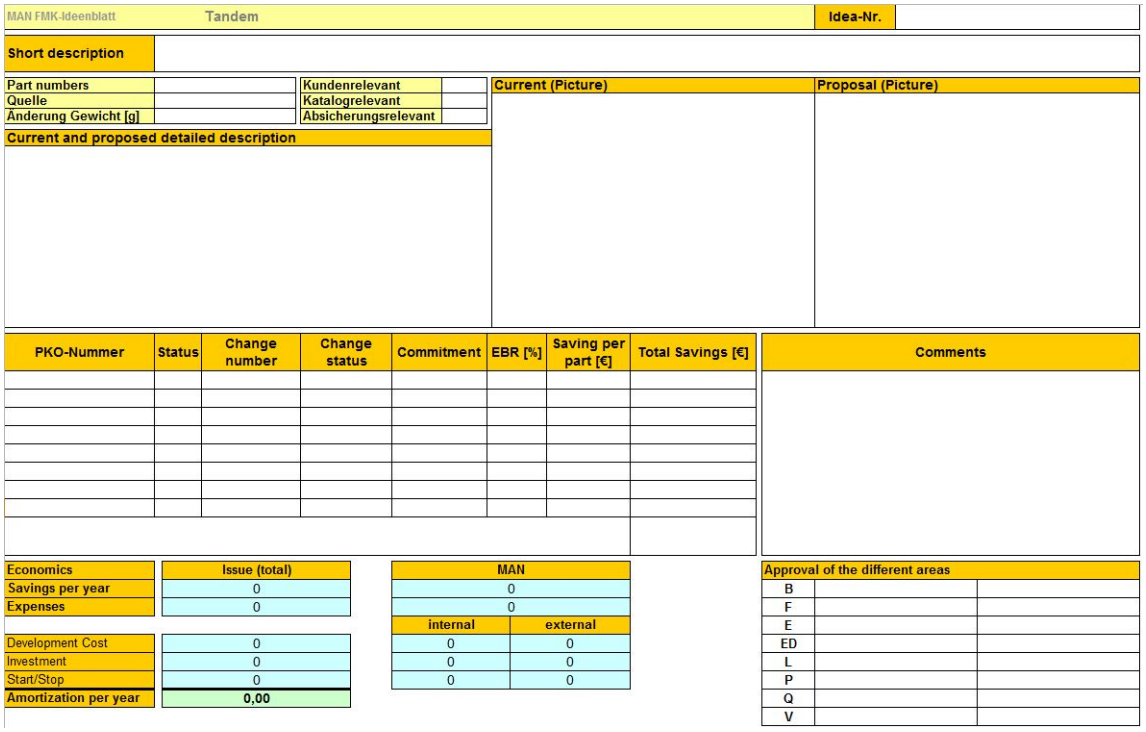
3.6 Powertrain Backlog

The powertrain backlog refers to an ordered list of ideas generated by each tandem. This backlog lists all the features and requirements that constitute the changes to be made to the engines in future releases. The backlog items have the attributes of a description, estimate values, images, savings, volume, among others[9].

The powertrain backlog refinement is the act of adding detail, estimates and order to the powertrain backlog. This is an ongoing process in which the PKO+ coordinator and the development team, collaborate on the detail of the powertrain backlog items. During the refinement, items are reviewed and revised. Higher ordered backlog items are usually clearer and more detailed than lowered ordered ones.

Idea Sheet

The idea sheet is what MAN uses to document all the generated ideas. This idea sheet need to be constantly updated since more information is added on it when going through the different process phases.



MAN FMK-Ideenblatt	Tandem			Idea-Nr.	
Short description					
Part numbers		Kundenrelevant		Current (Picture)	Proposal (Picture)
Quelle		Katalogrelevant			
Änderung Gewicht [g]		Absicherungsrelevant			
Current and proposed detailed description					

PKO-Nummer	Status	Change number	Change status	Commitment	EBR [%]	Saving per part [€]	Total Savings [€]	Comments

Economics	Issue (total)
Savings per year	0
Expenses	0
Development Cost	0
Investment	0
Start/Stop	0
Amortization per year	0,00

MAN	
0	
0	
internal	external
0	0
0	0
0	0

Approval of the different areas		
B		
F		
E		
ED		
L		
P		
Q		
V		

Figure 3.3: Idea sheet used by MAN
(Source: MAN internal documents)

Process Phases for PKO+

As mentioned above, the idea sheet pass through different phases. This is what MAN Truck & Bus call as "H" logic.

Figure 3.4: Process for PKO+
(Source: MAN internal documents)

This logic consist on filling certain type of information depending on which phase the idea is standing in a particular moment. This is mainly to avoid wasting time in case of an early discover of a non-potential idea.

In general, the development team generates a new idea and fill out basic information based on assumptions. Later on, more and detailed information is required for the next phases. The detailed description of the phases can be find in the table below:

Process Phases for PKO+

PKO+	New Idea (Idea)	Identification of Potentials (H0)	Measurements Evaluated (H1)	Measures Decided (H2) (H3)
Idea description	Rough description of the cost saving idea (not a concrete concept yet)	Description of idea (if not a concrete description it needs to be pointed out)	Description of the implementation concept	Detailed description of the concept, if possible, with specifications
Savings potential	Estimation of potential savings just based on assumptions	Estimation of savings based on assumptions and first possible annual volumes	Savings potentials based on the concept details, relevant vehicle volumes and rates	Confirmation of the savings potential by the business case of controlling
Feasibility	———	Feasibility assessment of the department representatives in the Tandem	All involved areas approved the concept of the saving cost idea Risks have been identified and evaluated	Any measures taken to overcome difficulties and avoid risks have been successfully completed.
Time / Appointment	Rough estimate of the earliest date of implementation	Estimate usage year and month	Rough schedule with the necessary actions is available	The detailed scheduling is available and the content is coordinated with the relevant departments
Expediture / Costs	———	Estimate of necessary expenses (engineering hours, for example)	The hourly estimates and external cost expenses are available	The necessary expenses have been confirmed by the relevant departments
Resources / Affordability	———	———	The affordability and necessary resources were queried and the results are available	The resources and affordability are confirmed by all relevant departments
Financial evaluation	———	Confirmation of the estimates by controlling	Estimation of the cost estimate sheet. If „Return of Investent" is too low it is neded to escalate the problem to the committee board	Confirmation of the business case and „Return of Investment" by controlling

Table 3.5: Description of Process Phases
(Source: MAN internal documents)

3.7 Benchmark

Benchmarking is a systematic approach to identify standards for comparison. It reveals the gaps in design attributes and provide ideas for design improvement. Benchmarking should include best-in-class objective attribute measures and research into how this attribute is achieved. It tends to be a business-based process used to measure and the improve performance. It can be effective in developing an understanding of the market and generating competitive advantage through increased efficiency[10].

A great technique is to perform a competitive benchmark design analysis. This technique analyses one fundamental design parameter against other by using a large amount of different engines. As benchmark may well form part of a business process, which will include a number of steps as illustrated in Figure 3.5:

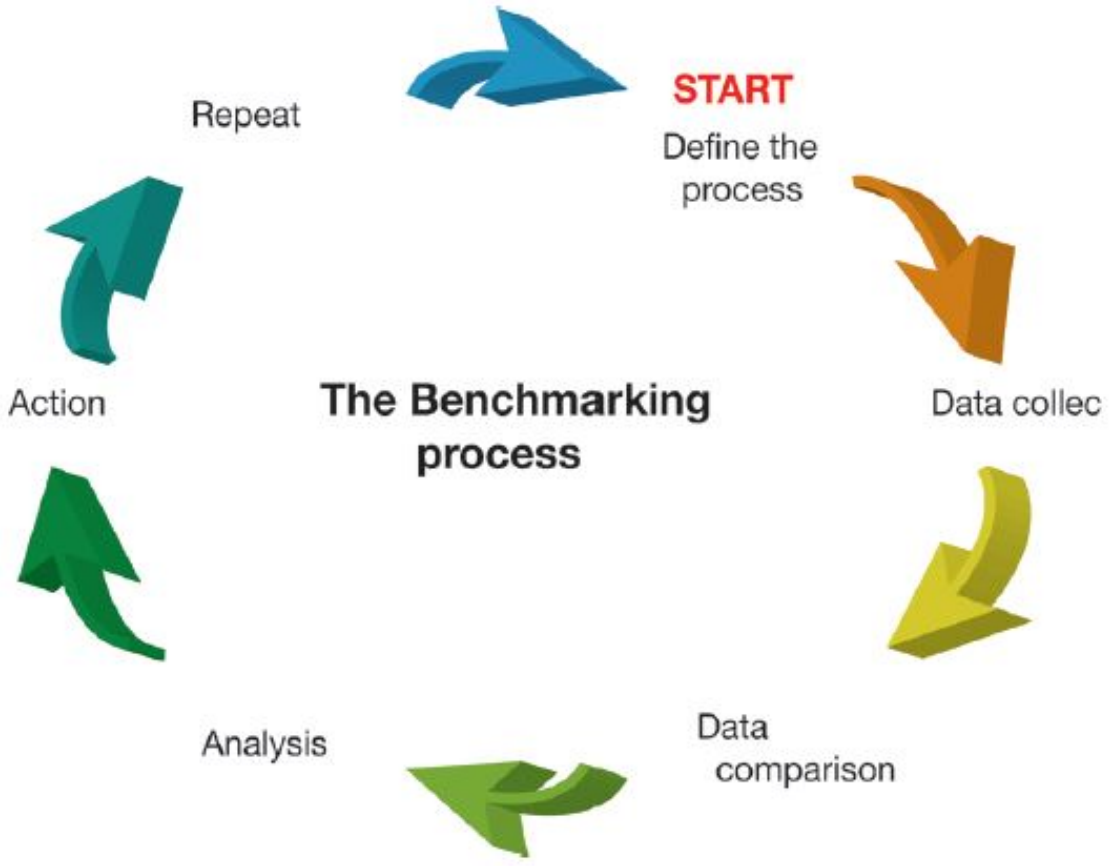


Figure 3.5: Benchmarking process
(Source: Cost analysis and benchmarking)

It is also worth considering the following before starting out on a benchmarking exercise:

1. Establishing a baseline with consistent use of measurement and cost breakdown. The baseline in this case are MAN engines and the intention is to compare it with other competitors engines.

2. Make sure the process to be follow is clear and define responsibility for data collection while keeping a simple structure.

3. Use appropriate technology to collect, manage and model data to get accurate results and ensure they are interrogated and reported.

Basic engine system design parameters are very important for analyzing performance and durability at an overall system level. Some common engine system parameters are presented as follows:

- The number of cylinders, which affects the torque balance.

- Engine cylinder bore diameter, which affects engine weight and wear.

- Cylinder centerline distance, conrod length, and piston compression height.

- Engine stroke, which affects mean piston and engine speed, and engine friction.

- Engine weight, among many others.

The benchmarking exercise will reveal the construction cost broken down into elements. An element is a major physical part of the engine that full fills a specific function or functions irrespective of its design. Then it is much easier to compare collected cost analysis data which can then feed into the estimating cost planning process.

Since MAN does not have enough resources to perform a benchmarking analysis, a consulting company has been reached out to provide engineers to perform such studio, gather data and share the results. This benchmarking process is not completed until the resulting data is analysed and neccesary action taken.

3.7.1 External Support for Benchmarking Analysis

Polarix is a consultancy company that aims to help external companies in the automotive, aerospace, engineering sectors. They coordinate solutions for different areas including benchmarking[11].

Polarix is a good option for MAN Truck and Bus since they have worked with benchmarking before for brands like Tesla and Scania and their work seems to be promising.

Background and Content

- MAN is planning a reduction in cost and technical improvement initiative called PKO+.

- Based on the current D08 design MAN would like to benchmark its own technical solution against suitable competitors solution.

- Main target of this benchmark is to understand the technical specifications of suitable competitors, to identify possible technical improvements as well as to set up derivations to full-fill the internal costing targets.

- Further target of the benchmark is, to understand the cost balance between MAN and the competitor solution on single parts but also in functional level.

Objectives

- Identify suitable competitors solution for an effective benchmark based on similar requirements for medium engines in the market.

- Preparation and moderation of structured competitors benchmarks.

- Detailed disassembly and evaluation of all engine components in the benchmark and documentation of results and findings.

- Bottom-up calculation of the engines as baseline and reference for cost out potentials.

- Development of clear recommendations for MAN engineering.

Polarix Approach

Polarix suggests a project with 5 main phases, which are illustrated in Figure 3.6:

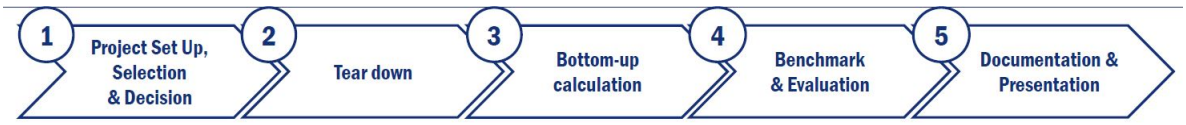


Figure 3.6: Polarix approach
(Source: Polarix Benchmark Analysis)

where;

1. Project Set Up, Selection and Decision: An approach, a team, a project plan and the competitors engines to evaluate are defined. Also common alignments such as the evaluation, calculation premises and the form of documentation are decided.

2. Tear Down: Disassembly of MAN engine and competitors engines happen in this phase with the intention of viewing the first specifications highlights such as weight and dimensions. The tear down also helps to identify technical potentials by comparing the engines. Finally, the documentation of the findings for evaluation and clarification.

3. Bottom-up Calculation: The project team aligns the calculation results and documents the cost information in MAN standardized bill of materials.

4. Benchmark and Evaluation: In this phase, the team compares and visualizes the calculation results. The generation and documentation of cost saving ideas is done, just to discuss the further development of workshops for such cost saving ideas. At the end, the team gathers to determine and evaluate the technical and commercial potential for the ideas generated.

5. Documentation and Presentation: Final overall documentation of the benchmark results. The final phase is to deliver MAN the substantial recommendations of possible actions and next steps for MAN design and engineering department. Handover of all calculations, documentations, etc.

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Chapter 4

Project House

Project House refers to the working space and the working methodologies that are used inside this working space to ensure that functions like Engineering and Purchasing identify, pursue, optimize, and implement the cost of the current products in the organization system and in the assembly line.

In Project House, the use of Cross-Functional Teams (CFTs) are key since they establish a closer link between functions and are considered to be a key factor to successful innovation. These teams are composed of those individuals from departments that are essential in achieving an optimal evaluation. PKO+ CFTs are structured as temporary teams because are not build in the organization structure. However, time and resources are being assigned to set up development, analysis and problem-solving studies[12].

The interaction of team members, from diverse backgrounds and experiences enhance to creativity which leads to new ideas and solutions. CFTs transforms work from sequential process to more simultaneous ones. The early and synchronized cooperation of all relevant functions helps to recognize potential problems in advance and allows for early countermeasures[12].

Creating CFTs for PKO+ have benefits not only in the way people interact to achieve the companies goals, but also creates some team spirit, which motivates people to make a good effort on their daily tasks. All the team members can get benefited from such team since everyone is continue learning from each other and broad the skills in the department. Having all the members in the same room creates transparency, which sooner or later transforms into trust.

4.1 Benefits of Project House

The potential advantages attributed to CFTs can be summarized in the following points:

Controlling Complexity

The increasing complexity of innovative tasks exceeds the information processing and coordination capabilities of individuals or functional groups. The combined expertise of CFTs is expected to add to the accomplishments of these tasks.

Efficiency

CFTs are expected to better perform certain activities simultaneously, wich otherwise would be performed sequentially.

Creativity

A greater variety of specialists offer a broader knowledge giving rise to more varied interpretations of the same information. These more varied interpretations are expected to result in more ideas being generated.

Communication

The communication is improved since it becomes clear, concise and constant. These leads to a fast alignment between functions and address problems more quickly. However, sometimes conflict can occur but is expected that this occur in a constructive matter.

Team Spirit

PKO+ gives the opportunity to make a team of high performers to take a big challenge and bring out a huge performance.

4.2 Concept of Project House

The intention of the project house can be summarized as follows:

Figure 4.1: Concept of Project House
(Source: Own Elaboration)

Where;

Ideation

This step is focused on the generation of ideas to meet PKO+ targets. If necessary, external support can be provided such as a benchmarking team.

Evaluation

Once the ideas are generated, it is time to prioritize them by due dates. It is necessary at this point to know all feasible options for year 2019. The evaluation consists of idea description, savings, assigned resources, efforts, timeline, etc.

Decision

In this stage, the Tandem presents idea to decision-making board. This committee needs to approve or provide feedback in case of rejection.

Implementation

The implementation consists of tracking the idea through the whole workflow process until it is implemented on the assembly line.

4.3 Agile Methods

Agile working means that self-organized teams steer through an environment of permanent change and constantly improve themselves.

Stacey Matrix

The Stacey Matrix is a decision-making tool to find the best approach for various projects and processes. This tool helped to determine that Agile is the correct approach for PKO+.

In the simple and complicated areas, the overall picture is already fixed and can be illustrated. It is about understanding the goal and the way to achieve it (Classical approach).

In the complex or chaotic areas, the overall picture is still unclear. Neither the goal nor the way to get there is clear. However, it is already clear that they will continue to change and therefore cannot be illustrated at the present time. You have to act or react until you have gained clarity (Agile approach).

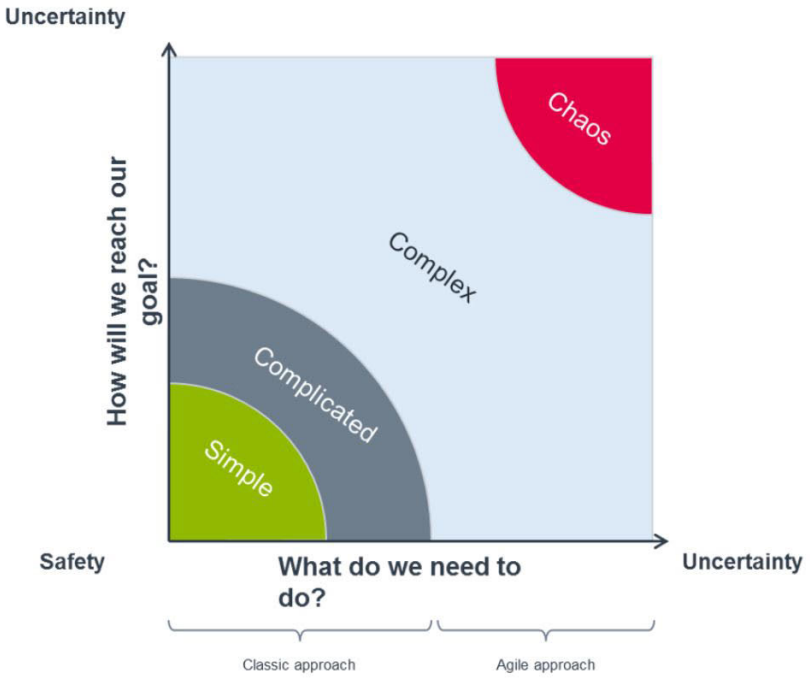

Figure 4.2: Stacey Matrix Concept
(Source: MAN Internal Documents)

Agile Values and Principles

To guarantee the success of agile working it is necessary to follow some values and principles and prioritize them since they need to meet MAN Truck and Bus working culture.

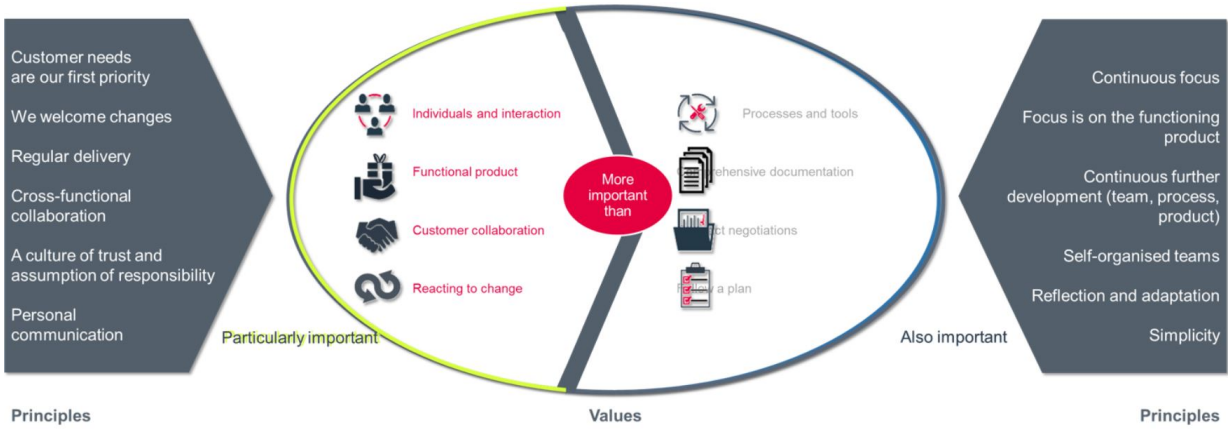

Figure 4.3: Agile Values and Principles
(Source: MAN Internal Documents)

Factors Influencing MAN

Figure 4.4 shows the agile factors that influence MAN.

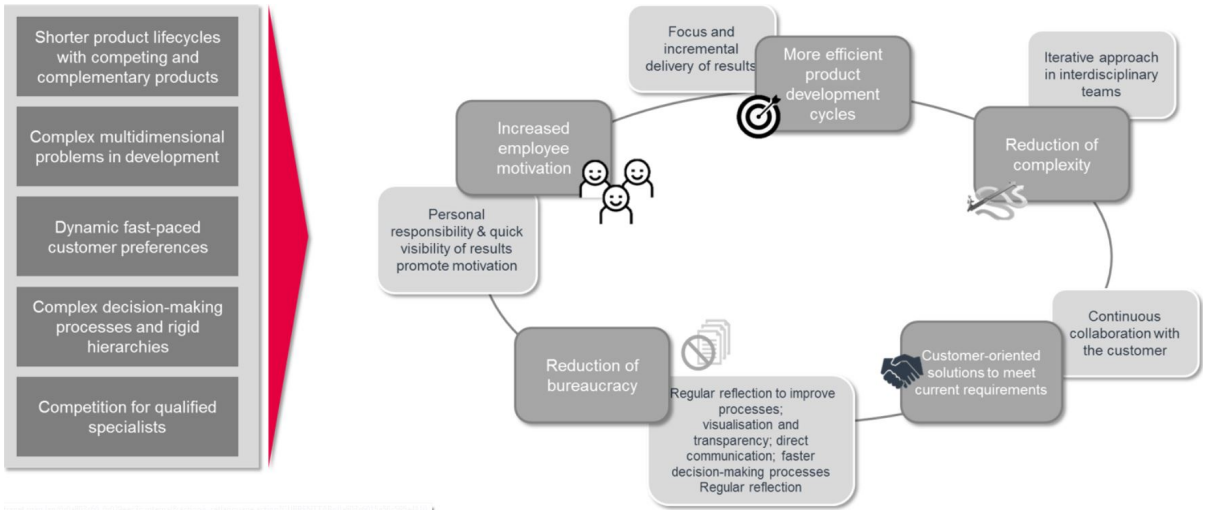

Figure 4.4: Factors Influencing MAN
(Source: MAN Internal Documents)

4.3.1 Design Thinking

Through Design Thinking, the needs of the customer are responded in a structured way in order to generate innovative solutions. It constantly examine the problem and its possible solution through an iterative approach[13].

It is commonly use for problem-solving situations or customer need analysis. It is common to find the following roles in this type of agile working: Presenter, Customer, and Interdisciplinary Team[13].

Presenter: The presenter takes over the content related and methodological organization of workshops. Makes sure that no one loses sight of the design challenge.

Customer: This role must not necessarily be physically present during development, but it would increase the speed of iterations. If present, it would always be a great help too.

Interdisciplinary Team: Here, experts of different departments that require a multifunctional, flexible point of view are in high demand. The more different point of views are represented, the more successful the process for generating ideas.

Procedure

Design Thinking procedure is not complicated. It follows a series of events that goes from understand the customer requirements up to the final step which is testing.

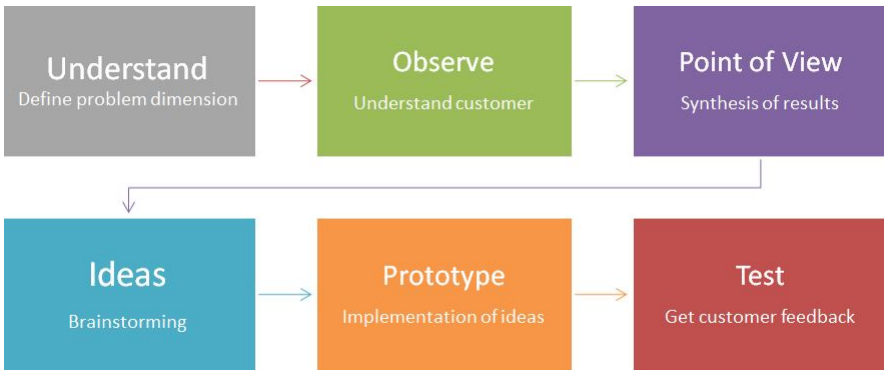

Figure 4.5: Design Thinking Procedure
(Source: Own Elaboration)

4.3.2 Scrum

Scrum is used for projects that are too large and complex to plan individual phases in detail in advance. The solution is self-determined and interdisciplinary teams that organise themselves according to defined guidelines, prioritize tasks and provide functions early on to include customer feedback[14].

Roles

There are three main roles in Scrum, which are: The Product Owner, The Scrum Master, and The Development Team.

Product Owner: Is the link to the customer, communicates his requirements to the team and prioritizes them. The product owner is responsible for maximizing the value of the product as well as the work of the development team and is the only person responsible for managing the product backlog.

Scrum Master: Is responsible for the understanding of Scrum and ensures that the Scrum Team follows the theory, practices and rules of Scrum Agile Work. He is a servant leader for the Scrum Team and helps to optimize the collaboration between the Scrum Team.

Development Team: Generates solutions from the requirements, plans them independently and implements them.

Artefacts

There are two types of backlog that need to be understand if PKO+ choose to work with Scrum.

Product Backlog: The product backlog is a list of customer requirements for the product. For PKO+ means, it is the list of ideas that need to be processes to meet the 2019 targets.

Sprint Backlog: The sprint backlog consists of the tasks to be performed for a sprint.

Procedure

Prescribed events are used in Scrum to create regularity and to minimize the need for meetings not defined in Scrum. All events are time-boxed, such that every event has a maximum duration.

Sprint: Cycle of 1-4 weeks, at the end of which a deliverable result is presented to the customer. The customer in this case means to the committee board.

Sprint Planning: The product owner communicates the goal to the development team, then the team works out how the goal will be achieved and plans the next sprint.

Daily Scrum: During the sprint, the team synchronizes daily for 15 minutes.

Review: The customer, in this case, the committee board, received a function based on which they can give feedback.

Retrospective: The team discusses how they can improve.

Backlog Refinement: The items in the product backlog are prepared for the upcoming sprint by being refined by the product owner together with the team.

Figure 4.6: Scrum Procedure
(Source: MAN Internal Documents)

4.3.3 Kanban

Kanban is an agile tool designed to help visualize work, limit work-in-progress and maximize flow process. It offers transparency in the department environment and thus offers an extremely high degree of flexibility. As flexible as Kanban may be, the focus must be maintained. This means the task started must be finished before starting a new one. With a maximum number of tasks coordinated in the team, this way, the team is protected from overload, quality is ensured and a fast pace is maintained. It also prevents tasks from remaining unfinished on the board[15].

This Agile tool is frequently used to manage projects, departmental activities, and meetings. The versatility is the major advantage Kanban offers, because this methodology is a comprehensive approach, which in principle can be applied to any existing process, whether Agile or not[15].

Kanban does not provide for explicit roles or fixed events. It is, however, important that there is at least one person who understands the principles of Kanban and feels responsible for the process. This may be the project lead, product manager, a Scrum Master, a department manager or an external coach. It is recommended the regular performance of retrospective to ensure harmony and constant optimization of the process.[15].

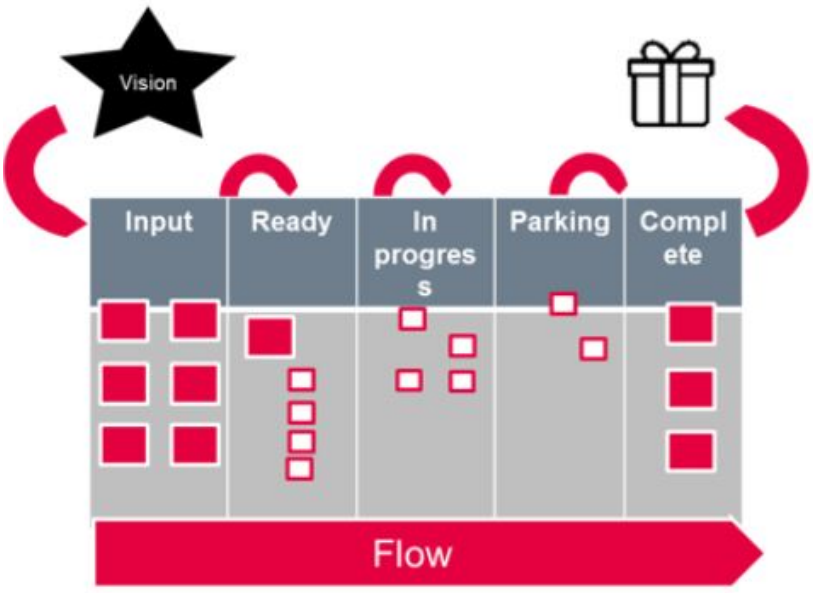

Figure 4.7: Kanban Flow Chart
(Source: MAN Internal Documents)

4.4 Team Members

At this point, the benefits of creating a cross-functional team were reviewed and briefly discussed some fundamentals concepts of the work methodology. However, it is time to formalize the project by assigning names to this cross-functional team.

As you may know by know, a cross-functional team gathers together a group of specialists with different backgrounds, and it is expected an innovative work from it. The following areas were considered for this project: Engineering, Validation, Purchasing, Materials, Controlling, Quality, Production, Logistics, and PKO Coordinators.

	External Engines	D08	D15	D26	X-Functional Components
Coordinators	Schmitt, Juergen (EPBS), Kloiber, Frank (BKO), Berg, Christian (BKO)				
Engineering	Huneke, Bernd (EPEPM)	Simon, Wolfgang (EPELT)	Spaeth, Moritz (EPEMT)	Rauscher, Sebastian (EPEHC)	Andersson, Kristoffer (EPEC)
Validation	-	Beckstein, Walter (EPPLM)	Hilbich, Nadine (EPPMM)	Luehmann, Lennart (EPPHV)	-
Purchasing	Porfyris, Georgios (BPE-N)		Nolte, Annalena (BNP-N)		
Materials	Dr. Scharf, Peter (EPTM)				
Controlling	Fischer, Reiner (FPU)				
Quality	Weis, Gerhard (GQKP)				
Production	Krawczyk, Justyna (PKPV)				
Logistics					

Table 4.1: PKO+ Team Members
(Source: Own Elaboration)

4.5 RASI Analysis

Once we know the team members, it is important to define their roles in the project and assign responsibilities. Otherwise, work can be done twice, or nobody feels responsible for doing certain tasks.

The RASI Matrix is an integrated view of who is involved and in which role across all project activities from start to end of the project. RASI stands for, Responsible, Approving, Supporting, and Informed. It is important that only one role can be responsible per activity[16].

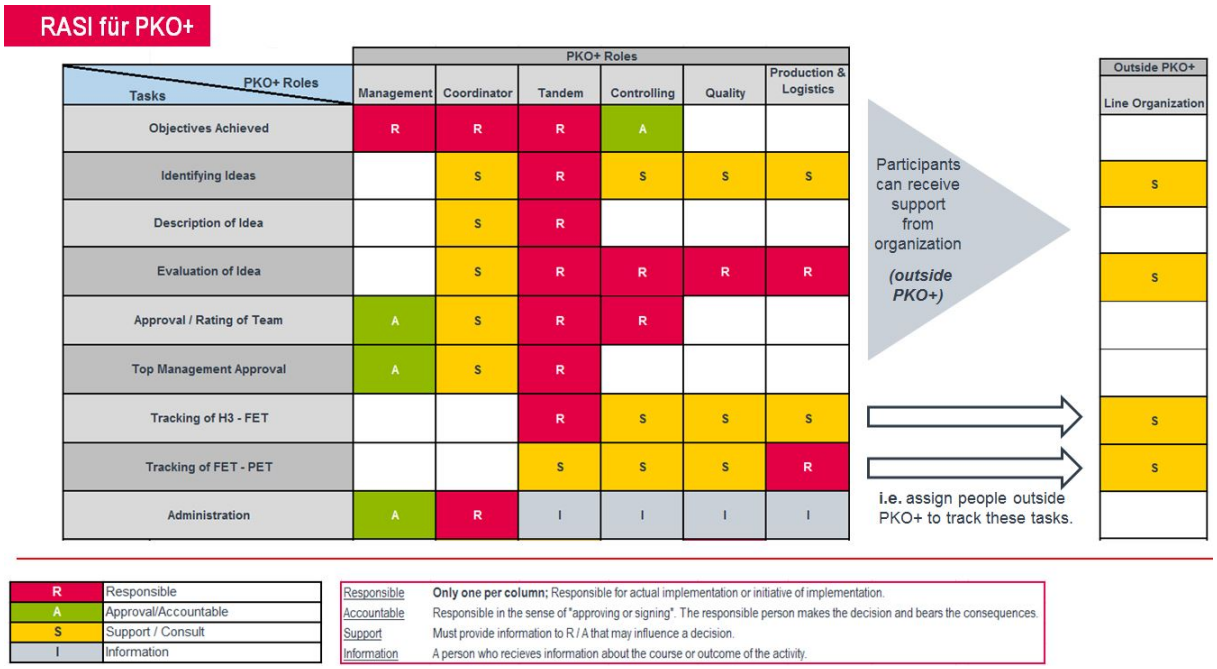

Figure 4.8: RASI Analysis for PKO+
(Source: Own Elaboration)

In Figure 4.8 can be noticed that more than one role is assigned as responsible for an activity. The reason for this, is that inside that activity there are some sub-activities which have different responsible. For example, under "Evaluation of Idea" there are activities such as, technical documentation, get quotes, get supplier lead times, timeline and define resources, and the Tandem is the responsible for these activities. You can also find tasks like quality and production & logistics efforts/timelines, which the quality expert and production & logistics expert are the main responsible. Finally, the evaluation of the business case is a task that the controlling specialist needs to make.

4.6 Layout Distribution for PKO+

MAN Truck and Busses, plant Nuremberg is a huge place. Where you can find areas of production, logistics, R&D, Administration, among others.

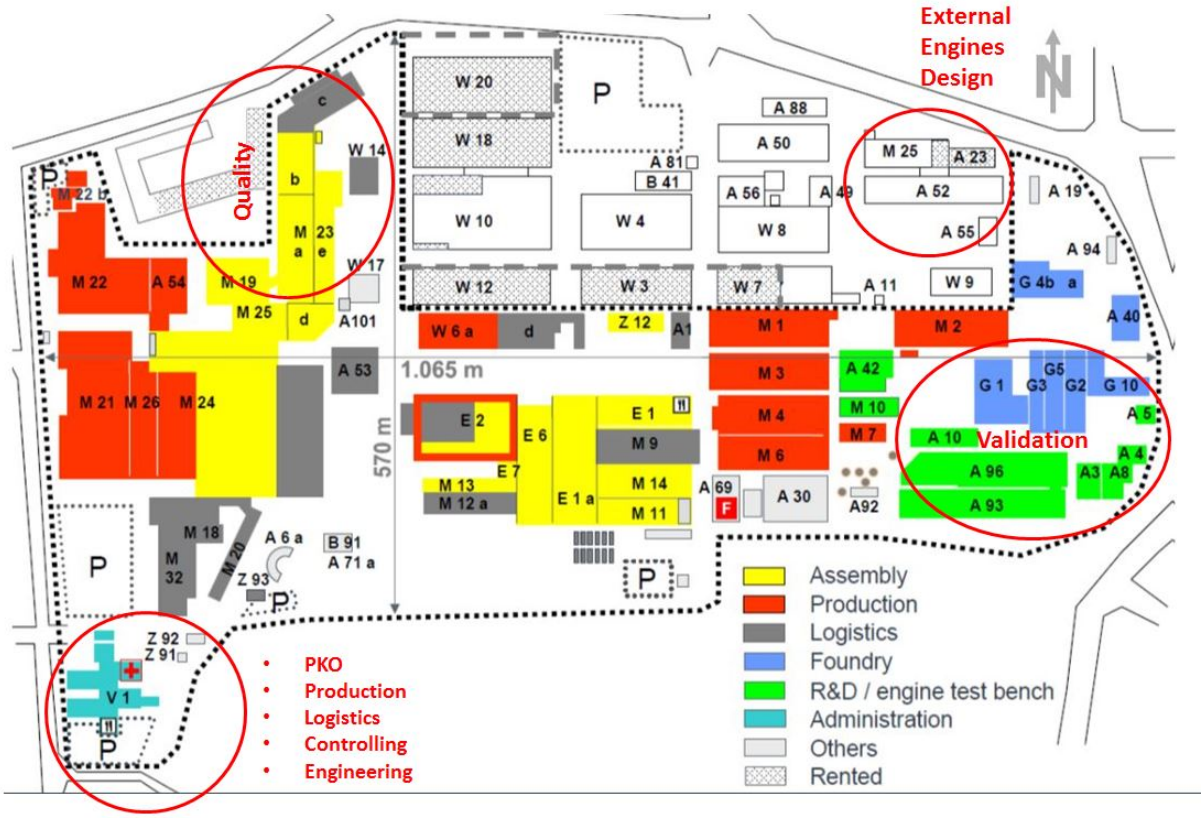

Figure 4.9: MAN NUE, Layout Distribution
((Source: MAN Internal Documents)

For that reason, as owners of the PKO+ projects, it is necessary to provide a working space for the participants, where they can join together and discuss PKO+ issues and work on solutions.

The following image shows the assigned rooms to each Tandem. All rooms are located in the same floor and in the same building V1, which is the administrative building.

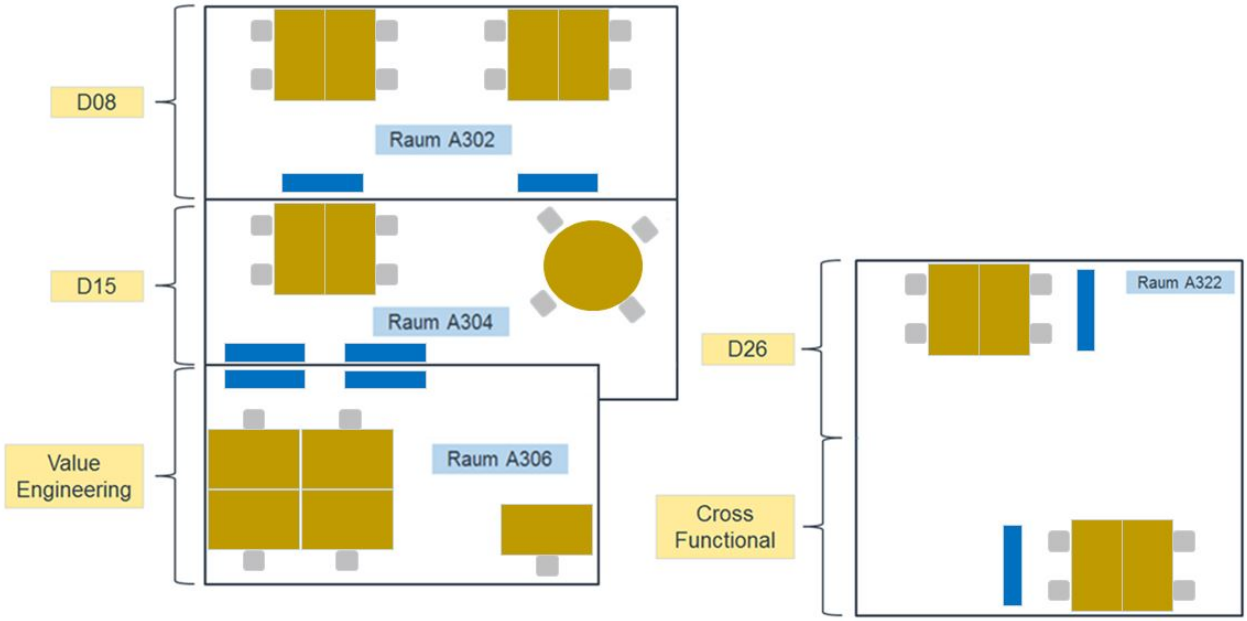

Figure 4.10: PKO+ Layout Rooms
(Source: Own Elaboration)

4.7 Workflow Process Concept

It is important to define a workflow process in order to create structure and operate with a great deal of efficiency. Operating with a loose process structure can be costly when dealing with correcting errors and managing damage control.

Figure 4.11 shows the workflow process concept that PKO+ demands.

Tandem

In charge of generating ideas including estimation feasibility and evaluating measures, such as, savings, timelines, etc.

Premeeting

Evaluation and confirmation of idea feasibility.

Powertrain Steering

Reviews the idea and improves its quality. Provides direction to the Tandem team.

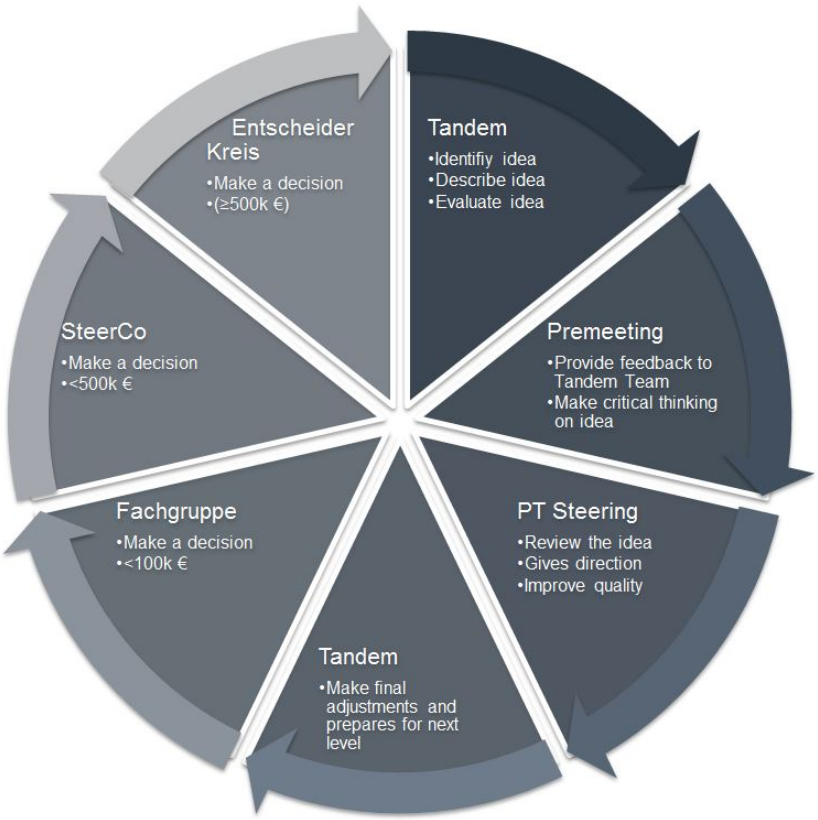

Figure 4.11: PKO+ Workflow Process Concept
(Source: Own Elaboration)

Tandem

If Tandem receives back the proposed changes, in this stage, they make the final adjustments and prepares for next level.

Fachgruppe

Makes a decision if budget does not reach 100.000,00 Euros.

SteerCo

Makes a decision if budget does not reach 500.000,00 Euros.

Entscheider Kreis

Makes a decision when budget reaches 500.000,00 Euros or more.

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Chapter 5

Developed Activities

5.1 Project House Workshop

This workshop consisted on three activities. The first one was to generate and discuss the first ideas, the second one was to create a working model and the last one was to propose their own schedules for PKO+.

To accomplish these tasks, the value engineering team provided markers, papers, pinboards, kanban boards, monitors, and more objects to the Tandem Teams.

5.1.1 Kick-Off Meeting

The objective of the kick off meeting for project house was to introduce everybody, explain the project house concept, explain the targets to the team and make a workshop to keep things dynamical.

Create and Prioritize Ideas

The first thing was to assign the tandems to their working rooms and start working on the first ideas. The purpose is to generate as many ideas as they can. In a further step the Tandems need to prioritize and work first on the ones that can be done for 2019.

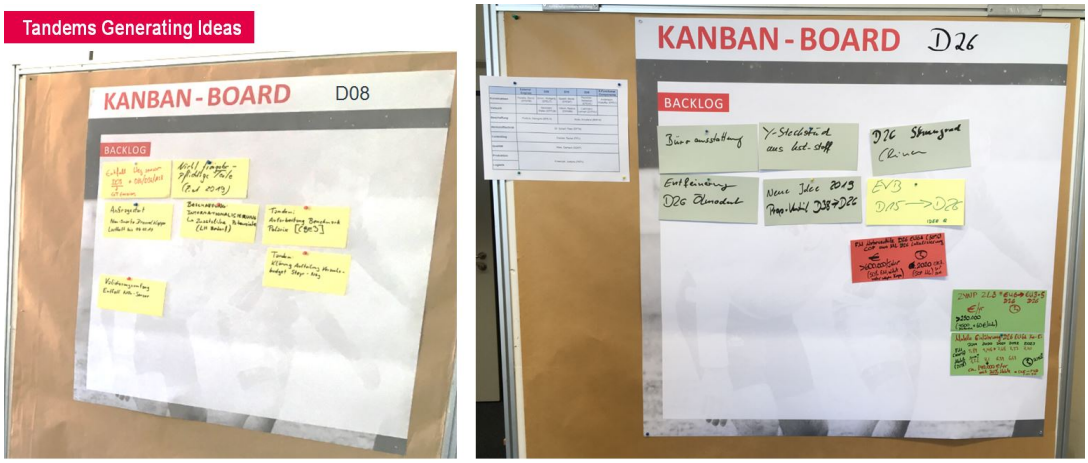

Figure 5.1: Project House Workshop 1,1
(Source: Own Elaboration)

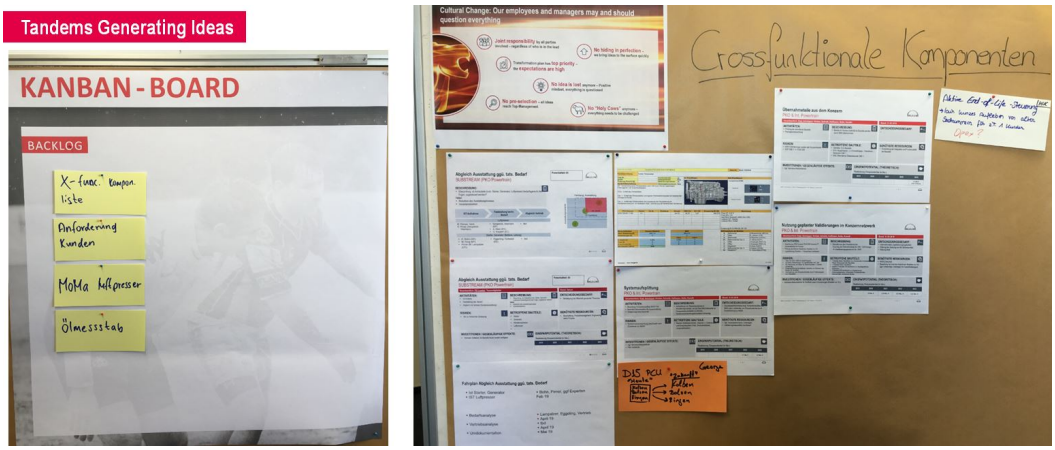

Figure 5.2: Project House Workshop 1,2
(Source: Own Elaboration)

Discuss Working Model

The workflow was discussed in detail by all Tandems and PKO+ Coordinators as a basis for structuring the weekly schedule and align the new ideas with the current workflow process.

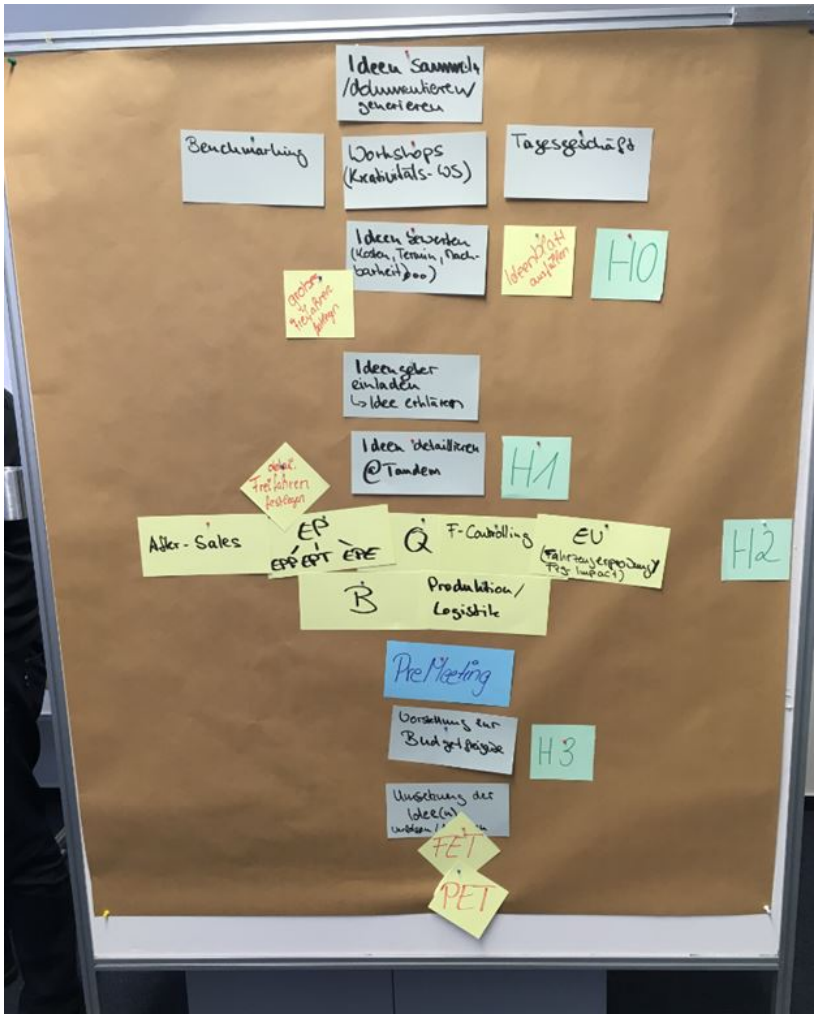

Figure 5.3: Project House Workshop 2,1
(Source: Own Elaboration)

Tandem Schedules

The purpose of this activity was to assign some working time to this project. At the moment, Tandems will not focus on PKO+ a 100%. The intention was to gather everyone together to discuss what will be the best time to meet.

Blank schedules were provided and Tandems needed to fill them out with glued spots. The only fixed times are the Stand Up meetings, which happens every Monday from 9:00 to 10:00 and the PT Steering meeting, which happens every Friday from 10:00 to 12:00.

Now, it is possible for VE to analyze and generate schedules for each of the Tandems.

Figure 5.4: Project House Workshop 3,1
(Source: Own Elaboration)

5.1.2 Project House Results

Team Members Availability

The tandem schedules were analyzed and the conclusion can be observed in the image below:

PKO+ Availability

	Monday								Tuesday								Wednesday								Thursday								Friday							
	D08	D15	D26	X-Fct	ExtE	Q	C	P/L	D08	D15	D26	X-Fct	ExtE	Q	C	P/L	D08	D15	D26	X-Fct	ExtE	Q	C	P/L	D08	D15	D26	X-Fct	ExtE	Q	C	P/L	D08	D15	D26	X-Fct	ExtE	Q	C	P/L
9:00-10:00	Weekly															D08																								
10:00-11:00						D08	D08																										PT-Steer Meeting					Weis, Hasa ch		
11:00-12:00						D15	D15																															Weis, Hasa ch		
12:00-13:00	BREAK TIME																																							
13:00-14:00																X-Fct																								
14:00-15:00																																								
15:00-16:00						D26																																		
16:00-17:00						D26																																		

Figure 5.5: Team Members Availability
(Source: Own Elaboration)

PT Steering Meeting

The PT Steering is a meeting where the progress of the tandems is evaluated by top management. Top management can give feedback and direction to the Tandems in these meetings.

The duration of this meeting is 2 hours, where, 30 minutes are spent per Tandem (D08 - D15 - D26 - Cross Functional Components) and this events happens once a week, in this case, on Fridays from 10:00am - 12:00pm. At the end of the PT Steering meeting, a minute is sent to all the team members to have in mind their tasks for the next week.

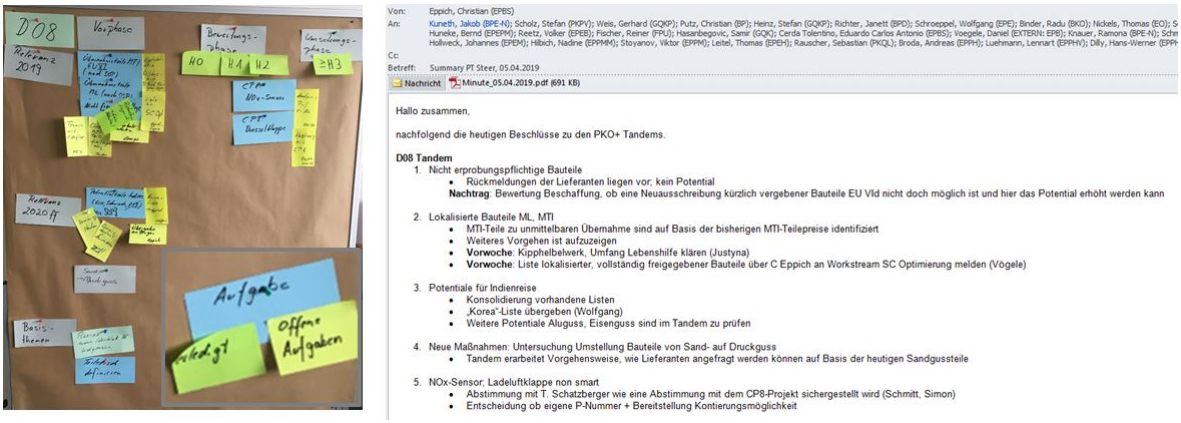

Figure 5.6: Minute Example
(Source: Own Elaboration)

5.2 Project House Optimization

After 6 weeks running the PKO+ Project House, the team is finally working and collaborating together, sharing ideas, documenting and implementing. However, it is easy to identify that the team is having issues adapting to the new system. Some of the initial impressions are that people is working on their tasks but not participating as expected. At this point, they are coming to the project house without laptop or IT equipment. It is like they do not have a clear idea of what PKO+ consists nor a defined term of "cross-functional" team.

For that reason, a meeting was planned to gather every member together in a room and ask them for feedback in order to optimize the PKO+ Project House. This meeting it is a chance for the whole team to reflect on a period of time. A blame-free look back to capture actionable items that help everyone to improve their work, the team and the working environment. Also it is an opportunity to define some clear rules regarding the Project House.

To have a successful retrospective, it is necessary the presence of the PKO+ Coordinators, each Tandem, Controlling, Quality and Production & Logistics. As well as some materials such as; pin wall, markers, sticky notes, and a timer.

5.2.1 Preparation of Retrospective

Step 1 - Set the Stage

Welcome everyone with positive spirit, set discussion boundaries and embrace the team for improvement.

Step 2 - What went well?

Have each team member use a green sticky note to write down what they feel went well and discuss the ideas briefly as a team. If discussions are dominated by 2 people it is necessary to find an opportunity to step in and encourage one of the quieter teammates to say something on the topic.

Step 3 - What needs improvement?

Same structure as step 2, but using red sticky notes. It is necessary to remind the team that the activity is about actions and outcomes, not about specific people.

Step 4 - Next Steps

Use yellow sticky notes to place ideas on the board. Discuss and agree which actions are going to be taken care.

5.2.2 Results of Retrospective

The workshop was well received and there was a lot of participation from the team members.

The feedback received from the team needs to be analyzed and implemented step by step. A brief summary of the retrospective results can be shown in Table 5.1

What went well?	What need Improvements?	Next Steps - Ideas
PT Steer meeting with management involved	Boards not up to date neither standarized	All tandems in one room
Cross - functional working	Quality, Controlling, and Production & Logistics can be integrated better	Digital documentation too. Not only in the boards.
Transparency (Visual Information)	Size of the room seems small	Agile working training
No Holy Cows! Everything is challenged	Too many parallel topics	Support prioritization of ideas through management

Table 5.1: Retrospective Summary
(Source: Own Elaboration)

PKO+ Project House Rules

This meeting was used to state some rules for PKO+ Project House too. Those can be described as the following:

- PKO+ is a high priority project that required the participation of the team members.

- Open and honest. Team resolve issues with dialogue.

- Pay attention to the colleagues and take care of loud noises and odorous food.

- Punctual attendance, if not possible to assist, well-founded justifications are needed.

- To work efficiently, team members need to bring their laptops and cellphones.

- Pay attention to clean the working space after using it.

5.2.3 Implementation of Improvements

Standardization of Boards

The board have been updated and standardized for all the Tandems in the PKO+ Powertrain. As a next step, these boards are going to be introduced to the München colleagues in charge of the vehicle cost reduction ideas.

The new structure of the boards consist of different columns with relevant information. This way is easy for people outside the team, for example, top management, to get informed quickly and clear.

These rows shows information regarding the priority of the idea, the idea sheet with relevant information on it, the phase, the request change number to find detailed information, a feedback column in order to keep things dynamic, a column of decision needed when an idea gets blocked for some reason, a column for a commit date, and finally, the person responsible for such actions.

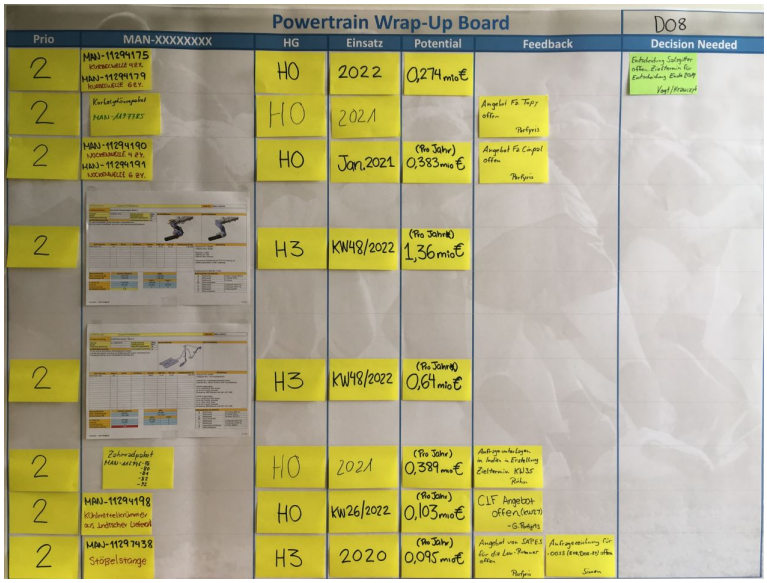

Figure 5.7: Updated Wrap-Up Board - D08 Example
(Source: Own Elaboration)

It was defined that comments and/or decisions needed from top management are noted in red, comments from the premeeting such as quality, production, logistics and controlling are noted in green. The yellow ones are noted by the same tandem team. The priority is split into 1 and 2, meaning low and high priority respectively.

New PKO+ Powertrain Room

Based on a initial concept and some modifications to it, a new room for PKO+ was obtained to gather all the team members in one single place. The purpose of this is to be in constant communication and optimize the alignment between departments. Now, it is easier to communicate information from tandem to tandem and generate more cost reduction ideas.

The official layout room is divided in 3 main sections. From left to right they are: the working area, coffee and exchange of ideas area, and the meeting and appointments area. This divisions will easily integrate the teams to work faster and in a more efficient way.

The room is equipped with tables, chairs, sound-proof walls, televisions, drawers and cabinets, and phones. The team will have everything they need for daily work and now the team spirit seems to have increase significantly.

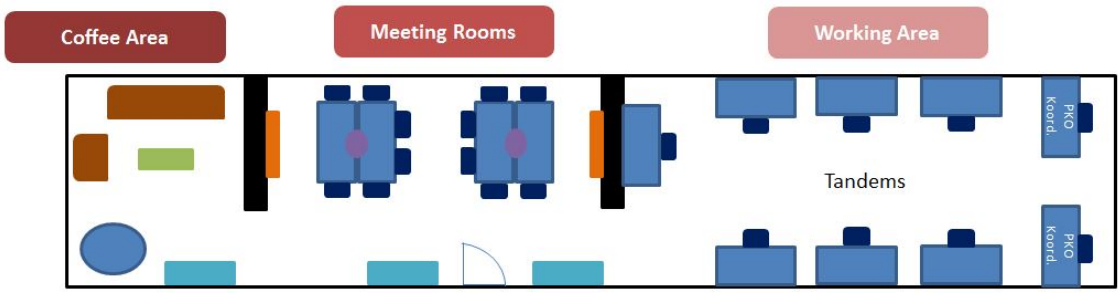

Figure 5.8: Initial Concept for New PKO+ Room
(Source: Own Elaboration)

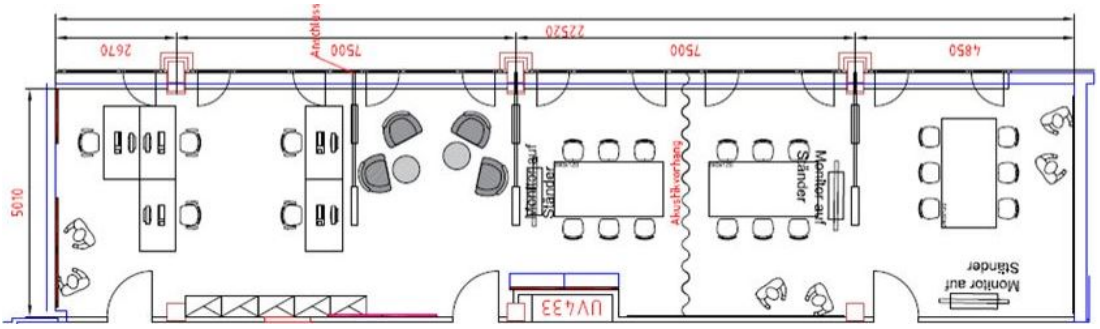

Figure 5.9: Layout for New PKO+ Room
(Source: MAN Internal Documents)

5.3 BOM Analysis

The BOM analysis is an idea aimed for 2019 that consists on reviewing the entire bill of materials of the light duty, medium duty and heavy duty engines to discover potentials on the internationalization workstream. The BOM analysis concept is to start sourcing parts to low cost countries and stop sending quotes to the current European suppliers to generate some cost savings.

Since the engine is a critical component for MAN Trucks Buses, there is a huge quantity of parts that require testing and validation approvals before introducing a new supplier for serial production. Usually these tests take a couple of years, for that reason, the BOM analysis is a task that evaluates every single part of the bill of material for each engine to determine which parts could be sourced to a low cost country without making any validation or test.

To find out if a test is required on certain part number it is necessary to understand the logic behind the numeration of the part number since it is directly related with the type of test.

Part Number Logic

All of the MAN part numbers consists of 11 numerical digits. Each of these numbers mean something to the part number, and could be easily explained with the figure 5.10

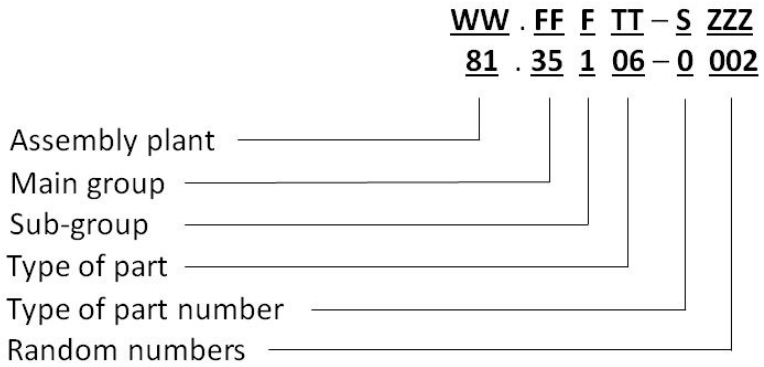

Figure 5.10: Part Number Logic
(Source: MAN internal documents)

All of the part numbers evaluated on this idea start with 51 since this is the code assigned to the engine assembly plant in Nuremberg, Germany.

The main components of the vehicle can be divided in 9 groups, which consists of:

- 0: Engine

- 1: Fuel and Exhaust System

- 2: Electronic System

- 3: Gear box, Clutch, Driven Axle, Propeller Shaft

- 4: Chassis

- 5: Brake, Compressors

- 6: Body Truck

- 7: Bus Body

- 9: General Components

From which 57% of the total bill of material comes from group 0 (Engine), 17% comes from group 1 (Fuel and exhaust systems), general components represents a 13% (group 9) and electronical systems (group 2) represent the 8% of the total of parts. Chassis, brake, and compressor parts just conforms the rest 5%.

In table below just a few examples for reference:

C	E	F	G	H	I	J
Part Number	Assembly Plant XX.xxxxx-xxxx	Main Functional Group xx.XXxxx-xxx	Sub-Functional Group xx.xxXxx-xxxx	Type of Part xx.xxxXX-xxxx	Type of Part Number xx.xxxxx-Xxxx	Random Numbers xx.xxxxx-xXXX
51.01903-0322	51- Nuremberg - Engine Assembly Plant	01- Engine housing	019- Sealing	01903- Seal for **.013	0- Finished parts	322
51.15600-7020	51- Nuremberg - Engine Assembly Plant	15- Exhaust system	156- Engine brake	15600- Engine brake ,ZSB-	7- Loose parts	020
51.26101-7270	51- Nuremberg - Engine Assembly Plant	26- Electrical machinery and equipment	261- Generator	26101- Alternator	7- Loose parts	270
51.38516-5020	51- Nuremberg - Engine Assembly Plant	38- Other gears and gear lubrication	385- Power take-off	38516- Drive shaft	5- Assembly of permanent joints	020
51.47101-7058	51- Nuremberg - Engine Assembly Plant	47- Hydraulic steering	471- Pump	47101- Hydraulic oil pump	7- Loose parts	058
51.54210-0235	51- Nuremberg - Engine Assembly Plant	54- Air compressor	542- Drive	54210- Drive gear	0- Finished parts	235
51.77970-0003	51- Nuremberg - Engine Assembly Plant	77- Interior finishing	779- Heating and air conditioning	77970- Refrigerant compressor	0- Finished parts	003
51.90490-0037	51- Nuremberg - Engine Assembly Plant	90- Screws, nuts, accesories	904- Special screws	90490- Others	0- Finished parts	037

Table 5.2: Part Number Logic Examples
(Source: Own Elaboration)

Tests Performed on Parts

Now, it is possible to easily known what parts require complex tests and parts that only need small validation or can be sourced directly without any testing. The reason of this is because the test needed is directly linked to the main function groups in the part number.

part/ component	partnumber	Funktionsgruppe	Einzelkomponente	Maße u. Toleranzen	Material/ Werkstoff	Festigkeit	Kompo-nenten-Versuch	Motorenprüfstand	Fahrversuch	
		functional group	single component	dimensions & tolerances	material	component-strength	component-function	engine-test durability	engine-test performance & emission	truck/ bus onroad test
crankcase with bearing cap	YY.0110X-XXXX	3		x	x	x		x		
crankcase cross-head			x	x	x	x		x		
crankshaft main bearing	YY.01110-XXXX			x	x			x		x
cylinder liner	YY.01201-XXXX	6		x	x	x		x		
oil sprayer nozzle	YY.01601-XXXX		x	x			x	x		
breather	YY.0180X-XXXX		x	x			x	x		
crankshaft	YY.0210X-XXXX	3 + 4		x	x	x		x		
timing gear - crankshaft camshaft gear drive gear	YY.02115-XXXX YY.04501-XXXX YY.11301-XXXX	10		x	x			x		
timing case / flywheelhouse	YY.01304-XXXX YY.0140X-XXXX		x	x	x	x		x		
timing case cover	YY.01305-XXXX		x	x	x	x		x		
vibration damper	YY.02201-XXXX		x	x		L		x		
connecting rod	YY.0240X-XXXX	4		x	x	x		x		
bush - connecting rod	YY.02405-XXXX	4		x	x	x		x		
conrod bearing	YY.02410.XXXX	4		x	x	x		x		
piston pin	YY.02502-XXXX	6		x	x			x		
piston ring	YY.02503-0XXX	6		x	x			x	x	
piston	YY.025XX-XXXX	6		x	x	L		x	x	
v-belt, narrow joined v-belts	YY.02601-XXXX YY.06503-XXXX YY.06606-XXXX YY.26105-XXXX YY.54201-XXXX YY.95800-XXXX		x	x				x		x
cylinder head	YY.0310X-XXXX	2		x	x	x	x	x	x	
valve guide	YY.03201-XXXX	2		x	x			x		
valve seat ring	YY.03203-XXXX	2		x	x			x		x
cylinder head gasket	YY.0390X-XXXX		x	x				x		

Table 5.3: Tests Performed on Parts
(Source: MAN Internal Documents)

Three main groups have been assigned:

1- No testing required: In this group are parts that do not require any testing at all or parts that only need small dimensions and tolerance or material validation.

2- Test and validation is required: The parts under this group need tests or validation that are not very complicated, but still it could take time to perform it. The tests involved in this group are component strength and component function.

3- Complex tests and validation: In this group the parts need to be testes with complex tests with a long duration for validation, the reason of this is because the performed tests are regarding durability and on-road.

Procedure of the BOM Analysis

With help of the list of tests and double checking the information with the engineering responsible for each of the engines, now, a complete list of parts has been classified as group 1, group 2 or group 3. As currently the team is aiming to goals for 2019, group 2 and group 3 are left behind for the moment and the team focuses only on those parts that do not require testing or only require small validation.

All the parts listed with group 1 are now delivered to the purchasing department, that way, the purchasing specialists can start looking for low cost countries that can produce these parts and deliver to MAN before the year ends.

A total of 164 parts have been identified as group 1. These parts have been already addressed to India for quoting.

Engine	Freigabetest	SACHNUMMER	BENENNUNG	Bezugsart	Next Step	Current Status
D0834	Dimensional & Tolerance and	51.54302-0107	ABSTUETZBOCK F LPR	KG		Quickwins Internationalization
D0834	Dimensional & Tolerance and	51.91606-0041	.VERSCHLUSSDECKEL DMR22	KG		Quickwins Internationalization
D0834	Dimensional & Tolerance and	51.54120-5530	SAUGLEITUNG LUFTPRESSE	KG		Quickwins Internationalization
D0834	Dimensional & Tolerance and	51.96305-0099	FORMSCHLAUCH D25 AM LU	KG		Quickwins Internationalization
D0834	Dimensional & Tolerance and	51.54120-6064	RESONANZROHR F LUFTPRE	KG		Quickwins Internationalization
D0834	Dimensional & Tolerance and	51.02301-5276	SCHWUNGRAD	HG		Quickwins Internationalization
D0834	Dimensional & Tolerance and	51.02301-3303	.SCHWUNGRAD	HG	India Sourcing	
D0834	Dimensional & Tolerance and	51.19101-0615	TRAEGER F GENERATOR	KG	India Sourcing Change Process	
D0834	Dimensional & Tolerance and	51.19101-5347	HALTER F GENERATOR	KG		Quickwins Internationalization
D0834	Dimensional & Tolerance and	51.01840-5031	HALTER F OELABSCHEIDER	KG		Quickwins Internationalization
D0834	Dimensional & Tolerance and	51.08240-0175	HALTER F RESONANZROHR	KG		Quickwins Internationalization
D0834	Dimensional & Tolerance and	51.12340-6062	HALTER F LECKOELLEITUN	KG		Quickwins Internationalization
D0834	Dimensional & Tolerance and	51.12340-6044	.HALTER F KRAFTSTOFFLEI	KG		Quickwins Internationalization
D0834	Dimensional & Tolerance and	51.12340-6059	HALTER F KRAFTSTOFFLEI	KG		Quickwins Internationalization
D0834	Dimensional & Tolerance and	51.98180-6000	.GV-STECKVERBINDUNG M R	KG		Quickwins Internationalization
D0834	Dimensional & Tolerance and	51.05102-0085	OELPUMPENGEHAEUSE	KG		Quickwins Internationalization
D0834	Dimensional & Tolerance and	51.05102-3070	.OELPUMPENGEHAEUSE	KG	India Sourcing	
D0834	Dimensional & Tolerance and	51.05806-5240	FUEHRUNGSROHR	KG		Quickwins Internationalization
D0834	Dimensional & Tolerance and	51.05805-5936	OELMESSTAB	KG		Quickwins Internationalization
D0834	Dimensional & Tolerance and	51.08231-6008	RESONANZROHR	KG		Quickwins Internationalization
D0834	Dimensional & Tolerance and	51.09412-0525	LADELUFTKRUEMMER	KG	India Sourcing Change Process	
D0834	Dimensional & Tolerance and	51.09412-0528	LADELUFTKRUEMMER N ATL	KG	India Sourcing Change Process	
D0834	Dimensional & Tolerance and	51.19101-0650	KONSOLE F KAEMIKO	KG		Quickwins Internationalization
D0834	Dimensional & Tolerance and	51.19101-0620	ABSTUETZBLECH F KAEMIK	KG		Quickwins Internationalization
D0834	Dimensional & Tolerance and	51.77970-0003	ANSCHLUSSTUECK	KG		Quickwins Internationalization
D0834	Dimensional & Tolerance and	51.93030-0415	ABSTANDSBUCHSE	KG		Quickwins Internationalization
D0834	Dimensional & Tolerance and	51.08120-0491	WAERMESCHUTZBLECH ZYL	KG		Quickwins Internationalization
D0834	Dimensional & Tolerance and	51.93030-0136	ABSTANDSBUCHSE HWF	KG		Quickwins Internationalization
D0834	Dimensional & Tolerance and	51.09141-0082	WAERMESCHUTZBLECH	KG		Quickwins Internationalization
D0834	Dimensional & Tolerance and	51.15240-0164	HALTER F ABGASKRUEMMER	KG		Quickwins Internationalization
D0834	Dimensional & Tolerance and	51.98110-0235	SCHWENKVERSCHRAUBUNG L	KG		Quickwins Internationalization
D0834	Dimensional & Tolerance and	51.98180-0041	SCHNELLKUPPLUNG (QUICK	KG		Quickwins Internationalization
D0834	Dimensional & Tolerance and	51.11640-0331	.HALTER F STEUERGERAET	KG		Quickwins Internationalization
D0834	Dimensional & Tolerance and	51.25441-0819	HALTER F KABELSTRANG A	KG		Quickwins Internationalization
D0834	Dimensional & Tolerance and	51.25441-0813	HALTER F STECKER LADEL	KG		Quickwins Internationalization
D0834	Dimensional & Tolerance and	51.25441-0803	HALTER F UEBERGABESTEL	KG		Quickwins Internationalization
D0834	Dimensional & Tolerance and	51.25441-5222	HALTER F KBS AM THERMO	KG		Quickwins Internationalization
D0834	Dimensional & Tolerance and	51.25441-5221	HALTER F KBS AM GENERA	KG		Quickwins Internationalization
D0834	Dimensional & Tolerance and	51.25441-5226	HALTER F E-RELAIS FLAM	KG		Quickwins Internationalization
D0834	Dimensional & Tolerance and	51.47303-5031	DRUCKLEITUNG DMR12	KG		Quickwins Internationalization
D0836	Dimensional & Tolerance and	51.91606-0091	.VERSCHLUSSDECKEL DMR50	KG		Quickwins Internationalization
D0836	Dimensional & Tolerance and	51.91606-0100	.VERSCHLUSSDECKEL DMR62	KG		Quickwins Internationalization
D0836	Dimensional & Tolerance and	51.54302-0107	ABSTUETZBOCK F LPR	KG		Quickwins Internationalization
D0836	Dimensional & Tolerance and	51.91606-0041	.VERSCHLUSSDECKEL DMR22	KG		Quickwins Internationalization
D0836	Dimensional & Tolerance and	51.54120-5532	SAUGLEITUNG LUFTPRESSE	KG		Quickwins Internationalization
D0836	Dimensional & Tolerance and	51.96305-0099	FORMSCHLAUCH D25 AM LU	KG		Quickwins Internationalization
D0836	Dimensional & Tolerance and	51.54120-6064	RESONANZROHR F LUFTPRE	KG		Quickwins Internationalization
D0836	Dimensional & Tolerance and	51.02301-5276	SCHWUNGRAD	HG		Quickwins Internationalization
D0836	Dimensional & Tolerance and	51.02301-3303	.SCHWUNGRAD	HG	India Sourcing	

Table 5.4: BOM Analysis
(Source: Own Elaboration)

5.4 White Spot Analysis

The white spot analysis is a tool used to identify product or technology field gaps, which could lead to new business opportunities. This tool has a matrix form, and its purpose is to guide in a simple and visual way the high economic attractiveness potentials[17].

The detailed white spot analysis shows an overview of the relevant and not relevant potentials. The matrix form help us to understand if the efforts of performing any changes in the different tandems are worth.

After creating the template, with help of the different Tandems, the white spot analysis was filled out to determine potentials and generate more cost reduction ideas for specific components. More detailed information regarding the white spot analysis topics can be found in Table 6.1 in the annexes section.

5.5 Preparation of Benchmark Workshop

A lot of benchmark workshops will be occurring during the PKO+ project since it is a way to generate ideas in means of constructive discussion or practical work on a specific subject in which a group of people share their knowledge or experience.

In MAN the workshop process is not well defined and to cover that need, a template was generated. These template has the intention to be used as a guide or instructions.

The first step is to get the basic information, for example, filling out the objective of the workshop, people needed, duration and location. Second, it is needed to prepare the benchmark workshop for the team, that means, to get similar engines in one place in order to compare with the competitors, this will help to the brainstorming of ideas. It is recommended that before the workshop, the user generate a discussion list with interesting topics to have an organized and fluid technical analysis. The user can provide the team with technical drawings and a cost break down analysis to see in a structured way why the price has certain cost. This could be for different reasons, such as, material, process, design, tooling, etc. After the brainstorming sessions is done, it is needed to document all the ideas generated and record them in an idea sheet in order to continue with the normal PKO+ process.

In the annexes section can be found an example in Figure 6.1 for a cylinder head gasket.

5.6 LCC Sourcing Throughout Benchmarking

Sourcing to LCC is very important because it is a very straight forward procedure and implement in general terms can be considered as easy. It require legal procedure, but if a low cost country can produce serial parts that MAN require it is something that is worth to perform.

The task here was to evaluate and sort from the Benchmarking performed by Polarix, which ideas have potential to be sourced to LCC and share these ideas to the purchasing department in order to start the process.

Table 5.5 show some examples of these ideas.

Component		Idea	Current Situation	Target Situation
	Crankcase	Alternative LCC supplier location for cylinder block raw part.	MAN using German casting supplier	Quote with Spanish or Brasilian casting supplier
	Crankcase	Outsourcing internal machining of block to LCC	MAN doing machining of block internally	Quote machining with Brasilian or Chinnese supplier
	Cylinder Head	Outsourcing internal sand casting of cylinder head to LCC	MAN doing sand casting of cylinder head internally	Quote with Spanish or Brasilian supplier for casting raw part
	Cylinder Head	Outsourcing internal machining of cylinder head to LCC	MAN doing machining of cylinder head internally	Quote machining with Brasilian or Chinnese supplier
	Coolant Pump	Alternative LCC supplier location for coolant pump	MAN using German supplier	Quote with Japanese and/or Italian supplier
	Throttle Valve	Use the same model of Throttle Valve for all engines	Using different models for MAN engines	Use same model in all MAN engines
	Turbocharger	Alternative supplier for Turbocharger	Using an expensive supplier	Quote turbocharger in identified supplier
	Turbocharger	Insource production for Turbocharger	Turbocharger is produced by supplier	Build up a Turbocharger production at MAN
	Pressure Pipe Neck	Alternative supplier for pressure pipe neck	MAN using German supplier	Get quote from Indian supplier
	High Pressure Pump	Alternative supplier for high pressure pump	MAN using supplier located in Czech Republic	Get quote from Indian supplier
	Starter	Alternative supplier for the starter	MAN using supplier located in Japan	Get quote from Hungrian supplier
	Cable Harnesses	Make or buy analysis for cable harnesses	Currently is sourced to external supplier	Make cable harnesses in house
	Air Compressor	Alternative supplier for air compressor	MAN using German supplier	Get quote from supplier located in Poland
	Oil Sump Module	Alternative supplier for oil sump module	MAN using Hungrain supplier	Get quote from supplier located inTaiwan

Table 5.5: LCC Sourcing based on Benchmark Analysis
(Source: Own Elaboration)

5.7 Cross Functional Components Tandem Ideas

During the internship period, I worked closely with the Cross Functional Components Tandem taking care of some cost reduction ideas and giving support with tracking activities. Currently have around 25 ideas on-going and 10 in the backlog. Table 6.2 in annexes shows the tracking list of these ideas.

5.7.1 Replace Current Clamps with Tie Straps

The supplier Panduit came to visit MAN engine plant and the intention was to look for cost reduction potentials during this time.

Currently, MAN hold the fuel and oil hard lines with two metallic p-clamps, using in total 3 parts for the assembly if we include the bolt that need to be installed to hold both p-clamps.

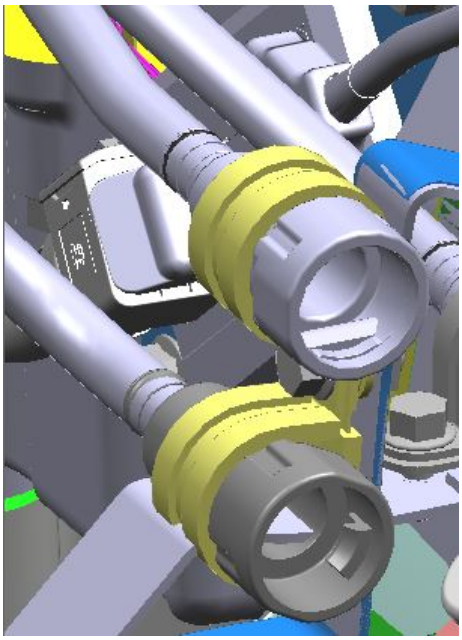

Figure 5.11: Current Assembly for Fuel and Oil Lines
(Source: Own Elaboration)

The proposal is to replace both metallic p-clamps with a single plastic double clamp tie from Panduit, which will reduce the amount of assembled parts from 3 to 2, and hopefully will reduce the price too.

Figure 5.12: Panduit Double Clamp Tie
(Source: Panduit Website)

A business case needs to be performed to determine if the idea will reduce the costs. Unfortunately, the offer obtained by Panduit for this double clamp tie is 9% more expensive than the current solution. For that reason, this idea needs to documented and cancelled.

5.7.2 Air Compressor Carry Over with Adaptor

A new common engine is being developed within the TRATON Group. To leverage from the low part price, due to high volume, common components such as the air compressors should be carried over to other brand unique engines. To be able to realize the carry-over the interfaces have to be identical and therefore an adapter solution to fit the current air compressor to the new engine was developed. With an adapter the air compressor from the common engine can be re-used and resulting in a lower part price.

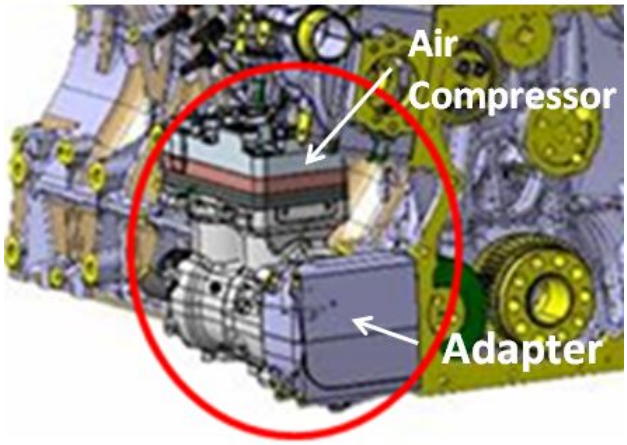

Figure 5.13: Air Compressor for TRATON Synergy Project.
(Source: MAN Internal Documents)

For this idea, there are four air compressors involved, and the prices for each of them is known as well as the price of the adapter that is required to fit the air compressor into the new developing engine.

Table 5.6 shows the savings in percentage for each of the carry overs planned for 2021.

Air Compressor	Engine Source	SOP	Yearly Volume	Savings (in %)
1	New Develop	2021		
2	New Develop	2021		
3	New Develop	2021		
4	New Develop	2021		
1	Current Engine	2021	8.000	13,50%
2	Current Engine	2021	3.000	24,28%
3	Current Engine	2021	1.000	46,90%
4	Current Engine	2021	200	56,80%

Table 5.6: Savings in % per Air Compressor
(Source: Own Elaboration)

5.7.3 Removal of EOL Testing

Previously in-house developed air compressor's were outsourced to an external supplier. To guarantee the quality an extensive end-of-line test was introduced at the supplier. Over time the supplier have improved the product and process quality. Therefore, the idea is to remove or reduce the testing.

This is a simple idea since it's not requiring any changes on engineering and easily can be done for 2020. The decision internally in MAN was to remove completely the EOL test since the quality of the air compressors is good and has been proved that full-fill MAN requirements, according to MAN quality department.

The next steps were addressed to the purchasing department to put pressure on the supplier to stop charging cost and together with quality department to keep track until it is completed.

The yearly volume of this part is 1.100 meaning that the savings will be considerably good because this was not a cheap EOL test and the efforts spent in this idea were not too high.

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Chapter 6

Conclusions

PKO+ is indeed a good methodology for a cost saving project with high targets and with long term duration. During the firsts months of the creation of the Project House, it has been noted by the team members and the top management that this is the way MAN wants to continue working on PKO+. Having all the departments involved in a single room, such as, engineering, purchasing, quality, controlling, logistics and production, is helping to move forward in a faster manner and in an effective way. It is clear that the process is being aligned naturally since the whole process is now transparent and reliable.

However, to achieve MAN demands, good coordination and planning were required. The constant tracking from the PKO+ coordinators is essential to ensure idea implementation from the cross-functional team. For that reason, Tandems Meetings were created. Under these meetings, the tandem team and the coordinator generate and evaluate ideas with an agile approach. Also a RASI Matrix was introduced with the purpose of showing to the team members their roles through the workflow process.

Since PKO+ is a 5 years project that was introduced in 2019, the constant feedback from the team is needed. There is no doubt that the Project House is working, however, with the help of the whole team it can be improved and constantly optimized.

The role of VE in PKO+ is important. The VE team is acting as the coordinators of the project, taking whole responsibility of the cost reduction ideas and yearly targets. They are also responsible of introducing new and efficient methods to the process. They coordinate the synergies between the TRATON Group and the Benchmarking Workshops. With these two concepts over 100 of cost saving ideas have been generated and the job of the VE team is to put together all this information in a timeline that could work out for everyone in the team.

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Annexes

White Spot Analysis - Discussed Topics

PKO	
Idea	**Example**
Material Change	Use cheaper / Alternative materials
Desgin Change	Integration of components, simplification of functional performance
Defibration & Tolerance	Lower tolerances (dimensions, shape / position, surface)
Take Over Parts from TRATON group	Takeover components from other brands / interlocking
Interface Optimization	Simplification of interfaces between components
Variant Reduction	Reduction of variants
Connection & Fastening Concepts	Simplification of connections and fixing concepts
Specifications Reduction	Reduction of requirements
Standard Components	Use of standard/ catalogue components
Change of Production Technology	Use of alternative manufacturing technology
Supplier Workshops	Query potentials by suppliers
Deletion of Parts	Void parts that are not used anymore (or low volume)
Wall Thickness	Reduce the wall thickness on heavy components
Text in Parts	Remove unnecessary text from current part numbers
Customized Trucks	High criteria when it comes to approve customized trucks
Internationalization	
Idea	**Example**
Best Cost Country Sourcing Europa	Sourcing of scopes in eastern Europe
Best Cost Country Sourcing Asia	Sourcing of scopes in eastern Asia
Best Cost Country Sourcing Rest of World	Sourcing of scopes in eastern RoW
Linear Performance Pricing	Price-perfromance comparison for component portfolios
Volume Bundeling	Bundling of awarding volume
Price Break Downs	Demanding breakdowns offer rates
Direct Sourcing	Elimination of distributors
Make or Buy	Check wheter in-house production before installation economically
Volume / Quantity of Parts	Buying high volumes to reduce part costs
Tooling	Check out supplier woth low cost or zero tooling
De-Contenting	
Idea	**Example**
Elimination of Customer Perceptible Scopes	Direct elimination of perceptible perimeters
Cancellation of non-customer perceptible scopes	Direct elimination of non-absorbables scopes
Elimination of Sales Variants	No special variants (low-torsion)
Standard Equipment as Special Equipments	Reduction of standard equipment
Price Increase in Special Equipment	Increasing the pricing for special equipment
Prototypes	Avoid the usage of physical prototypes
Supply Chain Optimization	
Idea	**Example**
Mode of Transport	Change to cheaper means of transport
Transport Routes	Change to cheaper transport routes
Packaging & Batch Sizes	Optimization packaging and batch sizes
Incoterms	Negotiation optimal Incoterms based on Total Landed Cost
Service Provider Structure	Optimization of logistics service providers
Storage & Intermediate Storage Concepts	Optimization of local warehouse concepts
Express Service	Avoid paying express services
Scrap Product	Reutilization or recycling of scrap product
Warehouse	Discuss the current contracts

Table 6.1: White Spot Analysis Topics
(Source: Own Elaboration)

Workshop Preparation - Cylinder Head Gasket

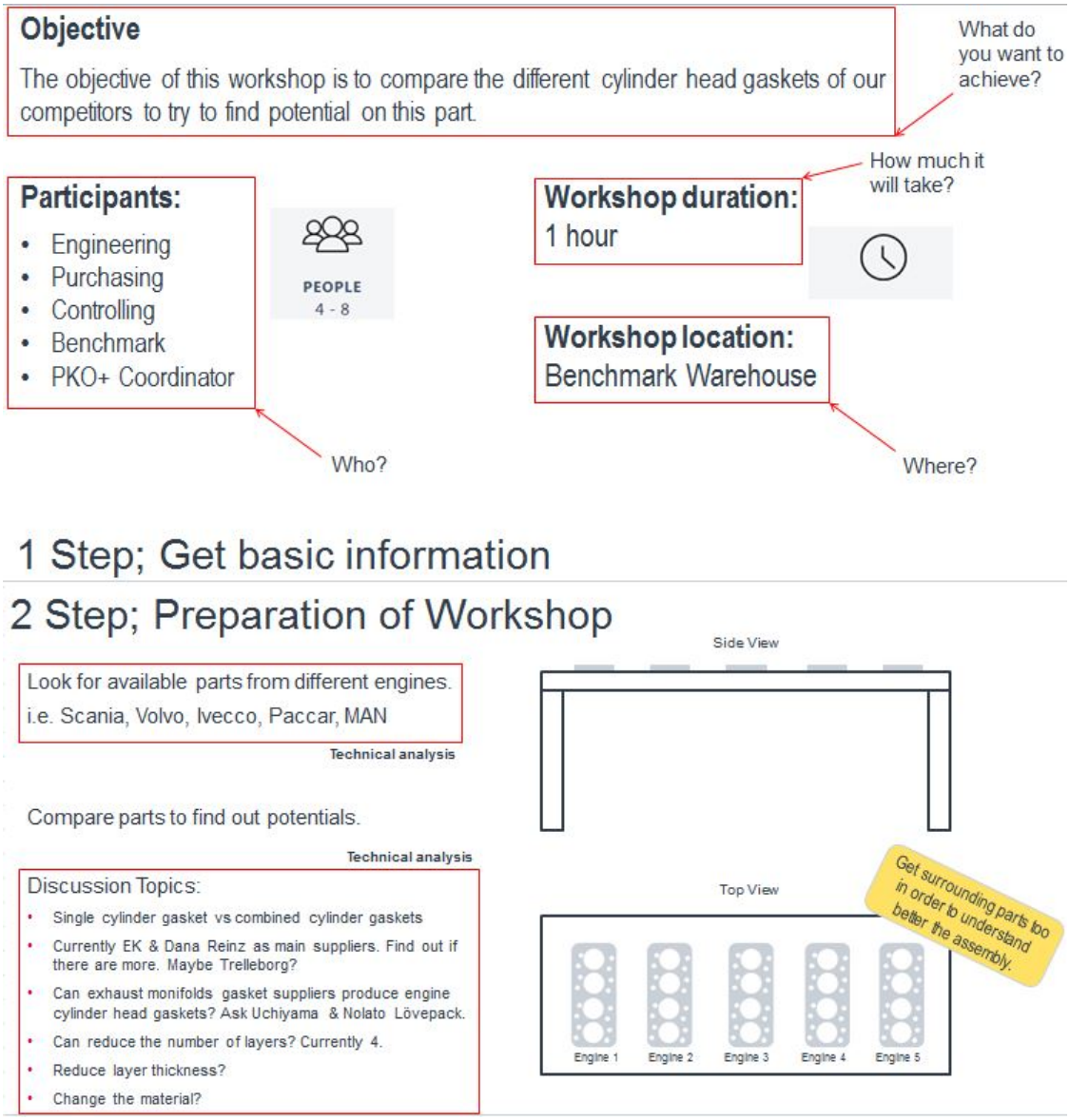

Figure 6.1: Workshop Preparation - Cylinder Head Gasket Example
(Source: Own Elaboration)

Cross Functional Components - Tracking List

	Übersicht PKO Crossfunktionale Team					
Maßnahmenbeschreibung	HG	Status/Aufgabe	H0 erreicht	H1 erreicht	H2 erreicht	H3 erreicht
Entfall Ölmessstab	H1	11.07. On agenda for SteerCo PKO+ 11.07, follow up situation with Quality, D38 cost estimation still pending 21.05. Business case to be updated with D15, D08 and D38. When the field quality issue is solved the oil dipstick will be removed.				
Variant reduction of Voith 2-stage air compressors for D15, D20, D26	H0	11.07. Meeting with GPBR Mr.Sauter 04.06, follow up with Eppich/Wiemann. New simulation show great dissadvantage (-0,9%) of removing the 2-stage air compressor. Present data at next CFK Tandem. 21.05 Waiting for a contact person at Sales "what fuelsaving is worth" 02.04. Fuel consumption simulation will be presented 26.04				
Variant reduction of STD air compressors for D20, D26 (standardize on ESS)	H0	15.07. Victor will give response in 2 weeks. 11.07. Ask the Purchaser Victor Lindberg. Mr. Wiemann said that MAN will standardise on AMS (sofisticated air manamagement system) for all MJ2019. Check part price for adding an ESS-line (air pipe) from the AMS to the ESS air compressor. 21.05. No qutation so far. KB will come to Nürnberg the 6/6 or 7/6, could be possible to discuss				
Harmonization of CBE-1 air compressors for D38 (with adapter)	H0	11.07. A first business case should be done before the investigation, we need a quotation from KB for a air compressor with PTO/drive-through. Scania have been asked but responsible purchaser is on vaccation. 21.05. Input is needed from Robert Wiemann, a first layout study should be done. We need to decide if we should have the PTO on the air compressor or the adapter.				
Harmonization of CBE-1 air compressors for D15 (with adapter)	H0	11.07. Not possible to re-use any other position of PTO's for the steering pump. We need a quotation from KB for a air compressor with PTO/drive-through. 21.05. Moritz to present the split for 1/2/3 PTO annual volume. Kristoffer to find the price for a 1 cylinder air compressor with drive through. Book a new meeting!				
Reduce/Remove EOL testing for air compressor at ITG	H0	11.07. Annalena will book a meeting with purchasing, engineering and quality to decide how to go on. 21.05. Annalena to check the contract situation with Lindberg/Geck, Kristoffer to excalate the quality question to Mr. Weiss.				
Riementrieb Umlenkrolle in Kunststoff/rolled steel	H0	11.07. Sheet metal pulley costs 15 euro per piece (C-samples). Kristoffer to check who is responsible for the part in the new organisation. And check the price for the Scania variant. 21.05. Eduardo to support. 02.04 Christian Eppich showed a plastic roller and a rolled metal roller				
Übertrag Knorr-Bremse 1 Zylinder nach Navistar (10 000 Einheiten pro Jahr)	H0	15.07. Navistar have filled the "Application Guideline" from Knorr-Bremse, however it was incomplete som it was sent back from KB to Navistar. 11.07. Check latest status with Mr. Wiemann. 02.04. Discussion with Joint-Venture purchasing about pricing and logistics.				
Umstellung ZiNi (chemisch Nickel) beschichtung	H3	11.07. Annalena to relase it to the supplier. 22.05. Gerhard have approved the change if we can guranatee the the drawings are OK. 21.05. Fischer got the task to evaluate the Busines case. Try with Quality and Production tomorrow again. Jürgen Schmitt to put it in the database.				
Umstellung von MAN247-1 („Ofenlack") auf MAN247-4 (Zinklamelle ähnlich unserer ZiNi Beschichtung)	H0	11.07. Current quotation show little potential. Mr. Lechner ask about which supplier was asked and for which part numbers the quotation was sent for? 21.05. No input from Purchsing, Annalena to follow up. 02.04. Quotation to be sent out by purchasing.				
Harmonization of Air compressor pistons (none Eu6d piston -> Eu6d piston). Saving potential of 1,14 Euro for	H3	11.07. Is being implemented, SOP in September 2019 and Februari 2020 21.05. Jürgen Schmitt to check the volumes. 02.04. Robert W. is putting together a Business case.				
Replace P-clamp with Panduit	H0	21.05. Eduardo to compare the cost for the current solution (P-clamp) and the new Panduit clamp. 15.05. Ask Wolfgang Simon (D08) for P-clamp part numbers. As a second step ask Annalena to get a quotation from Panduit, so we can compare with the current solution. Ask Jürgen for the annual volumes for all engines (D08, D15, D20, D26 and D38).				

Table 6.2: Tracking List for Cross Functional Components Tandem (Source: MAN Internal Documents)

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