CHALLENGES FOR INDUSTRY IN NORTH-WEST EUROPE

RESULTS OF THE MORE4CORE PROJECT

BEMAS
BRIDGE TO
WORLDCLASS MAINTENANCE & ASSET MANAGEMENT

MAINTENANCE FOR COMPETITIVENESS

Investing in Opportunities

This project has received European Regional Development Funding through INTERREG IV B.

INTERREG IVB

COAL MINE
BERINGEN, BELGIUM

The control panel of the power plant at the coal mine of Beringen (Belgium). This coal mine was one of the seven mines in the Campine. The first mine shafts were created in 1907, but digging was interrupted during the First World War. Coal was first brought up starting in 1922, at depths of 727, 789 and 850 m. On 28 October 1989, the mine was closed. The Flemish Mining Museum was set up on its premises.

Text www.wikipedia.org / Picture: Ronnie Husson

INTRODUCTION

According to the European commission, Industry is the backbone of the European economy. Industry is producing 80% of Europe's exports, accounts for 80% of the private research and innovation, and is providing high skilled jobs. However, the recent economic crisis has led to a further decline in manufacturing to 15.1% of GDP and some 3.5 million jobs have been lost in those sectors since 2008. Also Northwest European industry has gone through difficult times. The various economies in West European countries shrank, leveled off or experienced extremely low growth. In comparison to emerging markets, West European economies are still running far behind.

The European Commission aims to bring about an industrial renaissance in Europe. The objective of revitalization of the EU economy calls for the endorsement of the reindustrialization efforts in line with the Commission´s aspiration of raising the contribution of industry to GDP to as much as 20% by 2020. One of the possibilities is to reinforce the industry's competitive position by investing in better Maintenance, Repair and Overhaul policies and practices.

In the first part of this book you will find the results of a comprehensive benchmark study that was conducted among industrial companies located mainly in Belgium and the Netherlands, in the framework of the MORE4CORE-project. The benchmark study was used to identify quantitative, as well as qualitative trends and developments in the field of maintenance and asset management. The study focused extensively on KPI performance measurements, the aging of assets, the

technical condition of assets and asset risks, market integration and the outsourcing of maintenance, personnel trends within the sector and maintenance-related innovations. Best performers invest much more in preventive maintenance from the design and start-up of installations. As a result, the laggers see a major increase of the maintenance costs and necessary capital (re)investments during the next lifecycle phases. If we could rise maintenance and asset management practices throughout industry to the current best performers level, industrial EBITA could increase with up to 30%. It goes without saying that this would impact our industrial competiveness significantly. There is however an important point of attention: the benchmark also unveiled that within the next 10 year, up to 44% of the industrial assets reach end of life. This means important investments will have to be made in reinvestments and lifetime extension programs in order to keep the industrial asset base running…

The second Chapter consists of an macro-report analyzing the economic value and impact on maintenance and asset management in the infra-sector per country and for the NWE-region. An important conclusion is that there is an urgent need for transparent data and clear-cut definitions with regard to MRO and (industrial) asset performance. Failing to do so, will keep measuring the effects of industrial policies on a national and European level virtually impossible. If Europe is serious about the Industrial Renaissance ambitions, this issue should be addressed.

In Chapter seven, the MRO service market in Germany is analysed. The WVIS Branchenmonitor is an annual study that provides information on trends and development for the industrial services sector in Germany. The major conclusion is that the market of industrial maintenance service providers is still growing and that Industrial Services become more and more important in the framework of “Industrie 4.0”. The maintenance service sector is also becoming increasingly more internationally oriented. When there is a shortage of technical talent in the local job market, the capacity is sourced beyond the region and even across the border. In order to increase maintenance worker mobility, there is a need for a skill transparency.

In the third Chapter, we launch the idea for developing an European Maintenance Skill Passport which aims to tackle the current lack of transparency. The passport is a portfolio, owned by an individual, that gives in a uniform way information about the set of acquired and validated skills that this individual has obtained in the field of maintenance.

In industrial sectors, where production assets have a lifetime of several decades, economic competitiveness will for an important part be based on the continuous maintenance and overhaul of assets. New technologies and approaches need to be developed between innovators and researchers. At the European level, alignment of emerging national multi-disciplinary innovation program's is needed. *Chapter four* unveils the Strategic Research Agenda developed within the MORE4CORE-project. This agenda is intended to be a first step in identifying the major challenges and opportunities in research for maintenance. It aims to form the basis for the setting objectives and developing an implementation program, mostly through integration in existing innovation platforms like PPPs or programs like Horizon2020.

As described in Chapter five, MORE4CORE also worked on a Maintenance HR Award, named 'Magnet for Technical Talent'. The award is based on an in depth survey of maintenance technicians working at asset owners or maintenance service providers. The survey results reveals that in our production companies there is still a lot of room for improvement with respect to the human resources aspects of maintenance and reliability, which in turn also influences productivity and competitiveness.

The MORE4CORE-project's main objective is to promote maintenance issues and stakes at a European level. The goal in one of the work packages was to find out how to support transnational integration of Maintenance markets by improving the transparency, comparability and visibility over standards, regulation and offer services in the NWE region. *Chapter six* is the paper of this study in the MRO market.

To conclude this introduction, I would like to thank all MORE4CORE project partners for the efforts they have made to obtain the published results. You can find an overview of the different partners in the final pages of this book. I would also like to thank Mainnovation and KPMG for their contribution in the research and publication of the results. I am sure that some of the insights in this book will help you better understand the key role of maintenance and asset management in North-West Europe's Industrial competiveness.

Picture: Ronnie Husson

VAL SAINT LAMBERT FACTORY

SERAING, BELGIUM

Val Saint Lambert was founded in 1826 in the abandoned Val-Saint-Lambert Abbey by a chemist, M. Kemlin, who had previously worked for the Vonêche crystal works in the Ardennes.
In 1900 VSL offered over 930 models of lampshade. Indeed it had become a major international company with a huge and ever-changing product range. In the period around 1900 VSL production rose to a peak of 160,000 items per day, (90% exported) and used factories throughout the area to produce a very diverse range of wares in crystal, pressed-, blown- and machine-made glass. As the glass industry crashed in 1928-35, most factories were closed, and the survivors changed over to specialised products. The Val-St-Lambert name survived the post-war period by down-sizing and specialising in handmade crystal. Since the 1970's the glass studios have struggled through several more periods of decreasing profitability and further cuts. Today you can still visit the prestigious crystal factory & the castle of Val Saint Lambert and witness the art of the production of the world famous crystal glassware.

Text www.hogelandshoeve.nl/index45.html / Picture: Ronnie Husson

THE ROLE OF MAINTENANCE IN THE RENAISSANCE OF THE NW-EUROPEAN INDUSTRY

The role of maintenance in the renaissance of the NW-European industry

“Without maintenance, the NW European industry would not exist anymore”. I know this is a rather tough statement, but when you read this editorial and the successive chapters of this brochure, you will understand why this statement isn’t strange at all. For many people, maintenance is something they all do, they all know and that doesn’t have any link with economic activity, although it costs money. Now what is maintenance, how important is maintenance and what are the challenges faced by maintenance in fulfilling the role of key enabler?

According to the EN 13306, maintenance is a combination of all technical, administrative and managerial actions during the lifecycle of an item intended to retain it in, or restore it to, a state in which it can perform the required function. Today, it’s often a mixture of asset management and maintenance, but let’s not involve ourselves in an endless discussion and, instead, look at what the facts tell us about maintenance.

On analysing the European Union, you will find that based on GDP, about 10% is spent on maintenance, which is about 1,200 billion euro per year. Half of

this amout is spent on buildings and infrastructure, the other 50% goes towards keeping our industrial asset base in good condition. Translated to full time equivalents, about 35 million people, or 7% of the European population is employed in maintenance. Focusing only on industry, 6 million people are employed in the maintenance branch taking care of an industrial estate of 9,700 billion euros. This represents a direct cost of 600 billion euros (in comparison, the turnover of the European chemical industry is 550 billion euros). When translated to the impact on maintenance workers, the numbers and factors fluctuate between 3 and 5, so a conservative calculation estimates the impact of maintenance that is not performed appropriately at 1,800 billion euros. Seen from another viewpoint, 55 million people employed in European Industry, depend on the production reliability provided by 6 million people working in maintenance (in comparison, the chemical industry employs 1.25 million people). The production turnover of this industry is higher than 5,000 billion euros.

Up to now, we mostly have facts, or let us rather say scientific guesses, because finding the word “maintenance” in European statistics is a really hard job, so the word “about” needs to be used often.

Let us now look at how maintenance is perceived. Let us go to “the” source, the internet, and start to “Google”. When searching for keywords related to maintenance, you soon find some figures, but that’s all: logical or scientific explanation is hard to find. See for yourself:

Keyword	Hits
Maintenance	955,000,000
Asset management	81,000,000
Maintenance skills	326,000,000
Maintenance education	599,000,000
Maintenance research	686,000,000
Europe	1,690,000,000
United States	3,030,000,000
European Union	160,000,000

At least compared to the European Union, maintenance has more hits. When we look into the publications of the European Union, the numbers seem to be going down rather fast. Maybe it doesn’t mean that the word/branch of maintenance is not known or respected in the European Union, but that the EU isn’t familiar with that term. This makes retrieving data difficult. Just a few examples:

- EU Industrial Structure Report 2013: Competing in Global Value Chains:
  - Six records
- EU sectoral competitiveness indicators (2005):
  - Four records
- The cost competitiveness of European industry in the globalisation era – Empirical evidence on the basis of relative unit labour costs (ULC) at sectoral level:
  - One record

So far the holistic approach, but now to the real world of maintenance: I still stand by my statement, but that doesn't mean that everything is all roses. Maintenance too is facing challenges, and a few of these have been explained in other chapters of the brochure.
As an introduction to the world maintenance is moving in, a little bit of history would throw some light on the situation.

The world has changed enormously in the last 50 years. When we think about keywords like Marxism, economic growth, ethical impact, we immediately understand what has been happening.
Industry has also changed in North West Europe this region. From the golden sixties with its endless growth perspective, we are now in a volatile economic world where flexibility has become one of the most important issues.

We have to reinvent the world: the good old days, where everything was plannable, don't exist anymore. The world has become a village, the internet of things is knocking at the door, and sustainability has replaced growth.
The economic triad model leads to an industry, in our region, which has to deal with aspects of lower expansion. The focus must be on high-end products, and lifetime extension of our plants. Sustainability will become the driver: we only have one world, and sustainable EBIT will take the lead.
The European companies are faced with

- The challenge, cost optimisation versus plant availability/safety
- High level of growth in the (chemical) industry outside Europe
- Raw material and energy cost advantages in Arab countries and the USA
- Demographic change, especially in Western Europe
- Increasing oligopolization of the market for technical services (specialities)

Parallel to these economic evolutions, don't forget the social impact of things that happens when something goes wrong. A look at the actual social and economic development makes it clear that the economic growth is very closely tied to complex, effective and highly automated production equipment with functioning service areas. A failure of such systems leads to significant economic losses and reduces the quality of life, for example, by elimination of common services like railways.

On top of these economic and social changes, there are also the trends in maintenance that we encounter:

- The amount of maintenance required decreases,
  - Components/equipment become more reliable, thanks to R&D and better technology.
  - Maintenance evolves from reactive to preventive and predictive to pro-active.
- The legal constraints become sharper due to incidents which happen despite precautions.
- Possibilities to execute maintenance decrease (see

the longer periods between two car revisions). This leads to lower chances to gain experience.
- Complexity of processes and components increases: who can still master this?

All these influencing parameters lead to challenges for maintenance:
- Ageing workforce
  - Western world: baby boomers retire
- Ageing assets: lifetime extension is a challenge (see project VITALE in the Netherlands) when we don't replace
- Training and skills
- Mobility of technicians
- Shift in competences
  - Civil, Mechanical, Electro, Instrumentation, IT
- Processes and IT are more interlinked than ever
- What is the added value of maintenance?

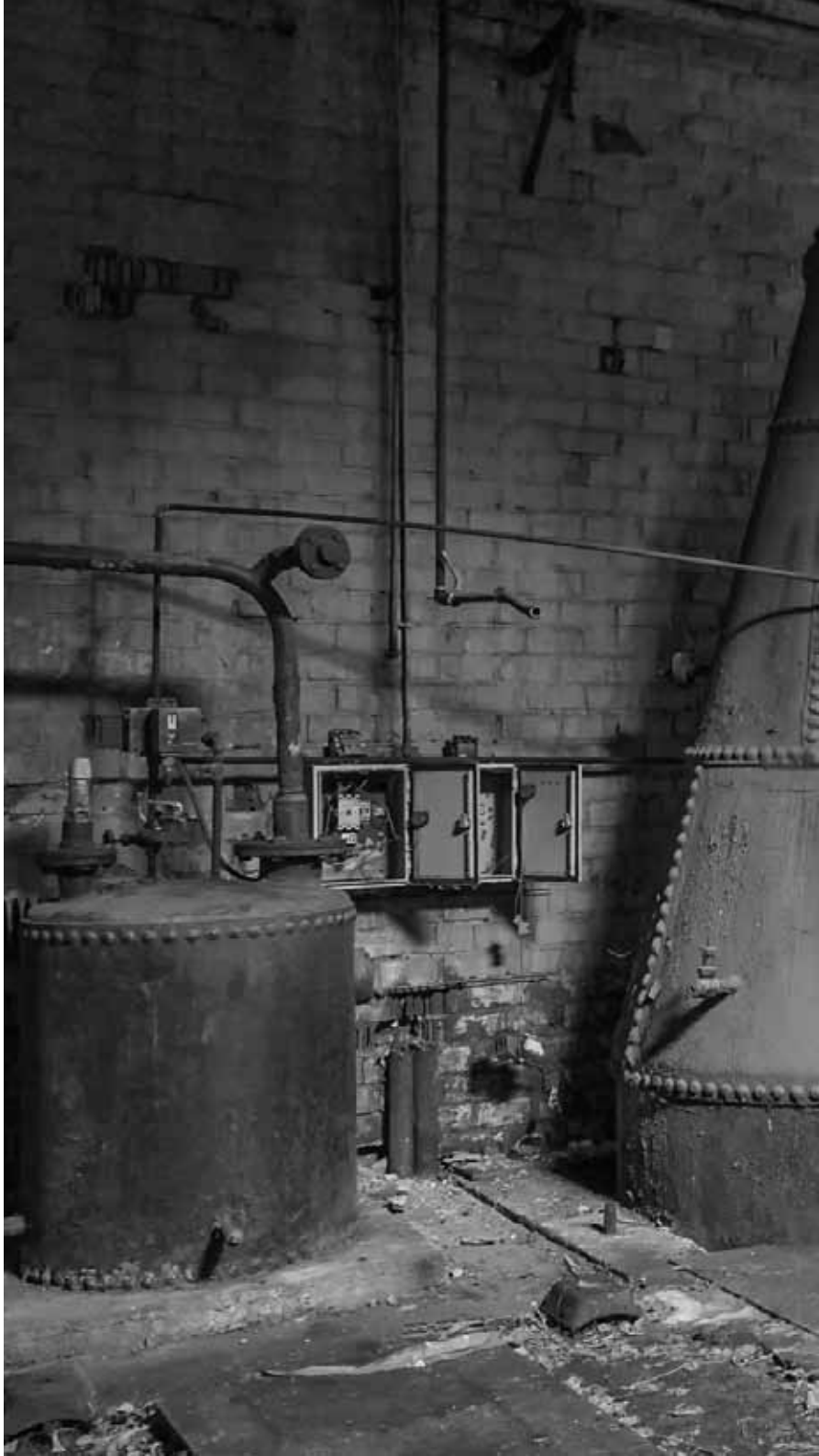
I would like to leave the conclusions of this editorial to the reader. Nevertheless, from my own experience, I can give a few hints.
- There is a clear trend towards internationalisation. For example, in Germany, the sales of the top 10 service contractors are 80% realised abroad. These companies are the largest maintenance contractors in Europe.
- Awareness about managing the ageing plants is necessary. New investments aren't always necessary, but lifetime extension must be studied.
- The mobility of the "common" technician is already an issue, this leads to the importance of mutual evaluation of skills.
- Harmonising the guidelines with respect to internationalising the market and creating the opportunity to work seamlessly all over Europe becomes urgent. From the technical viewpoint, the European Union is a patchwork of countries, each with its own rules and restrictions.
- Research in maintenance with emphasis on application as well as long-term strategies are important in order to stay on top of the economic waves and remain on top of the world.
- Last but not least: the word "about" should be excluded from the statistics. A harmonised benchmark is definitely a worthwhile investment for Eurostat and the national statistical institutes, so we can bring a better image of the maintenance as well as its impact on the European industry.

In conclusion, I would like you to remember the quote at the beginning of this piece. Maintenance is already doing excellent work in our industry, but bringing maintenance to a higher level and into more focus is really a key enabler in the competitiveness of the industry in Western Europe.

ALVAT BARREL FACTORY
DENDERMONDE, BELGIUM

Used industrial barrels were cleaned and reconditioned at the Alvat site in Buggenhout, Belgium. After the bankruptcy in 1995, an investigation was conducted into the nature and extent of the soil contamination at the site. Reprehensible practices during operation had unfortunately resulted in the contamination of both soil and ground water with heavy metals, mineral oil, BTEX, PAHs, VOCl and phenols. Currently the most heavily contaminated part, near the railroad, has been cleaned up.

Text: www.ori.be and www.hln.be / Picture: Ronnie Husson



THYSSEN SINTERANLAGE
DUISBURG, GERMANY

The former Thyssen Sinteranlage in Duisburg (Ruhr District, Germany) started out as 'Meiderich Ironworks' in 1910 and was renovated in the mid 1950s. Sinter is the basic raw material used in the production of iron. Sintering is a method for making solid pellets of powdered iron ore and coke, by heating the material until its particles adhere to each other. The Sinteranlage was feeding sinter to the steel factory that produced pig iron, a primary product for further processing in the steel works. The Blast Furnace 5 in the steel factory had undergone a complete overhaul just shortly before the closure of the complex. With its modern cooling system and hot blast stoves, it complied with strict environmental protection requirements. But due to European steel quotas, in order to reduce the overcapacity in the European steel market, the pig iron production was stopped in 1985. The sinter factory soon followed, and was abandoned in 1995, just after the merger of Thyssen Stahl AG and Krupp Stahl AG.
After citizen protests against the demolition of the old Duisburg Meiderich Ironworks, the brownfield site was transformed into the "Landscape Park Duisburg Nord", a world-famous open access industrial museum, culture, nature and leisure park.

Text: en.landschaftspark.de and www.urbexforums.com
Picture: Urbanexploration.nl

BENCHMARK STUDY IN THE MRO MARKET

mainnovation

BY ROB VAN DONGEN

MANAGEMENT SUMMARY

Since the start of the European economic crisis in 2008, the economy in Northwest Europe (NWE) has gone through difficult times. The various economies in West European countries shrank, levelled off or experienced extremely low growth. In comparison to emerging markets, West European economies are still running far behind. With a share of 19.5% of the collective Gross Domestic Product (GDP), the importance of industry to the Northwest European economy is significant. This is why there is a need to look for alternatives to keep and/or make the Northwest European economy competitive.

One of the possibilities to reinforce the industry's competitive position is to be smarter in dealing with Maintenance, Repair and Overhaul (MRO) within the asset intensive industry. To acquire insight into these opportunities, an international benchmark study was conducted within the industry. The benchmark study was used to identify quantitative, as well as qualitative trends and developments in the field of maintenance and asset management. The study focused extensively on KPI performance measurements, the aging of assets, the technical condition of assets and asset risks, market integration and the outsourcing of maintenance, personnel trends within the sector and maintenance-related innovations.

From the analysis of the performance of the current assets it is possible to conclude that there still is significant room for improvement. Indeed, the study shows that there is a major difference in performance between the top performers in the industry and the group of companies whose performance is lower: performance in terms of technical availability on average is 6% lower and in terms of cost on average it is 42% lower. If the entire asset intensive industry were to perform at the top performer level, this would result in the following added value for Northwest Europe:

- Increase in the industry's competitive strength with a 30% EBITDA1 improvement (EUR 85 billion per year).
- Savings of 25% in investment costs due to lifetime extensions instead of replacing aging assets (EUR 44 billion per year).
- Increase of 3% in employment in MRO activities (at asset owners but mainly in the MRO-service sector (80,000 FTE).
- Better living environment with a reduced probability of the occurrence of health & safety and environmental incidents.
- Increase of 1.8% in the industry's share of the collective Gross Domestic Product (GDP) of Northwest Europe[1] (EUR 103 billion per year).

Crucial to achieving the top performer level throughout the entire Asset intensive industry is the implementation of the following seven success factors:

- The maturation of the Asset owners, in which the optimisation of preventative maintenance across the entire lifecycle is a key theme. The development of reliability engineering competency is of crucial importance in this respect.
- Monitoring of performance and risks across the entire asset

[1] *Provided that the industry is in fact capable of selling the larger production volumes on the market.*

lifecycle. The development of the asset portfolio management competency plays an important role in this regard.

- Better health & safety management through higher reliability and better asset management. Governmental organisations supervise the development and enforcement of specific laws and regulations.
- The development and application of lifetime extensions for aging assets within the industry. Stimulating investment in lifetime extensions is of major importance in this respect.
- Training of sufficient young talent to absorb the growth of the MRO sector and the expected outflow of technical skilled personnel.
- Stimulating important innovations that ensure that the predictability of the need for maintenance, the investment requirements and the health & safety risks improve.
- Unambiguous macroeconomic follow-up of the asset strategy's by governments in order to obtain and keep a grip on the industry's future performance and to stimulate sustainable economic growth and the integration of innovations.

The Northwest European economy is still in dire straits; however, through the collective efforts of the asset owners, MRO service providers and government organisations, NWE's asset intensive industries can continue to be competitive for many years!

1. 1. INTRODUCTION

1.1 Motivation

Since the start of the European economic crisis in 2008, the economy in Northwest Europe (NWE) has gone through difficult times. The various economies in West European countries shrank, levelled off or experienced extremely low growth. From Figure 1 it is evident that by the end of 2012, the industry's added value in Belgium, Germany, France and the Netherlands had reverted to pre-crisis levels. In comparison to the industrial added value in emerging markets, West European economies are running still further behind.

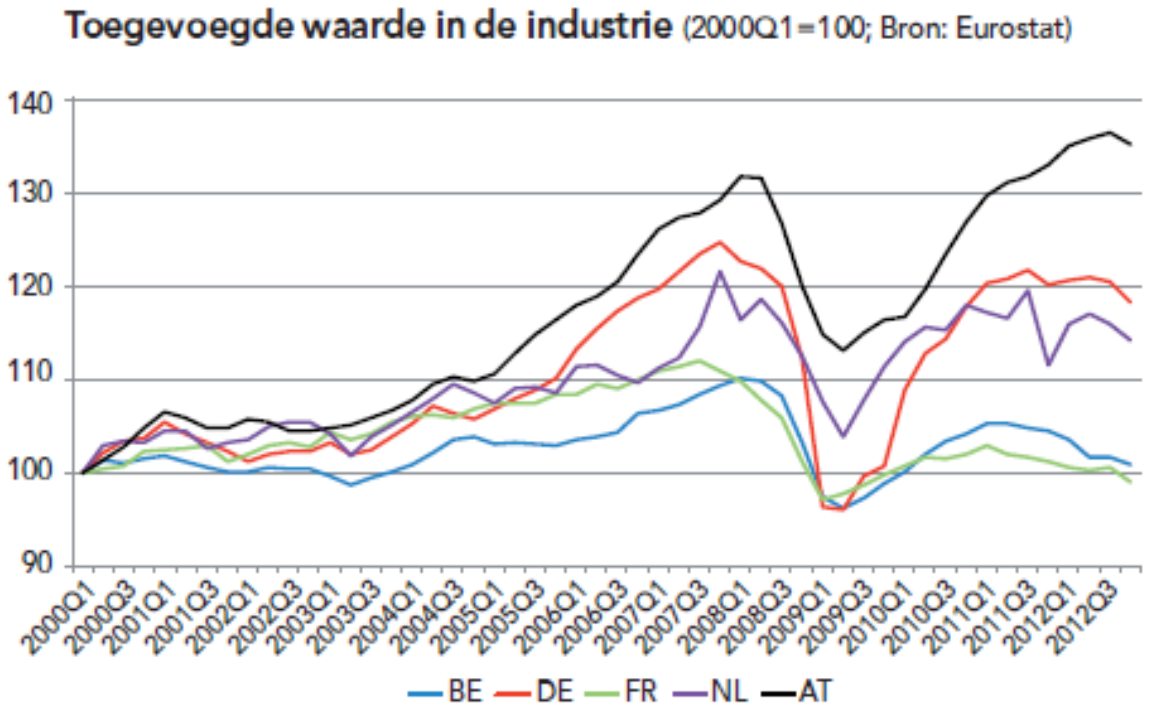


Figure 1.1. Industry added value

The importance of the industry in the economic growth of Northwest Europe is significant. In 2011, the share of industry in the collective Gross Domestic Product (GDP) of the EU was 19.5%2. Whereas in emerging economies new industrial assets are being constructed and equipped with the latest technologies, Northwest Europe is faced with an industrial asset base that was largely built during the fifties and sixties of the previous century.

In view of the current economic situation, a straightforward multi-billion replacement of this asset base in Northwest Europe is only possible to a limited extent and therefore there is a need to look for alternatives to keep and/or make the Northwest European industry competitive. One of the possibilities to reinforce the industry's competitive position is to be smarter in dealing with Maintenance, Repair and Overhaul (MRO) within the industry.

In this context, Interreg IVB, part of the European Union, initiated a programme to determine which developments in the context of employee mobility, market integration and innovations within the MRO sector are required to increase the desired improvements in the competitive position of the current industrial asset base. This is referred to as the More4Core programme. MORE4CORE stands for Maintenance, Overhaul and REpair for COmpetitiveness of the NWE REgion.

1.2 Objective

The objective of MORE4CORE is to obtain insight into the way in which market integration, employee mobility and innovation in the MRO sector can be improved such that the effectiveness and efficiency of this rapidly growing sector in Northwest Europe can be increased.

A key element of Work Package 2 of the MORE4CORE Programme is a Survey of the maintenance conducted by companies in Belgium, the Netherlands, France and Germany and the macroeconomic translation of the benchmark results to the Northwest European level.
The survey took a look at trends and developments within the following focus areas :

- KPI asset performance measurements
- Aging of assets
- Technical condition of assets and asset risks
- Market integration and outsourcing of maintenance
- Personnel trends within maintenance and asset management
- Maintenance innovations

By benchmarking the performance of the different participating Asset owners it was possible to determine which crucial changes and improvements can help to increase the average performance level in the industrial sector. This way this study contributes to giving the industry an impulse by providing focused improvement directions and recommendations for achieving smarter and better Maintenance, Repair and Overhaul.

The MORE4CORE Survey is focused on providing insight into the maintenance challenges facing industry and into the development of the necessary plans for the political establishment and industry.

1.3 Reading Guide

Chapter 1 explains the motivation and objective of the MORE4CORE Survey, while Chapter 2 explains the research methodology. This chapter clearly explains how the Survey is conducted

[1] Provided that the industry is in fact capable of selling the larger production volumes on the market.

and how the results can be interpreted. Chapter 3 deals with the characteristics of the MRO market in Northwest Europe on the basis of the micro- and macroeconomic studies carried out. Chapter 4 provides insight into the way in which Asset owners that score above average (the so-called top performers) manage to achieve better performance than the Asset owners that score below average (the laggards). On the basis of these best practices, Chapter 6 includes an economic and business analysis that establishes the added value of best in class maintenance and asset performance for industry in Northwest Europe. Finally, the report concludes with recommendations that can contribute to ensuring that the potential added value is in fact realised. These success factors are presented in Chapter 6.

2. APPROACH AND ACCOUNTABILITY

2.1 Project partners

The following parties, listed in alphabetical order, entered into a partnership designed to implement the MORE4CORE programme.

- Association française des ingénieurs responsables de maintenance (AFIM) - France
- Belgian Maintenance Association (BEMAS) - Belgium
- Dutch Institute World Class Maintenance (DIWCM) - Netherlands
- European Federation of National Maintenance Societies vzw (EFNMS)
- Maintenance Education Consortium (MEC) - Netherlands
- NV Brabantse OntwikkelingsMaatschappij (BOM) - Netherlands
- Voka: Kamer van Koophandel Antwerpen-Waasland vzw - Belgium
- WVIS Wirtschaftsverband für Industrieservice e.V. (WVIS) – Germany

In support of these partners, the maintenance consulting firm Mainnovation was involved in developing the benchmark study, executing the benchmark studies in Belgium and the Netherlands, and analysing the benchmark study results. KPMG provided support in supplying macroeconomic trends, developments and maintenance information.

2.2 Participants in the Survey

To execute the study, five sectors were defined that fall within the scope of this study. These sectors are identified below together with an explanation of the assets that are the focus of maintenance within these sectors:

- Processing industry: maintenance of and related to the (continuous) production processes of solid materials, liquids and gases. For example the chemical industry, energy production, oil refineries, blast furnaces and the paper manufacturing industry.
- Manufacturing industry: maintenance related to the manufacturing environment for the (discrete) unit production of goods and products (with the exception of the Food, Beverage & Pharma industry).
- Food, Beverage & Pharma: maintenance related to the manufacturing environment for the unit production of goods and products within the Food, Beverage & Pharma goods segment.
- Fleet: maintenance of vehicles (excluding passenger vehicles), vessels and airplanes engaged in professional transport over land (including rail) and water, and by air.

- Infra: maintenance of roads, water, rail and other infrastructural works, such as ports and airports. As well as infrastructure such as (electrical) cables and piping networks.

In total, 210 companies in Belgium, Germany, France and the Netherlands, spread across the five above-referenced sectors, participated in the benchmark study (see Figure 2.1). At 88 and 103, respectively, the number of participants in Belgium and the Netherlands is at an acceptable level. The number of participants in the benchmark study in Germany and France was 11 and 8, respectively, and consequently does not constitute a representative group of companies for the industry in these countries.

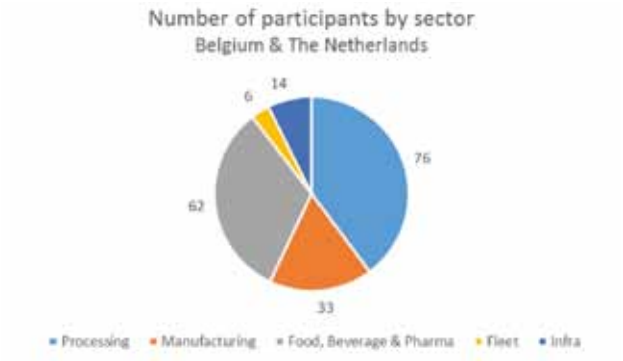


Figure 2.1 Number of participants in the benchmark by country

Next, the distribution of the total of 191 participants in the benchmark in Belgium and the Netherlands was analysed. From Figure 2.2 it is evident that a total number of 171 participants distributed across the processing (76 participants), manufacturing (33 participants) and food, beverage & pharma (62 participants) sectors provides a reasonable to good cross-section of the industry in these countries. By contrast, the Fleet and Infra sectors are only moderately represented with a total of 20 participants. Combined with the fact that the Infra sector includes a variety of technical assets, this justifies the conclusion that these sectors are not sufficiently represented to provide a representative picture of these sectors in Belgium and the Netherlands.

Figure 2.2 Number of participants by sector

On the basis of these numbers of participants, it was decided to primarily focus the results of the benchmark study on the Processing, Manufacturing and Food, Beverage & Pharma sectors in Belgium and the Netherlands.

2.3 Research methodology

To produce consistent results during the Survey, a research methodology consisting of five steps was followed. These steps are explained below.

Step 1: Identify the required research information

In consultation with the More4Core partners, the survey questions to be used were identified. Key Performance Indicators (KPIs) to identify the performance of the individual Asset owners were identified for the six focus areas (see Section 1.2). Annex 2 contains the list of KPIs. In addition, the supplementary quantitative and qualitative information required to determine which best-in-class methods of work

can assist the Asset intensive industry to structurally improve their performance was identified.

Step 2: Elaboration of the More4Core Questionnaire

A questionnaire was developed on the basis of the MRO information deemed necessary for the study. The questionnaire was validated by the More4Core partners. To increase the unambiguity of the MRO information to be submitted, an extensive glossary was included in the questionnaire. The questionnaire was prepared in German, English, French and Dutch and is included in Annex 3.

Step 3: Validation on the basis of company visits

All participating Asset owners were sent a copy of the More4Core questionnaire and completed the questionnaire. The answers of the participants were then validated together with specialised maintenance and asset management consultants. These validations were conducted during company visits and were focused on reviewing the definitions used and the interpretation of the questions. This way the consistency and quality of the benchmark information obtained in support of the Survey was safeguarded.

Step 4: Processing of the data in the More4Core database

The validated MRO information of all participants was then processed in a specially developed More4Core database. This database was used to provide the participating Asset owners with an individual MRO benchmark report to provide them with insight into their current performance and improvement potential. In addition, the database was used to perform analyses in support of the Survey. The tables and graphs included in this report are based on this database[3].

Step 5: Macroeconomic study of MRO trends

Parallel to the execution of the micro-benchmark studies within the companies, KPMG Asset Management conducted a macro-economic study of the MRO market. The data from this study was used to extrapolate the results from this Survey to the Northwest European level.

The MRO Survey and the macroeconomic study form the basis for this final report. Where necessary other sources are cited.

[3] Unless otherwise specified in this report, which always includes a reference to other sources of information used.

3. CHARACTERISTICS OF THE NORTHWEST EUROPEAN MRO MARKET

This chapter provides a comprehensive insight into the scope of the MRO market, its characteristics and the performance within various MRO focus areas. This not only involves a review of the average performance level of the industrial sector as a whole, but also by individual sector whenever possible. A general conclusion for each MRO focus area is provided on the basis of the findings.

3.1 Industrial asset base

The size of the total asset base was determined for the collective Belgian and Dutch MRO market. Furthermore, the obsolescence of this asset base was reviewed, as well as the measures expected to be taken at the end of the lifetime of these assets.

Size of the Belgian and Dutch industrial asset base

There was economic growth in the following decades as well, but this growth was significantly lower and required fewer large-scale investments in new construction and expansion than in the 1950-1970 period.

Asset replacement value (ARV) of industrial assets

The KPMG macroeconomic study shows that the industrial asset base in Belgium and the Netherlands represents a value of approximately EUR 700 billion (see Annex 4):

- Netherlands: EUR 420 billion
- Belgium: EUR 280 billion

Industry economic value added

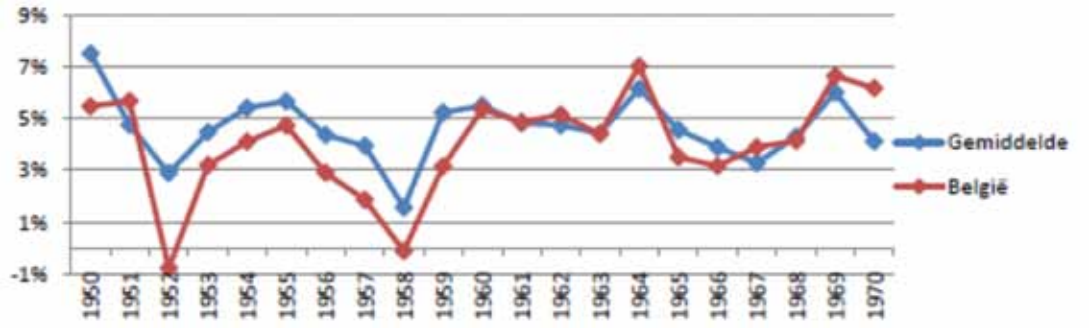


Figure 3.1.2 Economic growth in West Europe 1950-1970

[1] *Source: Master Thesis 'De Industriële Transformatie van België, Economische Groei en Investeringen 1953-1966' (The Industrial Transformation of Belgium, Economic Growth and Investments 1953-1966), Thomas Dumolyn, Ghent University, 2012.*

As indicated previously, industry in Northwest Europe contributes 19.5% to the collective Gross Domestic Product (GDP). Based on the Eurostat data, the total GDP of the countries in this Survey amounts to approximately EUR 1,000 billion:

- Netherlands: EUR 600 billion
- Belgium: EUR 400 billion

Remaining lifetime of industrial assets

As indicated, a large portion of the industrial assets was built during the period 1950-1970. The consequence is that many industrial assets, provided they have not yet been replaced, are currently reaching a lifetime of 40 to 50 years. The next sections provide insight into the trend of the remaining lifetime of assets in the various sectors.

Processing Industry

Based on the supplied asset replacement value of the assets, an assessment was made to determine when and which part of the asset base will reach the end of its technical lifetime in the processing industry in Belgium and the Netherlands. From Figure 3.1.3 it can be concluded that in the period 2015-2025, 41% of the total asset base will have reached the end of lifetime. In the two consecutive 10-year periods after this, these percentages drop to 27% (11-20 years) and 32% (20 years and older).

An assessment of the average technical lifetime of the assets in this sector shows that the expected average technical lifetime is approximately 33 years.

On the basis of this expected average technical lifetime it can be assumed that given a normal asset distribution, every 10 years approximately 30% of the asset base is due for replacement. The current 41% is therefore significantly higher.

Manufacturing

The characteristics for the manufacturing industry are comparable to those of the processing industry. Figure 3.1.4 shows that within 10 years, more than half (54%) of the current asset base will reach its end of lifetime. This subsequently declines to 21% in the period 2026-2035 and to 25% after 2036.

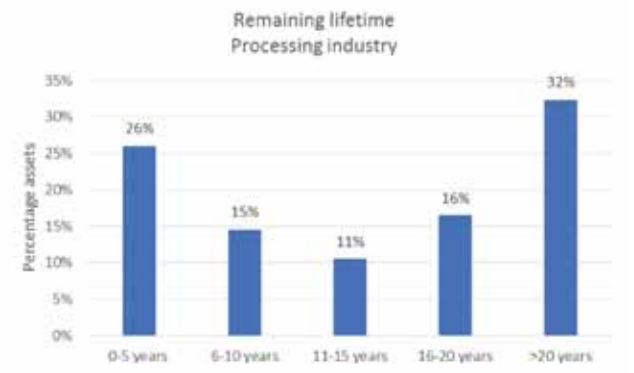


Figure 3.1.3 Remaining lifetime of assets in the processing industry

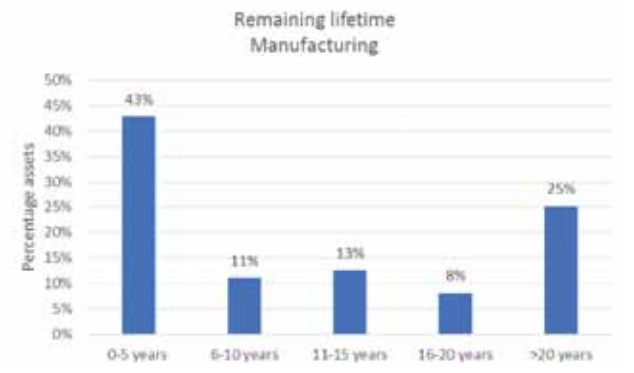


Figure 3.1.4 Remaining lifetime of assets in the manufacturing industry

On the basis of a benchmark study it was determined that the expected average technical lifetime of the assets within this sector is 27 years. From this it is possible to conclude that during every 10-year period approximately 35% of the assets reaches the end of lifetime. The observed 54% is significantly higher than this.

Food, Beverage & Pharma

Finally, a review of the food, beverage & pharma sector shows that the need for end-of-lifetime measures is greatest in this sector. Figure 3.1.5 shows that 62% of the assets will reach the end of the technical lifetime over the coming 10 years.

This percentage drops to 30% in the next 10-year period. What is striking is the very small percentage of 8% of the assets that will reach the end of lifetime after 2035.

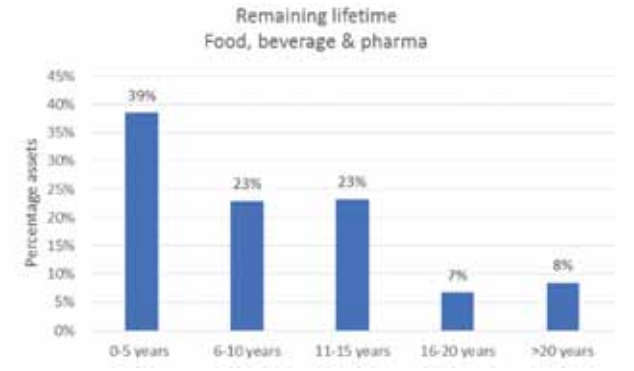


Figure 3.1.5 Remaining lifetime of assets in the food, beverage & pharma industry

The average technical lifetime for this sector was determined to be 27 years. This means that during every 10-year period approximately 35% of the asset base will qualify for end-of-lifetime decisions. The percentage of 62% for the next 10 years far exceeds this.

Regional variances

When the assets in the processing industry, the manufacturing industry and the food, beverage & pharma industry are considered collectively, and the remaining lifetime is calculated on the basis of the asset replacement value, this produces the trend shown in Figure 3.1.6. From this it is evident that in Belgium and the Netherlands collectively, 44% of the assets approaches its end of lifetime within 10 years.

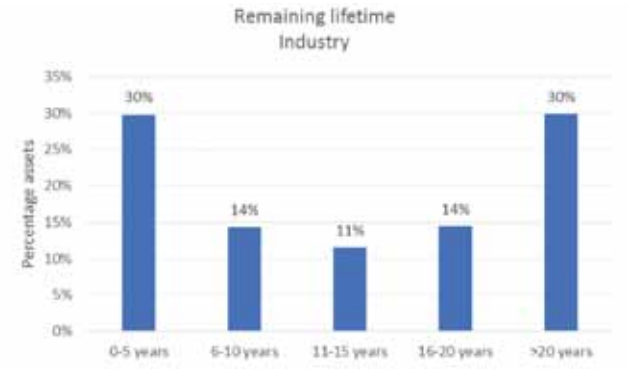


Figure 3.1.6 Remaining lifetime industry

The study then reviewed the distribution of the remaining lifetime for plants in the three industrial sectors in Belgium and the Netherlands (see Figure 3.1.7). From this data it is evident that during the period 2015-2024 the replacement challenge is comparable in both countries: 46% of the assets in Belgium versus 41% of the assets in the Netherlands. However, these differences increase in the subsequent decades. In the Netherlands, this need levels off to 18% in the period 2025-2034, while in Belgium 30% of plants approaches the end of lifetime during this period. For the years following this period, the Netherlands once again needs to prepare itself to address large-scale end-of-lifetime-related replacement issues.

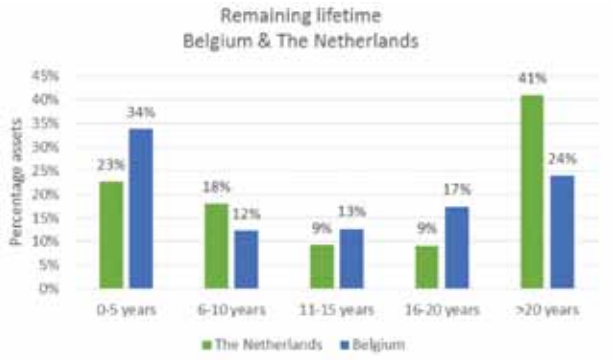


Figure 3.1.7 Remaining lifetime in Belgium and the Netherlands

An interesting observation is that a Survey conducted in the Netherlands in 2009[5] displays a similar remaining lifetime distribution (see Figure 3.1.8). From this it can be concluded that the replacement peak for the period 2010-2014 has been absorbed by extending lifetime on the one hand, and by replacing aging assets on the other.

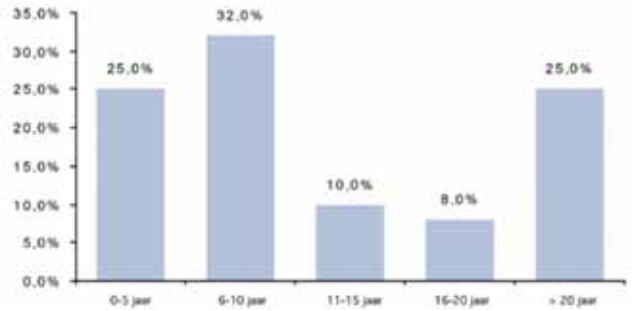


Figure 3.1.8 Projected remaining lifetime in 2009

From this it can be concluded that the average age of the asset base in Belgium is higher than the average age of the asset base in the Netherlands. However, for both countries the asset replacement issue in the first 10 years is at a high, challenging level.

Remaining lifetime at plant level

The finding here is that a significant portion of the asset base will have to be replaced within 10 years. The analysis of the results clearly indicates that in most cases this concerns parts of the plant and not the entire plant. Due to expansions and replacements of parts of a plant in the past, a plant often consists of components with different ages. For that reason, plants seldom qualify for total replacement. Figure 3.1.9 displays two examples of the asset base structure for two different plants. For each remaining lifetime category, this figure displays the percentage of the plant's asset base that falls within this category. For Plant 1 this means that 80% of the asset base has a remaining lifetime of less than 5 years.

Figure 3.1.9 Distribution of remaining lifetime within asset base by Asset owner

End-of-lifetime measures

There are a number of possible scenarios when assets reach the end of their technical lifetime. The benchmark study took a look at the following five scenarios:

- Disassemble the asset
- Extend lifetime

[5] *Source: Survey 'Hoe betrouwbaar is het Nederlandse machinepark?' (How Reliable is the Machine Park in the Netherlands?), Mainnovation, May 2010.*

- Replacement with retention of existing functionality; also referred to as '1-on-1 replacement'
- Replacement together with expansion of functionality; also referred to as '1-on-N replacement'
- Other

Alternatives for replacing assets

The participants in the benchmark were asked to indicate which part of their asset base qualifies for which end-of-lifetime scenario. Figure 3.1.10 summarises the data for the plants in Belgium and the Netherlands.

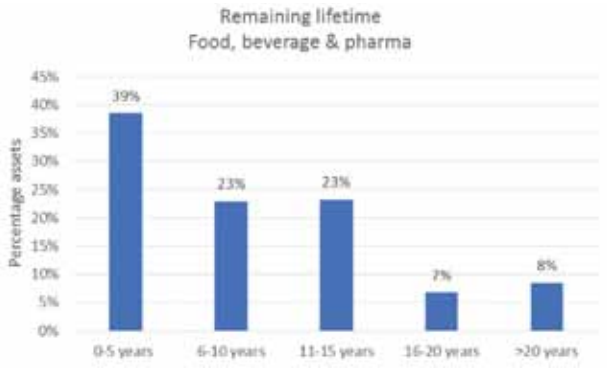


Figure 3.1.10 End-of-lifetime scenarios for plants in Belgium and the Netherlands

From this it can be concluded that 5% of the asset base is slated for closure at the end of its technical lifetime. Apparently these assets have reached such a state of obsolescence (technologically, commercially or economically) that they no longer have a viable commercial basis.

Replacement is considered the preferred measure at the end of lifetime for 63% of the asset base. For 27% of the assets, extending the lifetime is considered a serious option for keeping the assets operational longer. Due to the less favourable economic prospects, the expectation is that it will be impossible to obtain financing for all required replacements, as a result of which the share of lifetime extensions is expected to increase over the coming years.

Conclusion

From the analysis of the remaining lifetime of assets in Belgium and the Netherlands it can be concluded that during the period 2015-2024, a significant portion of the industrial assets will approach the end of technical lifetime: 44% of the total asset base. This represents a value of EUR 440 billion.

While there are differences between the various sectors, the trend in each sector is comparable: 41% of the assets in the processing industry, 54% in the manufacturing industry and 62% in the food, beverage & pharma industry will then reach the end of lifetime. Currently, extending the lifetime of an asset is considered the most important measure for 27% of the aging assets, while under pressure of macroeconomic conditions, the focus on extending lifetime will only increase.

3.2 Maintenance costs and investments

This section reviews the characteristics of the different types of MRO costs: maintenance costs, use of materials as a specific expense and investment item, and investments in projects.

Maintenance cost trends

Maintenance costs form a significant part of the GDP. From the

KPMG study it follows that it is reasonable to assume that 4-4.5% of the GDP can be related to maintenance within the industrial sector. For Belgium and the Netherlands collectively this represents a total expense item of approximately EUR 42 billion annually:

- Netherlands: EUR 25 billion annually
- Belgium: EUR 17 billion annually

In spite of these considerable expense items at a national level, maintenance cost trends are not recorded or monitored at a national or EU level.

Industry cost performance

The Maintenance Costs/Asset Replacement Value KPI is used to measure the performance of Asset owners in terms of their maintenance costs. From the data submitted by participating Asset owners it is clear that within the industry (all sectors collectively) on average 4.4% of the value of the installed asset base is spent on maintenance each year (see Figure 3.2.1).

Figure 3.2.1 Average maintenance costs per sector

However, there are significant differences between sectors[6]. For example, it is evident that the average cost level within the processing industry and the food, beverage & pharma industry is approximately 15-20% lower than within the manufacturing industry. This can be explained by the type of business processes and the associated required installations.

When the maintenance costs are related to company turnover, the importance of maintenance as well as the importance of controlling maintenance costs becomes evident. On average, maintenance costs within the industry amount to almost 4% of turnover (see Figure 3.2.2). One striking finding is that this proportion, at over 11%, is significantly higher within the food, beverage & pharma industry.

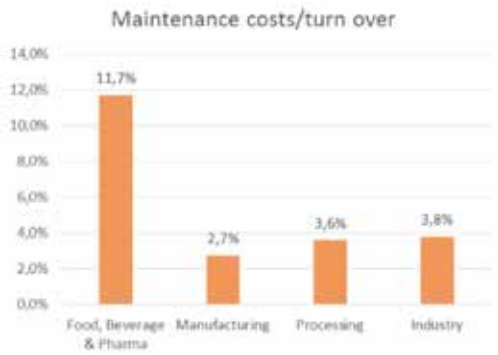


Figure 3.2.2 Maintenance costs as a percentage of turnover

Maintenance cost trends

Participants were asked to provide insight into the maintenance costs trend over the period 2010-2016. The maintenance costs in 2010 were used as the starting point. Figure 3.2.3 shows that the

[6] Performance differs within the defined sectors as well. For example, maintenance costs within the fine chemistry subsector are significantly lower than within the metal production subsector. Both subsectors form part of the processing industry sector.

absolute maintenance costs during the period 2010-2013 among participants increased by 4%. It is expected that this growth in maintenance costs will remain stable until 2016.

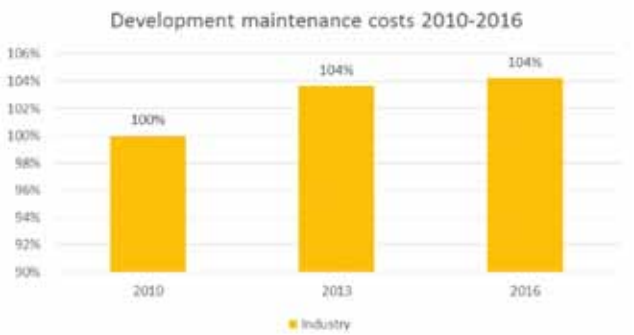


Figure 3.2.3 Trend in maintenance costs

The reason given for the growth during the period 2010-2013 is that production declined due to the economic climate prior to 2013 and that this put a great deal of pressure on reducing maintenance costs. The recovering economic climate with the growth in turnover contributed to the increased maintenance budgets in 2013. In spite of the further economic growth and the expected growth in turnover, maintenance costs are staying at the same level. Many participants indicate that this is due to the fact that during the period 2013-2016 maintenance costs had to be controlled in responsible ways in order to increase operating returns.

Cost of materials

The availability and use of spare parts play an important role within maintenance in terms of the ability to perform the work on a timely basis and thus limit downtime. Figure 3.2.4 shows that the use of spare parts on average represents 30% of the maintenance costs.

This section analyses the cost of materials. Section 3.6 presents the results of the outsourcing costs. Labour costs are presented in Section 3.7.

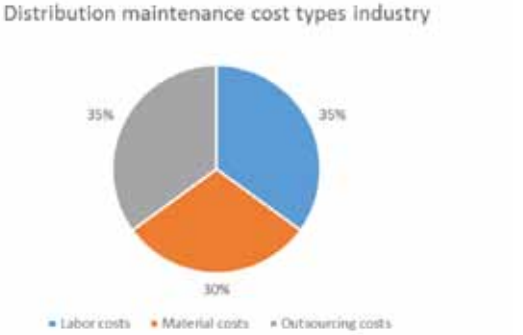


Figure 3.2.4 Distribution of types of maintenance costs within the industry

From Figure 3.2.5 it is evident that the share of material costs differs by sector. However, the magnitude of these differences is not such that materially different characteristics apply. The percentages can be influenced by the extent to which maintenance is outsourced. Many Asset owners do not separately record the materials provided by contractors while performing their work as cost of materials, and instead these costs form part of the outsourcing costs.

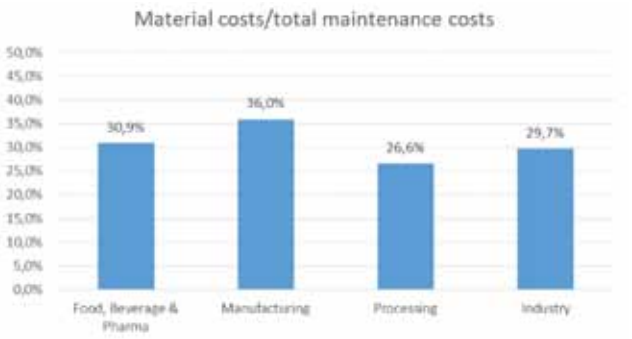


Figure 3.2.5 Consumption of materials by sector

In addition to the consumption of materials while performing work, there is another key parameter at play, which is the investments made in creating a spare parts inventory. The Spare parts inventory/ Asset replacement value KPI is a good indicator for this.
On average, the value of the spare parts inventory within the industry represents 1.7% of the asset replacement value (see Figure 3.2.6). This here concerns the inventories kept in MRO warehouses by the technical services. The level within the manufacturing sector is approximately 15% higher than the industry average.

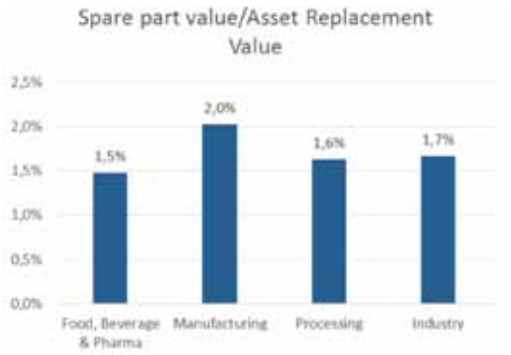


Figure 3.2.6 Value of spare parts inventory

Investments

Investments in industrial assets can pertain to various types of projects. This varies from the expansion of production capacity to the modernisation and replacement of assets or parts thereof. The costs associated with investments generally are considerable. Some investments are of a regular character (shutdowns, overhauls), while other investments are one-off (lifetime extension, replacement, expansion).

Annual investments

A comparison of the average annual investments in assets with the asset replacement value shows that on average 2.7% is invested annually within the industry (see Figure 3.2.7). This represents an annual investment of EUR 18.9 billion for Belgium and the Netherlands. The sector averages vary from -10% to +10% of this figure. From this it follows that the investment costs represent approximately 60% of the annual maintenance costs. All in all, given its size, this is a cost item that should be monitored carefully.

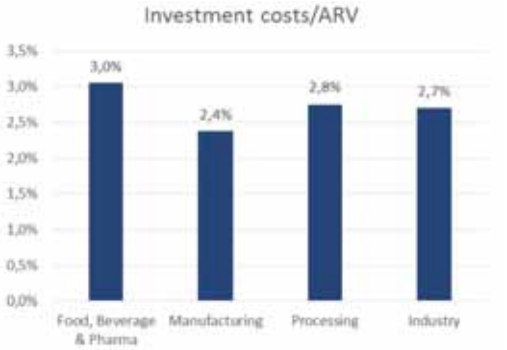


Figure 3.2.7 Average annual investment levels

A review of the types of projects to which these investment costs pertain shows that on average 19% of the costs are spent on regular investments, such as shutdowns and major overhauls (see Figure 3.2.8). This means that approximately 81% of the investment costs are one-off (modification, lifetime extension and replacement).
In addition, on the basis of the data it can be concluded that 73% of investments is focused on keeping the technical condition of the assets up to par. Functional modification projects are considered modernisation activities and serve to expand the function and/or capacity of the assets.

Figure 3.2.8 Type of investment projects within the industry

Investments in modernisation

Investments in modifications within the processing industry on average are up to 30% less than in the manufacturing and food, beverage & pharma industries (see Figure 3.2.9). This can possibly be explained by the fact that this type of industry is less subject to changing client demand on the one hand, and that in recent years sales have not increased and therefore there was no need for expansion on the other hand. As a result there was less of a need to implement functional modifications for this type of assets.

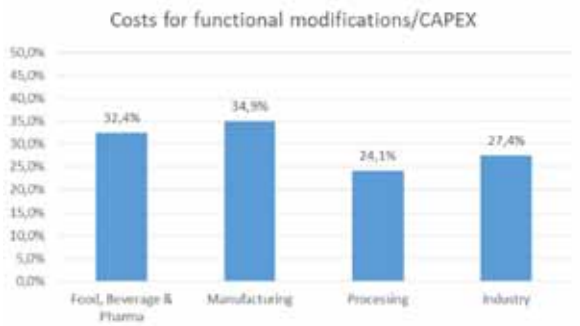


Figure 3.2.9 Investments in modernisation

Another interesting fact is that the scope of the functional modifications (ARV-related) within the industry decreases significantly as the relative asset age increases. In the first 20% of the operational asset lifecycle, this percentage is over twice as high as in the remainder of the lifecycle. This is reflected in Figure 3.2.10.

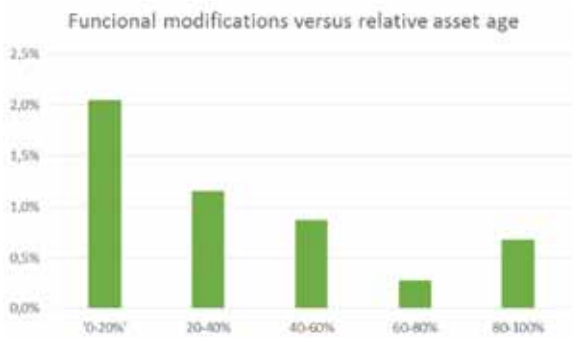


Figure 3.2.10 Modifications in relation to asset age

Conclusion

The total lifetime costs of industrial assets are considerable. On an annual basis, the industry spends almost 6.5% of the asset replacement value on asset-related maintenance activities and investments. For Belgium and the Netherlands collectively this represents approximately EUR 42 billion.

Given an average lifetime of 30 years, this means that on top of the initially invested capital to acquire and commission an asset, almost twice this amount is spent on maintenance and projects throughout the assets' entire lifetime.

Approximately 30% of the persons responsible for maintenance and asset management indicate that controlling and reducing maintenance costs must contribute to improving operating results over the coming years.

3.3 Technical availability and reliability

Whereas cost control as discussed in Section 3.2 can contribute to reducing maintenance costs and investments, increasing technical availability contributes to increased turnover. This section deals with the current industrial performance in this area.

Uptime of assets

The average uptime of industrial assets is 93.7% (see Figure 3.3.1). This means that for every 100 hours available for production, 6.3 hours cannot be used due to technical standstills. This standstill can be the result of failures that need to be resolved, the execution of preventative maintenance that causes an asset to be unavailable or the execution of major maintenance-related projects.

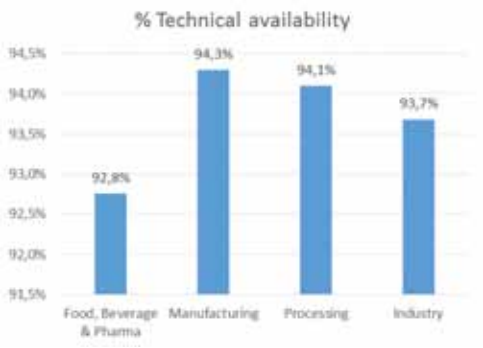


Figure 3.3.1 Technical availability of industrial assets

From the same figure it can be concluded that uptime differs among different sectors. This can be explained by the use of different types of installations and systems, each with its own characteristics.

The uptime trend experienced by assets throughout their lifecycle was reviewed for the industry as a whole. From Figure 3.3.2 it is evident that the average uptime of industrial assets throughout their entire lifecycle is relatively stable. The aging of assets does not appear to have a negative impact on this.

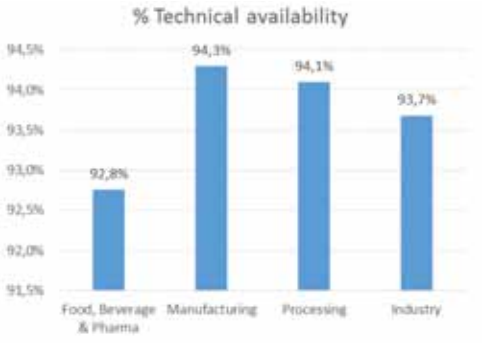


Figure 3.3.2 Technical availability related to lifecycle

Satisfaction with asset reliability

The persons responsible for maintenance and asset management were asked to assess the current reliability of their assets. From this data it is evident that 36% is not satisfied with the current reliability of assets (see Figure 3.3.3). This is contrasted by the fact that in only 5% of assets an increasing failure rate is observed, and that in almost 50% the failure rate decreases (see Figure 3.3.4). From this it can be concluded that reliability in all likelihood will experience a positive trend over the coming years.

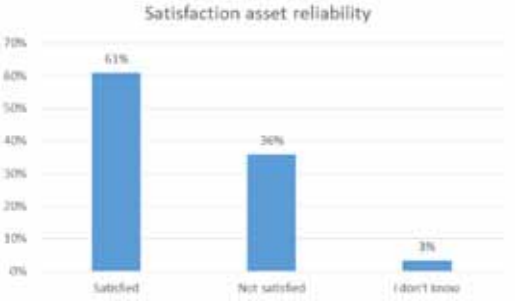


Figure 3.3.3 Satisfaction with asset reliability

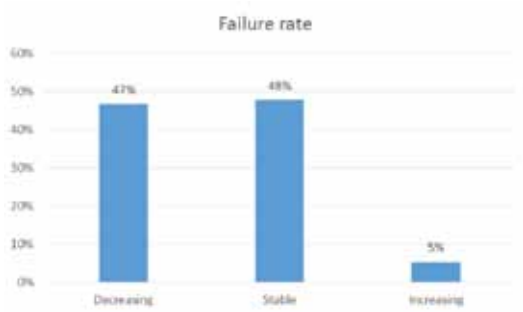


Figure 3.3.4 Failure rate trend

Conclusions

The uptime of industrial assets is relatively high at 93.7%. Improving uptime by reducing failure rates and increasing reliability are key focus areas for maintenance managers. The current findings concerning reliability and failure rates suggest a positive trend. By reducing downtime on the basis of maintenance, the industry is able to increase turnover[7]. Over 6% in turnover losses due to downtime is considerable. In terms of the turnover previously calculated for the industry in Belgium and the Netherlands in the amount of EUR 1,000 billion, this represents a turnover loss of EUR 600 million. From this it can be concluded that improving technical availability can not only result in turnover growth, it can also strengthen the industry's competitive position.

3.4 Safety

In the area of safety, the probability of the occurrence of health & safety incidents, as well as the probability of the occurrence of environmental incidents was investigated. These probability estimates are furthermore related to the aging of assets.

Probability of the occurrence of serious incidents

Figure 3.4.1 displays the estimated probability of the occurrence of health & safety incidents for the entire industrial asset base. The first conclusion that can be drawn from this is that 82% of plants consider the probability of the occurrence of a health & safety incident small or very small. The second conclusion, however, is that for almost 18% of plants there is a reasonable probability that a serious accident with health & safety implications can occur. A reasonable probability means that the probability is estimated to be possible (Category 3), probable (Category 4) or almost certain (Category 5).

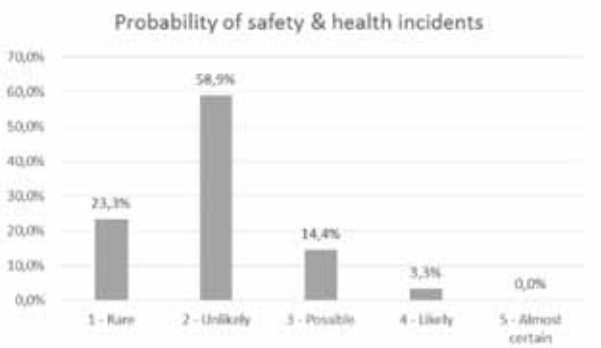


Figure 3.4.1 Distribution of the probability of the occurrence of health & safety incidents in industry

The probability of occurrence was also assessed for environmental incidents. This information is displayed in Figure 3.4.2. The same conclusions can be drawn here as with regard to health & safety, namely that for a significant part of plants there is a reasonable probability that there will be an environmental incident (22%).

Risk trends

It has become clear that the estimated probability of the occurrence of a risk with consequences for health, safety and the

[7] *This is of course only of interest if the additional production can also be sold on the market.*

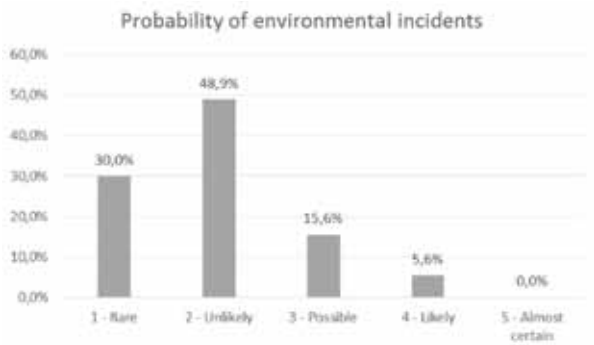


Figure 3.4.2 Distribution of the probability of the occurrence of environmental incidents in industry

environment is significant. When these statistics are compared to the results of the Survey concerning the reliability of the Dutch machine park conducted in 2010, it appears that the situation has deteriorated in comparison to 2010[8].

The findings from that survey showed that for an average of 8% of industrial companies there is a reasonable probability of a serious incident, while the current benchmark study puts this figure at approximately 20%.

Safety in relation to the age of assets

Based on the conclusions that there is a significant probability of the occurrences of incidents and the fact that a large part the plants are in the last stage of their lifecycle, it is important to know whether the aging of assets affects the risk profile. The average estimated probability is displayed in Figures 3.4.3 and 3.4.4 for the five relative age categories for both types of risk. From this it is evident for both types of risk that as the assets age, the average probability of the occurrence of incidents increases by 50-60 per cent. Given the approaching end of lifetime of a large group of plants over the coming 10 years, controlling asset risks will become an important challenge.

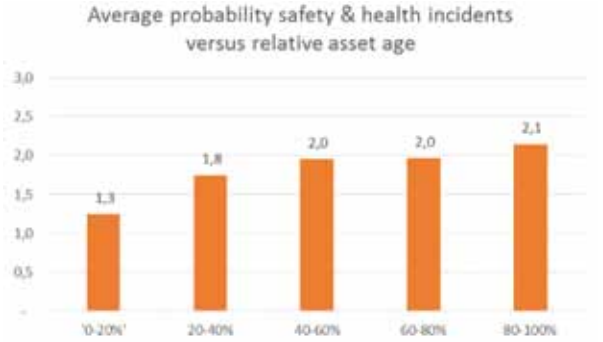


Figure 3.4.3 Relative age of plants and probability of the occurrence of health & safety incidents

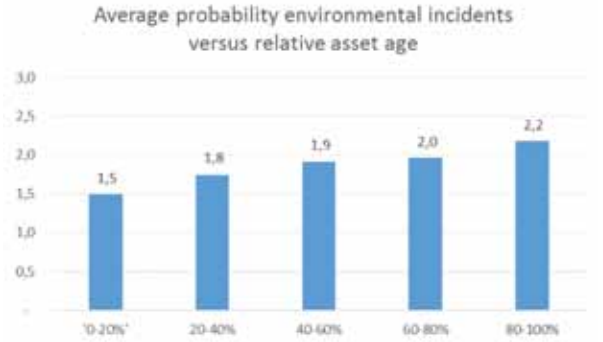


Figure 3.4.4 Relative age of plants and probability of the occurrence of environmental incidents

Conclusions

It is certain that the current industrial asset base has a relatively high risk profile. The increase in risks over the period 2010-2014 can possibly be attributed to the aging asset base. It has been demonstrated that the degree of risk increases for aging assets. With an eye on the aging asset base over the coming 10 years, the management of the risk of health, safety and environmental incidents must be a key focus of attention.

[8] Source: Survey 'Hoe betrouwbaar is het Nederlandse machinepark?' (How Reliable is the Machine Park in the Netherlands?), Mainnovation, May 2010.

3.5 Maintenance strategy and execution

Within professional Asset owners, making it possible for maintenance activities to be scheduled as much as possible is a necessity. By deploying maintenance and reliability engineers, preventative maintenance can be optimised, making it possible to decrease maintenance costs or increase uptime.

The preventative maintenance at the same time provides a good basis for planning and scheduling the maintenance activities. Everything that is regularly carried out can this way be efficiently planned and scheduled. The ultimate execution consequently will experience fewer interruptions due to unplanned breakdowns and repairs.

Preventative maintenance

The optimal preventative maintenance highly depends on the type of assets, the applicable maintenance strategy and current performance. These can vary from plant to plant. For example, there is no standard for the frequency of preventative maintenance. An assessment of the % Preventative Maintenance KPI shows that the industry average is approximately 49% preventative maintenance (see Figure 3.5.1). Comparable percentages for the Dutch maintenance market are evident from the NVDO Onderhoudskompas[9].

The variances per sector in relation to this average are limited. From the interviews it is apparent that many companies view the optimisation of their current preventative maintenance as an opportunity for improving asset performance. From this it can be deduced that at a lower failure rate due to more effective preventative maintenance, the share of preventative maintenance of the total maintenance costs will increase.

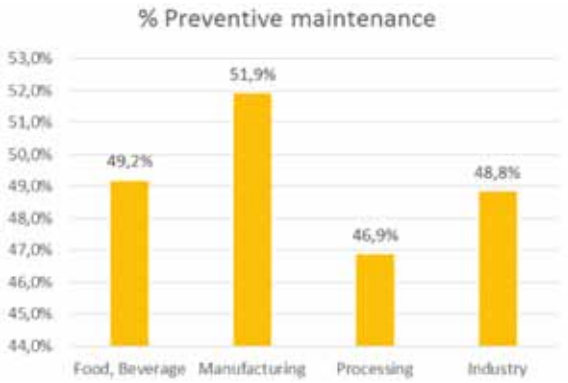


Figure 3.5.1 Degree of preventative maintenance within the industry

Sections 3.7 and 3.8 indicate that improving preventative maintenance is considered by many Asset owners to be their key innovative and organisational challenge. By better defining maintenance needs and where possible making them predictable (predictive maintenance) it becomes possible to easily schedule a larger part of the maintenance programme as a means of achieving essential efficiency benefits.

Scheduling accuracy

Efficiently executing maintenance activities requires the activities to be scheduled properly. Many maintenance organisations still struggle with the problem of how to get and maintain a grip on their extensive maintenance schedules. When the realisation of the schedules is measured on the basis of the number of work orders that is completed on time, it becomes clear that in the industry 68% of scheduled work orders is in fact ready on time (see Figure 3.5.2).

By contrast this also means that over 30% of the scheduled work (preventative maintenance and scheduled repairs) is not completed

[9] *Source: 'NVDO Onderhoudskompas-Visie, Trends en Ontwikkelingen in de Nederlandse Onderhoudsmarkt', NVDO, 2014 (NVDO Maintenance Compass - Vision, Trends and Developments on the Dutch Maintenance Market, Dutch Association for Effective Maintenance (NVDO))*

on time. When this concerns preventative maintenance actions, this has a negative impact on the uptime of the installations.

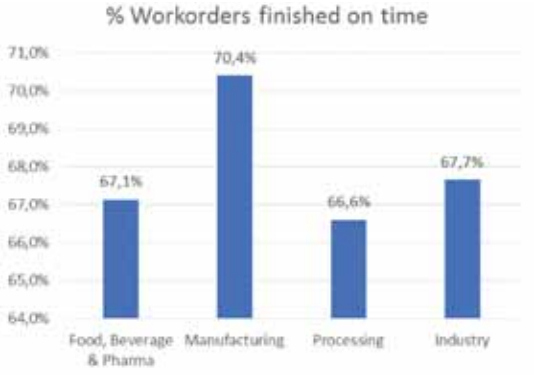


Figure 3.5.2 Scheduling accuracy within the industry

The key causes of the failure to complete maintenance that can be scheduled on time are as follows[10]:

- Disruption of the schedule due to high-priority failures
- Insufficiently accurately planned and scheduled work as a result of which resources are not or insufficiently available
- No approval by production for carrying out the activities, often due to poor coordination of maintenance and production schedules

In a general sense, it is possible to conclude that performance in the area of scheduling maintenance activities can only be evaluated to a very limited extent. The result of this is that preventative maintenance backlogs mount or that crucial repairs are delayed far too long, resulting in lower uptime.

Overdue maintenance

The failure to have well-organised maintenance schedules and the lack of regular evaluation of scheduling performance is reflected in the volume of overdue maintenance. Overdue maintenance here is defined as the share of outstanding maintenance activities whose deadline has passed by at least two months. From Figure 3.5.3 it is evident that the average backlog is 10%. This is measured in terms of the costs of the total work package.

The following conclusions can be drawn from this:
A percentage of overdue maintenance of this magnitude usually affects the uptime of the installations. Assuming that this does not involve any critical failures that result in an immediate standstill, this therefore then concerns significant backlogs in executing maintenance that can be scheduled. The consequence is that this causes the condition of the installations to deteriorate, resulting in a loss of uptime (over the shorter or longer term).

If it turns out that these backlogs have a limited impact on uptime (which is impossible to ascertain in this study), the conclusion that can then be drawn is that the current preventative maintenance strategy would appear to be ineffective. In that case there are opportunities here to reduce costs.

Actual practice will likely demonstrate that the reality is a combination of both conclusions. What is certain, however, is that the greater the size of the overdue maintenance, the lower the professionalism of the scheduling function within the Asset owner.

[10] *'Profion Tooltime results as at January 2013', Profion, 2013*

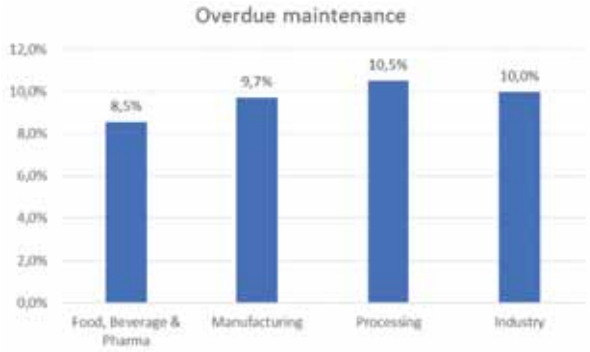


Figure 3.5.3 Overdue maintenance within the industry

Technician productivity

Maintenance backlogs can also mount due to low efficiency in carrying out maintenance activities. If work orders take structurally longer to complete than scheduled, backlogs will increase. Figure 3.5.4 shows that the average productivity in the industry is 70%. This means that of all available working hours, technicians on average cannot book 30% of their time against focused maintenance activities.

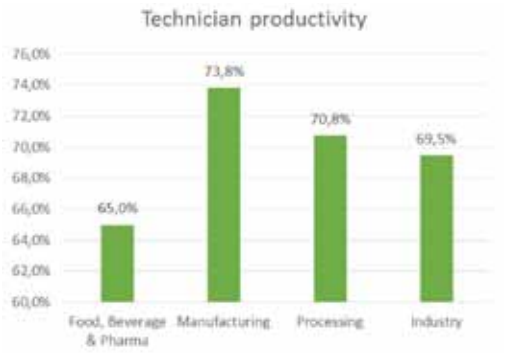


Figure 3.5.4 Technician productivity within the industry

Research conducted by Profion (Sector Association for Professional Industrial Maintenance in the Netherlands)[11] shows that on average 10% of the non-productive time is caused by work interruptions for personal reasons and for meetings. Other key causes of non-productive time (together about 17%) established by this study are:

- Operational discussions
- Collection of required data and registration of the results
- Inefficiency due to the organisational structure

The conclusion of this research is that it is possible to further increase technician productivity by eliminating delays through better work planning and scheduling, and proper advance coordination with production, suppliers and contractors. In addition, better facilities for technicians (a comprehensive toolkit and issue of tools close to the workplace) yields benefits.

Conclusions

Optimising the chain of preventative maintenance, planning and scheduling, and executing maintenance is crucial in terms of achieving the desired asset performance and controlling costs. It is evident that the further maturation of the three referenced maintenance focus areas is essential and possible.
Improving preventative maintenance schedules increases the amount of work that can be scheduled. Professional planning and work scheduling contributes to higher execution efficiency and fewer backlogs. If the work execution efficiency can be increased, this translates into lower maintenance costs, an increased Mean Time To Repair (MTTR) and increased uptime.

[11] *'Profion Tooltime results as at January 2013', Profion, 2013*

3.6 Market integration and outsourcing

In addition to in-house labour costs and the cost of materials, the cost of outsourcing also makes up a large part of the maintenance budgets. This section not only deals with the degree of outsourcing, but also with the different contract types.

Degree of outsourcing

Figure 3.6.1 shows that on average, across all industrial sectors, approximately 35% of maintenance costs is spent on outsourcing. The outsourcing costs include the costs of hiring personnel and materials provided by the service provider. This means that annually approximately EUR 15 billion is spent on activities carried out by service providers.

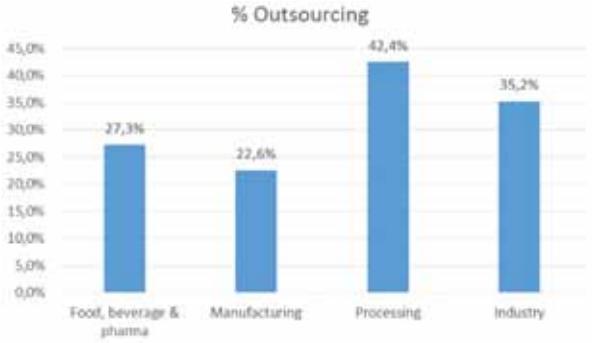


Figure 3.6.1 Degree of outsourcing by sector

At 20% higher than the industry average, the processing industry appears to outsource a significantly higher percentage of its maintenance than the other sectors. At 23%, the manufacturing industry outsources the least.

Finally, it is interesting to see whether there are regional outsourcing differences. What is striking in Figure 3.6.2 is that the Netherlands outsources over 65% more than Belgium. This is mainly due to the Dutch processing industry, which outsources almost half of its maintenance.

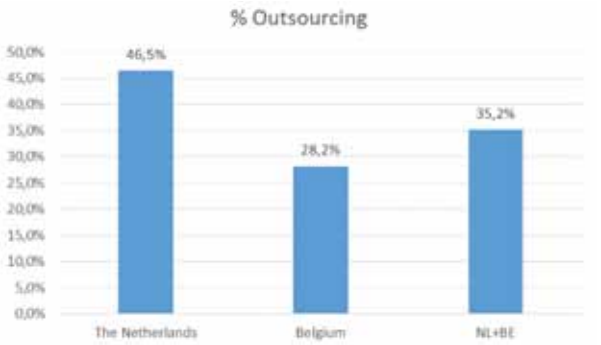


Figure 3.6.2 Degree of outsourcing by region

Outsourcing trends

In the benchmark study, participants were asked to indicate how they view the growth in maintenance outsourcing in terms of their own assets. They were asked to indicate what percentage of maintenance was outsourced three years prior the benchmark study (in 2013) and what percentage will be outsourced after the benchmark study (in 2016). Figure 3.6.3 shows outsourcing within the industry increased by 9% over the period 2010-2013. This growth is not expected to persist and in 2016 will remain at virtually the same level as in 2013. While there are differences per sector, these are not significant.

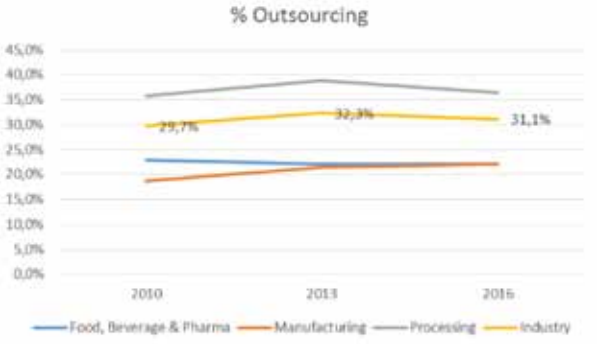


Figure 3.6.3 Short-term outsourcing trend

No quantitative questions were asked during the benchmark study for the period after 2016. Participants were asked, however, to provide their views on outsourcing maintenance over the long term. A number of considerations that were identified as a result of this are consistent with the earlier findings described in this report.

Consideration 1: Outsourcing as a response to the greying population

As soon as companies are no longer able to hire sufficiently qualified personnel, the probability that they will attempt to bring in the required knowledge and experience via outsourcing increases. As a result it is likely that the problem will shift from these companies to the service providers in the area of maintenance.

Consideration 2: Outsourcing to Original Equipment Manufacturers (OEMs)

Increasingly more OEMs are supplying maintenance services throughout the entire lifecycle of an asset that they themselves have installed. As the demand for specialised product knowledge increases in the future and the internal knowledge levels are no longer sufficient, asset owners tend to fall back on outsourcing maintenance to OEMs.

Consideration 3: Performance contracts not as lucrative as thought

The large-scale outsourcing of maintenance activities to contractors with a performance improvement objective for a complete asset or group of assets has proven to be successful on a limited scale only. As a result, asset owners are less likely to enter into a performance contract of this sort. When they do, however, it is generally for partial installations of the asset. The question is whether this type of outsourcing will increase in the future.

Outsourcing contract types

The outsourcing maturity is derived from the type of outsourcing contract used. The following maturity levels are used in this respect:

1. No contract: standard procurement and invoicing.
2. Call contract: contract with fixed daily rates, calculation of costs after service has been provided and without invoicing per individual call.
3. Unit rate contract: supply of services based on agreements with advance calculations based on standards and fixed prices.
4. Result contract: the supplier plans all maintenance activities and carries them out within a predetermined period and at a fixed price.
5. Performance contract: in addition to the result contract, the supplier has (joint) responsibility for improving the performance of an asset.

The analysis of the distribution by type of contract (based on contract value) shows that in as many as 52% of the contracts there is no previously established contract budget. This is the total of the 'no contract' and 'call contract' contract types (see Figure 3.6.4). Although the call contracts include daily rates, there are no prior agreements about the maximum number of hours to be spent on each call. There is no significant difference between the different industry sectors.

When the Category 1 and 2 type (low maturity) contracts are compared to the total of Category 3, 4 and 5 (high maturity) contracts, the corresponding ratio is 53%:47%. The share of performance contracts, where the supplier assumes responsibility for achieving performance improvements for (part of) the assets is very limited at only 3.4% of the total.

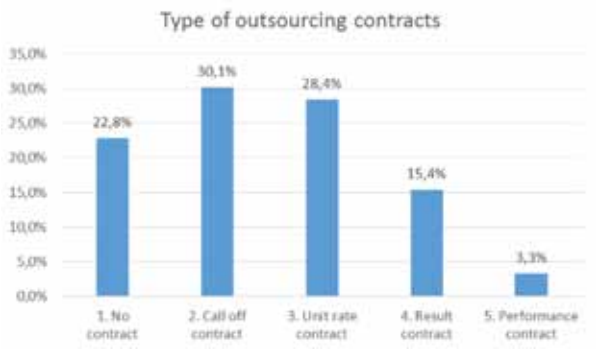


Figure 3.6.4 Distribution of contract types within the industry

As shown above, the Netherlands outsources significantly more than Belgium. Figure 3.6.5 shows that the share of high maturity contracts is higher in the Netherlands: 54% in comparison to 43% in Belgium. The conclusion drawn from this is that as the demand for outsourcing increases, the degree of contract maturity also increases.

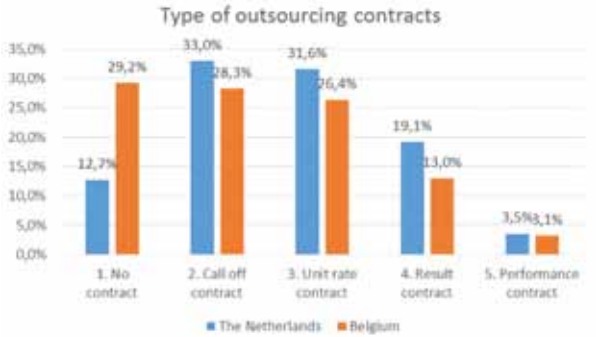


Figure 3.6.5 Contract type distribution by region

Contractor satisfaction

When activities are outsourced to an external party it is of major importance that the partnership is properly constituted within the applicable contractual agreements. The participants were asked about the degree of satisfaction with their contractors. From Figure 3.6.6 it is evident that almost 33% of the Asset owners is only moderately or not at all satisfied with their contractors.

This observation, together with the fact that due to the pressure on maintenance costs and performance there is a need to work more efficiently (and therefore cheaper), means that the delivery of this service requires further maturation. If this does not happen, then the question is whether the volume of outsourced work will remain stable or can grow in the near future.

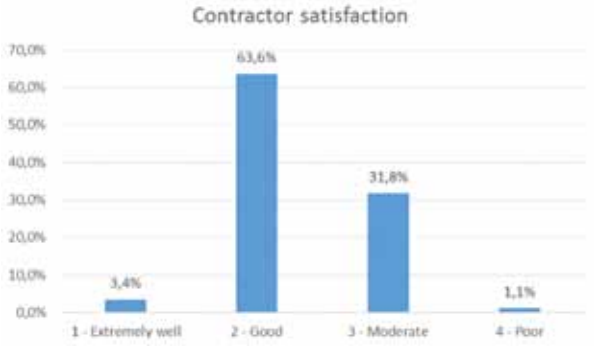


Figure 3.6.6 Satisfaction with contractors

Conclusions

The volume of outsourced maintenance work has been stable for years and is around 35% of the maintenance costs. No growth is foreseen in this area in the near future. To increase the level of satisfaction of Asset owners about this type of service, the outsourcing contract forms require further maturation. With an eye on the long term, developments are evident in which newcomers to the outsourcing market can play a key role. The primary focus here is on concepts such as servitisation by OEMs.

3.7 Employee mobility and personnel trends

The greying of the workforce, the increased inflow of employees from non-EU countries and vacant maintenance positions that cannot be staffed are regularly recurring topics of discussion. This section deals with these personnel-related topics within the Asset intensive industry and MRO sector.

Labour costs

The KPMG study shows that approximately 450,000 people have an MRO-job in Belgium and the Netherlands.

- Belgium: 180,000 employees
- Netherlands: 270,000 employees

Approximately 35% of the costs spent on industrial maintenance is spent on labour (see Figure 3.7.1). There are major differences between the different sectors, however. These differences are dependent on the percentage of outsourced maintenance. The higher this percentage, the lower the share of labour costs and material costs of the total maintenance costs.

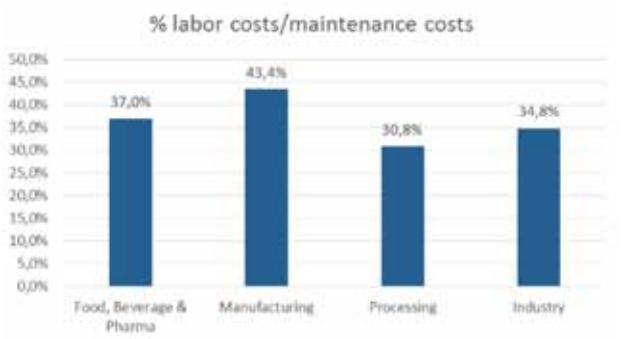


Figure 3.7.1 Labour costs as a share of maintenance costs

There are also major differences between Belgium and the Netherlands in terms of the share of labour costs of the total maintenance costs. In Belgium, these costs are almost 30% higher than in the Netherlands (see Figure 3.7.2). There are two key reasons for this:

- Belgian companies generally outsource less work (see Section 3.6).
- In Belgium, average salary costs are 15% higher than in the Netherlands (see Figure 3.7.3).

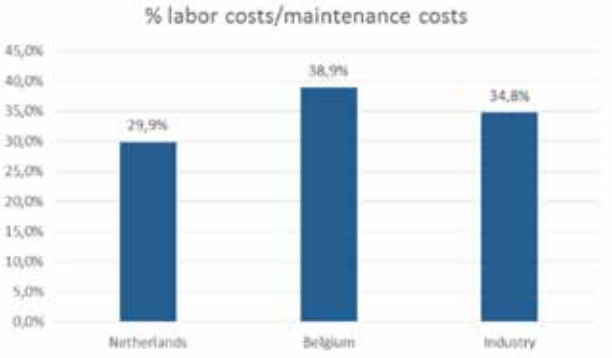


Figure 3.7.2 Regional labour cost variances

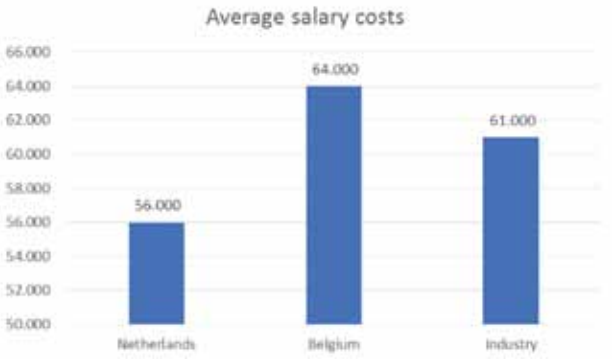


Figure 3.7.3 Average salaries of direct personnel

Age structure and vacancies

Based on the workforce's age structure, the age distribution for the three industrial sectors was determined. In each sector, in principle, the largest share of employees falls in the 45-to-54 age category (see Figure 3.7.4).

The average age within the processing, manufacturing and food, beverage & pharma industry sectors is 45.5, 42.7 and 43.0 years, respectively. Given an average working life of between 20 and 65 years of age, the average age of the workforce is 42.5 years. From the above figures it follows that the average age of the workforce in the industrial sector does not vary a great deal from this.

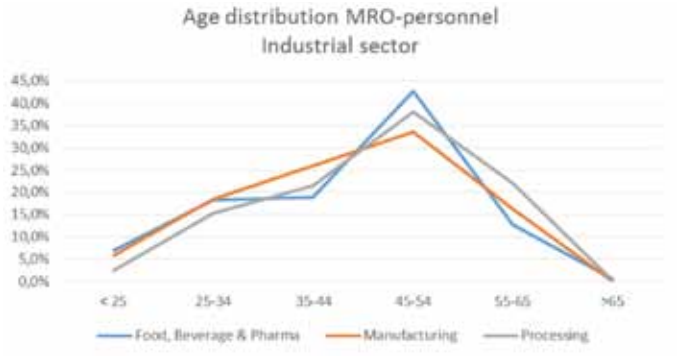


Figure 3.7.4 MRO Workforce age distribution within the asset intensive industry

Outflow of maintenance personnel

Zooming in on the age categories 55-65 and 65 years and older, it can be concluded that, depending on the sector, between 13% and 22% of MRO personnel will leave due to retirement over the next 10 years (see Figure 3.7.5). Across the industrial sector as a whole this represents an average of 19.4% of the MRO workforce. In principle, this outflow rate does not vary from actuarial projections. At an average working life of 40 to 45 years, it is reasonable to assume that every 10 years between 22% and 25% of personnel leave the workforce. The 19.4% is below this rate.

MRO vacancies

The economic crisis in recent years has resulted in an increase in unemployment in Northwest Europe. The closure of plants within

Figure 3.7.5 Outflow of personnel over the next 10 years

the different industrial sectors has contributed to this. This may have affected the number of vacancies within the MRO sector. Due to the increased unemployment, personnel become available on the job market, which makes it possible to staff vacancies. On the other hand, the number of vacancies in an economic crisis is lower than it is during favourable economic conditions.

A review of the statistics displayed in Figure 3.7.6 shows that the vacancy rate for both direct maintenance personnel (operational, supervising, planning and scheduling) and for indirect personnel (incl. management, maintenance engineering, EAM support) is low at 3.6% and 3.4%, respectively.

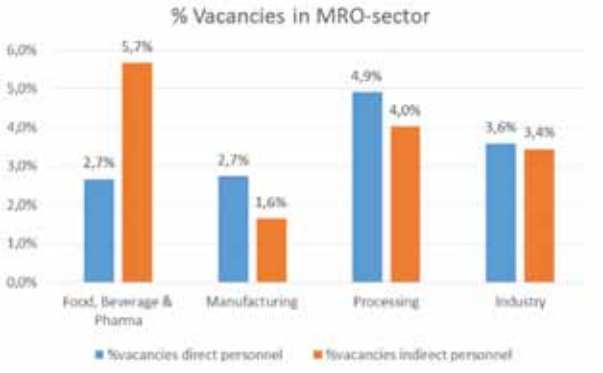


Figure 3.7.6 MRO personnel vacancies by sector

Earlier, we observed that the average age in the Netherlands is higher than it is in Belgium. From Figure 3.7.7 it is also evident that the number of job vacancies in this sector in the Netherlands is significantly higher than it is in Belgium: the vacancy rate is over twice as high for direct personnel and over three times as high for indirect personnel.

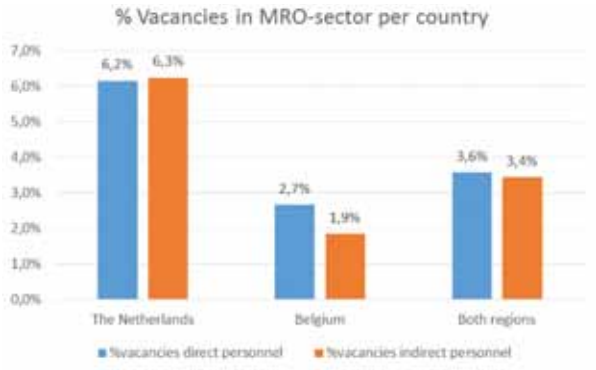


Figure 3.7.7 MRO personnel vacancies by country

From this it can be concluded that the vacancy rate for MRO personnel in Belgium is significantly lower than the national average of 8.4%[12], while in the Netherlands the 6.4% MRO job vacancy rate is just marginally below the national average of 7.3%. This could possibly be an explanation for the higher outsourcing rate in the Netherlands. Due to a lack of personnel (more vacancies), more work is outsourced to contractors.

Employee mobility and knowledge development

The expected outflow of MRO personnel over the coming 10 years presents Asset owners with an enormous challenge in terms of hiring and training sufficient new personnel. The continuity of production depends entirely on the availability of sufficient high-quality MRO personnel.

One solution to the potential shortage of personnel is to hire personnel from abroad. In the current situation it is striking that the share of personnel from beyond the national borders is very limited. From Figures 3.7.8 and 3.7.9 it is evident that only 3% of maintenance personnel in Belgium comes from abroad, of which one third comes from non-EU countries. In the Netherlands, the percentage of employees with Dutch nationality is as high as 99%.

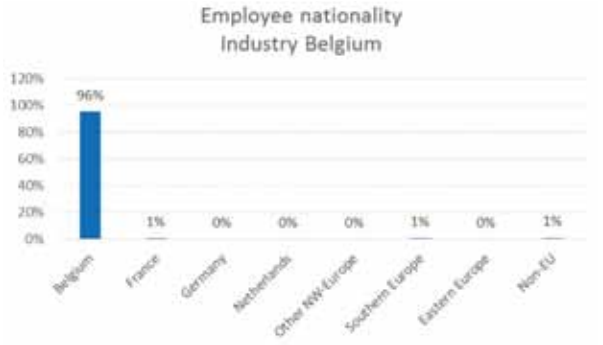


Figure 3.7.8 Nationality of MRO personnel in Belgium

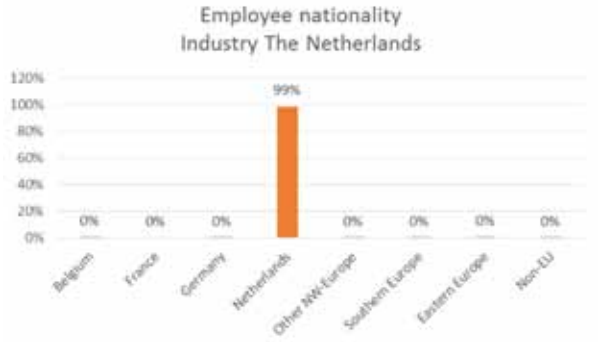


Figure 3.7.9 Nationality of MRO personnel in the Netherlands

From this it can be concluded that in the current situation the Asset owners of the industrial asset owners barely make any use

[12] *Source: Eurostat*

of the structural recruitment of foreign personnel. Perhaps this is different within the Asset owners of the service providers within the industry. However, this theme was not investigated in this Survey. Additional research may be required for this.

Education and training of MRO personnel

In addition to sufficient personnel, well-trained personnel also are a condition for keeping performance up to par. The Training Costs/Personnel Costs KPI provides good insight into the degree to which Asset owners provide for this. The figures by sector vary significantly around the industry average of 2.6%. The difference of almost 50% between the processing industry and the food, beverage & pharma industry is very high (see Figure 3.7.10).

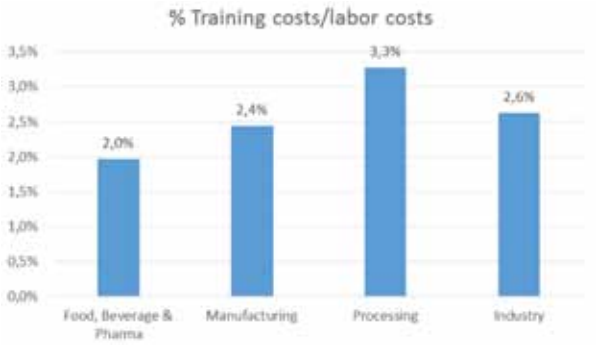


Figure 3.7.10 Attention to education and training of MRO personnel

The regional variances are significant as well. Figure 3.7.11 shows that the industry in the Netherlands on average spends 50% more on training than the industry in Belgium. From this it follows that personnel training and education do not always get the attention they deserve. In addition to the classical, substantive vocational education of maintenance personnel, it is becoming increasingly important to incorporate skills training and training related to the use of new technologies into MRO personnel education programmes. This type of training increases the effectiveness and efficiency of direct personnel and consequently improves asset performance.

Figure 3.7.11 Regional MRO personnel education differences

Structure of the Asset owner

Various models are available to structure the Asset owner. To provide insight into the structure of the average Asset owner, the structure shown in Figure 3.7.12 is used as a baseline. First, a distinction is made between direct and indirect personnel. Direct personnel comprises personnel responsible for the actual execution of the maintenance, and includes supervisors. These personnel are identified as 'Maintenance Execution' in Figure 3.7.12. In addition, the share of indirect personnel is further broken down between the boxes planning & scheduling and maintenance strategy. Personnel in the planning & scheduling box carry responsibility for preparing the maintenance activities, planning the resources and scheduling the activities, including the reservation of the needed materials and spare parts in the warehouse. Personnel in the maintenance strategy box carry responsibility for improving the maintenance strategy (medium and long term). In general this box includes the

maintenance and reliability engineers. Maintenance management, including support, is located at the top of the organisation chart. Support includes the procurement function and ICT systems support.

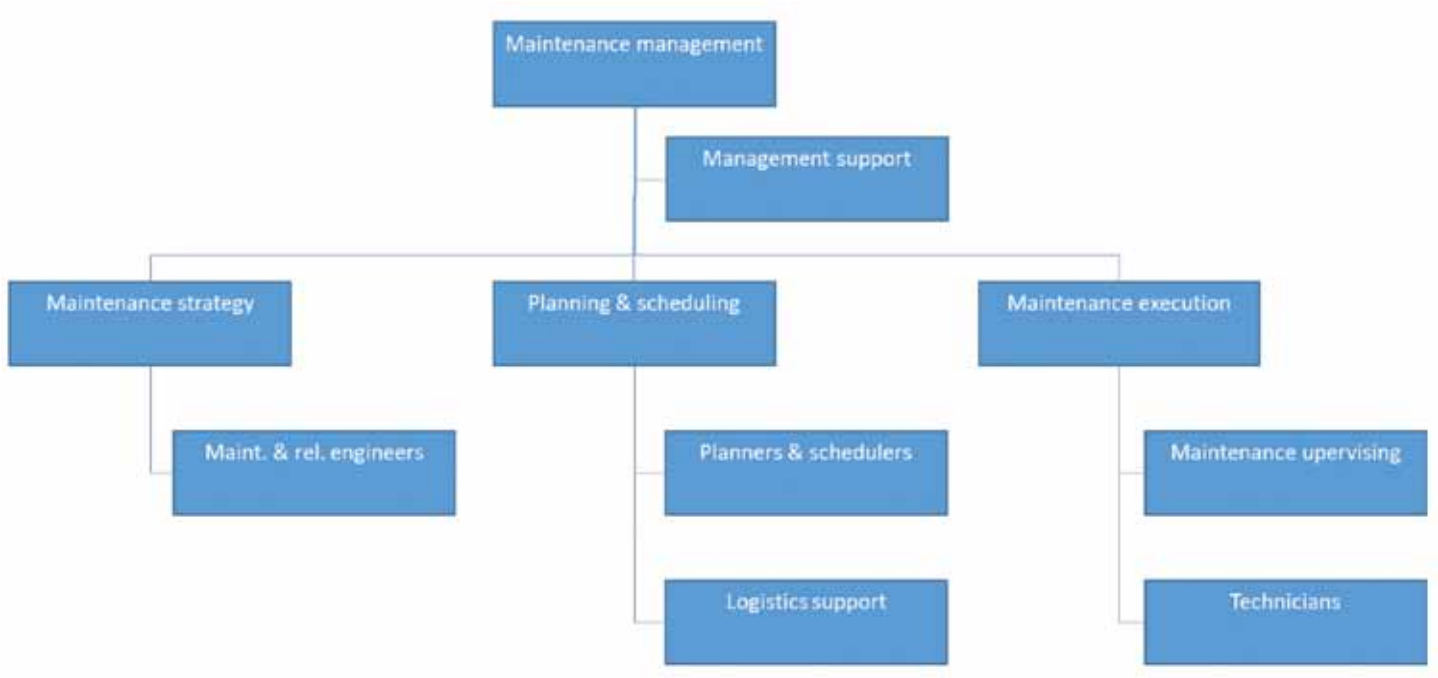


Figure 3.7.12 General Asset owner chart

The proportion of direct to indirect personnel within the industry is approximately 71%:29% (see Figure 3.7.13). The food, beverage & pharma sector deviates somewhat from this with a ratio of 77%:23%. A review of the distribution of personnel within the direct operational jobs shows that the classical technical fields (mechanical, technical and automation) have the highest level of representation with a total of 56% of the 71% in direct personnel (see Figure 3.7.14). In addition, supervision also plays an important role.
When the jobs are grouped on the basis of the standard organisation chart the distribution of jobs is as follows (see Figure 3.7.15). The ratio of the number of supervisors to direct operational personnel is 1:8 in this case. The ratio of the number of direct operational personnel to indirect personnel is 2:1. In other words there is one support FTE for every two technicians. On the basis of these characteristics it can be concluded that a relatively high percentage of indirect and coordinating personnel is required to carry out the maintenance activi-

ties. Further maturation seems possible. This would improve the ratio of direct to indirect personnel, and make it possible to work more efficiently and effectively.

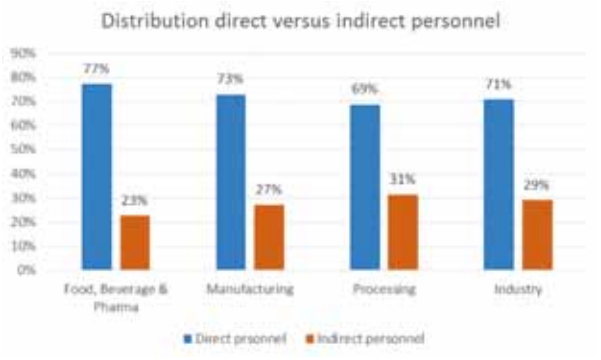


Figure 3.7.13 Ratio of direct versus indirect personnel

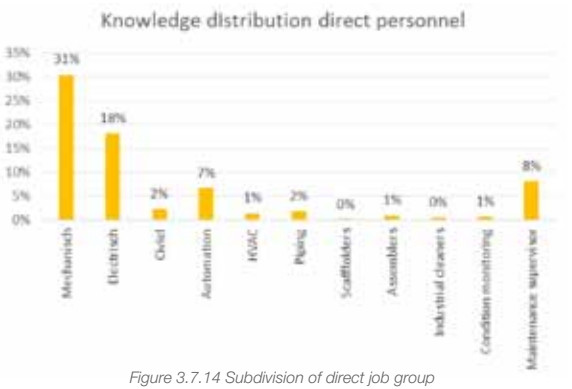


Figure 3.7.14 Subdivision of direct job group

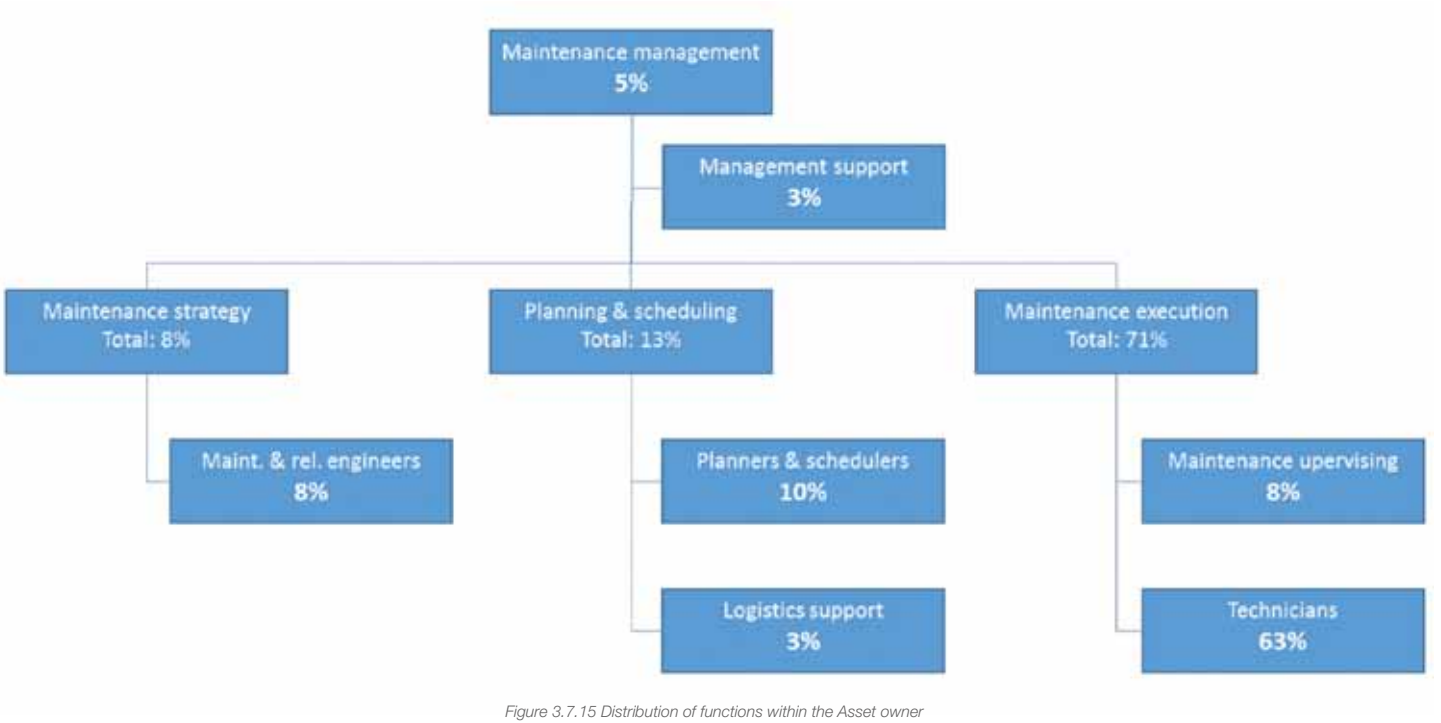


Figure 3.7.15 Distribution of functions within the Asset owner

Organisational challenges

The Asset owners stand on the eve of a challenging decade, involving outflow of personnel, pressure on the competitive strength of the industry and the introduction of new technologies. When asked about the largest organisational challenges, the persons responsible for MRO identified the following:

- Recruitment of sufficient and qualified personnel. This applies to both direct and indirect personnel. In the latter instance this mostly concerns maintenance and reliability engineers.
- A second challenge is to combine the knowledge and experience of operational personnel and to come up with all round profiles. The idea underlying this approach is that it increases the flexibility with which employees can be deployed, thus leading to higher efficiency and productivity over time.
- The last major challenge identified concerns the further development of specific knowledge of and experience with new technologies. The far-reaching application of automation and robotics are examples of this.

Conclusion

Over the next 10 years, asset owners will be faced with an average outflow of MRO personnel of 19.4%. Regional differences are clearly evident in this respect. Given the age distribution there is no greying of the MRO professional workforce. However, there is concern about the future inflow of new personnel.

The number of vacancies within the MRO sector is significantly lower than the average unemployment figure in the Northwest European region. Regional differences are observed here as well; however, on average this number represents 3.5% of the MRO professional group.

In the current situation, asset owners in the industry barely make use of MRO personnel originating from beyond their national boundaries. As such there is as yet no MRO employee mobility within NWE.

3.8 Innovation

The innovation area of focus is an important factor to be able to continue to produce sufficiently competitively in the future as well. With an eye on the positive turnaround of the economic climate, the question put to participants was whether the existing asset base is ready for this. In addition, participants were asked to identify the innovations that are important to them in the near future.

Assets ready for the future?

To the question whether existing assets are ready to handle a production increase of at least 10%, 35% responded that this is not a problem (see Figure 3.8.1). Approximately 20% can handle increased production targets after expending considerable effort on maintenance, modifications and removing bottlenecks. With as high as 35% of the assets it is impossible to achieve a production increase of at least 10%. The latter means that the increased demand can only be accommodated by expanding production capacity. To achieve this requires significant investments. There is a risk that these investments do not outweigh the relocation of production facilities to other regions, which would affect the Northwest European economy adversely.

Opportunities and challenges

The results shown in Figure 3.8.2 are an extension of the assertions made about the involvement in innovations over the past three years. Asset owners consider improving production reliability

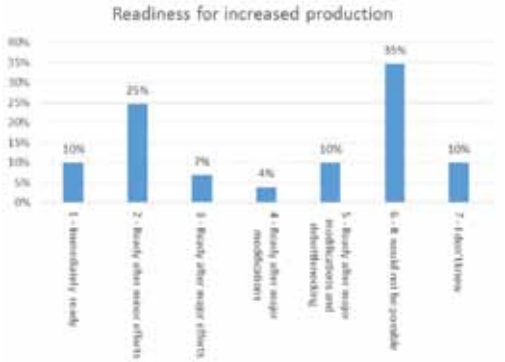


Figure 3.8.1 Readiness for increased production

one of the largest challenges in the near future as well. Condition-based maintenance could play a supporting role in this respect. The reduction in energy consumption was also mentioned before. The challenge concerning production asset lifetime extension entirely follows on from the aging asset base. This means that the industry is searching for new concepts and points of reference that would enable it to implement this properly. Experiences from the VITALE Project[13] demonstrate that managing lifetime extension is a relatively new competency within the MRO sector. Initiatives to further develop this competency are essential.

Future technological developments

In terms of technological developments it is becoming clear that the use of smart equipment, far-reaching ICT solutions and new materials is predominant (see Figure 3.8.3). This is a trend that has already been initiated in the form of predictive maintenance. This type of maintenance makes use of condition information generated by smart measurement devices and sensor technology incorporated into systems (smart equipment). This condition information is then combined with relevant environment information and is then

Figure 3.8.2 Opportunities and challenges for Asset owners

[12] *Source: Eurostat*

used as a basis for making predictions about when maintenance should be scheduled using powerful data analysis models (big data solutions). All of this, of course, to prevent the unnecessary standstill of assets.

Both technology trends can assist Asset owners to further reduce maintenance costs and improve the uptime of production assets. The expectation is that the development of knowledge and experience in this area will contribute to increasing the competitive position of the industry over the coming years.

Conclusions

Only one in three companies is ready for the future: the other companies are unable to meet a significant increase in the demand for products without major effort. This has a negative impact on the growth of the industry and the economy. To nevertheless be able to meet new market conditions in the near future, it is of key importance that the Northwest European industry focuses on innovations.

The development of knowledge and experience and the application of new technologies must ensure that Northwest Europe retains its leading position in the area of maintenance and asset management. Only in this way is it possible to respond to the necessary performance improvements and the aging of the industrial asset base.

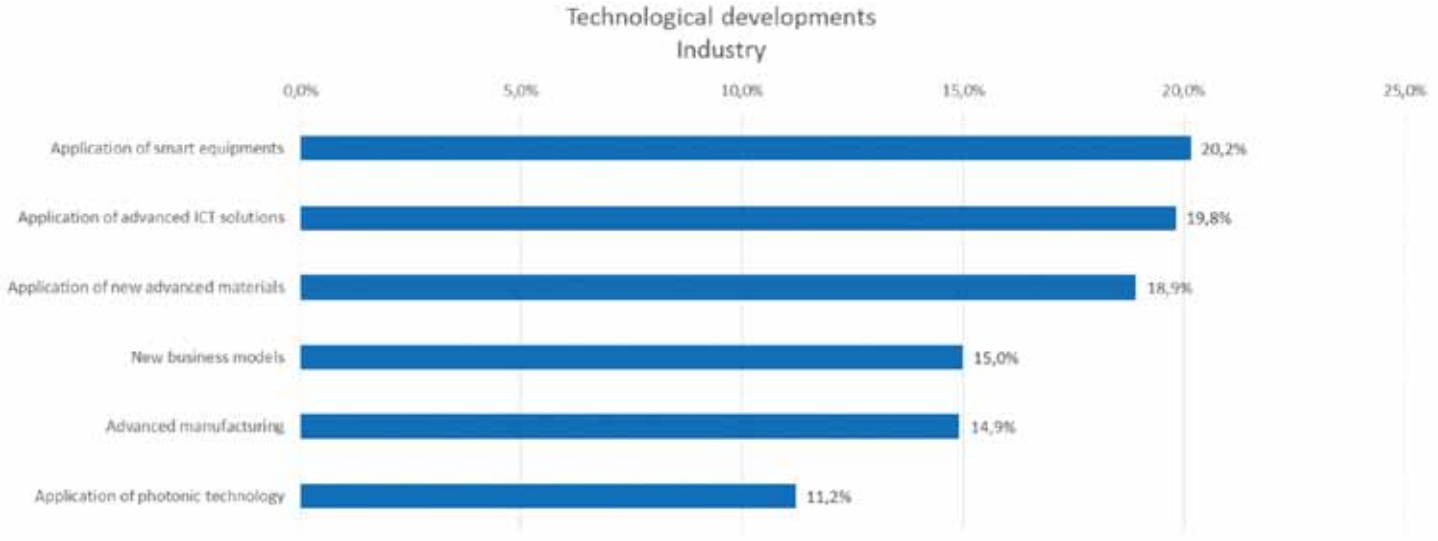


Figure 3.8.3

4. WHAT CAN WE LEARN FROM TOP PERFORMERS?

The characteristics of industry in Belgium and the Netherlands show that there is room for improvement in average performance. This could help industry to improve its competitive position and its operating results. This Survey includes an analysis of the differences in methods between the Asset owners with an above-average score (the top performers) and organisations with a below-average score (the laggards).

In this chapter we present the crucial differences between the two types of Asset owner. The measures that asset owners can take to structurally improve their performance are derived from this comparison.

4.1 Asset performance of top performers

The following key performance indicators (KPIs) are used to identify the group of Top performers:

- Criterion (a) % Technical availability: a KPI score above the sector average
- Criterion (b) Maintenance costs/asset replacement value: a KPI score lower than the sector average
- Criterion (c) SHE score: a KPI score between 0.96 and 1.00.

Since there may be major differences in the characteristics of the above criteria, the organisations included in the category of Top performer are identified for each sector. A top 25% for each sector has been opted for in order to select sufficient companies. This means that 25% of the companies in a sector are included in the Top performers and 75% of the companies in the group of Laggards. An example of how the top performers are selected is given in Figure 4.1.1. The top performers are shown in the top-left quadrant. In Annex 5 – Definitions for identifying top performers you will find a detailed specification of the calculation used to identify the top performers.

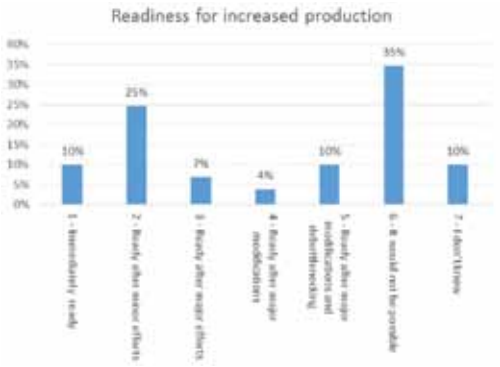


Figure 4.1.1 Top performers

Performance differences between top performers and laggards

The extent to which the performance of the top performers differs from the group of laggards is determined to establish the performance in terms of technical availability, maintenance costs and safety level. This is shown in Figure 4.1.2. The percentage shown is the difference between the two groups. A positive value means that the group of top performers is performing better than the group of

laggards. As an example: the top performers score 75% for technical availability, compared to 60% for the laggards. The percentage would in this case be ((75-60)/60=) 25%. A negative value means that the laggards are outperforming the top performers.

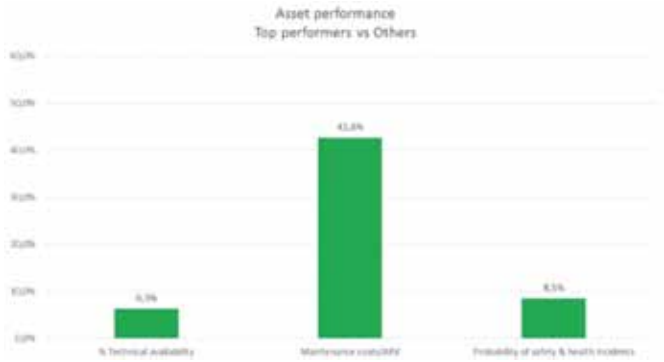


Figure 4.1.2 Asset performance of top performers versus laggards

It follows from this that the top performers score over 6% better on technical availability, whereas the score for maintenance costs is over 42% lower than in the group of laggards. It is also clear that the estimated probability of safety risks arising is 8.5% lower than in the group of laggards. In other words: top performers score better on all asset performance aspects.

Top performers score an average of 6% better on technical availability. The next step is to analyse how this performance develops during the lifecycle of the assets. In Figure 4.1.3 the score of the top performers is set off against the relative age. The score of the top performers for the period of 0-20% is taken as a reference. All other performance aspects of top performers and laggards are then placed in relation to this. This shows us that the uptime of the top performers is more or less stable from the assets being taken into use until the end of the lifecycle. Conversely, the group of laggards shows a decrease in uptime of 3% after the assets are taken into use, which remains stable until the end of the lifecycle.

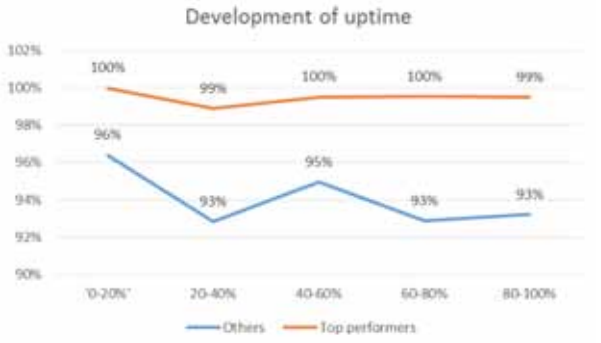


Figure 4.1.3. Development of the uptime during the lifecycle

If the same analysis is made of the maintenance costs between the two groups, we see a comparable trend (see Figure 4.1.4). Here too, we see that the top performers start the lifecycle with a significantly better performance level, which rises with the course of time by 15%. The group of laggards starts with 75% higher maintenance costs, which then rise significantly during the lifecycle.

Figure 4.1.4. Development of the costs during the lifecycle

Finally, the trend in the probability of safety incidents occurring is

considered. This is shown in Figure 4.1.5. The chance of safety incidents occurring mounts in the group of laggards, and ends up significantly higher than the chance of this occurring among the top performers. The top performers succeed in keeping the chance of incidents stable after the first phase for the rest of the lifecycle.

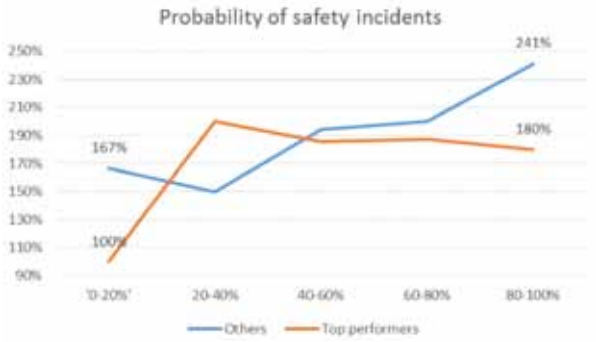


Figure 4.1.5 Development in the probability of safety incidents occurring

Conclusion

The top performers are capable of performing better on average on the three asset performance aspects technical availability, maintenance costs and safety. The top performers are also able to stably maintain these performance levels over the entire lifecycle. In contrast, the performance trend among the group of laggards decreases as the relative age of the assets increases.

4.2 Cause analysis

There are significant differences in the asset performance of the top performers and the group of laggards. The big question is which choices contribute to these results. The following explanations of the established differences have been examined:

- The average age of the asset base
- The average investment level (CAPEX)
- The level of the spare parts inventory
- The extent to which maintenance is outsourced
- The amount of preventative maintenance
- The quality of the maintenance scheduling
- The training of the maintenance personnel

Average age of the asset base

Figure 4.2.1 shows that there is barely any difference between the top performers and the laggards in the average age of the asset base. The relative age of the assets is around the 65% mark for both groups. It can be concluded from this that the age of the assets does not account for the difference in performance between the top performers and the laggards.

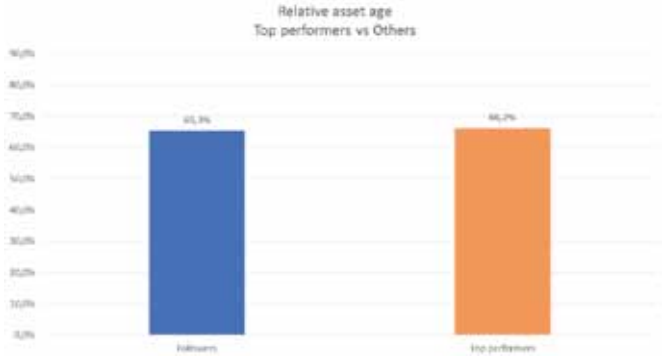


Figure 4.2.1 Average age of the asset base

Average investment level

Regarding the investments aimed at optimising the asset performance (i.e. not including the functional modifications), we see that the top performers spend 35% less on investments over the entire lifecycle. Figure 4.2.2 shows that this is chiefly because the group of laggards invest significantly more in their assets during the last 60% of the lifecycle. It is notable that the top performers not only

keep this investment level lower in the same phase of the lifecycle, but also keep it stable. The fact that the top performers appear to make targeted investments at the beginning in order to maintain the level of the asset performance could be vital to the asset performance during the lifecycle.

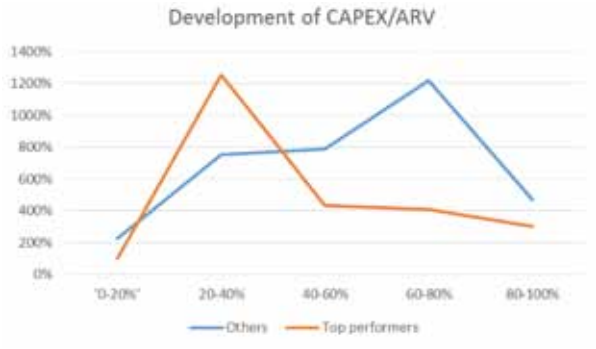


Figure 4.2.2. Development of investments during the lifecycle

Taken in combination with the stable performance in uptime and maintenance costs, this justifies the conclusion that larger investments do not lead to a higher performance level, because it follows from the figures of the group of laggards that with larger investments the uptime decreases and the maintenance costs increase. It can be concluded from this that the top performers are able to maintain the level of their assets with lower investments by:

- Taking more effective investment measures at the beginning of the lifecycle, which puts them in control at an earlier stage
- Achieving a better basic condition of the assets on average through operational maintenance, based on the knowledge of how the systems work

Spare parts inventory levels

The higher technical availability level could be explained by keeping larger quantities of spare parts in stock. In that case the chance of shortfalls in the event of contingencies is usually smaller, which minimises downtime and increases uptime. However the difference in the spare parts inventory levels between the top performers and the laggards shows the opposite: top performers perform better with their inventory value lower by 50% on average. Figure 4.2.3 shows that the top performers succeed in keeping the level stable over the entire lifecycle, while the inventories of the laggards increase significantly after the first life phase of the assets.

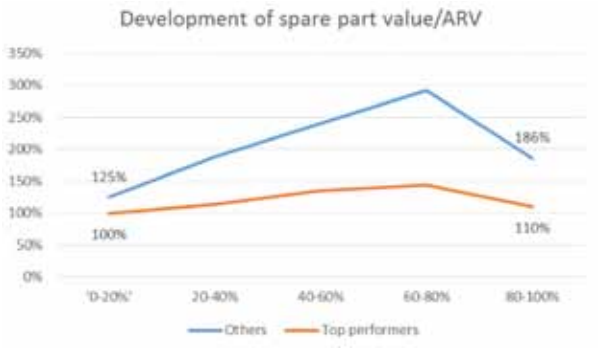


Figure 4.2.3. Development of the spare parts inventory value during the lifecycle

It follows from the characteristics of the group of laggards that large spare parts inventories are probably the result of lower uptime. It is known in practice that lower uptime and - accordingly - more breakdowns cause a rise in the stocks of critical (expensive) spare parts. The purpose of this is to limit downtime for repairs. For the top performers this means that with a smaller number of breakdowns the stock of critical spare parts can be reduced.
It is concluded from this that the level of the spare parts inventory is not an active means of improving performance. It is, however, true to say that the composition of the spare parts inventory has to be carefully considered to place it in line with demand.

Extent of outsourcing

The top performers outsource an average of 10% more maintenance than the laggards. A larger amount of outsourcing can only lead to improved performance if smart outsourcing contracts with performance targets are used or if the outsourced work is carried out much more cheaply and effectively. Figure 4.2.4 shows that the maturity of the outsourcing contracts is not significantly different between the two groups. Both groups use very mature contracts in almost half of the outsourcing.

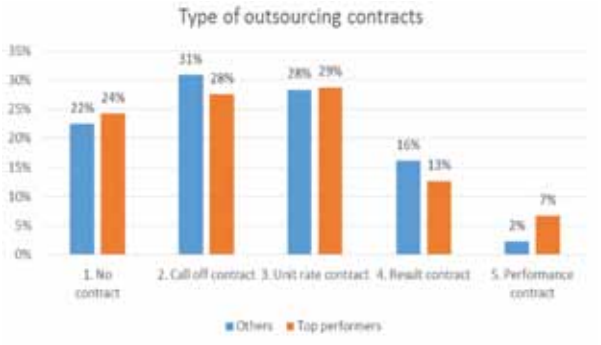


Figure 4.2.4 Maturity of the outsourcing contracts

It can be concluded from this that it is important to professionalise the outsourcing contracts, but that the outsourcing of maintenance and the use of mature outsourcing contracts is not a differentiating factor for better performance.

The amount of preventative maintenance

Among the top performers the share of preventative maintenance in the overall maintenance costs is almost 20% higher than among the laggards. When we consider the amount of preventative maintenance among top performers it is notable that significantly more attention is paid to preventative maintenance during the first 40% of the lifecycle (see Figure 4.2.5). The share of preventative maintenance decreases as the assets increase in age.

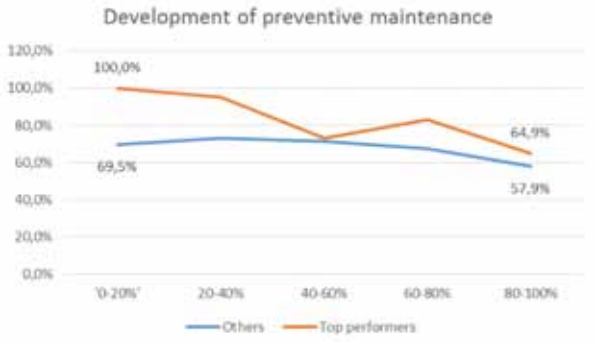


Figure 4.2.5. Development of preventative maintenance during the lifecycle

Optimising preventative maintenance may relate to the system uptime, but may also be aimed at lowering the maintenance costs. It has been demonstrated that the share of preventative maintenance among top performers is 20% higher than among the group of laggards and that the maintenance costs are over 40% lower. In absolute terms this means that the top performers carry out less preventative maintenance than the laggards and also succeed in carrying out significantly less corrective maintenance.

The conclusion to be drawn from this in terms of the ability to achieve more uptime is that top performers are able to optimise their preventative maintenance in such a way that it is much more effective than the preventative maintenance of the group of laggards. The fact that the top performers pay more attention to preventative maintenance once their assets have been taken into use justifies the conclusion that better preventative maintenance enables Asset owners to maintain the basic condition of their assets, which calls for fewer investments.

The quality of the maintenance scheduling

The difference in the number of work orders that are ready on time as an indicator of the quality of the scheduling shows that the difference between the top performers and the laggards is relatively small, because the top performers perform just 6% better in this area. This better performance can be attributed to the fact that the share of maintenance that can be scheduled is larger owing to more effective preventative maintenance and a lower failure rate. It is concluded from this that the relatively small difference in the scheduling performance does not lead to any big differences in the asset performance levels between the top performers and the group of laggards.

The training of the maintenance personnel

Market research has shown that the average age of the MRO personnel among the top performers and the group of laggards is virtually the same at around 45 years of age. The age spread is shown in Figure 4.2.6.

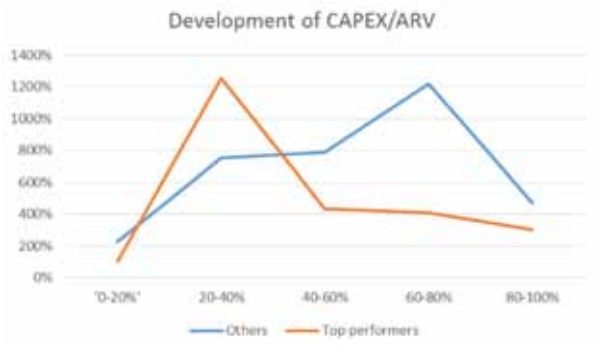


Figure 4.2.6 Age spread of MRO personnel

The question of whether bigger investments in the education and training of MRO personnel contribute to better asset performance has been looked into. The analysis of the declared investments of the two groups of Asset owners shows that the group of laggards spends an average of 4.2% more on education and training than the group of top performers.

The conclusion drawn from this is that the level of the training costs is not decisive for the ultimate asset performance. It is possible that this does, however, apply to the quality and type of training.

Conclusions

It is generally safe to say that it is worthwhile to invest in optimising preventative maintenance. This Survey shows that the share of preventative maintenance among the top performers is 20% higher and that they start to optimise the preventative maintenance as soon as the assets are taken into use. Additionally, they improve the condition of the assets with targeted investments in the first half of the lifecycle of their asset base. This enables them to achieve the following benefits:

- Structurally lower maintenance costs
- Substantially higher uptime in the production systems
- Lower chance of safety risks arising
- Lower investments in expensive spare parts inventories
- Lower reinvestment costs
- Total lifecycle costs (OPEX+CAPEX) 50% lower

The conclusion is that preventative maintenance and targeted investments can significantly improve the operating results and competitive position.

4.3 Professional maintenance and asset management organisation

It would be an oversimplification to say that optimising preventative

maintenance and targeted investments are the only factors that improve the maintenance and asset performance levels. This does form an important basis for improving performance, but more is needed for this purpose.

We see in practice that Asset owners that perform above average but also those that succeed in making serious improvements also have a second element in common: a professional maintenance and asset management organisation. Important aspects of this maturation include:

- Fully-fledged reliability engineering competency
- High-quality planning and scheduling
- Evaluation of completed work and administration
- Integral strategic decision-making on maintenance and investments
- Modern control of the maintenance and asset performances

The characteristics of these five elements of a professional maintenance and asset management organisation are discussed in more detail below.

Fully-fledged reliability engineering

Maintenance and reliability engineers have a clear task in optimising the maintenance at Asset owners. Professional Asset owners have these tasks carried out on the basis of a clear maintenance and asset management strategy. Optimisation for a cost reduction strategy is simply different from that needed to increase the uptime. As well as optimising the preventative maintenance, reliability engineering at these organisations also has a key role in optimising the spare parts inventory. This is reflected in the characteristics of the top performers in this area: achieving higher uptime with significantly smaller spare parts inventories.

Another focus area for reliability engineering is participation in investment projects. This has two advantages:

- The impact of new technology on the maintenance and asset performance can be determined proactively.
- Past experiences can be used to prevent the recurrence of problems.

Effectively performing reliability engineering teams consist of well-trained employees who are able to use the most effective methods depending on the situation.

High-quality planning and scheduling

We have established that the top performers have a slightly higher score for work orders being ready on time (+6%). This can be attributed in part to the larger share of work that can be scheduled, but we know from experience that top performers use a much more structured method than the laggards. Important elements of this method include:

- Maintenance scheduling based on capacity demand and availability
- Maintenance scheduling based on several horizons (multi-term schedules)
- Precise scheduling meetings and agreements with production and other stakeholders
- Having the work process supported by information systems that are in line with the planning and scheduling method
- Planners and schedulers that are educated and trained well

Experience shows that Asset owners that take this approach have on average a smaller number of planners and schedulers compared to the operational personnel group.

Evaluation of completed work and administration

According to the statistics the technician productivity is the same among the top performers and the laggards. In practice the operational personnel in professional Asset owners are more effective: fewer recurring faults owing to better analysis skills and targeted contributions to downtime prevention. The technicians are made more effective by applying the following aspects:

- The planners provide specific maintenance history for the order
- On completion of the work assignments a brief evaluation of the completed work is conducted (via the supervisor or planning and scheduling)
- Records are kept of maintenance details in maintenance information systems

Education and training are of great importance to maintaining the effectiveness of the technicians at a high level. At professional Asset owners, more and more education and training are given for skills in addition to technical vocational education. Examples of this include defect analysis skills, but also learning how to use maintenance information systems to obtain the necessary asset information.

Integrated maintenance and investment strategy

More and more Asset owners are moving away from the idea that short-term asset optimisation is the best approach. Leading Asset owners have set in motion the change from a traditional maintenance service to an asset management organisation (and some have already successfully completed it). This basically means that the focus is shifting to a strategy in which, as well as short-term targets, the impact of changes in the longer term is considered. Whereas reliability engineering used to be the highest strategic level of an Asset owner, that has now become asset portfolio management. This asset management competency translates the wishes and requirements of all stakeholders into concrete asset improvement plans, which includes optimising the preventative maintenance. The question of how investment budgets can be used as effectively as possible is also considered. Proactively working on the basis of a clear strategy featuring clear choices creates transparency and calmness in the organisation.

In fact, this is reflected in the characteristics of the top performers: the asset performance is high with low maintenance costs, low investment levels and a low risk profile.

Modern control of the maintenance and asset performance

Finally, we see that professional Asset owners periodically measure and evaluate their performance and take measures to improve it where necessary. Completing the Plan-Do-Check-Act circle is an essential aspect of maturation.

This involves working from the perspective of a clear control philosophy on which the work processes and information supply are based. Important success factors in this area include:

- A clear division of responsibilities in the organisation
- A clear report structure
- The operation of clear KPIs that not only lay down the ultimate asset performance levels, but also clarify the progress being made by the processes.
- Modern information systems that can provide the input for KPIs and facilitate efficient analyses of non-conformities
- A management culture in which evaluations and performance lead to improvements being made

5. HOW CAN MRO MAKE OUR INDUSTRY STRONGER?

One of the objectives of this Survey is to provide an insight into the added value of the MRO activities for the Northwest European economy. This subject is discussed in this chapter.

We start by considering the characteristics of the Northwest European economy and possible levels of ambition of the Asset intensive industry in this region. These characteristics and ambitions are used to extrapolate the results established for Belgium and the Netherlands at Northwest European scale[14].
We then discuss four economic value aspects of the Northwest European economic region:

- Increase in competitive strength
- Growth in employment
- Better living environment
- Increased industrial turnover
- Success factors

5.1 Starting points and ambitions of MRO

The discussion of the characteristics of the MRO market in chapter three was based on the performance of companies in Belgium and the Netherlands. The established results have to be extrapolated to estimate the added value of the MRO activities for the Northwest European region as a whole. Also, an ambition level for the whole of Northwest European industry is established in terms of asset performance improvements (raising uptime and reducing costs).

Extrapolation to Northwest European scale

In this report the replacement value of the industry is primarily used to determine the added value. This indicator gives a clear impression of the scope of industry and is measured by the Asset owners taking part in this Survey. The macroeconomic study carried out by KPMG shows an estimate of the replacement value of the collective industrial assets in Belgium, Germany, France and the Netherlands totalling EUR 4,000 billion (see Annex 4).

Eurostat data show that the added value of the industrial production in Northwest Europe is about EUR 9,500 billion. This is the sum of the Gross Domestic Product (GDP) of Belgium, Germany, France and the Netherlands achieved by the industrial sector.

Asset performance improvement ambition

The differences in performance between the top performers and the group of laggards were discussed in the previous chapter. This is based on a group of top performers that account for 25% of the overall population of Asset owners. This implies that improvements to asset performance levels relate to 75% of the Asset owners.

The analysis has shown that the differences in performance be-

[14] Annex 4 contains an overview of the macroeconomic characteristics used in this chapter.

tween the two groups of Asset owners are substantial:

- System uptime: 6.3% improvement potential for the group of laggards
- Maintenance costs: 42.5% improvement potential for the group of laggards

To establish the added value for the Northwest European industry this chapter assumes a maximum improvement in the performance of the group of laggards. This is a challenging assumption, but it does give a clear impression of the potential represented by our industry.

The subject of the end of the lifecycle also presents a challenge. 44% of the industrial asset base will reach the end of its technical lifecycle in the next 10 years. At present, the asset owners are only considering measures to extend the lifecycle in 27% of these cases. Given the potential value of extending the lifecycle, an ambition of 50% of the obsolete assets must be possible.

5.2 Increase in competitive strength

The competitive strength of industry will increase in keeping with the extent to which the following four performance levels can be improved:

- further reduction of maintenance costs (per unit of product)
- increase in uptime
- improvement in the safety risk
- investment in extending the lifecycle rather than replacing obsolete assets

Reduction of maintenance costs

If the overall group of laggards succeeds in professionalising up to the level of the top performers, cost reductions up to a maximum of 42.5% are possible. Assuming the characteristics of industry in Germany and France, which are similar to those in Belgium and the Netherlands together, the savings on maintenance costs for the whole Asset intensive industry in Northwest Europe could run up to as much as EUR 68 billion a year[15].

Increased income

The difference in technical availability between the group of laggards and top performers is 6.3% for the whole industry. If the technical availability rises and more products are sold, this will lead to a rise in the EBITDA. The costs needed for production have already been taken into account here.

As soon as the average industrial uptime reaches the level of the top performers, this will yield an annual increase in the EBITDA of EUR 17 billion a year[16].

Raising safety levels

Further professionalising all Asset owners to top performer level places individual Asset owners in a better position to structurally raise the safety performance to an acceptable level and maintain it. As a result of this the safety risks will fall substantially from 20% to 7% of the assets in which there is a reasonable chance of safety and environmental risks arising.

Extending the lifecycle rather than replacing obsolete assets

This is based on the target of 50% of the obsolete assets being eligible for lifecycle extension, where the costs involved in extending the lifecycle are 50% lower than investing in replacing the as-

[15] See Annex 7 for a detailed calculation of the reduction in maintenance costs.

[16] It is assumed in this regard that all extra production can actually be sold in the market for the same prices. See Annex 7 for a detailed calculation.

sets. For the overall Northwest European asset base that will have reached the end of its lifecycle in the next 10 years, this represents an annual CAPEX of 44 billion[17].

Conclusion

If the two improvements in the company performance can be used in parallel to increase the maturity level of the MRO-activities in the asset intensive industry, this will represent a structural increase in value of EUR 85 billion a year:

- Cost saving potential: EUR 68 billion
- Potential increase in income: EUR 17 billion

This added value of EUR 85 billion a year is about 30% of the current estimated EBITDA of industry in Northwest Europe.

Additionally, the investment costs involved in modernising the obsolete asset base in Northwest Europe will be an average of 25% a year lower through extending the lifecycle rather than replacing the assets.

5.3 Growth in employment

Lifecycle extension could become one of the driving forces of the Northwest European economy. If industry is able to convert 50% of the planned replacements of obsolete assets into lifecycle extension, this would give the asset intensive industry a huge boost, because most of the lifecycle extension projects would be carried out by the MRO service providers. This is in contrast to the replacement and newbuild projects, in which this share is very limited. This implies that during the next 10 years the turnover of the Northwest European MRO market would increase by approximately EUR 5 billion a year. With an average annual wage of EUR 61,000 this represents growth in employment of 80,000 FTE[18]. This is an increase of over 3% of the current employment levels in MRO jobs.

5.4 Better living environment

A rise in industrial production accompanied by lower maintenance costs appears to be an inconsistency when the safety aspect is included. But it has been demonstrated that top performers also get better results in this area, throughout the entire lifecycle.

The current estimate of asset and maintenance managers that the chance of safety and environmental incidents occurring is around 20% is a matter of great concern. This is being caused mainly by:

- The group of laggards who generally appear unable to control the risks and keep them within acceptable limits
- The aging asset base, which shows that the chance of safety risks increases as assets age.

Stricter laws and regulations are being introduced in response to more and more attention being paid to safety and the environment in society. There is a clearly perceivable trend in which not only stricter laws and regulations are being introduced, but in which they are being enforced more intensively and professionally. This is one of the driving forces behind the management of safety and environmental risks in Asset owners.

Further professionalising all Asset owners to top performer level places individual Asset owners in a better position to structurally raise the safety performance levels to an acceptable level and keep them there. As a result of this the safety risks will fall substantially

[17] See Annex 7 for a detailed calculation of the investment saving.
[18] See Annex 9 for a detailed calculation of this growth in employment.

to 7% of the assets in which there is a reasonable chance of safety and environmental risks arising.

5.5 Increased industrial turnover

The rise in industrial turnover is taken as a measure of the growth in the Northwest European economy resulting from improved performance and further maturation of the maintenance and asset management practices. The 6% improvement in technical availability contributes to higher turnover. It is assumed that the extra production can actually be sold at the same prices.

Assuming a structural improvement in the performance of the group of laggards up to top performer level, this will yield an increase in turnover of industry in Northwest Europe of EUR 103 billion19. This represents a 1.8% increase in the industry's share of the collective Gross Domestic Product (GDP) of Northwest Europe.

5.6 Success factors

The asset intensive industry can achieve an important economic growth if the average performance of its assets improves . These improvements can only be made if the necessary investments in resources in maintenance and asset best practices are made. Maby governments could stimulate asset owners to do so. The following factors play an important role in successfully realising the potential additional economic value:

Maturation of reliability engineering

It has become clear that Asset owners that structurally address and invest in optimising preventative maintenance over the entire lifecycle of their industrial assets perform significantly better. It is vital that asset owners reach higher maturity levels in maintenance and reliability engineering. Investing in the development and training of personnel in this field is key, and it does not only concerns Asset owners, but also government and education institutes.

The effect of optimised preventative maintenance becomes apparent only if the Asset owner is able to implement this preventative maintenance. This means that the rest of the internal maintenance chain has to be able to carry out the necessary work on time and within the set parameters (turnaround time and costs). Professional planning and scheduling are needed for this, as is the ability to measure the achieved process performances. Asset owners should able to autonomously improve their performance to the desired level.

Development of asset portfolio management

To manage the asset performance levels over the entire lifecycle the Asset owners need to move away from the short-term maintenance management philosophy and work towards lifecycle management. The development of the asset portfolio management competency has an important role to play here. This competency makes it possible for Asset owners to monitor the lifecycle of assets and make the right choices about investments in modernisation and lifecycle extension on the basis of short term and long term developments. Integrally monitoring the end of the lifecycle for technical obsolescence, but also for economic, commercial obsolescence and obsolescence caused by new laws and regulations, prevents suboptimal decision-making. Experiences from the VITALE project[20] show that managing lifecycle extension is a relatively new competency. There is a need for initiatives to continue to develop this competency.

[19] See Annex 8 for a detailed calculation of industry's growth in turnover.

[20] Source: 'VITALE-referentiemodel voor levensduurverlenging' ('VITALE reference model for lifecycle extension'), Rob van Dongen, October 2011

Improving safety management

It is necessary to increase focus more on this area in order to limit the risk of safety and environmental incidents. Governments could respond to this by developing targeted laws and regulations and perform the necessary follow-up and monitoring of its application. Asset owners must limit the risks by developing and applying new concepts such as Asset Integrity Management, Risk Based Inspections and reliability engineering. Additionally, new technologies can be used to measure and predict the integrity and condition of assets more effectively (such as smart equipment and real-time condition monitoring). If the governments encourage such innovations, this will speed up the development and the risks will be reduced more quickly.

Encouragement of lifecycle extension

The necessary lifecycle extension projects and replacement projects will call for substantial investments in the next 10 years. In the current economic situation it will be very difficult for the Asset owners to obtain money from the capital market for this purpose. Without these investments in modernising the industrial assets, it will not be possible to continue to compete with other economic regions.

It would be advisable for the governments to improve the investment climate for the modernisation of the industrial assets. Asset owners and the MRO sector need to continue to invest in professionalising lifetime extension projects in order to ensure that available budgets are used as effectively as possible.

Training of young talent

It is highly probable that the MRO sector will grow in the decades to come. This means that - in addition to making provision for the group of people taking retirement - attention has to be paid to attracting young talent. It is necessary to encourage training courses in a wide range of technical professions in maintenance, in order to ensure that sufficient, qualified personnel will available. Knowledge and experience are of vital importance to improving performance in industry and to keep NWE as an attractive region for industrial investments.

One the one hand, this is a responsibility of the government and education institutes, but on the other the asset intensive industry and the MRO sector must itself provide sufficient resources to have this done correctly.

Encouraging important innovations

In addition to raising organisational maturity, a boost could be given to improving performance by using new technologies and IT concepts. Both companies and governments should invest time and money in innovation in the years to come.
The most important innovation relevant to asset intensive industries and the MRO sector are the development of smart industry concepts and the targeted use of big data solutions, resulting in higher productivity by being able to predict potential failures and the demand for maintenance more accurately. Also the application of new materials has potential to increase asset reliability and productivity.

Macroeconomic steering

Getting a clear impression of the performance of the Northwest European industry market in the framework of the M4C project, proved to be quit a challenging process. Many companies had difficulty providing the right information for the benchmark study.

Techno-economic information about industry asset performance and remaining lifetime of the assets was only available only to a very limited extent.

Given the impact of asset performance to the economic added value of industry in this region, there is a need to structurally monitor the performance of the asset intensive industry and steer where necessary. The following measures would need to be introduced for this purpose:

- Compulsory company reporting on the Asset performance. This information could be made accessible and used at national and European level.
- Development of a simple common set of KPIs in order to monitor the asset performance and the condition of the asset portfolio. An initial onset for this is made in Annex 6.
- Periodic market research at to monitor developments in the MRO sector.

ANNEXES

Annex 1 – Maintenance & asset management KPI definitions

A standard set of KPIs has been defined to make it possible to mutually compare the performance of maintenance organisations and to compare characteristics. This set consists of 13 KPIs which, in conjunction with each other, provide an impression of the maintenance performance on the various maintenance competencies. The KPIs are shown in the table below, including the definitions.

In a number of the KPIs the cost performance is expressed as a percentage of the replacement value of the asset base. This asset replacement value is the new value of all properties, production-related facilities/rooms and buildings, but does not include business offices and general buildings. This replacement value is used to remove the dimensions from the cost performance in order to make it possible to compare the performance of maintenance organisations of various sizes.

KPI	Definition
% Technical availability	Percentage of production losses or production downtime resulting from maintenance (corrective and preventative).
Maintenance costs/replacement value	The overall maintenance costs, consisting of personnel costs and the materials of the engineering departments, as well as the costs spent on maintenance performed by operators and/or third parties, as a percentage of the replacement value of the asset base.
% Preventative maintenance	The overall maintenance costs spent on preventative maintenance as a percentage of the overall maintenance costs. Preventative maintenance includes planned overhauls, planned replacements, lubrication activities, inspections, condition-based maintenance, including repairs arising from inspections and condition-based maintenance.
% Work orders completed on time	The number of planned work orders executed on time, divided by the total number of planned work orders.

Technician productivity	Technicians' hours booked against work orders related to assets and production locations (including waiting time) divided by the total number of work hours.
Stock value/replacement value	The total value of spare parts, disposable parts (MRO items) as a percentage of the replacement value of the asset base.
% Outsourcing	The costs of third parties, direct costs or contracts as a percentage of the overall maintenance costs
% Training costs	The costs of training and education for the company's own personnel within the maintenance organisation as a percentage of the overall maintenance costs.
% Documentation up to date	The percentage of drawings and documents that are up to date, i.e. corresponding to the 'as-built' situation.
Probability of health & safety incidents	Estimate of the probability of an incident with a serious impact on health and/or safety caused by technical failure within a period of three years.
Probability of environmental incidents	Estimate of the probability of an incident with a serious impact on the environment caused by technical failure within a period of three years.
CAPEX/replacement value	The CAPEX is regarded in this benchmark as the total investment costs in the asset base with the purpose of a functional modification, lifecycle extension, shutdown, major overhaul, replacement or renewal. These costs are estimated outside of the normal maintenance budget.
% Relative age of the asset	The percentage of the overall technical lifecycle of an asset that has already expired. A low percentage is referred to as a young asset (0% of a new asset), a higher percentage as an old asset (100% is the end of the lifecycle).

Annex 2 – Definitions of end of lifecycle measures

The following five definitions of the end of lifecycle measures are given in the benchmark study.

- Dismantling of an asset

  This arises from the inability to continue to use an asset profitably, as a result of which the production capacity is no longer needed at that location.

- Lifecycle extension

  This means that specific investments can be made to make the existing asset continue to produce profitably for longer. This does away with the need to dismantle or completely replace the entire production asset.

- Replacement whilst retaining existing functionality, also known as '1-to-1 replacement':

  The existing asset is generally largely replaced by an asset featuring newer technology that is able to achieve the same production volumes and products as the old asset.

- Replacement whilst extending existing functionality, also known as 1-to-N:

  In this case the asset is replaced by an asset with more functionalities in respect of types of products and product volumes and product qualities.

- Others:

  All investments not included in the other four categories.

Annex 3 – Macroeconomic statistics Northwest Europe

To gain an impression of the added value of the MRO sector for Northwest Europe it is necessary to extrapolate the results given in this report at NWE level. The results in this report relate to industry in Belgium and the Netherlands.
The most convenient extrapolation method is to use the asset replacement value. This value is provided by the participants in the benchmark. It has not proved possible to find an estimate of the replacement value of industry in this region using the usual statistical databases such as Eurostat for the NWE countries. We therefore have to fall back on other sources[21].

Replacement value of the industrial asset base

Research of ConMoto and VWIS has produced the following information on the replacement value:

- Germany: EUR 1900 billion

KPMG research has yielded the following estimate of the MRO professional grouping for each participating country:

- the Netherlands: 274,615 FTE
- Belgium: 183,077 FTE
- Germany: 1,235,769 FTE
- France: 938,268 FTE

In this study it is assumed that there is a linear connection between the size of the professional grouping and the replacement value of the assets. This yields the following information about the replacement value of the industrial asset base of the participating countries and NWE:

- the Netherlands: EUR 420 billion
- Belgium: EUR 280 billion
- Germany: EUR 1,900 billion
- France: EUR 1,440 billion

This takes the total replacement value of industrial assets in NWE to EUR 4,000 billion, while the total for Belgium and the Netherlands is EUR 700 billion. It should be noted that this is a rough estimate, but is used as a starting point in the absence of concrete figures.

Employment in the MRO sector

KPMG research has yielded the following estimate of the MRO professional grouping for each participating country:

- the Netherlands: 274,615 FTE
- Belgium: 183,077 FTE
- Germany: 1,235,769 FTE
- France: 938,268 FTE

For the whole of Northwest Europe this represents approximately 2.6 million FTE.

Industrial turnover in Northwest Europe

Based on Eurostat data the industrial share in Gross Domestic Product (GDP) is determined for countries in Northwest Europe:

- the Netherlands: EUR 600 billion
- Belgium: EUR 400 billion
- Germany: EUR 2,700 billion
- France: EUR 2,050 billion

For the whole of Northwest Europe this represents an industrial turnover of EUR 5,750 billion.

[21] *Source: 'Macroeconomic report with regards to the MRO market in Europe', KPMG, 2015*

Annex 4 – Definitions for identifying top performers

The top 25% per sector are identified as follows. The first step is to determine the average score over all participating companies on the criteria (a) and (b) for each sector. An example of this is given in the figure below.

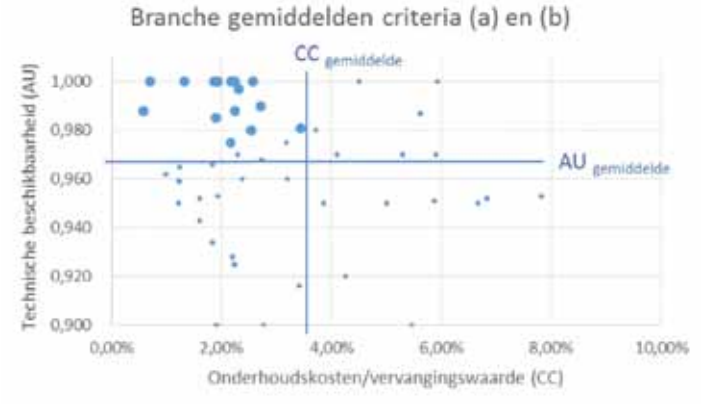


Figure B3.1 Sector averages

Each company's deviation from the sector averages is then determined for each criterion. In Figure 3.2 these are shown as ΔAU (criterion (a)) and ΔCC (criterion (b)). Top performers necessarily have a positive ΔAU and ΔCC and an SHE score of at least 0.96.

Finally, the size of the average performance deviation for each company is determined in relation to the averages for the two sectors using the formula:

Performance deviation = The 25% of the companies in the sector with the biggest performance deviation are included in the 25% Top performers in a sector. The other 75% in the sector are placed in the category Laggards.

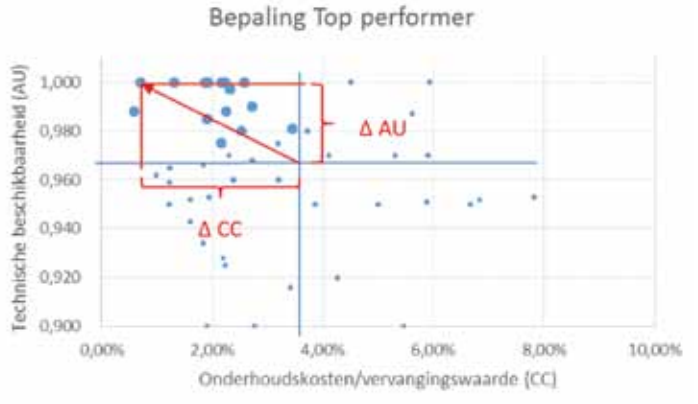


Figure B3.2 Deviation from the averages

Annex 5 – KPIs for macroeconomic monitoring of the MRO sector

KPI	Definition
Asset Technical Age Index (ATAI)	Weighted average asset age/Weighted average technical age
Asset Economic Age Index (AEAI)	Weighted average asset age/Weighted average economic age
Technically Aged Asset Ratio (TAAR)	Value of assets that have reached the end of their technical life-cycle/total value of the asset base
Economically Aged Asset Ratio (EAAR)	Total value of assets that have reached the end of their economic lifecycle/total value of the asset base
Old-asset Dependency Ratio (ODR)	Total value of assets in the last 20% of the technical lifecycle/total value of the asset base
Asset Replacement Urgency (ARU)	Total value of assets in the last 20% of the economic lifecycle/total value of the asset base
Asset Aging Index (AAI)	Total value of assets in the last 20% of the technical lifecycle/total value of the assets in the first 20% of the technical lifecycle

KPI	Definition
% Technical availability	Percentage of production losses or production downtime resulting from maintenance (corrective and preventative).
Maintenance costs/replacement value	The overall maintenance costs, consisting of personnel costs and the materials of the engineering departments, as well as the costs spent on maintenance performed by operators and/or third parties, as a percentage of the replacement value of the asset base.

KPI	Definition
% Preventative maintenance	The overall maintenance costs spent on preventative maintenance as a percentage of the overall maintenance costs. Preventative maintenance includes planned overhauls, planned replacements, lubrication activities, inspections, condition-based maintenance, including repairs arising from inspections and condition-based maintenance.
% Outsourcing	The costs of third parties, direct costs or contracts as a percentage of the overall maintenance costs
Probability of health & safety incidents	Estimate of the probability of an incident with a serious impact on health and/or safety caused by technical failure within a period of three years.
CAPEX/replacement value	The CAPEX is regarded in this benchmark as the total investment costs in the asset base with the purpose of a functional modification, extending the lifecycle, shutdown, major overhaul, replacement or renewal. These costs are estimated outside of the normal maintenance budget.
% Relative age of the asset	The percentage of the overall technical lifecycle of an asset that has already expired. A low percentage is referred to as a young asset (0% of a new asset), a higher percentage as an old asset (100% is the end of the lifecycle).

Annex 6 - Calculations of the increase in competitive strength

Reduction of operational maintenance costs

It has been demonstrated that cost reductions up to a maximum of 42.5% are possible if the maturity of the group of followers rises to the level of the top performers.

The following formula is used to calculate the cost savings:

The calculation is based on the following key principles:

- Targetscenario = 42.5% cost reduction
- Cost levelfollowers = 0.054 (maintenance costs/replacement value)
- ARV[22] followers NWE = 75% x ARVNWE = 75% x EUR 4,000 billion = EUR 3,000 billion.

This yields a potential cost saving of:

Increased income

The difference in technical availability between the group of followers and top performers is 6.3% for the whole industry. The rise in income is calculated on the basis of an increase in the EBITDA. The EBITDA is a good indicator of the organisation's free cash flow. If the technical availability rises and more products are sold, this will lead to a rise in the EBITDA. The costs needed for production have already been taken into account here.

The following formula is used to calculate the rise in income:

The calculation is based on the following key principles:

- Targetscenario = 6.3% improvement in uptime
- EBITDA followers BE+NL = EUR 2.5 billion (statement of participants in benchmark study)
- ARV follower NWE = 75% x ARVNWE = 75% x EUR 4,000 billion = EUR 3,000 billion.
- ARVfollower BE+NL = 75% x ARVbenchmark = 75% x EUR 37.6 billion = EUR 28 billion (statement of participants in benchmark study)

This yields a potential rise in income of:

Lifecycle extension instead of replacement

The chance of success of a lifecycle extension project as an alternative to replacing a complete asset depends on a number of factors. The envisaged functionality of the asset should of course be maintained by modifications for a period of at least 5 years. The technical condition

of the asset at the end of the lifecycle is another dependent factor. If the asset is in very poor condition, the costs of extending its lifecycle rise substantially. The following characteristics have been established for the successful lifecycle extension projects:

- The costs of such a project average 7.5% of the replacement value.
- The extension of the lifecycle with such an investment averages 15% of the technical lifecycle. For an average factor with a technical lifecycle of 30 years this represents a lifecycle extension of around 4.5 to 5 years.
- It follows from this that an average lifecycle extension costs approximately 1.7% of the original replacement value for each additional year.

If we set this off against the alternative of a replacement investment, for a comparable factory with a technical lifecycle of 30 years this would mean an average investment of 100% ARV/30 years = 3.3% of the annual replacement value. This represents a saving of almost 50% on the investment costs.
Accordingly, extending the lifecycle could be a very attractive alternative to replacement in terms of costs.

Based on the characteristics set out above, it follows that in the case of lifecycle extension, it is possible to achieve an average annual saving in investments of 1.6% of the ARV of the asset base being replaced.

Based on the same targets used to determine the market growth of the MRO sector:

- The target is to extend the lifecycle of 50% of the obsolete assets
- 44% of the total asset base will reach the end of its technical lifecycle within 10 years
- Replacement value industrial asset NWE = EUR 4,000 billion
- Saving yielded by lifecycle extension compared to replacement: 50%

This represents an annual saving in investment costs for industry in Northwest Europe of EUR 44 billion in the next 10 years.

[22] ARV = asset replacement value

Annex 7 – Calculation of growth in industrial turnover

Improving asset performance will improve the commercial performance of the industrial companies. The improvement in technical availability contributes to higher turnover. Assuming the objective of achieving a structural improvement in the technical availability of the group of followers up to top performer level, this will yield an increase in turnover of industry in Northwest Europe of:

- Targetscenario = 6.3% improvement in uptime
- Current turnover followers BE+NL = EUR 15.3 billion (statement of participants in benchmark study)
- ARV followers NWE = 75% x ARVNWE = 75% x EUR 4,000 billion = EUR 3,000 billion.
- ARVfollower BE+NL = 75% x ARVbenchmark = 75% x EUR 37.6 billion = EUR 28 billion (statement of participants in benchmark study)

This yields an increase in industrial turnover of:
With the right investments to achieve improvements in the asset performance, industry in Northwest Europe is able to achieve an annual added value of EUR 103 billion.

Annex 8 – Calculation of growth in employment

Lifecycle extension could become one of the driving forces of the Northwest European economy. If industry is able to take up the challenge of converting the planned replacements of obsolete assets into lifecycle extension, this would give the MRO sector a huge boost, because most of the lifecycle extension projects will be carried out by the MRO sector itself. This is unlike the replacement and newbuild projects, in which this share is very limited. The growth of the MRO market through lifecycle extension is calculated using the following formula:

The calculation is based on the following key principles:

- Share of labour in the MRO sector with lifecycle extension = 35%
- Costs of lifecycle extension average 1.6% of the annual ARV
- The target is to extend the lifecycle of 50% of the obsolete assets
- 44% of the total asset base will reach the end of its technical lifecycle within 10 years
- Replacement value industrial asset NWE = EUR 4,000 billion

If these figures are used in the formula, the result is:

This implies that during the next 10 years the Northwest European MRO market will increase by approximately EUR 5 billion a year as a result of carrying out lifecycle extension projects.
With an average annual wage of EUR 61,000 this represents growth in employment of 80,000 FTE.

Annex 9 - List of abbreviations

ARV	Asset replacement value
CAPEX	Capital expenditure s
EU	European Union
GDP	Gross Domestic Product
KPI	Key Performance Indicator
MRO	Maintenance, Repair and Overhaul
NWE	Northwest Europe
OPEX	Operating expenditure
PM	Preventative maintenance

COAL MINE
CHERATTE, LIÈGE, BELGIUM

The Cheratte coal mine became operational in 1848 with two shafts (170 and 250 metres deep). In 1877, operations stopped after a water breakthrough which killed several miners. In 1905, the concession was taken over by SA des Charbonnages du Hasard. In 1930, 1,500 people worked in Cheratte and daily production was 1,000 tons. Things started to go downhill for this mine in the 1970s. When it closed in 1977, it was the last but one functioning mine in Liège. 590 people lost their jobs.

Text: www.belgischesteenkoolmijnen.be / Picture: Ronnie Husson


ATIONALE D'ELECTRICITE LIEGE

RUSTENHOVEN FACTORY

DAMSTERDIEP, NETHERLANDS

Stone and tile factory Rustenhoven was founded in 1804 by Jan Hindrik Sissingh and is located at the Damsterdiep, West of Appingedam (Netherlands). In 1924, the factory was modernised by the then owner, Berend van der veen, who built a new ring furnace with 24 chambers. In 1937, the clay deposits north of the factory were depleted, so deposits south of the Damsterdiep were mined and the clay was transported by truck. The company closed in 1965 due to lack of modernisation and investment.

Text nl.wikipedia.org, Noorderbreedte & Jan Abrahamse / Picture: Urbanexploration.nl

MACROECONOMIC REPORT REGARDING THE MRO MARKET IN EUROPE

BY KOEN BOGERS

1. APPROACH

1.1 Introduction

MORE4CORE aims to improve market integration, worker mobility and innovation in the MRO (Maintenance, Repair and Overhaul) market. This should increase the effectiveness of this rapidly growing sector in North-West Europe (NWE). The MORE4CORE project, therefore, is funded by INTERREG.

The MRO market plays a crucial role in modern production facilities. In the first place, it must ensure and improve productivity. Additionally, new energy friendly and efficient technologies are constantly being introduced.

As correctly stated in the AFIM study (2013), Europe's economic outlook faces different interests and multiple speeds at which the economic landscape is evolving. There is the economic recession that caused a serious disruption within Europe. This, of course, had a serious impact on the growth, sustainability and further economic development of the MRO sector.

In this contribution, a number of tendencies are highlighted and recommendations are made to take this forward.

1.2 Input European Studies/European Commission

The main sources for the contribution are the publications of:

- Eurostat
- ISO/CEN (European Committee for Standardization)
- European Commission
- KPMG publications
- EFNMS publications
- Other sources as mentioned in the references

1.3 Overall assumptions with regard to the development of a global European maintenance view: Macro-economic tendencies

In this contribution, a number of assumptions are developed. The objective of these is to place the current maintenance situation in perspective and also to create a framework against which any conclusions and recommendations can be positioned. This approach includes a benchmarking approach based on local, regional and European studies that have been carried out across the different regions and throughout the different industries within France, Belgium, Germany and The Netherlands.

1.4 Data requirements and the lack of relevant data

With regard to the maintenance situation within the EU, there is a lack of transparency and KPI definition. In this respect, there is still a lot of ground to be covered that not only relates to maintenance, but also to the related Business Services and Facility Management as a whole. At this point in time, it is not possible to gain a good and thorough understanding of the current and future situation, let alone make coherent predictions for the future.

For example, the final report on Business Services (2014) includes facility management and does not use a stringent NACE based bottom line for its data definition. On the other hand, the data presented in the 2009 study on jobs and skills in the EU (with reference to other services, maintenance and cleaning) is based upon the NACE 90, 91, 93 and 95 codes. So comparing of trends, data and figures remains a challenge.

A number of European data bases exist. Although there is a lack of transparency within these data bases as far as the MRO market goes and for Business Services as a whole, we still can detect a number of common topics within the EU Member States.

The European system of national and regional accounts (ESA) provides the methodology for national accounts in the EU. The current version, ESA95, is fully consistent with the worldwide guidelines for national accounts, the 1993 SNA. Following international agreement on an updated version of the SNA in 2008, a respective update of the ESA – ESA2010 – is, at the time of writing, close to finalisation.

2. MACRO-ECONOMIC TENDENCIES: ASSUMPTIONS

Macro-economics is not an exact science; therefore, one speaks about macro-economic tendencies. It is impossible to know exactly how the macro-economic variables are related to one another. A number of models were created that try to explain various observations and relationships between different macro-economic variables. Observed phenomena may lead to different explanations in different models and different models will lead to different predictions of macro-economic variables.

In the below study, a number of assumptions are made in relation to macro-economic tendencies:

- Unemployment and hours worked are directly related.
  - One assumes here a negative relationship between these two components. If the number of hours worked increases, the unemployment will fall and vice versa.

- With regard to employment/unemployment, one can argue that the higher the technological level of production, the lower the unemployment rate for the 20- to 35-year-old category of the working population.

- A rise in GDP will be reflected in higher investments.
  - GDP is here the sum of consumption (private and government); investment and net exports.
- Ageing of installations is linked to investments.
  - The assumption here is that the higher the investments, the lower the overall age of the installations in that specific industrial sector.

- Asset lifecycle age.
  - The average lifecycle of assets is assumed to be 30 years. This age period does not imply that this phenomenon is directly linked with asset replacement and/or investment. Assets can be upgraded/downgraded/partially replaced or modified. However, a certain knowledge factor can be attached to this, meaning that there can be a link between the ageing of personnel and expertise.

- Innovation and the development of innovative techniques and methods are not directly linked to their implementation.
- Unemployment is defined as the sum of the rates of frictional, structural and classical unemployment (excluding cyclical unemployment).

2.1 North Western Europe overall economy related issues

Economic background: Short term

In the short term, the economic crisis of 2008 has hit the European economies very hard. Overall, Europe is still trying to recover from the severe setback/downturn it has experienced since then. This had had enormous implications on the way we are currently looking at the European and worldwide economies.
The current situation in a nutshell:
Unemployment has been steadily rising in the EU, going from 9.6 (2010) to 10.8 (2013). Youth unemployment went up from 21.1% to 23.4% (2013) of the active population of the Member States. Now, in 2014, one can witness the beginning of a levelling out of these trends. According to the latest trends, we see a slight decline in absolute figures with regard to EU unemployment. But it is still early days to predict that the worst is over.

Looking back: Longer term historical macro implications

When estimating that the asset lifecycle spans 25 years, one can distinguish three waves of 25 years starting, roughly, after the Second World War. The point of departure for this assumption is the landmark of the Second World War with the rebuilding of Europe (Marshall Plan, etc.) which started in full around this period. In general, one could set cut off points at 1970, 1995 and 2020.

The major implications of these three distinctive periods are shifts in the nature of maintenance that can be distinguished. Notably, the increased importance of IT and IT related services has significantly changed the maintenance landscape. In the 2020 year period, there is an increase in the importance of mechanical maintenance related activities. This upward trend is partly due to the asset lifecycle estimation.
The assumption here is that the asset lifecycle for industrial installations is set to be between 25 and 30 years.
Another factor to take into account is the economic outlook. Economic related tendencies (Energy and financial turmoil) play a significant role in the overall asset lifecycle definition and asset lifecycle prolongation.

Ageing of industrial complexes

As a first overall assumption with regard to the lifecycle of industrial complexes, a starting point is that this is related to a 25- to 30-year cycle.

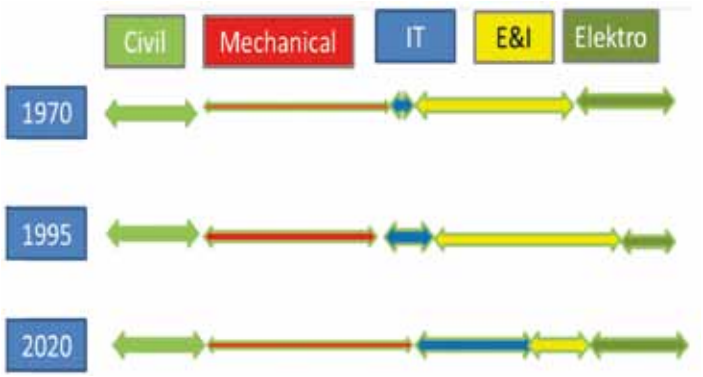
With regard to numerous industrial complexes, we take 1960 as a rough starting point. The year 1990 would then become a maturing landmark phase of these complexes and then 2020 would become another landmark. However, when looking at these landmarks, one sees that complexes (brownfield industries) are not fully replaced but are still in use. Thus, renewal of an internal nature takes place automatically.

One could state that the lifetime of installations gives one an indication about the usage and usage intensity of the underlying asset management systems and their robustness. It is a fact that a substantial portion of the industrial infrastructure dates back to the 60s and 70s of the last century (e.g. BASF is celebrating its 50th anniversary in Antwerp this year). This does not imply that the technical infrastructure dates back to the same period. Many of the installations have been upgraded, renewed or replaced in the lifetime of the plant. However, one cannot deny that the original lifecycle

of installations has been reviewed and, in a significant number of cases, has been prolonged substantially.
Adaptation and refitting of industrial complexes have had an impact on the technology in use. The use of IT, technological upgrades and introduction of new production ways of working have helped industries achieve this lifetime extension.

Studies by the European Federation of National Maintenance Societies (EFNMS) and NVDO (Maintenance Compass) 2014, 76-85, are in line with this point of view. Clearly, better established industries like power production, water supply, pulp and paper and metal industries have a longer lifecycle pattern, versus, for example, the pharmaceutical industry which experiences a much shorter economic age pattern due to the nature of its business (where R&D has a strong influence). On an average, the age of the assets is between 20 and 25 years based on figures from The Netherlands (NVDO 2012: 34). This seems to be confirmed as far as Belgium, Germany and France are concerned. Data is lacking for the rest of the EU members. In the infra world, assets are estimated to have a lifespan between 35 and 40 years.

Technical and technological quantum leap



Shift in technical and technological components constituting the outlook of MRO

The quantum leap within technology has a significant impact on the way we look at jobs and also on the creation of jobs. According to Goos (KUL, cf. Wouter van Driessche, 2014) abstract work and manual labour gain significantly in favour of a regression with regard to routine jobs; this means that the jobs that include a large percentage of routine tasks are much more subject to automation and/or outsourcing compared to labour that is more of an abstract or manual nature.

In the above representation, a shift is noted towards an increase in IT services (in the largest sense) at the cost of mechanical and E&I related tasks. Civil related tasks have remained stable over the years. However, these tendencies should be linked with a number of economic phenomena, such as outsourcing and the evolution of maintenance departments towards autonomous business cost centers.

In an article in The Asset Journal (September 2014, Issue 03), A. Kruger describes the changing way we do business. In the article, the author talks about the fourth industrial revolution, stating that the industry is changing in five dimensions, due to:

- The product and asset lifecycles merging and being condensed
- Manufacturers, service providers, dealers, operators working in a much more interconnected and heterogeneous environment
- More transparency of information between shop floor, plant-oriented systems and corporate/business IT
- New business models
- New ways of distributing and consuming information

As a consequence, this means that machines and systems will be able to regulate themselves based on their built-in intelligence. But humans will continue to play an ever growing role in decision-

making when running a system of assets (controlling cost, risk and performance). The creation of more and more data will lead to a greater need for means to prepare data for decision-making purposes. In short, data must be available, reliable and consumable.

2.2 Changes in the EU's industrial structure and the rise and diversification of Business Services

2.2.1 Introduction

As mentioned before, a shift has been taking place not only in the basic nature of MRO, moving away from purely manual labour tasks towards "non-physical jobs" (introduction and development of IT related tasks) but this has also created the tendency to outsource certain non-core business tasks. This tendency actually started and developed a number of Business Service industries. The industrial structure of an economy is the result of long-term trends. As indicated earlier, the long-term shift from manufacturing towards business services is continuing; Business Services have grown to a point where they account for nearly half of the EU gross value added. When looking at non-market value services, the same trend can be seen, with an increase up to nearly 23% in 2012 (EU Industrial Structure Report, 2013).

Although manufacturing shares have been quite stable within Europe, due to the economic crises, a partial shift within the EU Member States can be observed. This shift is mainly towards the new Member States which inherited large manufacturing sectors from their pre-transition period. In this way, new economic clusters were added to the existing ones, thus creating extra pockets of industrial concentration.

2.2.2 Business Services and the MRO market

Only recently (2009), the European Commission introduced and adopted the notion of Business Services. Meaning that: "Business Services are services where one business supports another in the execution of its activities" (European Commission, MEMO, 2014). These include among others, management consultancy services; technical services; engineering or technical maintenance services; and operational services.

Facility Management services form an integral part of Business Services as described by Eurostat (2009), among others. Now this terminology creates some confusion as it is not totally clear whether outsourced maintenance services are included or not. Nevertheless, the figures and trends as analysed by Eurostat give some indication of the overall direction in which these economic tendencies are going.

Business Services are a booming business within the European Union. There is a significant increase in the development of Business Services over the last decade. More and more companies tend to rely on outsourcing part of their needs to external companies. The distinction between outsourced core and non-core services is difficult to establish. Fact based figures for this topic are not available.

Manufacturing firms are increasingly using services as part of their business processes – in the development and sale of products, and for horizontal business activities such as accounting and logistics. Between 2000 and 2009, the service content of manufacturing output embodied in domestic final consumption increased in every Member State. The financial crisis does not appear to have had a significant impact on the service content of manufactured goods. (EU Industrial Structure Report, pp. 17-27.)

When comparing these figures with the 2010 figures (Final report of High-Level Group on Business Services, EU, 2014), there is a substantial decrease notable due to the economic crisis. This gives us the current situation:

	Number of enterprises (thousands)	Turnover (€ billion)	Number of people employed (thousands)
EU 27	3,907	1,518	20,695

Nevertheless, the economic realisation of Business Services within the total economic world of the EU is quite important. The global Business Services market is estimated to exceed €3.5 trillion and to have doubled in size in the last decade. It accounts for 11% of the EU economy. Even when looking at a worldwide scale, the question would be how that share of the global business can be captured. The challenge on the table would not only be how successful Business Services can be in a strict European context, but what role they can play on a worldwide scale.

These figures are in line with the figures presented in the ConMoto study of 2012. However, the assumption can be made that the above figures also include direct maintenance. So the fear is justified to assume that this data is relevant for a grand total of MRO and Business Services. This, however, only reinforces the importance of two major conclusions:

1 Data is, at this point in time, not coherent and needs further investigation.
2 The importance of these markets for the EU and intercontinental businesses.

And as a point of reference, one can assume that between 10% and 15% of the active working population is employed in sectors related to maintenance. For the countries concerned in this study, this would give us the following:

Maintenance	**related active**	**Active population**
Belgium	450,000	4,500,000
The Netherlands	730,000	7,300,000
Germany	4,300,000	43,000,000
France	2,900,000	29,000,000
Europe (EU countries)	23,000,000	230,000,000

If one assumes that the average hourly cost is approximately €30, and one works on average 1,700 hours per year, then the estimate can be made that the MRO market is good for 2,000 billion euros in the European market. This would include direct and indirect expenditures.

Based on the data available, it is, however, not possible to make the above-mentioned distinction.
However, based on the ConMoto and WVIS studies, the direct maintenance expenditures are estimated to be around 9,700 billion euros.
This figure is based on the Asset Replacement Value (ARV) (Wiederbeschaffungswert).
This amounts to:

Germany	€1,900 billion
Europe	€9,700 billion

The maintenance cost derived from the Asset Replacement Value would be estimated around 4.5%. This means that the direct maintenance cost for the industry would be in the range of 450 billion euros for the European Member States.

2.2.3 Evolution in the labour market from a Business Services point of view

Labour market	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Employment in Services (% total employment)	67.3	67.9	68.4	68.8	69.2	69.5	69.8	70.5	71.5	71.8	72.2
Employment in Industry	26.1	25.7	25.4	25.2	25	25	24.8	23.8	23.2	22.9	22.6
Employment in Agriculture	6.6	6.4	6.2	6.1	5.7	5.5	5.4	5.4	5.4	5.2	5.2

(EU, Employment and Social Developments, 2013; 428)

Over a 10-year period, this means an increase of 5% at the cost of employment in the industry and agriculture. It is, however, not possible to zoom in on what the effects of outsourcing are on the decline of employment in the industry and the rise within services. Is this merely a shift, but with the number of jobs remaining the same, or is it a real shift in expertise and effective jobs?

The use of the NACE code Rev. 2 with regard to Business Services

This description corresponds with the notion of Business Services as mentioned elsewhere.

section	***Description NACE rev. 1.1***	section	Description NACE rev. 2
G	Wholesale and retail trade: repair of motor vehicles, motorcycles and personal and household goods	**G**	Wholesale and retail trade; repair of motor vehicles and motorcycles
H	Hotels and restaurants	**I**	Accommodation and food service activities
I	Transport, storage and communications	**H J**	Transportation and storage information and communication
J	Financial intermediation	**K**	Financial and insurance activities
K	Real estate, renting and business activities	**L M N**	Real estate activities Professional, scientific and technical activities Administrative and support service activities
L	Public administration and defence; compulsory social security	**O**	Public administration and defence; compulsory social security
M	Education	**P**	Education
N	Health and social work	**Q**	Human health and social work activities
O	Other community, social and personal services activities	**R S**	Arts, entertainment and recreation Other service activities
P	Activities of private households as employers and undifferentiated production activities of private households	**T**	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use
Q	Extraterritorial organisations and bodies	**U**	Activities of extraterritorial organisations and bodies

Within the European classification of NACE codes, there is no separate class dedicated to “maintenance” as such. A vast number of service providers offer multiple services whereby there is no traceability between, for example, electrical, IT related and mechanical services.

2.2.4 Trends in the MRO market as part of Business Services

Outsourcing non-core and, lately, core business has become a very common business approach. In most situations it started from the cost effectiveness approach, but now it also lays emphasis on the added value to primary activities. It has become a vital part in organisations.

In the process, design-build-(operate)-maintain organisations extend their activities to the chain. Organisations build and maintain for a period of time. Also the management and provision of several services may be included. Public policy is a driving force in this development process.

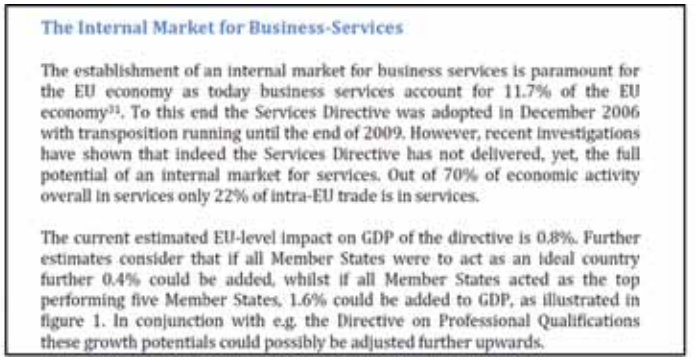
Current status of the overall MRO and Business Services markets

As described earlier, as a result of the shifts within the European economy, a number of economic forces influence both the nature and the impact of the way in which different accents are developed and put in place. On the one hand, there are a number of technological developments (development of IT related innovations) and on the other hand, there is the link with more outsourced activities. These Business Services are responsible for a significant portion of the economic activity, not only within the EU, but also on a more global level.

> *“Business Services will play a central role in the reindustrialization of Europe, both through the provision of innovative and productive services to other firms, and through the servitization of manufacturing. Already the global Business Services market is estimated to be in excess of €3.5 trillion and to have doubled in size in the last decade. In Europe alone Business Services account for €1.5 trillion gross value added and provide jobs for more than 20 million people, across 4 million enterprises. If economic activity in Business Services grows to the levels achieved by some countries, then the total global market for Business Services will be €7.8 trillion within a decade.”*
>
> *High Level Group on Business Services, 2014: 5*

Based on partial data (NVDO 2012: 24), the situation for the Dutch maintenance market has apparently remained stable between 2010 and 2013. This study indicates that the MRO market in The Netherlands is between 30-35 billion euros and has between 260,000 and 300,000 FTEs. On average, the total maintenance spent is about 5% of the total turnover. This is relative to the sector. Overall, the study reflects the opinion that the MRO market will increase in the years to come.

Within this overall landscape, one notices that the number of big players is limited. Predominantly the market is a place for small players (over 99%), while a middle market is missing.



The Internal Market for Business-Services

The establishment of an internal market for business services is paramount for the EU economy as today business services account for 11.7% of the EU economy[31]. To this end the Services Directive was adopted in December 2006 with transposition running until the end of 2009. However, recent investigations have shown that indeed the Services Directive has not delivered, yet, the full potential of an internal market for services. Out of 70% of economic activity overall in services only 22% of intra-EU trade is in services.

The current estimated EU-level impact on GDP of the directive is 0.8%. Further estimates consider that if all Member States were to act as an ideal country further 0.4% could be added, whilst if all Member States acted as the top performing five Member States, 1.6% could be added to GDP, as illustrated in figure 1. In conjunction with e.g. the Directive on Professional Qualifications these growth potentials could possibly be adjusted further upwards.

We also know that many Business Services firms are small (over 99% employ less than 50 people). While there are some large Business Services firms, there is a missing middle. This missing middle hampers growth and productivity and limits the total economic impact of Business Services. Hence we need to find ways of encouraging SMEs to grow and improve their performance by innovating, adopting best practices and building collaborative relationships with their customers and with large prime contractors, who may be willing to subcontract elements of Business Services.

European Commission. 2014. High Level Group on Business Services. Final Report. Brussels. EU for business. Pp.25

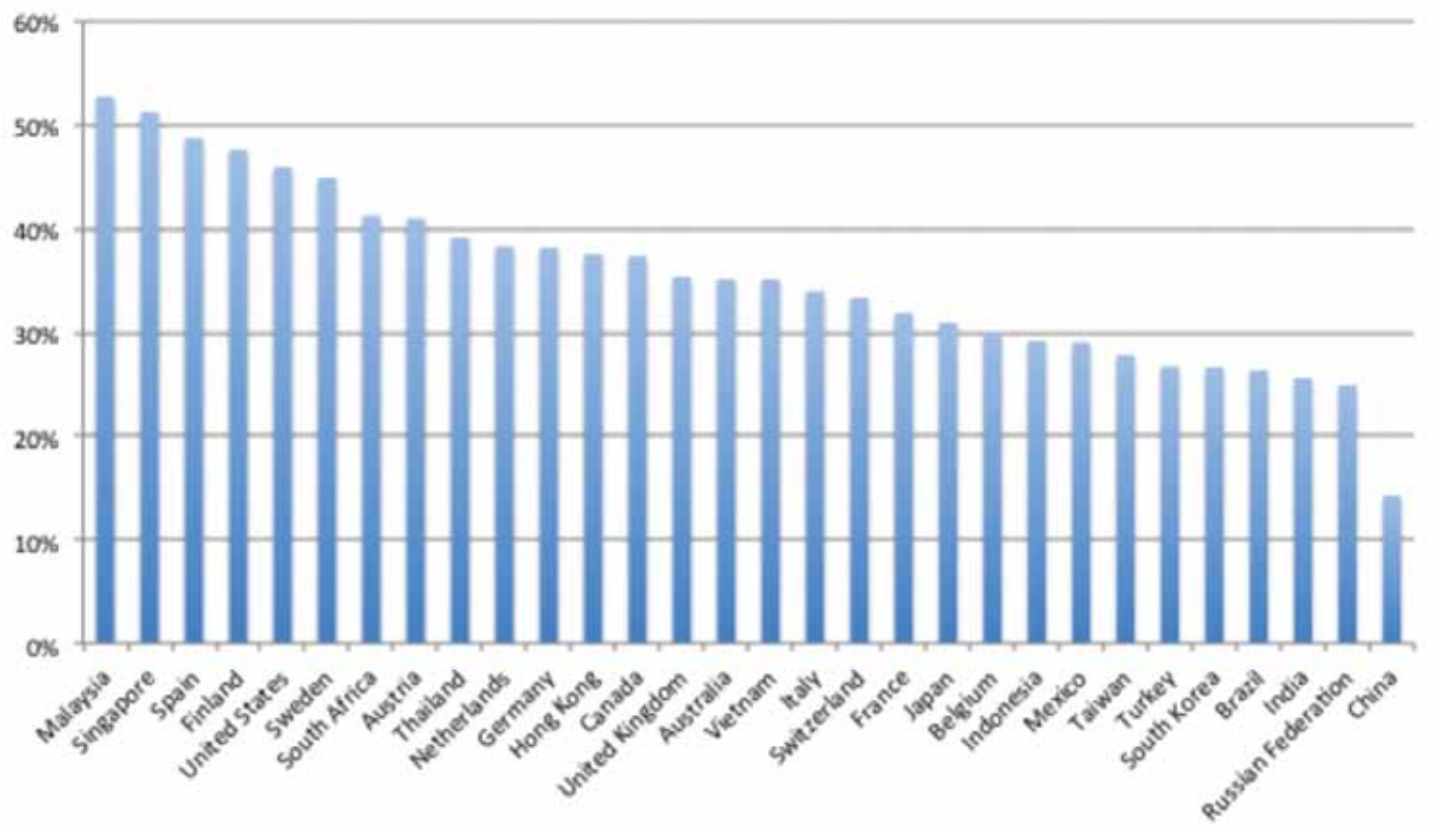
Facility Management is described within Business Services as an integral part of it. Maintenance is mentioned as one of the building blocks that is incorporated within Facility Management. However, it is not clear what percentage maintenance is delivering to the overall contribution of Business Services, let alone to Facility Management. From a data and data analysis point of view, clarification is needed here.

The facility management sector has evolved immensely over the last 20-30 years. It has gone from providing single services, such as cleaning of an office space, to delivering multifaceted and highly integrated facility services (IFS). Today the sector consists of a range of intertwined sub-sectors 'working together' to create integrated service packages for customers. To mention only a few of the elements integrated today: cleaning, furniture, office supply, logistics, event management, energy management, maintenance, catering, document management and ICT. The significance of this is that the sector is divided into a labour intensive part (vastly predominant) and a knowledge intensive part. This has consequences for the fragmentation of the sector in its internal organisation.

The company structure of the sector is characterised by many micro enterprises (up to 75%), however, more than half the sectors turnover is placed in a few (1.4% of enterprises in the sector) large enterprises[43]. The main driver of facilities management today is outsourcing. 2.5% of GDP in the top five EU countries (Germany, UK, France, Italy, and Spain) has already been outsourced, and if including internal facility management services it could be up to as much as 5% of GDP[44]. The trend shows that enterprises tend to be larger in the Member States with the highest outsourcing rate[45].

European Commission. 2014. High Level Group on Business Services. Final Report. Brussels. EU for Business. Pp.45

To add an extra dimension to this overall view, a substantial number of companies have developed their own service proposition. The reasons for this are many: existing infrastructure, knowledge and expertise, availability of workforce, market share and market contacts.

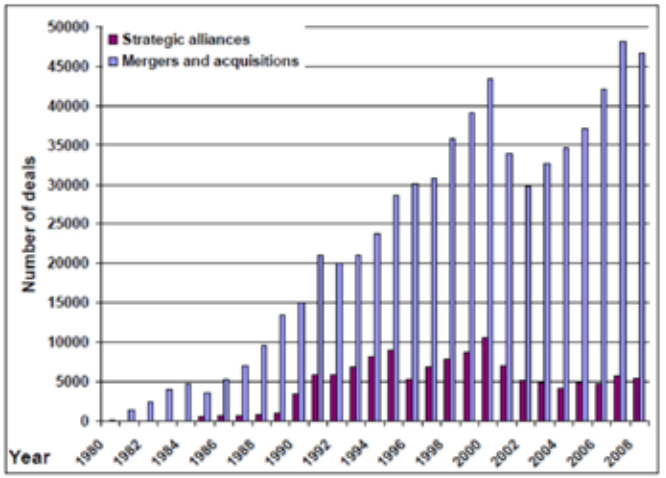


Proportion of Manufacturing Firms Offering Services

Apart from the fact that the data on this topic is scarce and fragmented, one witnesses a new trend in the market and that comprises the fact that manufacturing companies are entering the Business Services market themselves. Within a number of larger companies, the MRO departments and their activities are regarded as independent cost centres. Thus, they are obliged not only to offer services internally but also have to look to make the best use of their internal expertise and equipment outside the factory. When looking at The Netherlands, Belgium, Germany and France, between 30% and 40% of the manufacturing companies offer services, whatever the form or format may be, thus blurring the distinction between the MRO and Business Services market even more.

2.2.5 Innovative Tendencies within the Business Services market/MRO market

The commonest way for companies to make use of research and implement innovation is to acquire it from outside. Other ways are strategic alliances, joint ventures or external R&D (SA=Strategic Alliances and M&A= Mergers and Acquisitions).



Source: GloboInn Project

Number of worldwide SA and M&A deals in 1980-2008

Furthermore, several studies show that:

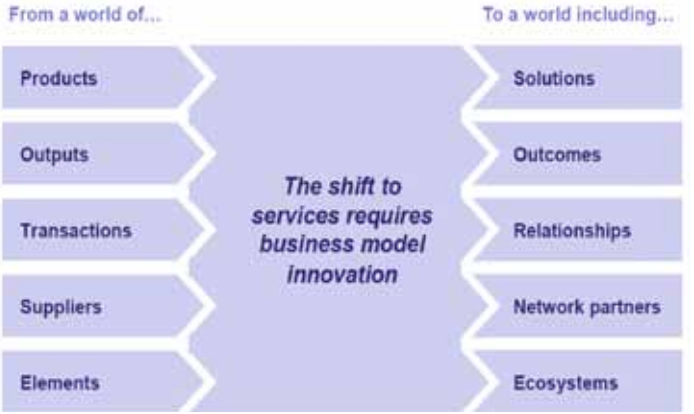
1 European firms use their non-European subsidiaries in order to internationalise their technology alliance components
2 Small enterprises and those in the new Member States have a technological deficit, particularly with regard to an extra-European dimension
3 Thirty percent of innovative firms cooperate on innovation with a partner from the same country
4 The cooperation with other European countries is 15%
5 Twenty percent engage in cooperation on innovation within the old Member States

The above graph gives an industry-wide perspective, but one can easily assume that this trend is applicable to Business Services as well.

Innovation and the implementation of innovative products, methods and technologies often has more to do with change management (the changing nature of the business) than with technological applications in themselves.

The changing context as depicted hereunder applies as well for Business Services as for the MRO market in its totality.

Figure 2: The Changing Context for Business Services[16]



European Commission. 2014. High Level Group on Business Services. Final Report. Brussels. EU for Business. Pp.45

When looking at Business Services, and the MRO market in particular, one comes to the conclusion that the “traditional” business models for these are rapidly changing.

Be aware of the fact that innovation and technological state of the art tools do not necessarily reflect the status of implementation. It is not that the invention of the LED lamp immediately led to a massive replacement of TL lighting devices. It is only after a number of years that the industry is willing to embrace (and replace) older technology by a more advanced version of it.

2.2.6 Current strengths and weaknesses of the MRO market and of Business Services

Table 1: SWOT Analysis of European Service Firms and Internationalisation

Strengths	*Weaknesses*
• The diversity of European services – many firms have already developed a strong international footprint. • SMEs exploiting niches in rapidly moving markets. Larger firms able to focus on more stable markets. SMEs need to be nimble and fleet of foot as the market alters. This includes entering new markets and also exit strategies (Energy firm). • Critical importance of reputation and heritage. Development of international strategy based around major projects. Targeted approach to bidding. • Working with local partners with the foreign firm providing the added value and the local dealing with building regulations, etc. • Contracts and legal practices in specific subsectors. • Some parts of Europe have a reputation for the provision of business services. • Innovative capacity through services. • Diversity driven innovation.	• Need to follow clients overseas and also to provide an integrated approach to services. • Working with local partners is a challenge in emerging markets. • Finding the right local partner. • Many SMEs provide services without benefiting from the co-ordination of linked services provided by other firms. There is fragmentation in the provision of business services. • Low margins in some areas and increasing commoditization of business services. • Move beyond conceptualising service trade as flows of activity between countries and to explore trans-local or trans-place relationships and activities. • Pricing mechanisms. Difficulties in pricing bespoke services. • The development of a customer perspective in firms. Poorly developed key performance indicators (KPIs) prevent many business service firms from maximising their competitiveness.
Opportunities	*Threats*
• Web-based platforms and the positioning of local firms for international business. This can work both ways in internationalization. Role of interns and the development of an alumni network. • Focus on the interaction between advanced manufacturing and services. Importance of political support in markets beyond the EU (contract signing events with key political leaders). • Working with larger firms. • Bilateral trade agreements with the US and Japan. • Services in relation to the ageing society • Services and the green economy; building sustainable growth • Trade agreements • University link and movement of students and faculty • Manufacturing and services; as a combined driving force • Clusters and agglomeration effects. • Big data. • The provision of service bundles of 'manuservices' or bundles of linked services.	• Facilities management – more project-based business. Strategy shifted to the provision of service bundles. • Size matters in several of the business services sub-sectors, in order to be able to follow clients abroad; all about the provider and the global footprint. • Missing out on standards and procurement possibilities. Different standards apply in different national contexts. • Competition from emerging multinational, India, China. • Lack of trade liberalization • Transparency and corruption • Visa restrictions • Loss of IPR • Cultural differences • Skills; regulatory aspects • Race to the bottom for the provision of low value services. Increasing commoditization of services. • Limited sharing of knowledge between firms.

European Commission. 2014. High Level Group on Business Services. Brussels. EU for Business.

Overall, one could state the above remarks are valid as well for the overall MRO market (Business Services and Facility Management).

Strengths	Weaknesses
• The MRO market is a mature market and has accumulated a lot of expertise, growing together within and with the different industries. • There are strong local roots for a large number of these companies/industries.	• Flexibility and agility seem to be lacking. Mobility seems to be an important factor to focus upon. • There is no coherent approach towards MRO, not only with regard to legal issues but also with regard to skills integration and harmonisation.
Opportunities	**Threats**
• Internationalisation still needs to be exploited and given a boost for service companies that have margin for growth	• Local cultures and local differences • A culture of change has to be embraced and made sustainable

2.2.7 Rough values (KPIs) with regard to the MRO market (inclusive Business Services)

Based on a limited number of studies that have been carried out over the period from 2000 to 2014, a picture emerges that is in line with the data as presented by Business Services. In the Nordic Benchmarking Analysis from 2001, the following picture emerges:

KPI	Mean	Unit	World Class
Maintenance Cost as % of Plant Turnover	4.1	%	<3%
Maintenance Cost as % of Plant Replacement Value	3.0	%	<1.8%
Contractor Cost as % of Maintenance Costs	35	%	
OEE	76	%	

The figures here project only a limited number of companies in three Nordic Countries. Nevertheless, taking into account the trends as being deployed within Europe, it is fair to assume that these are in line with the trends observed.

Recent studies by NVDO show similar figures (NVDO Maintenance Compass 2014: 24-36) where they set a baseline of maintenance cost as a percentage of turnover of 5% cross sector wise. This data is in line with the overall European data as represented above.

As a rule of thumb, a percentage of 35% of tasks is outsourced in any given industry. Certain activities are outsourced nearly 100%, in

particular: scaffolding, insulation and painting. With regard to mechanical activities, depending on the industry and point of view, between 30% and 75% of tasks are outsourced, especially with regard to piping, rotating equipment (pumps and compressors), special machinery and static equipment.
At this point in time, there is a clear gap in the identification of MRO KPIs. Instead of limiting the number of KPIs, there appears to be a tendency to establish KPI after KPI. This finally leads to total confusion and misalignment. The establishment and measurement of KPIs in different countries often overlap and slightly otherwise define, only creating a tower of Babel, thus making any interpretation difficult and meaningless. The same goes for any attempted benchmarking exercise.

2.2.8 Workforce mobility/migration and the in- and out-sourcing of labour

Workforce migration has been an overall challenge throughout the period of discussion; there are no clear indicators/figures as to which department/MRO workforce was deployed in the period 1960-1990. But workforce mobility has been in place since those early days. The only shift that can be detected is that since 2010, there is a more structured workforce mobility in place with its own and proper geographical connotations. Also a number of geographical differences can be observed with regard to the willingness and adaptability to migrate and with the flexibility to work in other Member States of the EU.

There is an evolution from owner based technicians (insourcing) to more service oriented companies/strategies (outsourcing), which was not known in the earlier days. This, in combination with the TAR strategies, leads to more mobility, and recognition and mobilisation of knowledge (this could be done by means of the creation of a European Skills Passport).

This movement from insourcing towards outsourcing is supported by the data we find in the available European reports (e.g. Employment and social developments, 2013). There is a shift from industry and agriculture in favour of services.

The question that remains to be answered is how to guarantee an acceptable skills level within the European Member States that is recognised as a standard and accepted as such?
At this point in time, there is not one European based skills system in place that guarantees the competence or skills level of qualification for certain jobs and, as such, creates the possibility of an open and coherent job market. Such a tool would definitely facilitate the notion of a workforce pool where the notions of adaptability, mobility and quality of work could play their role.

The biggest barrier to mobility of the maintenance technicians is the fact that there is no transparency of the skills of maintenance workers. This is due to the fact that a lot of the skills and competencies are acquired through experience in the work field (informal and formal learning). On top of that, employers in certain states don't have a clear insight into the capabilities of holders of a diploma or training certificates.

A European Maintenance Skills Passport tackles this lack of transparency. The passport is a type of portfolio, owned by an individual, that gives information about the acquired and validated skills that the individual has obtained in the field of maintenance.

These skills are named to conform to the ESCO nomenclature and described in a uniform way using Learning Outcomes (LOs).
An individual will be allowed to add skills to his/her passport through the following possibilities:

1. Recognition of his/her diploma obtained through formal learning
2. Through an accredited certificate. For example, safety certificates such as VCA (Safety, Health and Environment, Checklist for Contractors) in Belgium and The Netherlands, SCC certificates in Germany (Safety Certificate for Contractors) ('Operating companies' employees' and 'Operating companies' executives'), MASE (Manuel d'amélioration Sécurité des Entreprises) in France.
3. ISME ATEX Certificate in France.
4. Through another accredited assessment (in-company or in a test center) testing his/her knowledge, skills and competencies obtained through nonformal and informal learning

Reasons for internalisation of companies:

- With the increasing complexity of products and production coupled with market innovation, the demand for internationalisation has increased
- Specific location characteristics can create a "pull" effect on location decisions
- Government incentives can have a secondary influence in the choice of relocation or co-location

Europe is clearly in favour of promoting transitions within the labour markets, not only horizontally but also vertically (geographically). Europe is advocating that these transitions within the market should be supported by a number of security measures in order to, as they call it, "make transition pay" for the workforce. So a set of structured measures should be put in place to guarantee and support a more dynamic labour market.

As of the 1990s (the second industrial breath period), a shift can be observed, moving from an overall insourced approach towards a return to core business tasks to be kept in-house. So outsourcing became an option to be studied and implemented.

From the 1990s, we see a continuation of this outsourcing phenomenon, with the establishment of dedicated service providers covering a wider spectrum of tasks that were insourced so far.

Regional, structural and sectorial policies

Along with business cycle and macroeconomic policy analysis, there are other policy-related uses of European national and regional accounts data, notably concerning regional, structural and sectorial issues.

The allocation of expenditure for the structural funds is partly based on regional accounts. Furthermore, regional statistics are used for ex-post assessment of the results of regional and cohesion policies.

Encouraging more growth and more jobs is a strategic priority for both the EU and the Member States, and is part of the Europe 2020 strategy. In support of these strategic priorities, common policies are implemented across all sectors of the EU economy while the Member States implement their own national structural reforms. To ensure that this is as beneficial as possible, and to prepare for the challenges that lie ahead, the European Commission analyses these policies.

Policies, target setting, benchmarking and contributions

Policies within the EU are increasingly used for setting medium or long-term targets, whether binding or not. For some of these, the level of GDP is used as a benchmark denominator, for example, setting a target for expenditure on research and development at a level of 3% of GDP.

National accounts are also used to determine EU resources, with the basic rules laid down in a Council Decision. The overall amount of own resources needed to finance the EU budget is determined by total expenditure less other revenue, and the maximum size of the own resources is linked to the gross national income of the EU.

As well as being used to determine budgetary contributions within the EU, national accounts data are also used to determine contributions to other international organisations, such as the United Nations (UN). Contributions to the UN budget are based on gross national income along with a variety of adjustments and limits.

Please note that the alignment between the different members leaves room for improvement and one is still a long way away from an excellent and transparent system.

2.3 GDP: Gross Domestic Product

Definition: Total value of products & services produced within the territorial boundary of a country.

The GDP is used to measure the health of economies. But be aware that the GDP does not measure the well-being of society. For example, the GDP does not give information about the environmental impact of growth or sustainability.

The main difference between Gross Domestic Product and Gross National Product (GNP) lies in the fact that the latter can be described as "the total value of goods and services produced by all nationals of a country (whether within or outside the country)". Basically, as with any measurement, it will only start making sense in conjunction with other indicators. It shows only part of the puzzle.

2.3.1 Gross Domestic Product versus maintenance expenditures

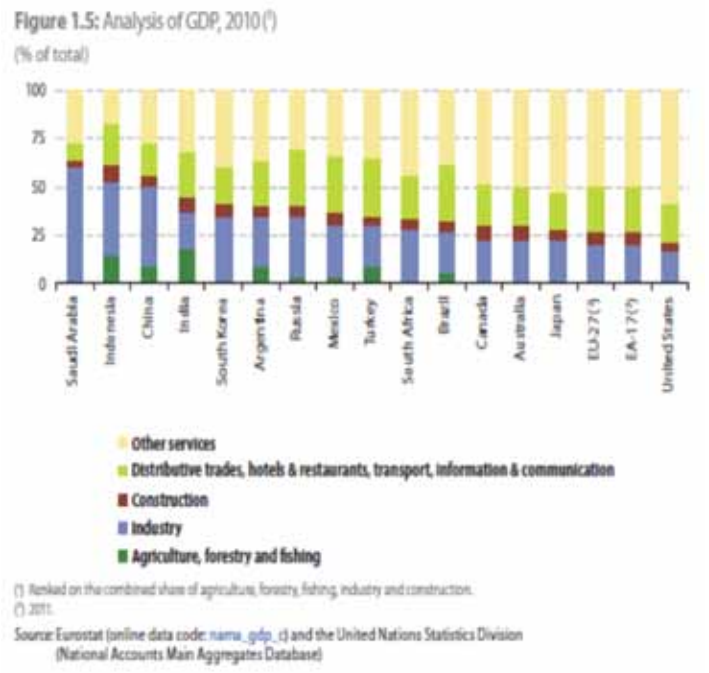
Gross Domestic Product industry spread: Europe versus the world (emerging economies)

When analysing the data with regard to the development and trending of the industrial situation within Europe, there is a clear downward trend in agriculture and industry. This has been compensated by the rise and development of secondary businesses. More specifically, Business Services has been, and still is, growing in that respect. The use of the term, Business Services, is applied here as defined by the European Community and based on the 2014 report.

> *("Business Services involve one firm providing services to another in support of their activities. They range from professional services (such as management consultancy, accountancy and legal services) through technical services (such as design, engineering and architectural services) to operational support services (such as office leasing, labor recruitment and employment, security and industrial cleaning activities)", p.10).*

The MRO market has become more and more incorporated within the field of Business Services. This also includes everything connected with IT and communication. Again, the borders between these broad categories are not at all clearly marked and outlined. As mentioned before: Facility Management and Maintenance Management are included in these figures, but it remains difficult, if not impossible, to extract these from this broader framework.

The MRO market as part of GDP



The first graph gives a partition of the different industries and their percentage of the total GDP. The distribution of “other services” of the GDP for the EU amounts to nearly 50%. These services also include the Business Services and in that sense one observes their mounting importance. This category includes outsourced maintenance services, Facility Management, outsourced IT services, logistics and the like. The MRO market will be situated partially within the industry and partially within the “other services”.

The EU countries have clearly become more focused on the service providing industry than on agriculture, for example.
There is no first-hand data available where a direct link can be made between GDP and maintenance expenditure. This is the case for direct as well as indirect maintenance costs. Neither is there any substantial data available on the share the MRO market (in the largest sense) is accountable for.

Based on the available data at hand, a number of assumptions have been made. These assumptions are supported by a number of studies, notably from WVIS and ConMoto. However, one has to be careful with any extrapolation of these data as there is not sufficient and reliable data available for any conclusive European extrapolation. But as a basis for further study, it can be justified. Nevertheless, the assumption that 4-4.5% of the GDP is linked to maintenance practices in the industry seems to hold ground. Of course as mentioned before, regional and national differences will occur among the Member States of the EU (see further).

As mentioned before, one has to be careful to compare the direct with the indirect maintenance data. As mentioned earlier, there are a number of grey areas that make this comparison difficult (clear-cut definition of the boundaries of Business Services, the fact that a number of companies are themselves providers of maintenance services, etc.).

Abbildung 1: Wirtschaftliche Bedeutung der Instandhaltung

(ConMoto 2011: 8 – 21)

This data is confirmed both by the ConMoto and WVIS studies (2011 and 2012).

Based on these studies, we can make extrapolations for the European situation. If we assume a share of 4% of the GDP is dedicated to maintenance (in the large sense of the definition, so direct as well as indirect), deduction can be made of the data presented hereby. The point of entry here is the GNP, focused on the MRO market, in the strict sense. The overall picture, including Business Services, will be around 10% of the GDP.

Based on the data from the above graph, between 2% and 3% of the active population is employed with the MRO industry in the largest sense of the word (including Business Services and Facility Management).

Maintenance in NW Europe						
Basis: analysis NVDO and Conmoto						
Maintenance cost is ca. 4 - 4,5% of GNP						
		NL	BE	FR	DE	Eurozone
Population		17.000.000	11.200.000	66.000.000	82.000.000	509.000.000
GNP	Mrd €	600	400	2.050	2.700	9.500
Active population	%	74	63	64	73	65
Unemployment (versus active population	%	7	8,4	11	5,2	12,1
Maintenance cost (4-4,5% GNP)	Mrd €	25,5	17	87,125	114,75	403,75
Split: 70% Hrs - 30% material						
Maintenance cost in € (based on hrs)	Mrd €	17,85	11,9	60,9875	80,325	282,625
Hrs/man/year	Hrs	1.380	1.574	1.480	1.400	
cost of 1 FTE in maintenance	Euro*	65.000	65.000	65.000	65.000	65.000
Employees in maintenance	number	274.615	183.077	938.269	1.235.769	4.348.077
real active population	active-unemployed	11.699.400	6.463.269	37.593.600	56.747.280	290.817.150
Fraction of the active population in maintenance		2,350	2,830	2,500	2,180	1,500
* based on a limited number of cases for Belgian and Dutch companies						
with limited extrapolation for the EU						

2.3.2 Evolution of the GDP within the European Union (GDP=Gross Domestic Product)

The figures represented here are from the European Commission (2012). The latest updates can be found in DG Enterprise and Industry, monthly short-term industrial outlook. The overall outlook remains aligned with the figures presented here.

Nominal GDP 2007-2012 (sortable; in billions of USD)							
2012 Rank	**Country**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
—	World	55,827	61,364	57,983	63,468	70,221	71,707
—	European Union	17,001	18,348	16,368	16,288	17,589	16,584
1	Germany	3,329	3,641	3,307	3,312	3,607	3,401
2	France	2,586	2,845	2,627	2,571	2,778	2,609
3	United Kingdom	2,827	2,670	2,193	2,267	2,432	2,441
4	Russia	1,300	1,661	1,223	1,525	1,899	2,022
5	Italy	2,130	2,318	2,117	2,059	2,196	2,014
6	Spain	1,444	1,601	1,460	1,392	1,480	1,352
7	Netherlands	784	875	798	781	838	773
8	Switzerland	451	524	509	551	661	632
9	Sweden	464	487	406	462	539	526
10	Norway	393	454	379	421	491	501
11	Poland	425	529	431	470	514	488
12	Belgium	460	510	475	473	515	485
13	Austria	376	416	385	380	418	399
14	Denmark	311	344	311	313	334	314
15	Finland	246	273	240	237	264	250
16	Greece	306	343	322	295	290	249
17	Portugal	232	253	235	229	238	213
18	Ireland	259	263	225	208	221	210
19	Czech Republic	180	225	197	199	217	196
20	Ukraine	143	180	117	136	163	176

Nominal GDP 2007-2012 (sortable; in billions of USD)							
2012 Rank	Country	2007	2008	2009	2010	2011	2012
21	Romania	170	204	164	165	183	169
22	Hungary	136	154	127	128	139	127
23	Slovakia	75	95	87	87	96	92
24	Belarus	45	61	49	55	60	63
25	Croatia	59	70	62	59	62	57
26	Luxembourg	51	55	50	53	59	57
27	Bulgaria	42	52	49	48	54	51
28	Slovenia	47	55	50	47	50	46
29	Lithuania	39	47	37	37	43	42
30	Serbia	39	48	40	37	43	37
31	Latvia	29	33	26	24	28	28
32	Cyprus	22	25	23	23	25	23
33	Estonia	22	24	19	19	22	22
34	Bosnia and Herzegovina	15	19	17	17	18	17
35	Albania	11	13	12	12	13	13
36	Macedonia	8	10	9	9	11	10
37	Malta	8	9	8	8	9	9
38	Moldova	4	6	5	6	7	7
39	Kosovo	5	6	5	6	6	6
40	Montenegro	4	5	4	4	5	4
41	San Marino	3	3	2	2	2	2

2.3.3 Developments in GDP over the last seven years (2007-2014)

Growth in the EU-27 GDP slowed substantially in 2008 and GDP contracted considerably in 2009 as a result of the global financial and economic crisis. There was a slight recovery in the level of EU-27 GDP in 2011 but this development stopped in 2012. The euro area accounted for 74.5% of this total in 2011, while the sum of the five largest EU Member State economies (Germany, France, the United Kingdom, Italy and Spain) was 71.1%. However, cross-country comparisons should be made with caution as notably exchange rate fluctuations may significantly influence the development of nominal GDP figures for those EU Member States that have not adopted the euro.

Among the EU Member States, real GDP growth varied considerably – both over time and across countries. After a contraction in all of the EU Member States except Poland in 2009, economic growth resumed in 22 countries in 2010, a pattern that was continued in 2011 when real GDP growth was registered in 24 of the EU Member States. The highest growth rates in 2011 were recorded in Estonia (7.6%), Lithuania (5.9%) and Latvia (5.5%). The economies of Slovenia (-0.2%) and Portugal (-1.7%) contracted in 2011 – while the recession in Greece deepened, as GDP contracted for the fourth consecutive year (-6.9% in 2011).

The effects of the financial and economic crisis lowered the overall performance of the EU Member State economies when analysed over the whole of the last decade. The average annual growth rates of the EU-27 and the euro area between 2002 and 2011 were 1.4% and 1.2% respectively. The highest growth, by this measure, was recorded for Slovakia and Lithuania (both 4.7% per annum), and followed by Latvia (4.2%), Estonia (4.1%), Romania and Poland (both 4.0%). By contrast, the lowest growth rates for the development of real GDP during the period from 2002 to 2011 were recorded in Italy and Portugal (0.4% per annum) as well as Denmark (0.6%).

2.3.4 Main GDP clusters

Despite a decline of 2.0 percentage points between 2001 and 2011, industry (19.5%) remained the largest activity (at this level of detail) in 2011, followed closely by distributive trades, transport, accommodation and food services (19.4%), and public administration, education and health (19.1%); the share of the latter was 1.3 percentage points greater than in 2001. The next largest activities in 2011 were real estate activities (10.3%), followed by professional, scientific, technical, administrative and support services (hereafter, Business Services) (10.0%), construction (6.3%), financial and insurance services (5.7%) and information and communication services (4.5%). The smallest contributions came from entertainment and other services (3.5%) and agriculture, forestry and fishing (1.7%).

Services contributed 72.5% of the EU-27's total gross value added in 2011 compared to 70.2% in 2001. The relative importance of services was particularly high in Cyprus, Malta, France (2010 data), Greece, Belgium, Denmark and the United Kingdom where they accounted for more than three-quarters of the total value added. Structural change is, at least in part, a result of phenomena such as technological change, developments in relative prices, outsourcing and globalisation, often resulting in manufacturing activities being moved to lower labour-cost regions, both within and outside the EU.

Four activities were particularly affected by the financial and economic crisis: industry experienced the deepest contraction, value added falling overall by 13.8% (in volume terms) between 2007 and 2009; construction experienced the longest contraction, with its output falling by 10.4% between 2007 and 2010; business services as well as distributive trades, transport, accommodation and food services experienced just one year of falling value added between 2008 and 2009, but the declines were substantial, -7.3% and -5.7% respectively. Smaller reductions in value added were experienced for other activities during the crisis, most notably in 2009 and 2010 for agriculture, forestry and fishing, and in 2010 and 2011 for financial and insurance services.

2.3.5 GDP and investments

Among the EU Member States, there was a wide variation in the overall investment intensity (public and private combined) and this may, in part, reflect the different stages of economic development as well as growth dynamics over recent years.

In 2011, gross fixed capital formation (total investment) as a share of GDP was 18.5% in the EU-27 and 19.2% in the euro area. It was highest in Romania (22.7%), the Czech Republic (23.9%) and Slovakia (22.4%) and lowest in Ireland (10.1%), Greece (14.0%) and the United Kingdom (14.2%). The vast majority of investment was made by the private sector: In 2011, private sector investment accounted for 16.1% of the EU-27's GDP, whereas the equivalent figure for public sector investment was 2.5%. With 5.7% and 5.2%, public investment was highest in Poland and Romania, while private investment was highest in Austria (20.3%).

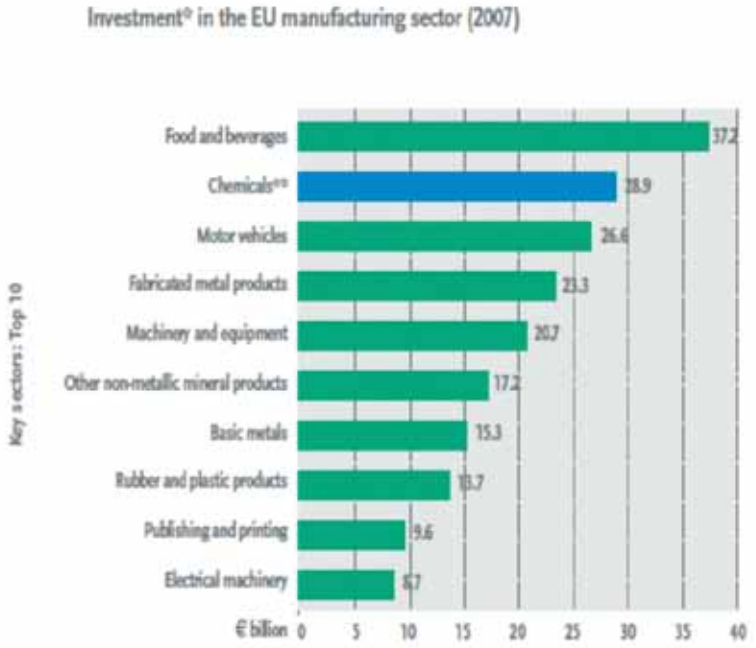
An analysis of GDP within the EU-27 from the income side shows that the distribution between the production factors of income resulting from the production process was dominated by the compensation of employees which accounted for 49.1% of GDP in 2011. The share of gross operating surplus and mixed income was 39.0% of GDP, while that for taxes on production and imports less subsidies was 11.8%. In 2009, compensation of employees fell by 3.0%, but by 2011 it was 2.2% higher than its corresponding level recorded in 2008. For the gross operating surplus and mixed income, there was already stagnation in 2008, followed by a fall of 8.5% in 2009; by 2011 this income aggregate had returned to a level within 0.6% of its pre-crisis peak (in 2007). The fall in taxes on production and imports less subsidies had already started in 2008 (-2.7%) and accelerated in 2009 (-8.6%); these losses had been recovered by 2011 when this income aggregate stood 1.1% above its previous peak (also 2007).

2.3.6 Complementary data

Economic output can also be analysed by activity: at the most aggregated level of analysis, 10 NACE Rev. 2 headings are identified: agriculture, hunting and fishing; industry; construction; distributive trades, transport, accommodation and food services; information and communication services; financial and insurance services; real estate activities; professional, scientific, technical, administrative and support services; public administration, defense, education, human health and social work; arts, entertainment, recreation, other services and activities of household and extra-territorial organisations and bodies. An analysis of output by activity over time can be facilitated by using a volume measure – in other words, by deflating the value of output to remove the impact of price changes; each activity is deflated individually to reflect the changes in the prices of its associated products.

2.4 Investments and investment climate in Europe versus the rest of the world

Investments, whether direct or indirect, play a significant role in the contribution of the GDP of the different EU Member States. Investment climate is a barometer for the economic growth and importance of the EU Member States. It is also the driving force behind job creation and gives an indication of the trust of investors within the region.



EU chemicals industry – the second leading manufacturing sector in terms of investment (in € billion, 2007)

- Around 2.3 million enterprises were operating in the EU-27 manufacturing sector in 2007, generating together €262.4 billion of gross investment in tangible goods.
- Sectoral data show that the largest three subsectors in 2007, at the NACE division level, were food & beverages; chemicals, including pharmaceuticals; the category motor vehicles. Taken together, they contributed in 2007 to 35.3 per cent of total investment.
- The EU chemicals industry is the second largest contributor in the EU manufacturing sector, accounting for €28.9 billion in investment.
- Gross investment in tangible goods is defined as investment in all tangible goods. Included are new and existing tangible capital goods, whether bought from third parties or produced for own use (i.e. capitalised production of tangible capital goods), having a useful life of more than one year, including non-produced tangible goods such as land. Investments in intangible and financial assets are excluded (Source: European Commission, SBS database).

Sources: Eurostat and Cefic analysis
* Gross investment in tangible goods
** Including pharmaceuticals

Unless specified, chemicals industry excludes pharmaceuticals
Unless specified, EU refers to EU-27

The graph above represents data based on the year 2007 (CEFIC. 2011. Facts and Figures 2011. The European Chemical Industry in a Worldwide Perspective).

In a study from 2012, Ernst and Young have looked at the attractiveness of Belgium for foreign investments and have flagged up a number of issues. On average, every investment project translates into 40 new jobs (on a European level). Only very few Member States do better than this (The Netherlands, Switzerland). The main country of origin for investments is the US and next to it are the neighbouring Member States within the EU.

A number of recommendations are made in this report:

- Focus on the “green economy”
- Stimulate entrepreneurship
- Invest in education and training and support a culture of innovation and creativity
- Give extra support for small and medium companies and high tech industry
- Develop a European model with regard to pension
- Implement measures that encourage labour
- Develop and implement coherent fiscal and tax measures to encourage investments

FDI by country

Ranking by number of projects

Rank	Country	2011	2012	Change	Share (2012)
1	United Kingdom	679	697	2.7%	18.4%
2	Germany	597	624	4.5%	16.4%
3	France	540	471	-12.8%	12.4%
4	Spain	272	274	0.4%	7.2%
5	Belgium	153	169	10.5%	4.5%
6	Netherlands	170	161	-5.3%	4.2%
7	Poland	121	148	22.3%	3.9%
8	Russia	128	128	0.0%	3.4%
9	Ireland	106	123	16.0%	3.2%
10	Turkey	97	95	-2.1%	2.5%
11	Serbia	67	78	16.4%	2.1%
12	Finland	62	75	21.0%	2.0%
13	Czech Republic	66	64	-3.0%	1.7%
14	Switzerland	99	61	-38.4%	1.6%
15	Italy	80	60	-25.0%	1.6%
	Others	669	569	-14.9%	15.0%
	Total	3,907	3,797	-2.8%	100%

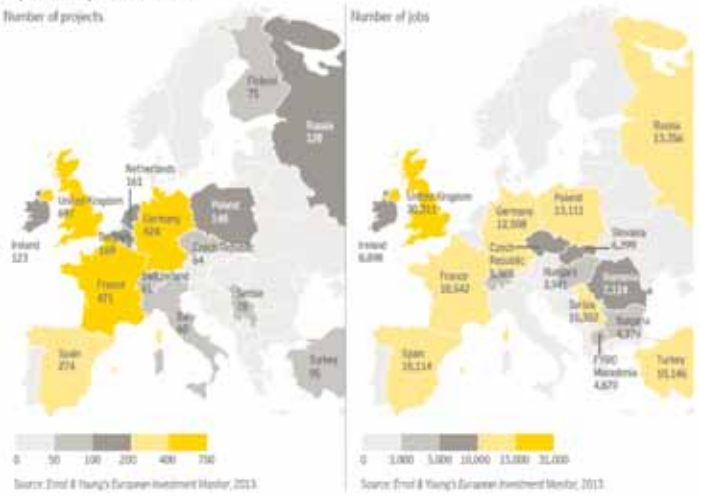
Source: Ernst & Young's European Investment Monitor, 2013

Ranking by jobs created

Rank	Country	2011	2012	Change	Share (2012)
1	United Kingdom	29,888	30,311	1.4%	17.8%
2	Russia	8,362	13,356	59.7%	7.8%
3	Poland	7,898	13,111	67.3%	7.7%
4	Germany	17,276	12,508	-27.6%	7.3%
5	France	13,164	10,542	-19.9%	6.2%
6	Serbia	13,479	10,302	-23.6%	6.0%
7	Turkey	7,295	10,146	39.1%	6.0%
8	Spain	9,205	10,114	9.9%	5.9%
9	Ireland	5,373	8,898	65.6%	5.2%
10	Romania	5,985	7,114	18.9%	4.2%
11	Slovakia	4,007	6,299	57.2%	3.7%
12	Czech Republic	5,168	5,508	6.6%	3.2%
13	FYRO Macedonia	3,040	4,670	53.6%	2.7%
14	Bulgaria	2,680	4,379	63.4%	2.6%
15	Hungary	5,237	3,941	-24.7%	2.3%
	Others	19,834	19,235	-3.0%	11.3%
Total		157,831	170,454	8.0%	100%

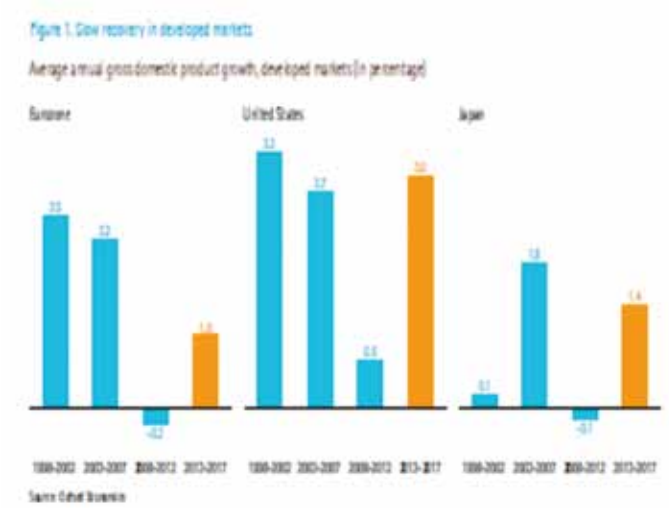
Source: Ernst & Young's European Investment Monitor, 2013

Top 15 European countries



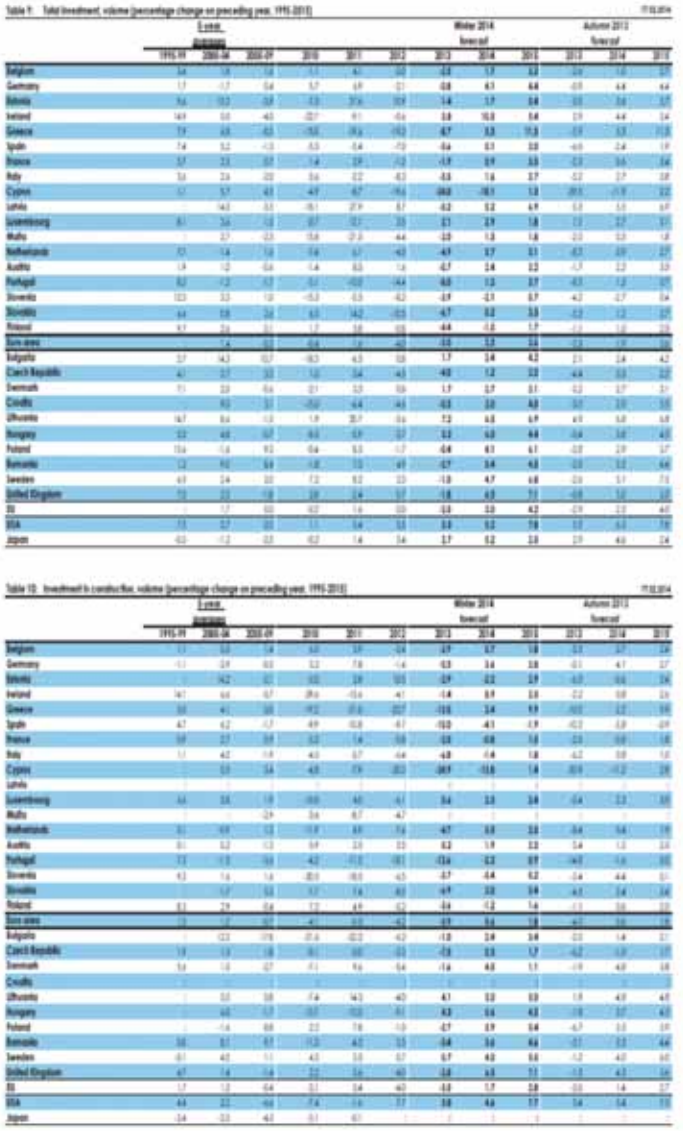
(E&Y. 2013. Europe 2013. Coping with the crisis, the European way. Pp. 14-20)

An increase in FDI may be associated with improved economic growth due to the influx of capital and increased tax revenues for the host country. Host countries often try to channel FDI investment into new infrastructure and other projects to boost development. Greater competition from new companies can lead to productivity gains and greater efficiency in the host country and it has been suggested that the application of a foreign entity's policies to a domestic subsidiary may improve corporate governance standards. Furthermore, foreign investment can result in the transfer of soft skills through training and job creation, the availability of more advanced technology for the domestic market and access to research and development resources.



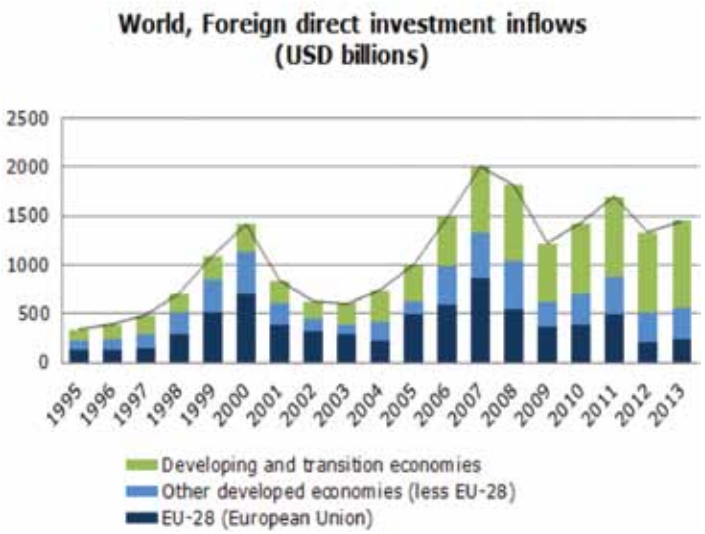
Accenture. 2013. Energizing Global Growth. Understanding the Changing Consumer.

From the annual domestic growth product, there is a similar trend emerging. There is a more optimistic feeling in the market and nearly all studies show a slight progress. However, this has to be confirmed by facts as we go along; nevertheless, there are some indicators that are progressing towards green areas in the cockpit indicators.



European Commission. 2014. European Economic Forecast. Winter 2014. Pp.138.

With regard to investments, one witnesses a recovery (or at least a predicted recovery). It seems that most European countries will pick up again with investment levels as witnessed at the beginning of the century. The recovery period has been much longer than originally estimated by most economic institutions. Even then this will be a slow process which will take several years to materialise.



Foreign direct investment (FDI), in new facilities and cross-border mergers and acquisitions, has been an important driver of globalisation.

Despite the growing importance of emerging economies as hosts to foreign-owned firms, the EU remains the largest investor and recipient of FDI.

In 2013, FDI inflows to the EU increased by 14% to USD 246 billion compared to 2012 when an exceptionally low volume of inflows was registered. Both inflows and outflows of foreign direct investment remain significantly below their 2007 peak.

Within the European Union, FDI flows are a crucial element for the consolidation of the Single Market, while investments to and from the rest of the world ensure that the EU is well positioned in world markets and able to profit from worldwide technology flows.

Furthermore, rapid technological progress, particularly in transport and information and communication technologies, increasingly allows firms to separate and reorganise their production processes, locating different parts of their activities around the world according to the advantages they offer. Therefore, FDI is at the core of the international fragmentation of production activities, within global value chains.

Attracting FDI from the rest of the world has become an increasingly important challenge for the EU since the financial crisis. Therefore, policies aim to make the EU more attractive by:

- extending and deepening the single market;
- ensuring open and competitive markets inside and outside Europe;
- improving European and national regulation; and
- expanding and upgrading Europe's infrastructure and scientific base.

2.5 Employment

2.5.1. Introduction

The EU currently faces huge problems with regard to employment and linked with unemployment. The economic crisis has divided Europe not only between the different Member States, but has also created a shift in development between different industries. Employment rates have dropped dramatically.

2.5.2. Sectorial differences and industrial clustering

The European integration process is constantly deepening. In the 90s of the last century, the project of the internal market was completed and then Member States started to implement the provisions of a monetary union.

Coordination proceeds also in terms of fiscal, structural and, to some extent, social policies. Nevertheless, the European Union is quite heterogeneous as a whole. Individual economies are different both in absolute and relative economic indicators; the economic and social disparities of the member base are even more marked after the recently realised enlargement of the original 15 by the 12 new Member States. It is not surprising that the economic level of the European Union differs not only across Member States, but also across regions. The crucial part of the economic activities of the EU is still quite heavily concentrated in certain areas, both in terms of geography and sector. Nearly half of the GDP is produced in the most advanced regions of North-Western Europe where slightly less than a third of the Union's population lives.

Sectorial concentration reaches a relatively high level. According to current data of the European Cluster Observatory, more than 2,000 different industry-concentrated clusters operate within the European Union. The goal of this study is to clear up the current trends of regional differentiation and agglomeration (regional clusters) of the European Union.

Regional cluster	Employment	Stars
Automotive		
Stuttgart, DE	136 353	***
Piedmont (Turin), IT	85 915	***
Upper Bavaria (Munich), DE	82 339	***
Brunswick, DE	79 997	***
Catalonia (Barcelona), ES	74 086	*
Île de France (Paris), FR	61 351	*
Lombardy (Milan), IT	51 631	*
Flemish Region, BE	46 084	*
West Sweden (Gothenburg), SE	42 832	***
Karlsruhe, DE	40 694	***
Chemical		
Rhineland-Palatinate (Mainz), DE	40 075	***
Lombardy (Milan), IT	33 528	*
Catalonia (Barcelona), ES	30 645	*
Düsseldorf, DE	25 248	**
Flemish Region, BE	21 937	**
Rhône-Alpes (Lyon), FR	20 361	**
Darmstadt (Frankfurt am Main), DE	16 250	**
Köln, DE	15 928	**

Southern Netherlands (Maastricht), NL	14 946	*
West-Netherlands, NL	14 825	*
Biopharma		
Île de France (Paris), FR	47 493	**
Lazio (Rome), IT	21 990	**
Darmstadt, DE	16 459	**
Central Hungary HU	14 197	**
Centre (Orléans), FR	13 960	**
Karlsruhe, DE	13 207	**
Mazowieckie (Warsaw), PL	11 522	**
Berlin, DE	10 350	**
Stockholm, SE	10 325	**
Tübingen, DE	9 650	**
Textile		
Lombardy (Milan), IT	91 468	**
Catalonia (Barcelona), ES	52 885	*
North (Porto), PT	51 205	***
Northeast (Iasi), RO	45 786	***
Centre (Brasov), RO	38 378	***
Piedmont (Turin), IT	35 914	**
Veneto (Venice), IT	32 153	*
Flemish Region, BE	31 583	*
Tuscany (Florence), IT	29 943	**
Valencia, ES	27 376	*

(Source: European Cluster Observatory on-line http://www.clusterobservatory.eu/index.php?country_ID)

The largest clusters of MRO and Business Services providers are also found mainly in the so-called Pentagon's most advanced regions of the European Union, which include mainly the regions of northern Italy, western Germany, Benelux, northeastern France, Austria and Great Britain. High employment in the tourism cluster is evident mainly in the areas of the Mediterranean countries (Italy, Spain, Greece, Portugal, Cyprus and Malta) and also in large conurbations (London, Paris, Amsterdam, etc.). Significant knowledge-based clusters are found mainly in the regions of Great Britain, Scandinavian countries and in developed areas of Western European countries.

Industrial agglomerations with the highest number of employees occur in the automotive, pharmaceutical, chemical and clothing industries. Agglomeration of the automotive industry are mainly in German regions, northern Italy, northern Spain, western Austria, western France, southern England and southern Sweden. Many automotive clusters formed in the 90s also served in the new EU Member States, in western and central Hungary, in the west of the Slovak Republic and particularly in the Northeast region and Central Bohemia, the Czech Republic. The largest number of clusters in the chemical industry operate in Belgium, the Netherlands and Germany.

The concentration of biotechnology and pharmaceutical industries is typical for France, Germany, Denmark, Italy, northern and central regions, and major cities in Sweden, Poland and Hungary. Although the sectors of clothing and textile industry are not in the contingent of dynamic sectors, they show a relatively large concentration of employment in the cluster. The largest of them are located in regions of Southern Europe (mainly Portugal, Italy, Bulgaria, Romania and Spain) and in Poland and the Baltic countries.

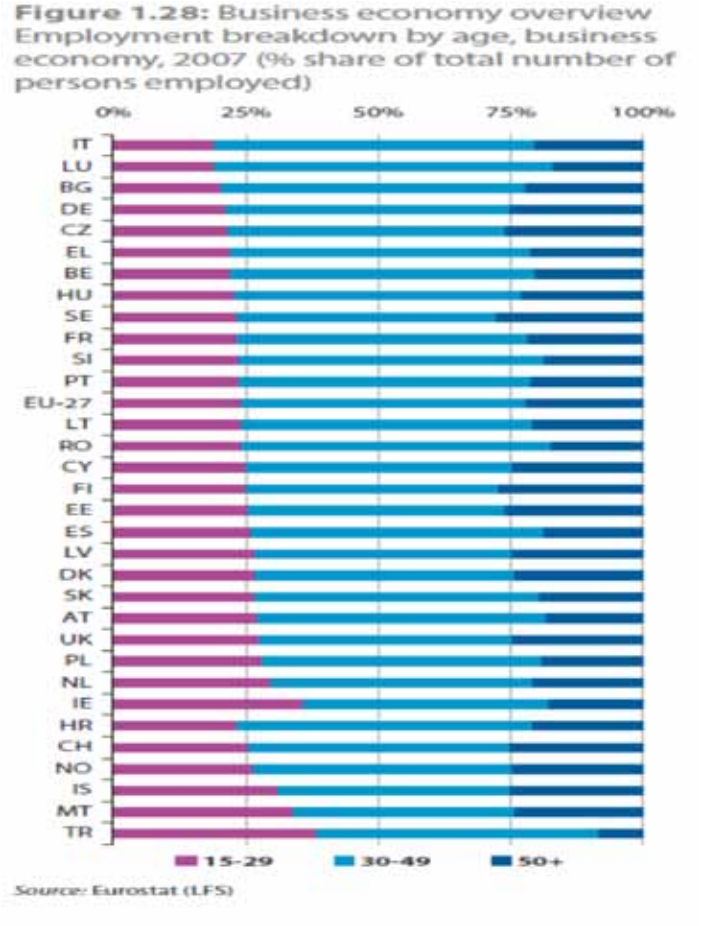
Table 5.1 Employment by occupation in the other services sector (NACE 90+91+93+95), 2006 (in million)

	Total	Managers	Religious professionals	Professionals, technicians	Clerks	Other personal service workers	Other service workers	Skilled agricultural and fishery workers	Craft and related trade workers	Motor vehicle drivers, mobile plant operators	Other plant and machine operatives	Domestic helpers, cleaners, launderers	Other elementary occupations
EU	14.0	0.7	0.4	2.0	1.0	3.0	1.0	0.3	0.5	0.5	0.4	3.1	1.2
EU6	7.7	0.3	0.2	1.3	0.6	1.6	0.5	0.1	0.3	0.2	0.2	1.6	0.6
EU9	5.0	0.3	0.1	0.5	0.3	1.0	0.4	0.2	0.1	0.2	0.1	1.4	0.4
EU15	12.6	0.6	0.3	1.8	0.9	2.5	1.0	0.3	0.4	0.4	0.3	3.3	0.9
NMS	1.4	0.1	0.1	0.2	0.1	0.4	0.1	0.0	0.1	0.1	0.0	0.1	0.2
Belgium	*0.2*	*0.0*	*0.0*	*0.0*	*0.0*	*0.1*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
Germany	*2.8*	*0.1*	*0.1*	*0.7*	*0.3*	*0.6*	*0.2*	*0.0*	*0.1*	*0.1*	*0.1*	*0.3*	*0.2*
France	*1.5*	*0.1*	*0.0*	*0.2*	*0.1*	*0.2*	*0.1*	*0.0*	*0.1*	*0.0*	*0.0*	*0.5*	*0.1*
Italy	*2.4*	*0.1*	*0.0*	*0.2*	*0.1*	*0.5*	*0.2*	*0.0*	*0.1*	*0.1*	*0.1*	*0.8*	*0.3*
Luxemb.	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
Netherl.	*0.6*	*0.0*	*0.0*	*0.1*	*0.1*	*0.2*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
Denmark	*0.2*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
Ireland	*0.1*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
Greece	*0.3*	*0.0*	*0.0*	*0.0*	*0.0*	*0.1*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.1*	*0.0*
Spain	*1.8*	*0.0*	*0.0*	*0.1*	*0.1*	*0.3*	*0.2*	*0.0*	*0.0*	*0.0*	*0.0*	*0.9*	*0.1*
Austria	*0.2*	*0.0*	*0.0*	*0.0*	*0.0*	*0.1*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
Portugal	*0.3*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.2*	*0.0*
Finland	*0.1*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
Sweden	*0.3*	*0.0*	*0.0*	*0.1*	*0.0*	*0.1*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
UK	*1.7*	*0.2*	*0.1*	*0.2*	*0.2*	*0.4*	*0.1*	*0.1*	*0.0*	*0.1*	*0.0*	*0.2*	*0.1*
Bulgaria	*0.1*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.1*
Czech Rep.	*0.2*	*0.0*	*0.0*	*0.0*	*0.0*	*0.1*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
Estonia	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
Cyprus	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
Latvia	*0.1*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
Lithuania	*0.1*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
Hungary	*0.2*	*0.0*	*0.0*	*0.0*	*0.0*	*0.1*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
Malta	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
Poland	*0.4*	*0.0*	*0.0*	*0.1*	*0.0*	*0.1*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
Romania	*0.2*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
Slovenia	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
Slovakia	*0.1*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*

Source: Alphametrics/Eurostat/TNO

When looking at Business Services, the lack of coherent and consistent data is obvious. No conclusions can be made on the basis of what is currently available.

2.5.3. Employment breakdown by age and by European country



(Source: European Business: Facts and figures. Eurostat 2009.)

Observation can be made that within most countries of the EU, a quarter of the workforce is situated in the 50+ quadrant. This is the growing tendency within the EU.

The decision for prolongation of the working life age has significant impact on the dispersion of age categories within the total age distribution categories. In the wake of the economic crisis, we see a very substantial rise in youth unemployment. The European economy is creating fewer jobs and at the same time the choice of suitable candidates for any new job has become much larger, giving opportunities to employers to pick more experienced/skilled candidates.

One can assume that this trend will continue to grow over the

coming years and an overall 25% of the employed workforce will be situated in the 50+ margin of the overall age breakdown graph.

Table 1.19: Business economy overview
Employment characteristics, EU-27, 2007 (% share of total number of persons employed)

Chapter		Employees, 2006 (1)	Gender		Time at work		Age		
			Male	Female	Full-time	Part-time	15-29	30-49	50+
	Business economy	:	64.1	35.9	85.7	14.3	24.2	53.9	21.9
1	Non-financial business economy	86.5	64.9	35.1	85.7	14.3	24.3	53.7	21.9
	Industry	94.2	69.9	30.1	92.7	7.3	21.1	56.1	22.8
2	Mining & quarrying	97.9	86.2	13.8	97.3	2.7	12.9	63.2	23.9
3	Food, beverages & tobacco	93.3	57.6	42.4	88.8	11.2	23.9	55.1	21.1
4	Textiles, clothing, leather & footwear	91.7	30.6	69.4	91.8	8.2	18.4	59.9	21.8
5	Wood & paper	90.0	79.0	21.0	94.6	5.4	22.0	56.4	21.6
6	Fuel processing & chemicals	98.8	65.0	35.0	93.2	6.8	17.9	58.9	23.2
7	Rubber & plastics	96.5	71.5	28.5	93.9	6.1	22.6	56.5	20.8
8	Other non-metallic mineral products	93.8	78.1	21.9	94.5	5.5	19.7	57.0	23.3
9	Metals & metal products	92.2	84.5	15.5	94.7	5.3	21.6	53.9	24.5
10	Machinery & equipment	95.6	81.9	18.1	94.8	5.2	20.1	54.7	25.1
11	Electrical machinery & optical equip.	95.0	65.0	35.0	93.3	6.7	23.1	56.3	20.5
12	Transport equipment	98.6	81.5	18.5	96.3	3.7	22.0	56.0	22.0
13	Furniture & other manufacturing	89.1	71.9	28.1	89.9	10.1	22.8	55.8	21.4
14	Network supply of elec., gas & steam	98.8	76.8	23.2	94.5	5.5	15.6	55.4	29.0
15	Recycling & water supply	97.3	78.4	21.6	93.6	6.4	16.4	56.2	27.4
16	Construction	82.2	92.1	7.9	94.3	5.7	25.1	53.6	21.3
	Non-financial services	83.7	55.6	44.4	79.7	20.3	26.0	52.4	21.6
17	Motor trades	82.7	81.9	18.1	90.5	9.5	29.0	50.4	20.6
18	Wholesale trade	86.4	66.6	33.4	89.1	10.9	21.8	56.0	22.2
19	Retail trade & repair	79.7	37.8	62.2	71.1	28.9	31.2	48.8	20.1
20	Accommodation & food services	82.1	44.4	55.6	71.9	28.1	35.7	46.5	17.8
21	Transport and storage	88.0	79.1	20.9	90.9	9.1	17.7	56.7	25.7
22	Media & communications	95.0	60.6	39.4	83.0	17.0	21.5	55.4	23.0
23	Real estate, renting & leasing	72.9	53.0	47.0	79.5	20.5	18.7	51.4	29.8
24	Research & development	100.0	55.4	44.6	86.6	13.4	20.2	54.1	25.6
25	Business services	84.5	55.3	44.7	78.8	21.2	23.4	55.3	21.3
26	Financial & insurance activities	:	48.0	52.0	86.0	14.0	21.4	57.0	21.6

(1) Fuel processing and chemicals and real estate, renting and leasing, 2005; food, beverages and tobacco, excluding tobacco.

Source: Eurostat (SBS, LFS)

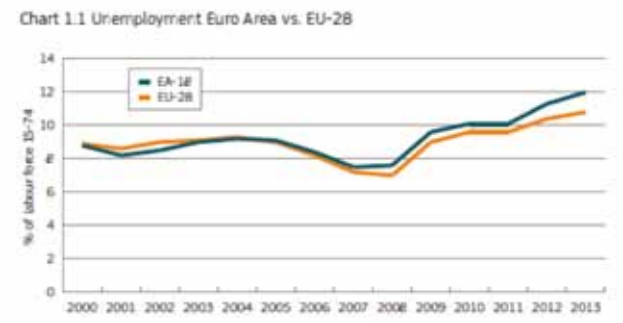
(Source: European Business: facts and figures. Eurostat. 2009)

The sharp rise and development of Business Services is not only linked with a technological leap over the last decade, but is also linked to a high division between full- and part-time work possibilities. Already, Business Services has one of the highest scores of part-time work possibilities within the EU, making it very attractive as a first opportunity or for re-entering the labour market.

The rise in Business Services is also linked to:

- The fact that more companies outsource certain activities. This due to a number of different reasons
- In some sectors, companies cannot afford to hold on to staff only for occasional projects
- The industry cannot find qualified staff, so the share of Business Services increases in certain areas of expertise
- Falling back on specific core business development and execution activities creates opportunities for Business Services
- After unemployment, people find a “relative” easier and better start when joining a Business Services company
- A higher degree in automation is often related to an increasing need for a well educated, well trained and highly skilled maintenance workforce. This know-how has to be bought on the market;

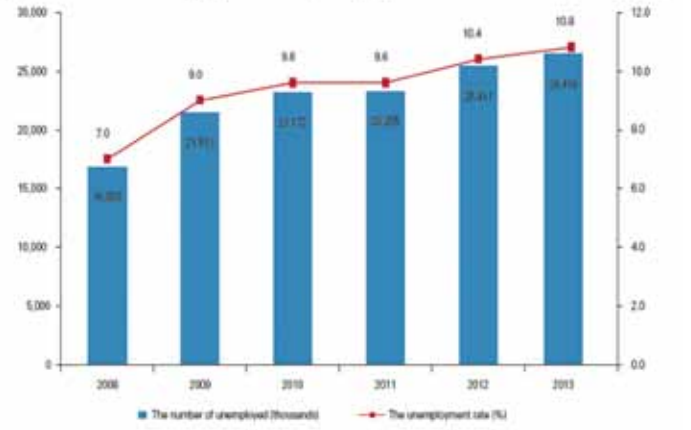
2.5.4 Unemployment rate within the EU



Source: Social Europe Guide: Volume 8: 14-16.

The economic crisis has taken much longer to recover than overall expected and anticipated. Unemployment figures are still on the rise and very alarming figures are produced, especially in the age group below 25 years. This will result in a late entry for this age group into the active working world, thus causing a possible breach between the technology education of the age group under consideration and the actual application of these learned skills into practice. Not being active on the job market could also lead to a loss of skills, a re-direction of skills, or a downgrading of acquired skills (people going to work in sectors where their training and schooling is of little or no relevance). This is directly linked with the next point of the ageing of the workforce and the active lifetime prolongation.

Figure 1.The number of the unemployed and the average unemployment rate in the EU 2008–2013 (according to LFS)



Source: KPMG: A new approach to activating the unemployed: European and international experiences. 2014.

2.5.5 Ageing of the workforce and active life prolongation

Linked with the above cycle of 30 years' lifecycle of an industrial complex is the fact that an overall working life is increasing over this 60-year-period. Where it was still possible to take retirement up till the 90s at the age of 55, now there is an increase in the retirement age to 65, thus prolonging the active lifecycle by 10 years. As will be established later, this will become one of the major challenges not only for the MRO sector, but will also become an overall industrial problem.

In the wake of the economic crisis of 2008, the debate on the active lifetime prolongation is more relevant than ever. Most of the EU Member States are considering an extension of the active working lifecycle period. One has been talking about a prolongation from 60 up to 65 years of age before retirement can be taken up.
This has, of course, multiple consequences. First, there is the problem of the inflow of people leaving school and not finding a place in the active economy. Next, there is the downside of keeping older people employed. This is with regard to the use and implementation of new(er) technology and IT tools. The adaptability of this ageing workforce to new, innovative skills might not be of the same level as the below 30 age group.

Already in the first decade of this millennium, it was pointed out by various governing bodies that along with the age gap, there is a skills gap that needs to be filled. As the age of the working population is going up, the need to create possibilities to keep this workforce interested and bring it up to speed with new technologies is becoming increasingly important. The need of the industry to produce greener and more innovative implies that the technologies used to fulfill these demands are high tech based. That requires a skill set which is not always "off the shelf" available.

We have not been able to find conclusive material that clearly points out and distinguishes these dangers and tendencies (cf. The chapter on Business Services). Moreover, we cannot split up these tendencies and their meaning with regard to industry, business services and asset owners.

In conclusion:

- With the work life prolongation as a "hot" topic across Europe, the work life pyramid has been pushed forward, thus shifting the immediate needs further away by 10 to 15 years. That does not mean, however, that the problem has been solved;
- Study should be done with regard to ageing in the different industries and the implications of regional differences (as already noted by WVIS-Branchenmonitor for Germany);
- The implications of these differences should be mapped and correlated with the activities within Business Services.

3. EUROPEAN INITIATIVES TO COUNTER UNEMPLOYMENT

In the light of the current economic crisis, Europe is developing a number of measures to counter the current situation. As mentioned before, the overall European landscape is blurred by regional differences. Some regions are hit harder than others and not every sector has suffered the same downfall with regard to production and labour losses.

Nevertheless, some general trends are visible within this overall European landscape. As a result of the economic and financial crisis, several measures and recommendations have been formulated. These initiatives are important for the development of a clear policy with regard to the MRO market. What is still lacking is a coherent MRO strategic mission and vision statement incorporating these initiatives with regard to unemployment. Therefore, time will be spent on this topic as it will also feature as one of the main recommendations for the commission with regard to skilling/upskilling of the current MRO workforce population.

3.1 Europe 2020

The EU has developed and proposed the Europe 2020 Strategy in 2010. Without going into too much detail, the three main lines of action are:

- Smart growth – developing an economy based on knowledge and innovation
- Sustainable growth – promoting a more resource efficient, greener and more competitive economy
- Inclusive growth – fostering a high-employment economy delivering economic, social and territorial cohesion

With regard to the employment issues, this means there is a necessity to:

- Boost the job potential of the green economy
- Develop employment in the health care sectors
- Support an increase in highly qualified ICT labour and promote digital skills across the workforce

The relative competitiveness of Europe in the global economy and the current changes have an effect on the labour markets in a number of ways. This is absolutely true as far as the creation and maintenance of jobs are concerned.

3.2 Restoring the dynamics of the labour markets

Doing the right things, at the right time and at the right place will help achieve this, as also encouraging the transition of workers and ensuring that these transitions are of the right quality, so investing in skills in order to create a genuine EU labour market (EU publication: Employment policy beyond the crisis: Social Europe Guide: Volume 8: p. 23).

A number of premises have to be fulfilled in order to leverage their potential fully:

- Contractual arrangements
- Unemployment benefits
- Investment in active labour market policies
- Minimum wages at appropriate levels

3.3 Investing in skills: young potentials

3.3.1 Introduction: Current situation for vocational training in maintenance

"Europe has long faced the problem of mismatches between workers' qualifications and skills and job requirements; the crisis has made this situation worse. According to Eurofound, 39% of the EU employers reported difficulties finding workers with the right skills in 2013. Investing in skills is crucial to overcome these bottlenecks."(cf. Social Europe Guide, Volume 8, p.24).
This quote needs explanation. This would be especially true in the MRO market where, intra-Europe, there is currently no system in operation where certificates, training, courses are matched with each other among the different Member States. Nor is there any initiative yet in place to develop monitoring tools for skills needs. As proposed by the Employment Package, the development and installation of an EU skills panorama with regard to the MRO industry should be high on the priority list. The impact of such monitoring tools would also have a secondary effect on the MRO market and that would be an inventory about the skills status between demand and offer. It would provide knowledge about the market requirements, and the response to these demands. Moreover, it would allow the development of a coherent vision of the European MRO market which is currently lacking.

3.3.2 Improving conditions for young people

With regard to youth unemployment, the European figures are alarming. Some 5.2 million young people are out of work in the European Union. The youth unemployment rate, which stood at 23. 5% in 2013, is over twice as high as that for people of working age in general. A staggering 7.5 million of people aged 15-24 are not in employment, education or training (NEET). One-third of young unemployed have been jobless for more than one year.

It is clear that one of the most important building blocks, according to the European Commission, is the investment in human capital as a force for innovation and economic growth. In its report, "A stronger European industry to contribute to growth and economic recovery" (Brussels 2012), the Commission explicitly mentions that more investments in human capital and expertise will be absolutely necessary in order to guarantee the success of future economies. Not only the creation of new jobs but also a fine tuning of these jobs with the knowledge and knowhow of the youth is necessary. The development of a new skills set for the employee of the future has to be linked with the identified prioritised new economic areas, to know:

- Markets for advanced clean manufacturing technologies
- Development of markets for key technologies (micro- and macro-technologies)
- Development of markets for products on a bio basis
- Sustainable industrial policy and sustainable building, commodities and building products
- Clean vehicles and transport means
- Smart grid development

In order to boost these economic spear point of attention, one of

the accompanying tasks is to ascertain that the needed skillsets, especially for maintenance workers, are in place to support these measures.

As MRO is essential for the competitiveness of the industry, a sustainable policy and investments in workforce are necessary. If the European industry wants to be successful in the long term, it has to be capable to lock into the available human resources and to employ and develop those skills which are necessary to respond to the future challenges of a globalised industrial framework.

4.INNOVATION/TECHNOLOGY

Innovation and the development of innovative technology is not automatically linked with the implementation of these technologies in the MRO market. A striking example in this respect is the implementation of TL light bulbs. As an innovative development, LED lightning was developed many years ago, but it was more than a decade before steps were taken within the MRO world to introduce this type of lighting in working environments.
In the contribution of the European Commission on: “Databases from Socio-Economic Research Projects for Policymaking” (2011), a study is presented on the role of research and innovation in economic growth, competitiveness and employment. In short, four main topics are developed in this study:

1 Investment in research has a positive impact on growth, competitiveness and employment.
2 Europe is lagging behind in the service sector for both the personal and the business services (see also the chapter on Business Services). Business Services are essential inputs to industrial production. They increase value, allow for better specialisation and improve competitiveness.
3 To ensure growth and increase exports, companies must develop innovative components themselves or acquire patents. They have an incentive to work together in networks and closely with innovation centres in order to pool their knowledge.
4 Policies aimed at improving the attractiveness of universities and research centres have an important role to play. In this respect, the development and implementation of an EU skills passport is recommended.

4.1 Transmission of technology and innovation

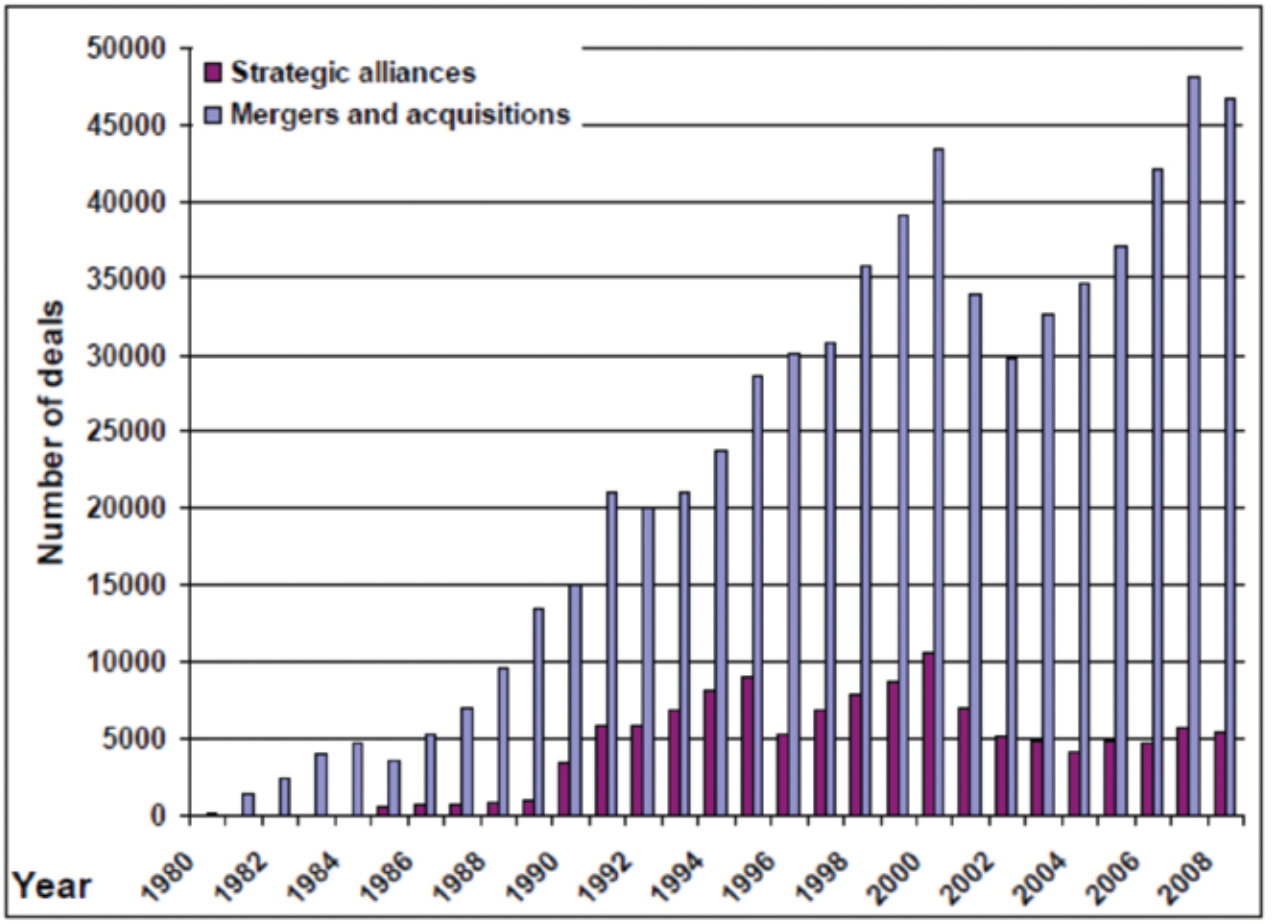
Companies are more frequently using extensive sources of external knowledge. Technological convergence, lower acquisition costs and shorter product lifecycles imply that it may be preferable for companies to acquire innovative technologies from outside than to develop them in-house. This tendency is in line with the findings with regard to the trends in Business Services.

The above graph depicts the transmission of technology through mergers and acquisitions up to 2008. The use of mergers and acquisitions to share and introduce new methodologies and innovative techniques is the most common way for a fast diversification of these techniques into the market place.

4.2 Data analytics and condition monitoring

Increasing automation of processes and the ability to measure and sample the conditions or performance of a machine is generating important information for the MRO business. Analysis of data is a process of inspecting, cleaning, transforming, and modelling data with the goal of discovering useful information, suggesting conclusions, and supporting decision making. Data analysis has multiple facets and approaches, encompassing diverse techniques under a variety of names in different business, science, and social science domains.

Firms may commonly apply analytics to business data, to describe, predict, and improve business performance.



Source: GlobInn Project

Specifically, arenas within analytics include predictive analytics, enterprise decision management, retail analytics, store assortment and stock-keeping unit optimisation, marketing optimisation and marketing mix modelling, web analytics, salesforce sizing and optimisation, price and promotion modelling, predictive science, credit risk analysis, and fraud analytics. Since analytics can require extensive computation (see big data), the algorithms and software used for analytics harness the most current methods in computer science, statistics and mathematics.

5. ECONOMIC ADDED VALUE OF MAINTENANCE/SHIFT IN THE NATURE OF MAINTENANCE

"The equipment will perform better."
"Equipment life will be extended."
"Repair costs will fall."
"Downtime will be reduced."
"Tenant satisfaction will increase."
"The manufacturer says we need to do it."

Much has happened in engineering since the industrial revolution a couple of hundred years ago, but perhaps the most dramatic changes have occurred in the last fifty years. These changes have, of course, affected how industry plants have been maintained.

Prior to the Second World War, machinery was generally quite rugged and relatively slow running; instrumentation and control systems were very basic. The demands of production were not overly severe so that downtime was not usually a critical issue and it was adequate to maintain on a **breakdown** basis. This machinery was inherently reliable. Even today we can see examples of machines made in that period which have worked very hard and are still essentially as good as the day they were made.

From the 1950s with the rebuilding of industry after the war, particularly that of Japan and Germany, there developed a much more competitive marketplace; there was increasing intolerance of downtime. The cost of labour became increasingly significant leading to more and more mechanisation and automation. Machinery was of lighter construction and ran at higher speeds. It wore out more rapidly and was seen as less reliable, perhaps it was too that it was utilised more fully. Production demanded better maintenance which led to the development **of Planned Preventative Maintenance.**

It was recognised that at a level of failure of, say, 10 machines in 100, the probability of failure had become unacceptably high and the full group of machines needed to be overhauled. However, there might be a significant loss in potential life in the remaining group of machines, but in view of the risk, this was considered justified. The planning involved plant overhauls based upon a time interval or usage at which the failure rate of a group of similar machines became unacceptable. This led to the basic assumption that ***the older equipment gets, the more likely it is to fail.***
In the 1960s, with the introduction of the Boeing 747, the aviation industry in its search for improved reliability questioned the then current maintenance strategies and the long established basic assumption that ***the older equipment gets, the more likely it is to fail.***

From the 1980s, plants and systems became increasingly complex, the demands of the competitive marketplace and intolerance of downtime increased, and maintenance costs continued to rise. Along with the demands for greater reliability at a lower cost came new awareness of failure processes, improved management techniques and new technologies to allow an understanding of machine and component health. The study of risk has become very important. Environmental and safety issues have become paramount. New concepts have emerged; condition monitoring, just in time manufacturing, quality standards, expert systems, reliability centred maintenance to name just a few.

Engineering, and maintenance with it, are subject to the whims of **fashion** – "value engineering, hazard and operations studies, project task force teams, World Class, CMMS, CAD, TPM, TQM, and so on". We have seen the development of "**Centres of Excellence**" from such major players as Shell, ICI, DuPont, UKAEA, etc., where reliability specialists were employed to advise, analyse, troubleshoot, etc., and advocate on economic justification for increased expenditure to gain in reliability and availability against pressure of capital expenditure.

There is the thrust towards acceptance of lifecycle costs which recognises that the design & build of a plant must be lumped in with the ongoing maintenance cost and the eventual cost of decommissioning and disposal. Manufacturing and production enterprises are under intense pressure to achieve maximum efficiency. The winners will be seen to be – so we are told – those that maximise their investment in people and equipment assets to achieve the highest profitability.

In the United Kingdom, the mid-90s saw the creation of The Institute of Asset Management. Asset Management is currently receiving the full attention of most organisations with the creation of new departments dedicated to its implementation – no doubt there will be a period of exploration and evolution as it develops and becomes understood. It will provide a means of integrating the many seemingly unrelated parts into a whole that will provide for moving into a cohesive strategic model.

The process of moving Towards Improved Plant Reliability through Precision Skills requires a significant change in attitude and thinking at all levels in the maintenance organisation.
Additionally, there must be an appreciation of the assets within the maintenance organisation that represent significant value:

- good engineering & maintenance experience
- accumulated plant knowledge of the staff
- proven technologies, systems & services

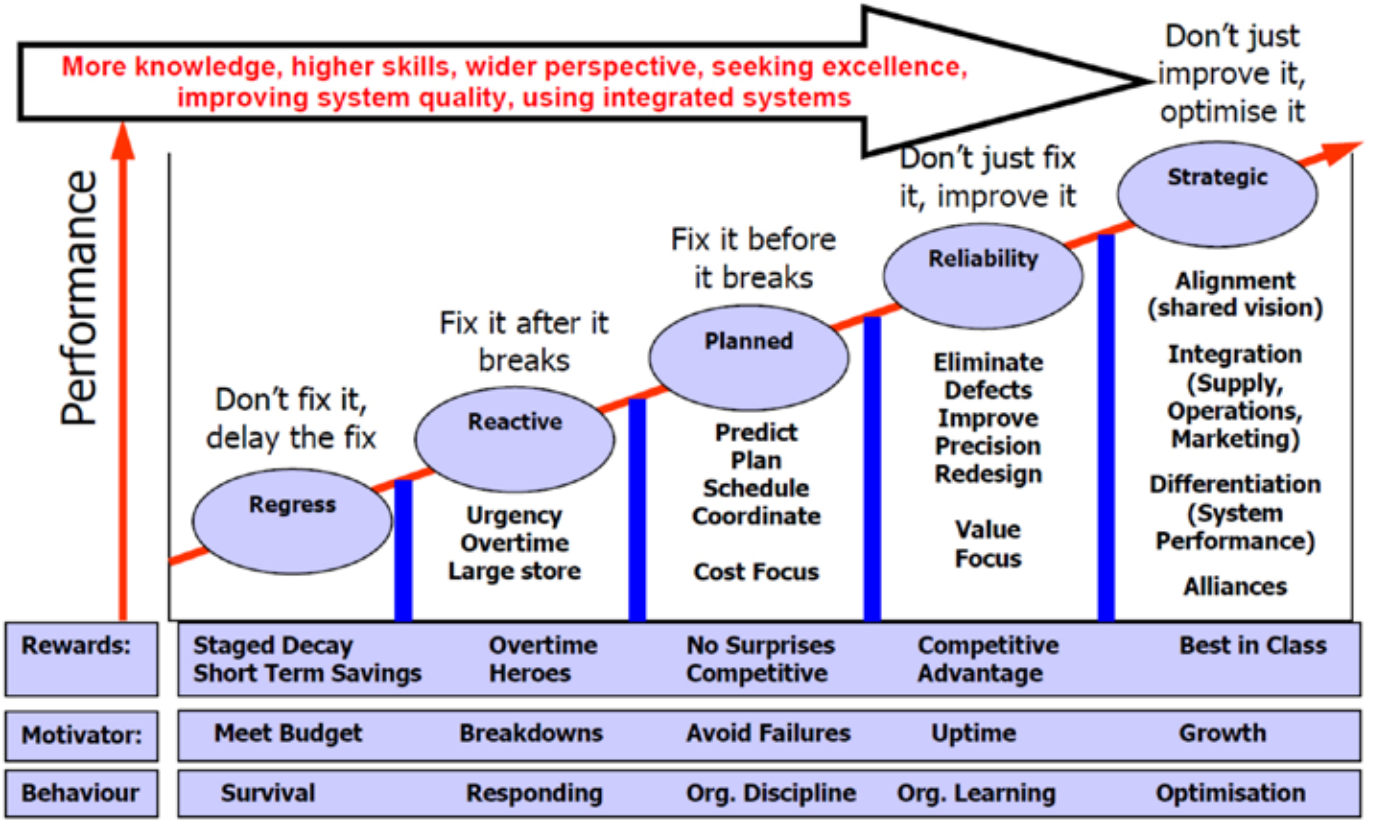


Figure 9 – DuPont Stable Domain Model

6. OVERALL CONCLUSIONS

American saying:
"You cannot make cookies if you haven't got the dough, and you need a tin to put the dough in."

Facts and figures:

- Within the industry (in the EU), 6,000,000 people find work in the MRO industry. When we extrapolate this figure and include Business Services' 35,000,000 FTEs or 7% of the active population, we find they are connected with MRO in a direct or indirect way.
- Financial impact: the direct maintenance costs amount to 450 billion euros with an additional 1,300 billion euros linked to the industry when maintenance is not executed appropriately.
- This implies that for the biggest industrial sectors, 55 million workers are dependent for their production on the maintenance support of 6 million people, representing a total value of 5,000 billion euros.

Together with these conclusions, a number of recommendations are made. These are overall in line with the findings of the working group on Business Services and are supported by them. However, with regard to the MRO market, a number of restrictions have to be taken into account:

- There is an urgent need for transparency and clear-cut definitions with regard to MRO, Business Services and Facility Management. This is not only on a European level, but also within the different member states.
- The definition of a limited number of KPIs is advisable so as to serve as a basis for further investigation with regard to the status and situation of the MRO market within Europe. The challenge will be to arrive at accepted, uniform and unambiguous means of measurement throughout the EU. This to enable comparison of data.

- All investigated contributing factors with regard to MRO and the situation of the MRO market plead for an overall EU-wide approach. It does not make much sense to talk about NW Europe and the rest of Europe. This is based on the findings with regard to the changed nature of the industry (globalisation), ageing, industrial clustering, mobility of workforce and technological innovation within the different industrial sectors.

- With regard to ageing:
  - There is an ageing aspect in relation to the working population. However, with the prolongation of the active life duration, there is no current shortage noticeable in the current situation of the MRO market.
  - The ageing topic could become a stringent problem within 10-15 years if no adequate measures are taken. In this respect, a number of studies, recommendations and projects have been initiated on a European level.

- The internationalisation factor is limited within the Member States. Mobility and flexibility would be geographically restricted

to a limited geographical area. The cost of moving equipment and people could be a limiting factor.

- The current lack of harmonisation of standards within the EU and between EU Member States could prove to be too big a hurdle at this time. It would be desired to draw up a plan mapping out these steps and plan them realistically towards the future. At this point in time, CEN and CENELEC are committed to supporting the development of voluntary standards that would enable business to be more efficient, so as to contribute to improving the quality of services and facilitate the completion of the European Single Market. This would encourage growth within these economic sectors.

- Barriers to growth: Skills shortages and pace of change. Slow internal pace can be a factor that prevents change and innovation from happening. The capability to react with agility and swiftness to changing market requirements creates an advantage for companies since they need to operate at a higher level and detect possible obstacles to realising their objectives.

- The capability to understand and deal with information and information "overload". The surfeit of data available from numerous sources and channels obscures more than it reveals. The art of mastering this data influx enables companies to take better decisions as far as their maintenance and MRO approach is concerned as well as take the decisions with regard to in- and outsourcing in line with their objectives and strategy. In the future, it would be necessary to secure a standardisation in data exchange between the parties concerned (the OEM, asset owner and service provider alike).

- Put in place flexible organisation and organisational capabilities to act on insights. Companies should be versatile enough to experiment with new forms of maintenance (set up pools for spare parts exchange (for example, in the energy sector: turbines and pumps) and sectorial networks to investigate best practices. Putting things into a broader perspective, for example, like creating an Asset Management framework to redirect, refocus and recreate the necessary efforts in order to improve effectiveness and efficiency within companies.

- Focus should be given to hire, train and retain human capabilities as they form the backbone of day-to-day operational and maintenance activities (ageing pyramids between the EU countries, flexibility between European countries) (see also mobility chapter 3.3).

- The use of data and the implementation of analytical tools to be used in order to shorten reaction time, to prevent certain events happening. However, one should be aware of the fact that the collection of data is not an end in itself. When talking about data and data-analysis, one should focus on the collection of the right data. This is also a point of attention for the MRO market. First think and then act. In order to make proper predictions about maintenance (predictive maintenance and condition monitoring), one should be able to understand the failure phenomena and based on those insights, should define the parameters for collection of data. On a broader perspective: data gathering and data interpretation with regard to the MRO market within Europe remains a difficult topic; there is no clear-cut Europe-wide definition with regard to MRO and its related industries in this respect. The data that is available is not always transparent and often leaves room for interpretation.

- Operational excellence: Operational maintenance and production can only exist when they go hand-in-hand so as to achieve overall operational excellence. Operations and maintenance activities will need to strive for one overall goal with a final aim of operational excellence. As such this has a wider scope than the MRO market by itself.

- The decision of in- or outsourcing (Business Services) of certain MRO activities should not be made only on a financial basis, but should also take into account a number of intangible factors, like the MRO capabilities, geographical location, etc.

- With regard to the European region, one aspect will become more and more important. That is the question of how the industry is going to deal with its ageing assets. The development and implementation of methods and structures that will deal with lifecycle management and the prolongation of the life of the current assets is rapidly becoming an urgent topic. Sustainable asset management will become a growing necessity.

- The biggest barrier in mobility of the maintenance technicians is the fact that there is no transparency of the required skills of maintenance workers within the EU. This is due to the fact that a lot of the skills and competencies are acquired through experience in the work field (informal and formal learning). On top of that, employers in certain Member States don't have a clear insight on what a holder of a particular diploma or training certificate is capable of.

- A European Maintenance Skills Passport would partly tackle this lack of transparency. The passport is a type of portfolio owned by an individual that gives information about the acquired and validated skills that the individual has obtained in the field of maintenance. These skills are named to conform to the ESCO nomenclature and described in a uniform way using Learning Outcomes (LOs).

An individual will be allowed to add skills to his/her passport through the following possibilities:

1. Recognition of his/her diploma obtained through formal learning
2. Through an accredited certificate. For example, safety certificates such as VCA (Safety, Health and Environment, Checklist for Contractors) in Belgium and The Netherlands, SCC certificates in Germany (Safety Certificate for Contractors) ('Operating companies' employees' and 'Operating companies' executives')
3. Through another accredited assessment (in-company or in a test center) testing his/her knowledge, skills and competencies obtained through nonformal and informal learning
4. Companies should harmonise their internal and external requirements

7. RECOMMENDATIONS:

The development of a Europe 2020 strategy with regard to maintenance is necessary. At this point in time, there does not appear to be any trace of a coherent EU approach with regard to this topic. One can detect fragments of a vision across the different Member States, with local initiatives. These initiatives are very limited in scope, geographically as well as in content.

There should be the will and the active support within the Commission to support firms to look further than their own boundaries. As a first step, the focus should be directed intra EU. For the next step, attention should be focussed on extra EU territory. This should be included in the EU master plan 2020 on maintenance.

The development and upskilling of the maintenance workforce. At this point in time, there is no transparency between the different approaches and initiatives of the Member States of the European Union. An overall maintenance passport indicating the skills and requirements connected with a certain level of necessary tasks is mandatory. Next to that, a strategy should be developed within the Commission to ensure that whatever initiatives are being developed with regard to skilling and upskilling are in line with future demands and requirements of tomorrow's economic landscape. The skills passport will benefit the individual worker in the following ways (cf. Private correspondence EFNMS):

- Increased mobility: the uniform skills passport will enable him/her to demonstrate his/her skills and competencies to employers all over Europe.
- An individual will be able to demonstrate in a transparent way the full value of his/her diploma in the field of maintenance.
- An individual will be able to continuously upgrade and validate his/her skills and competencies acquired through experience.
- A worker will eliminate potential risks to his/her personal safety by avoiding being assigned tasks he/she is not qualified and trained for.

It will be clear that a further shift in skills towards ICT literacy and proficiency will play a growing role in the future orientation of maintenance and maintenance support. This should also be included in today's educational systems along with continuous attention to upskilling the current workforce.

In order to realise these, there should be a focus on creating the necessary infrastructure in order to guarantee a sustainable and innovative solution. There also needs to be a common interest among Member States so as to share knowledge and to create a common platform.

A coherent and transparent benchmarking exercise should be established EU wide. Not only should a database be constructed containing relevant information with regard to the MRO market, but this tool should also serve to gain knowledge regarding the implementation of innovative methods and approaches concerning MRO.

On a European level, more attention should be given to the development of voluntary market-led standards, based on best practices, taking into account the needs of service-providers and service-users.

Process and data exchange should be encouraged between similar industries on a European level. This should be done taking into account the data quality and content. The question should be asked what data is meaningful and how can this data be interpreted in order to gain a better understanding of processes and process information.

8. BIBLIOGRAPHY/ REFERENCES

- Accenture. 2013. Energizing Global Growth. Understanding the Changing Consumer.
- AFIM. 2013. Conjuncture de la maintenance industrielle. Conjuncture 2012 et perspectives 2013-2014.
- Agoria Vlaanderen. 2006. Skills for the Future. Competentieagenda 2015. De technologische industrie in Vlaanderen.
- Atradius. 2014. Atradius Country Report. Spain. September 2014. Amsterdam. 2014.
- Branchenmonitor. 2012. WVIS. Befragung Industrieservice in Deutschland; Ergebnisbericht. Dusseldorf.
- European Economic and Social Committee. The European ship maintenance, repair and conversion sector; a resilient and competitive industry. 2013.
- European Agency for Safety and Health at Work. Maintenance in agriculture – A safety and health guide. 2011.
- Advisory Council on International Affairs. Wisselwerking tussen actoren in internationale samenwerking. Naar flexibiliteit en vertrouwen. 2013. Brussels.
- Robert E. Hall, Olivier Jean Blanchard, R. Glenn Hubbard. Market Study and macroeconomic tendencies. Nd.
- BEMAS. Major Trends & Innovations in Maintenance and Asset Management. N.d.
- Tom Svantesson. EFNMS Maintenance Benchmarking Committee. “Asset management supported by comparative analysis and benchmarking. N.D.
- Datamonitor. 2009. Strategic Responses in B2B energy markets.
- European Union. 2014. High-Level Group on Business Services. Final Report. EU for Business. Brussels.
- Eurostat. 2008. Industrial Production Indices – Global developments. Brussels.
- Eurostat. 2007. Short-term statistics. Industry, trade and services. European Communities. Brussels.
- Eurostat. 2009. European Business: Facts and figures. European Commission.

- Eurostat. 2012. The EU in the world 2013. A statistical portrait. Brussels. European Union.
- Eurostat. 2013. Key figures on Europe. 2013 digest of the online Eurostat yearbook. Brussels. European Union.
- Eurostat. 2014. The EU in the World 2014. A Statistical Portrait. Brussels. European Union.
- Eurostat. 2014. Eurostat Regional Yearbook 2014. Brussels. European Union.
- Eurostat. 2014. Basic figures on the EU. Third quarter 2014. Brussels. European Union.
- EFFAS/DVFA. 2010. KPIs for ESG. A Guideline for the Integration of ESG into Financial Analysis and Corporate Valuation. Frankfurt am Main.
- Eurofound. 2010. Social dialogue and recession in the automotive industry. European Union.
- Eurosystem. European Central Bank. 2014. Statistics. Pocket Book. Frankfurt. Germany.
- Eurobarometer. 2007. Employment and Industrial Restructuring: Qualitative Study in 16 European Countries. European Commission.
- European Benchmarking Co-operation. 2012. Learning from International Best Practices. Water and Wastewater Benchmark. Rijswijk. The Netherlands.
- Jochumzen, Peter. 2010. Essentials of Macroeconomics. Bookboon.com
- KPMG. 2013. Shipping Insights; Issue 5. Turning risk into advantage.
- KPMG. 2012. Infrastructure 100: World Cities Edition.
- KPMG, Knowledge Management Department. 2009. Chemical Industry in Belgium. Market Intelligence Report.
- KPMG. Knowledge Management Department. 2006. LoB Issues; Consumer Market.
- KPMG. Knowledge Management Department. 2006. LoB Issues; Industrial Market.
- KPMG. 2005. Pharmaceuticals: Pressure Points. Risk Management in the Pharmaceuticals Industry. KPMG International.
- KPMG. 2014. Future State 2030: The Global Megatrends shaping Governments. KPMG International/Mowat.
- KPMG. 2008. Pharmaceuticals: Pressure points. Risk management in the pharmaceuticals industry.
- KPMG. 2014. Future State 2030: The Global Megatrends Shaping Governments. The Mowat Centre. Toronto.
- Kruger, A. 2014. How IT/OT Integration and the Cyber-Physical World is Changing the Way We Do Business. The Asset Journal. Issue 03, September 2014. Volume 8, pp. 9-11.
- Datamonitor. 2009. Strategic Responses in B2B energy markets; how the recession is affecting B2B energy markets and how utilities can respond.
- Coby Frampton. Benchmarking World-Class Maintenance. Charles Brooks Associates, Inc. Not Dated.
- CEFIC-EPCA. A. McKinnon. 2004. Supply Chain Excellence in the European Chemical Industry. Edinburgh.
- CEFIC. 2011. Fact and Figures 2011. The European chemical industry in a worldwide perspective. Brussels.
- Alan Tate. Pragma. Physical Asset Management Benchmarking. Not Dated.
- Will Swan and Emma Kyng. An Introduction to Key Performance Indicators. Centre for Construction Innovation. Not dated.
- OOM. 2012. Business plan OOM 2012-2015. Hazerwoude.
- Nordic Benchmarking Analysis 2001. Analysis on Production Efficiency and Maintenance in Denmark, Finland and Sweden. UTEK, EFNMS, DVV, KPY.

- Wouter Van Driessche. 2014. Modern Minds. Kan uw hoofd de 21ste eeuw aan. Mediafin: de Tijd.
- WVIS. 2013. Branchenmonitor 2013. Düsseldorf.
- Manshanden, W., Rietveld, E., Bouman-Eijs, A. 2009. Investing in the Future of Jobs and Skills. Scenarios, implications and options of future skills and knowledge needs. Data Annex; Other services, Maintenance & Cleaning. European Commission, DG Employment, Social Affairs and Equal Opportunities.
- European Commission. 2011. Databases from Socio-Economic Research Projects for Policymaking. Brussel. EUR24822 EN.
- European Commission. JRC Scientific and Technical Reports. 2011. Summary Report: Analysis of Maintenance Related Events. European Clearinghouse on Operational Experience Feedback. 2011.
- European Commission. 2013. Employment and Social Developments in Europe 2013. Belgium.
- EU Industrial Structure report 2013. Competing in Global Value Chains. EU Industrial Structure Report 2013. 2013. European Commission.
- European Commission. 2014. MEMO. High Level Group on Business Services: frequently asked questions. Spokesperson's Service.
- European Commission. 2014. Employment Policy beyond the crisis. Social Europe Guide. Volume 8. European Union. Publications Office of the European Union.
- European Commission. 2014. Press Release. Business services crucial for keeping Europe's industry fit. Spokesperson's Service. Brussels.
- European Commission. 2014. Investing in people: EU funding for employment and social inclusion. Social Europe guide. Volume 7. European Union. Publications Office of the European Union.
- European Commission. 2014. European Economic Forecast. Winter 2014. Economic and Financial Affairs. Brussels.
- NVDO. 2014. De toekomst van Asset Management met een Europese visie. Amsterdam. Industrielinqs.
- NVDO. 2012. De toekomst van onderhoud binnen de Food, Beverage & Farma-sector in 2020. Amsterdam. Industrielinqs.

AVEBE FACTORY
VEENDAM, NETHERLANDS

The DWM factory (Duintjer, Wilkens, Meihuizen & Co) in Veendam (Netherlands) was established in 1871 for the production of potato-flour and molasses. The firm grew in the following decades into a major employer in the region. The difficult 30s and the Second World War were a challenging survival trip.
The third generation of the family business could not avoid the takeover by the cooperative Avebe in 1963. The new management, headed by R.T. Roelofs, put a lot of effort into the development of new products. Research was crucial and 'efficiency' was the magic word. After further acquisitions within the group, the Veendam production location was no longer a priority in the following decades. In 2009, after nearly 140 years of potato starch manufacturing, the last boiler was shut down.
Avebe is, however, again headquartered in Veendam since 2011 and has production locations in the Netherlands, Germany and Sweden. The cooperative is currently the largest producer of potato starch and starch derivatives in the world.

Text: www.defabriekvanmijnvader.nl and nl.wikipedia.org
Picture: Urbanexploration.nl

POVEL II FACTORY
NORDHORN, GERMANY

In 1872, textile merchant Anton Povel opened the Povel textile company in Nordhorn (Germany). By 1913, Povel already employed 1,000 workers and was praised as the prototype of German industrial techniques. In the 1920s, the demand for textiles thrived. Povel modernised and expanded its factory. By 1927, the company employed 1,600 workers. During the economic miracle years in the 50s and due to the huge accumulated need for clothing, Povel reached its highest employment figures in 1957 with a workforce of 3,000. During the economic recession, which was triggered by the first global oil and energy crisis in 1973, the demand for textiles declined. Prices for synthetic fibres rose, since they were manufactured on the basis of crude oil. Plain cotton products, for example the “Blue Jeans”, underwent a revival. At Povel’s, the unsalable warehouse stocks were piled up to the ceiling. A modernisation of the machinery did not occur. In October 1978, Povel filed for bankruptcy.

The picture is a detail in the Povel II factory, a five storeys high building alongside the Nordhorn-Almelo canal. In this building, the Norgatex textile company operated a yarn spinning mill with 40,000 yarn spindles from 1983 to 2002. The building was dismantled in the spring of 2010.

Text: www.stadtmuseum-nordhorn.de / Picture: Urbanexploration.nl

EUROPEAN MAINTENANCE SKILL PASSPORT

DUTCH INSTITUTE
WORLD CLASS
MAINTENANCE

BY RENÉ STRIJBOSCH

1. INTRODUCTION

The maintenance sector has increasingly become an internationally oriented sector. Especially the work activities planned for shut downs require a large number of employees to perform work activities in a short time. Because the region is not able to provide the necessary numbers, the capacity is sourced far beyond the region and even across the border. During a shutdown, companies will encounter employees from abroad. Because diplomas and certificates are not easily comparable between countries, it is often difficult for the recipient party to assess the competences of the technician applicant. It is also not sufficient for the recipient party to attach diploma and/or certificate requirements to the position because these diplomas and certificates are often not recognised across the border. The need to have a system that describes competences in a transparent manner is increasing for both asset owners as well as service providers as the maintenance sector is becoming more international. SHEQ requirements, evolving technologies and organisational changes increase the required level of knowledge and skills of maintenance workers. Through the mechanisms of outsourcing and contracting we already see some worker mobility in the field of MRO, but due to an increasing shortage of technical talent in a lot of EU member states, we foresee a considerable increase of maintenance worker mobility in the near future.

The biggest barrier is the fact that there is no transparency of the skills maintenance workers. This is due to the fact that a lot of the skills and competences are acquired through experience in the work field (informal and formal learning). On top of that, employers in a certain member state don't have a clear insight in what a holder of a certain diploma or training certificate is capable of.
The objective of the Interreg IV project More4Core is to realise transparency and alignment in countries in Northwestern Europe regarding standardisation, normalisation, regulation and human capital. As such, the project aims to strengthen the maintenance sector in Northwestern Europe and make the industry more competitive due to more efficient and effective maintenance. One of the success markers is having well qualified maintenance technicians. The European maintenance-Competence Framework (m-CF) is a first step in the direction of transparency in maintenance position profiles and competence requirements. The final objective is to create a European Maintenance Skill Passport (EmSP).

2. THE EUROPEAN MAINTENANCE COMPETENCE FRAMEWORK (M-CF)

a. What is the European Maintenance Competence Framework?

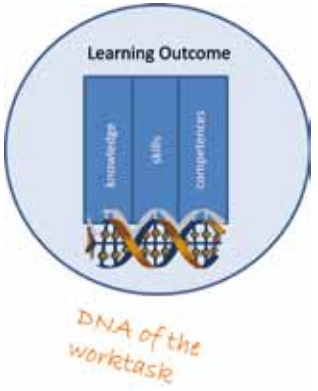
The European m-Competence Framework is a reference framework with competences that are relevant to the maintenance sector. The m-CF can be used by HR managers to describe their position requirements systematically and consistently which makes these easier to translate into the requested position requirements and education programmes for individuals and education and training officers.

b. The structure of the European Maintenance Competence Framework

The European m-CF aims to provide generic and competitive maintenance competences that can be utilised for and adjusted to different maintenance contexts.

The basis for designing the European Maintenance Competence Framework is the Learning Outcome.
A Learning Outcome (LO) is a statement that specifies what knowledge, skills and competences a person is required to have in order to execute a certain task. In the world of education LO's are used to describe what a leaner is able to do as a result of a learning activity. Each profession can be described as a set of work tasks and the corresponding LO's.

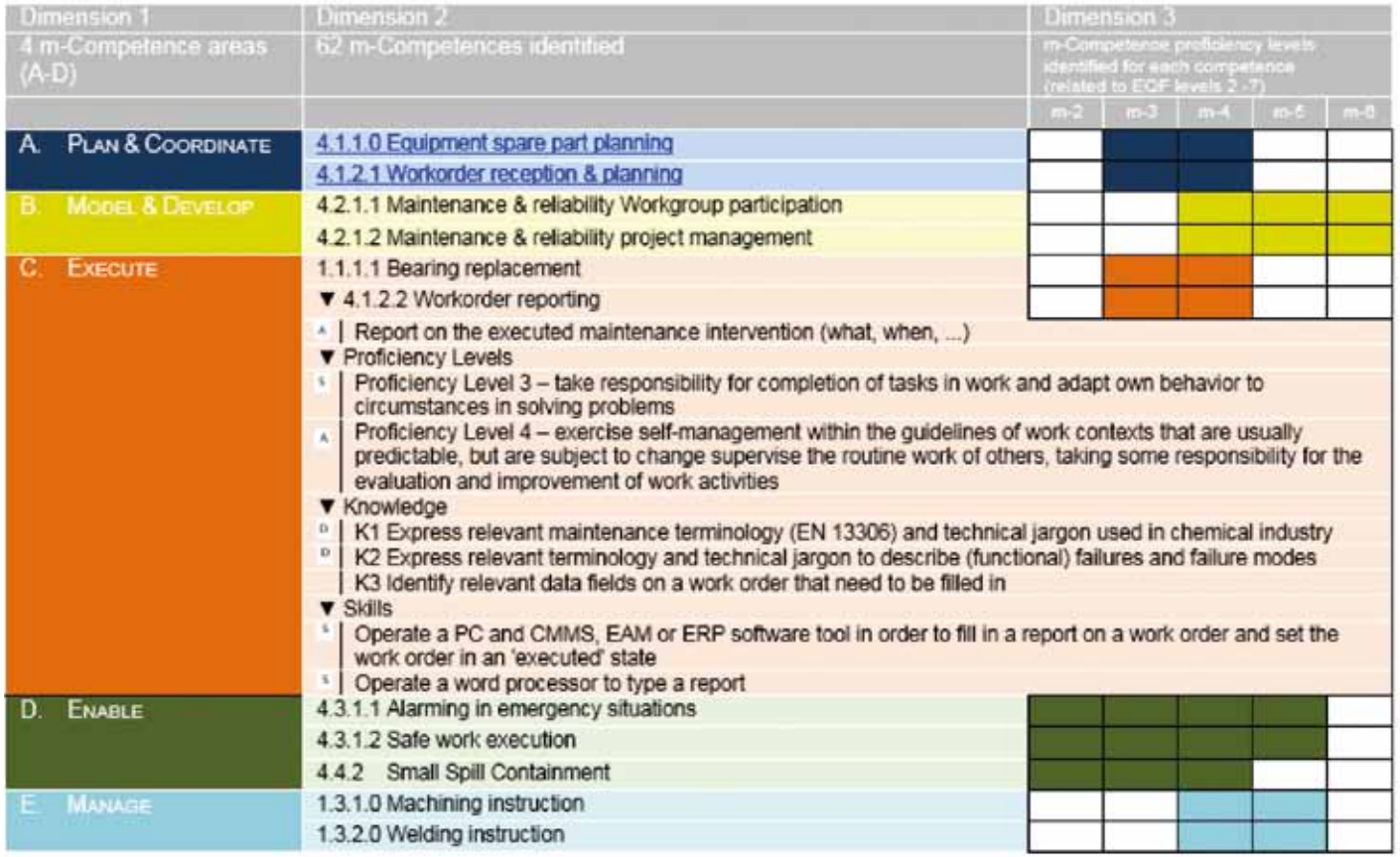
The DNA of the European Maintenance Competence Framework is the set of Learning Outcomes that are applicable in the maintenance sector.



The structure of the m-CF consists of 4 dimensions:
Dimensie 1: the 5 m-Competence areas

- A: Plan & Coordinate
- B: Model & Develop
- C: Execute
- D: Enable
- E: Manage

Dimension 2: a set of m-competences for the different m-competence areas. The m-competences are described generically. In the project More4Core 64 competences are described that relate to the technical positions in the maintenance branch on EQF level 2, 3, 4 and 5. The number of m-competences can, of course, be expanded. In other projects, competences are described that can be included in this system.



Dimension 3: Proficiency levels of each m-competence. The system distinguishes 5 m-competence levels m2 to m6. The levels are differentiated in terms of level of knowledge (simple-complex), skills (simple-complex) and attitude (for instance supervised-independent).

Dimension 4: specification of knowledge and skills that apply to the relevant m-Competence.

As mentioned above, the m-CF is related to the EQF system. However, there is a difference between the m-CF and EQF system. The EQF is a qualification framework for the comparison of qualifications, such as diplomas and certificates. With the EQF system, diplomas of the education systems of European member states can be compared on the basis of the references described in EQF. However, the EQF framework is not a system that can be used for the description of positions prevalent in the maintenance sector, because the EQF

framework is not designed for the description of work tasks but for the comparison of diploma qualifications. However, it is possible to make a comparison between the m-Competence framework and the EQF framework, see the table below:

m-CF level	Related to EQF level
m-2	2
m-3	3
m-4	4
m-5	5
m-6	6

The EQF refers to qualifications, while the m-CF refers to work competences.

3. How to understand and use the European Maintenance Competence Framework

The European Maintenance Competence Framework is a reference framework for maintenance competences and can be used by asset owners, service providers, contractors and employees in the maintenance sector. The m-CF can be used by HR managers to describe their positions systematically and consistently making it easier to translate to the requested position requirements and required education programmes for individuals and education and training programmes. It helps companies to describe their request in a recognised manner. It helps HR managers to effectively recruit employees. It helps the maintenance manager to describe and continually upgrade the position requirements. It helps the employee to take the right steps in the professionalization trajectory, aim at "currency" or at a promotion ambition. The schema below provides a good overview of the possibilities that the EU m-CF offers to both companies as well as individual employees.

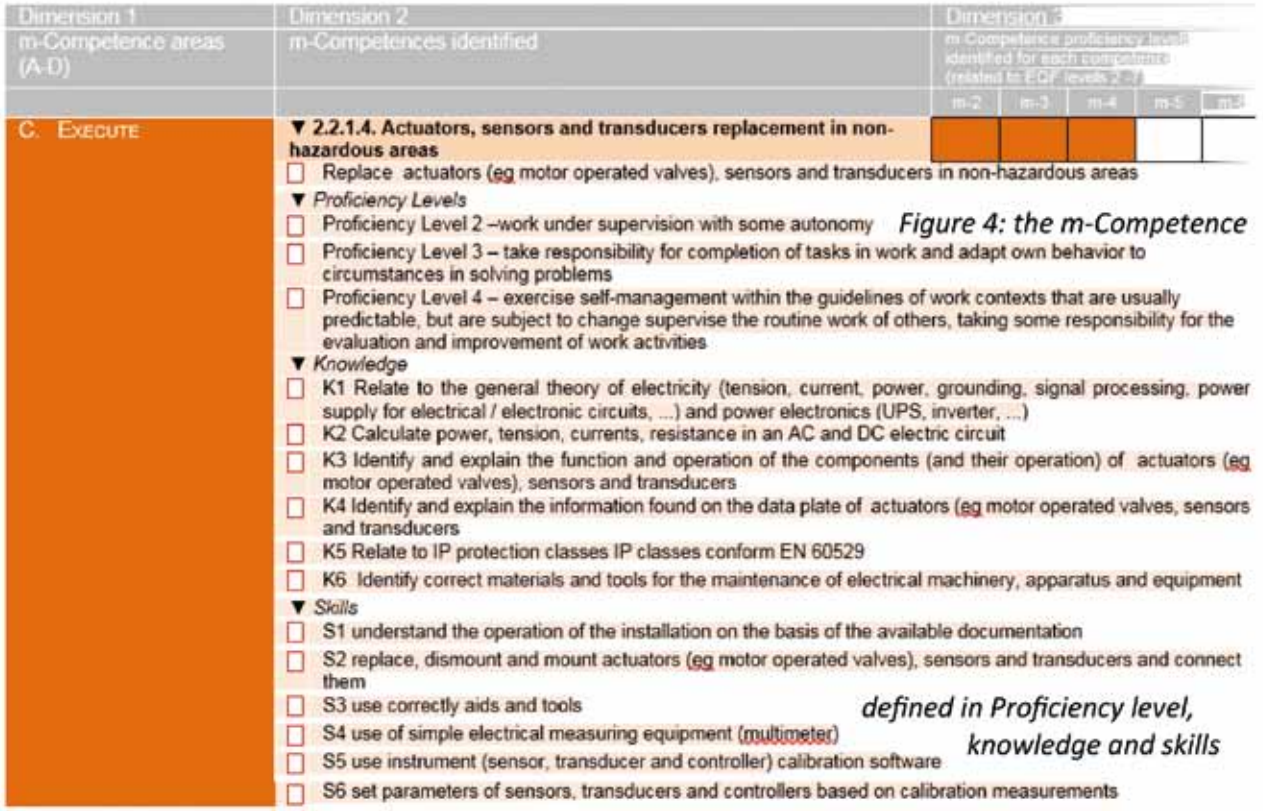
4. The European m-CF as a basis for the European Maintenance Skill Passport

The project More4Core utilised 64 m-competences. For every m-competence, the proficiency level, skills and knowledge are described. The m-competences are derived from work tasks applicable to the maintenance branch. In the project More4Core only the m-competences of the maintenance technician EQF level 2, 3 and 4 are described. The list of m-competences is, therefore, not nearly complete, the m-competences that belong to other work tasks not investigated will have to be developed in the future. To this effect, the same methodology can be used that has been used

and developed here in the ECVET (European Credit System for Vocational Education & Training). The ECVET methodology includes the description of qualifications in terms of learning outcomes (knowledge, skills and attitudes) organised in learning outcome units which may be transferred, validated and accumulated.

To register all the defined m-competences, the register below can be used. The defined m-competence is included in one of the 5 m-Competence areas. As such, a database of m-competences is established for the maintenance sector. In the register, the level of Proficiency on which the m-competence is performed is indicated per m-competence.

For instance: m-competence 2.2.1.4. Actuators, sensors and transducers replacement in non-hazardous areas is included in m-Competence Area Execute and is performed on Proficiency level m-2, m-3 and m-4.



As mentioned, every m-competence is defined regarding the knowledge, skills and Proficiency level.

With the European Maintenance Competence Register described here, it is possible to take a step towards the development of a European Maintenance Skill Passport. The EmSP is registered to the name of the maintenance employee. In the EmSP, the m-competences that the employee masters are registered. This registration occurs on the basis of an acquired diploma or certificate, on the basis of work experience and/or on the basis of an assessment. In the project More4Core, the setup of the EmSP is described and the proposal for the organisation for the maintenance and management of the EmSP. Administration and maintenance are also under the responsibility of the EU maintenance Competence Register.

5. The European Maintenance Skill Passport

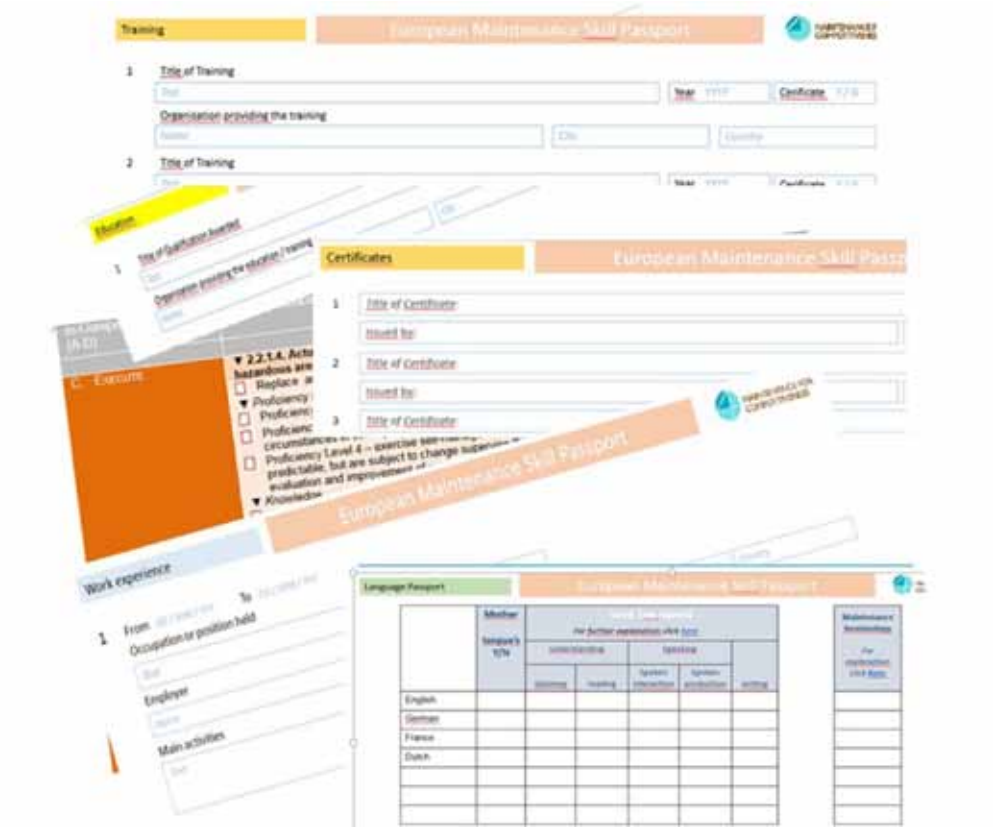
The More4Core project aims to tackle the lack of transparency by developing an European Maintenance Skill Passport. The passport is a type of portfolio, owned by an individual person, that gives information about the acquired and validated skills that this individual has obtained in the field of maintenance. These skills are named conform the ESCO nomenclature and described in a uniform way using Learning Outcomes (LO's).

The EmSP gives the opportunity to register relevant information about the competences and skills of the individual. The available skills and competences can be developed through education programs, through training and work experience. All these routes gives an impression of the skills and competencies of an employee. The mentioned routes, however, are not always familiar to anyone. For example, a degree obtained in Germany giving an inadequate impression for a company in the Netherlands. The same applies to certificates and training.

Basically the same for the work experience. Experience says perhaps more about the "maturity in craftsmanship" than mastering specific skills and competencies. To identify skills, knowledge and competencies transparently Learning Outcomes are used. The Learing Outcome is the DNA of a work process. The employee can select the Learning Outcomes that he/she owns. The evidence of this is demonstrated by a diploma and/or a certificate issued by an authorized (national) institution. The evidence of the Learning Outcomes based on work experience has to be assessed by an accredited body. The organization of the EmSP provides this procedure.

So the structure of the European Maintenance Skill Passport is:
personal data

- the Language Passport
- summary of the diplomes (national qualifications obtained)
- summary of the certificates (specific professional training)
- summary of branch specific certificates (safety certificates, but also driver licenses)
- summary of work experiences
- overview of selected Learning Outcomes



An individual will be allowed to add skills to his/her passport through the following possibilities:

a. recognition of his/her diploma obtained through formal learning
b. through the European Credit system for Vocational Education and Training (ECVET),
c. through an accredited certificate. For example safety certificates as VCA (Veiligheid Gezondheid en Milieu Checklist Aannemers) in Belgium and the Netherlands, SCC-certificates in Germany ('Operativ tätige Mitarbeiter' en 'Operativ tätige Führungskraft)
d. through another accredited assessment (in-company or in a test center) testing his/her knowledge, skills and competences obtained through nonformal and informal learning.

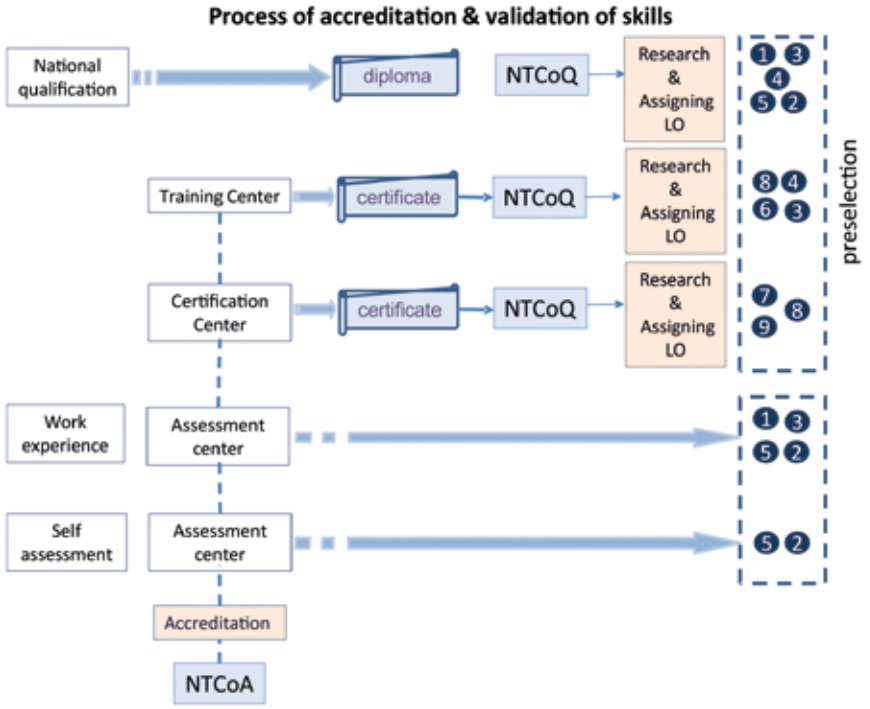
6. Benefits of the European Maintenance Skill Passport

The Skill passport will benefit the individual worker in following ways:

a. Increased mobility: the uniform skill passport will enable him/her to demonstrate his/her skills and competences to employers all over Europe.
b. An individual will be able to demonstrate in a transparent way the full value of his/her diploma in the field of maintenance
c. An individual will be able to continuously upgrade and validate his/her skills and competences acquired through experience
d. A worker will eliminate potential risks to his/her personal safety by avoiding of being assigned tasks

The European Maintenance Skill passport will benefit the company for different arguments:

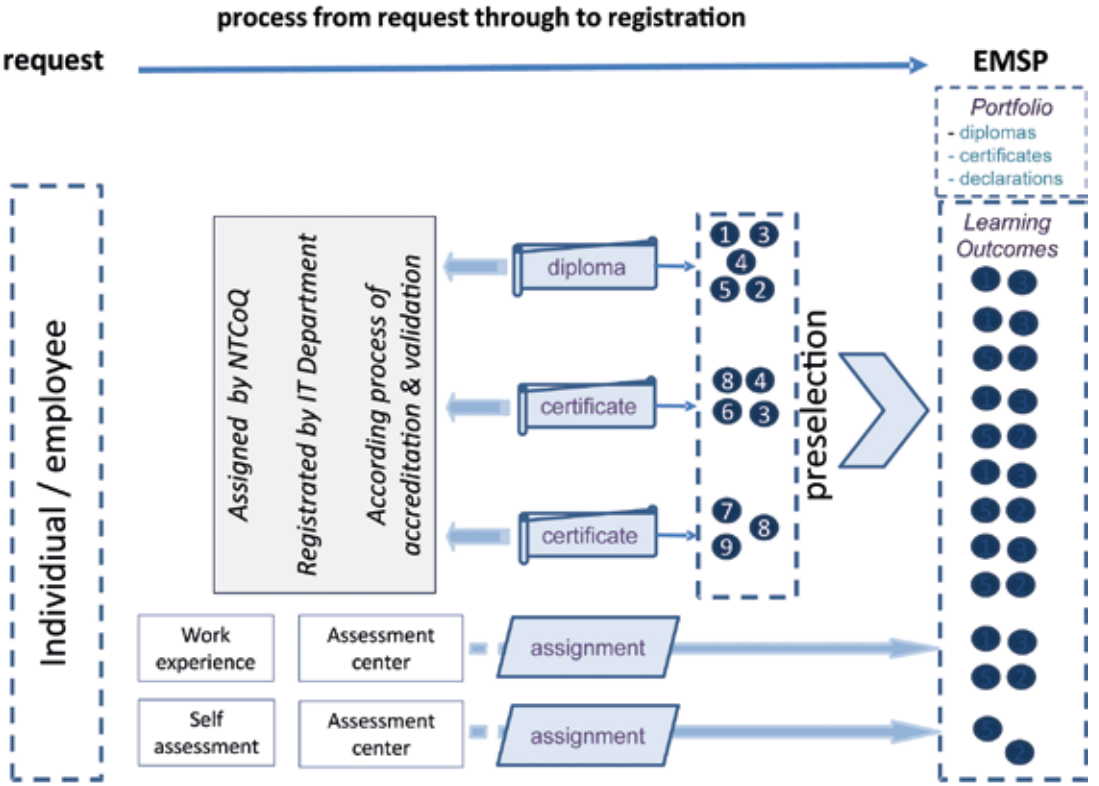
a. The company needs a technician for a specific (group of) tasks. The HR manager and/or Maintenance manager can select persons with the needed skills. The company can search in the EmSP database for available technicians. This is a benefit specially for the asset owner.
b. The “one person company” has a platform to offer his/her services thanks to the EmSP. This is also the case for a company; the company has a platform to offer the services thanks to the EmSP.
c. The possibility to specify exactly in what knowledge, skills and competences a maintenance worker needs to be trained
d. Hire foreign maintenance workers without risks regarding his/her capabilities, thanks to the transparency of well described and assessed LO’s.



7. The procedure of accreditation and validation the EmSP

In the process of accreditation and validation of the European Maintenance Skill Passport the National Technical Committee of Accreditation (NTCoA) and the National Technical Committee of Qualification are the key players.

On national level the NTCoQ will be able to investigate which set of Learning Outcomes applies the national qualification, granted by a



validated diploma. The relation between the qualification and the LO's will be fixed in the EmSP databank. That can be done for all qualifications and certificates of interest, for example certificates issued by training centers, in company training, mandatory certification (safety etc.). Diplomas and certificates are thus preselected. If an person demonstrates his/her diplomas and certificates, the IT system will automatically select the Learning Outcomes for the personal EMSP.

Work experience is also one of the ways to improve the individual competences. The person can demonstrate his/her work experience by

submitting a statement from the employer. This statement will be recorded in the Portfolio part of the personal EmSP. To validate the experience the person has to be assessed by an assessment centre. That can be any assessment centre with an accreditation of the National Technical Committee of Accreditation (NTCoA). After the assessment, the assessment centre is authorized to register the LO's in the personal EmSP. If an employee is convinced to possess learning outcomes, but he/she is not able to demonstrate that by diploma, certificates or a statement from the employer, he/she has to prove it by an assessment in an assessment centre, the same procedure as the procedure used for validation of the work experience. o the process from the request of an individual through to validation and registration of his/her skills in the European Maintenance Skill Passport is shown in the figure above.

8. Some typical cases in using the EmSP

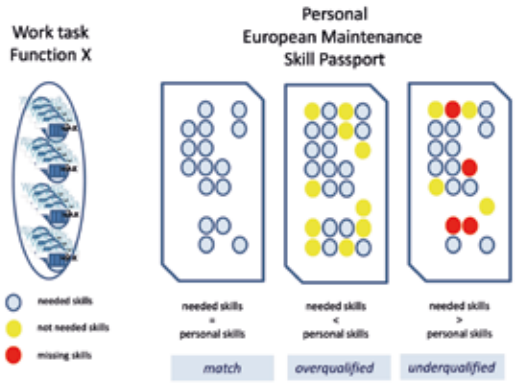
The ownership to fill in the EmSP always lies with the employee. He/she is the owner of the EmSP. After completing the EmSP using the web-based tool, a validation officer should verify the data. The applicant should therefore provide digital evidence:

- in case of (vocational) qualifications: a copy of the diploma
- in case of a training: a copy of the certificate
- When it comes to certificates obtained (eg safety certificates) a statement by the executive body
- When it comes to work experience: a statement of the employer.
- If it concerns Learning Outcomes: a statement from an assessment center.EmSP accredited by the NTCoA

After validation of the data the EmSP of the person is declared valid and EmSP will be available to the owner and other companies. Here are some possible situations outlined:

Case 1:

An MRO service company sends a service technician to execute a maintenance job at an asset owner (customer) . A service technician will make his job competences visible because the client for which he goes to work asks for that. After permission by the technician, the customer can read his EMSP in order to verify if the technician has the competences to execute the job on the customers 'equipment.



Case 2:

A freelance technician wants to use the EmSP to offer themselves for maintenance, in particular work on a shut-down in the chemical industry. He fills the EmSP, complete with the Learning Outcomes. He publishes his EmSP through the EmSP database available for asset owners and service providers. They may consult the EmSP database recruitment of maintenance technicians.

Case 3:

A service technician will continue his career in the company after 15 years in another function. He wants to know whether he is competent enough to make the switch and what skills need to be

developed. To do this research is the technician fills in the EmSP, especially the part with the Learning Outcomes. If the employer has indicated the learning outcomes that are applicable to the function the technician can determine what skills need to be developed.
See figure below.

9. Business case European Maintenance Skill Passport

The roadmap to the full operating European Maintenance Skill Passport has 3 stages:
Stage 1: development of the EmSP into a working application
Stage 2: the EmSP used by early adaptors
Stage 3: the EmSP as a standard for the European maintenance sector.

Stage 1: development of the EmSP.

The development will be done within a European project with funding. The More4Core project present a project proposal and will give recommendations for submitting the best fitting EU program for developing the EmSP application and work structure.
We recommend in addition to the four “maintenance”partners to acquire a IT partner to develop the EmSP application. The EMSP application must be a “21th proof”, innovative and smart.

Stage 2: running the EmSP by the early adaptors

In this stage the EmSP structure must have been installed and functioning on European level as well as national level.
The prognoses for the amount of users that will have a registration in the EMSP is about 15% of the total amount of technicians at the start of the registration.
That means an amount of 15.000 technicians in Germany, 1.500 in Belgium, 2.250 in the Netherlands and 12.000 in France, in total 30.750 technicians in the 4 countries.

Stage 3: the EmSP as a standard for the European maintenance sector

The number of users will increase. Also the number of countries that will participate will increase.
The success of the EmSP is related to the acceptance of the EmSP by the companies.

Of course a sustainable funding scheme will also need to be developed.
Possible sources of income are:

- from the individual user
- from companies and other organisations viewing the passport
- structural EU funding
- structural funding by employers
- start-up funding from EU in the framework of a project
- ...

It’s no doubt a solid business plan with structural and realistic sources of income will be one of the key in the success factors to realize the European Maintenance Skill Passport.

DUMONT-WAUTIER LIME FACTORY
AMAY, BELGIUM

This picture shows the exit of a 150-metre long rotary furnace in Amay, Belgium, built in 1967 by Dumont-Wautier. The Meuse Valley is especially rich in stony materials and limestone. According to parish registers, a lime kiln ran here as early as 1548. By means of calcination, lime is converted into cement in the rotary furnace. Extraction at the quarry in Amay stopped in 2009. Part of the factory is now the museum 'Maîtres du Feu' (Masters of Fire).The company, 'SA Carrière et Fours à Chaux Dumont-Wautier,' is still active, now as part of the Lhoist Group, one of the world's leading producers of lime and dolomite for industrial, agricultural and environmental applications.

Text: www.lesmaitresdufeu-siteofficiel.be / Picture: Ronnie Husson

ANTWERP PETROLEUM SOUTH
BELGIUM

Antwerp Petroleum South was one of the first petroleum ports in Europe. In 1900, 54 hectares of land in the Hoboken polder were expropriated for the construction of new petroleum installations, and use started in 1903. In August 1904, a large fire broke out in the petroleum port, leading to increased fire safety measures. Nevertheless, fires in 1906 and 1918 inflicted heavy blows to the Antwerp oil activity.

In 1920, Petrofina, a precursor of Total, was established. Other companies active in this field included American Petroleum Company (later Esso), Belgian Benzine Company and Continental Petroleum Company. Despite the fact that Antwerp was the most important European petroleum port in the first quarter of the 20th century, its development waned in the 1930s. Today, most activity in the Petroleum South area has disappeared and it has been transformed into the sustainable 'Blue Gate' business park.

Protected relics include a boiler of the Belgian Benzine Company, aboveground pipelines, storage tanks and jetty pier. They are witnesses to the history and development of Antwerp as a petroleum port and contribute to the preservation of the historical identity of the place.

Text: Amsab-ISG and research by Adriaan Linters / Picture: Ronnie Husson
Picture: Urbanexploration.nl

STRATEGIC RESEARCH AGENDA

BY COEN SANDERINK, ROLF BASTIAANSSEN & ELZBIETA KUROWSKA

THE NEED FOR A EUROPEAN STRATEGIC RESEARCH AGENDA ON MAINTENANCE

In industrial sectors, where production assets have a lifetime of several decades, economic competitiveness will for an important part be based on the continuous maintenance and overhaul of assets. New technologies and approaches need to be developed between innovators and researchers. At European level, alignment of emerging national multi-disciplinary innovation programmes is needed. The EFNMS / MORE4CORE SRA is intended to be a first step in identifying the major challenges and opportunities in research for maintenance. It aims to form the basis for the setting objectives and developing an implementation programme, mostly through integration in existing innovation platforms like PPPs or programmes like Horizon2020.

MEGATRENDS

The long-term development of Europe, and the European Manufacturing and Process industries is shaped by structural shifts in political, economical, societal and technological factors, so-called megatrends. Anticipation on these trends will enhance the resilience or growth of these sectors. The following, often interacting, megatrends are considered to be most relevant for Maintenance and Asset Management.

GLOBALISATION & FINANCIAL CRISIS

Europe's witnessed a spectacular industrial growth in the early post-war period, lasting up to the 1990's. Currently, the focus of investments – including in high-tech sectors – is shifting towards Asia. This leads to an ageing European asset base. Still, existing assets are expected to remain in active production for years to come. In North-West Europe, only around 17% of installed assets is expected to be replaced over the coming 10 years (Mainnovation). These assets are under increasing competition from other regions. The economic crisis further reduces attractiveness of new investment, exacerbating this trend. This means a greater focus on Maintenance and Asset management. Asset lifetime needs to be extended, while overhaul or upgrade of existing facilities increasingly is preferred over greenfield developments.

DEMOGRAPHICS

Europe's population is expected to remain stable overall, with the average age reaching 52,3 in 2050, compared to 37,7 now. Zooming in on the region's workforce, in particular in the industrial sector, the workfoce is expected to shrink by 16% by 2050, while over 30% of the technical workforce is expected to flow out in 15 years. A foreseen shortage of skilled labour means a trend towards automation of inspection, maintenance and repair activities.

ICT AND THE INDUSTRIAL RENAISSANCE

ICT has profoundly changed interpersonal communication, both in private as well as business spheres. Over the coming 10-20 years, the next wave of technology development will connect devices, systems and people across domains and applications in what in the industrial environment is labelled ´industry 4.0, ´smart industries´. ICT is recognised as a main driver for the Industrial Renaissance. For maintenance and asset management, potential uses are self-optimization and self-configuration of processes, including machines that predict failures and trigger maintenance processes autonomously.

SUSTAINABILITY

Especially in Europe, there is a strong societal ambition to reduce the environmental impact of human activity, including industrial processes. This includes, among many factors, a reduction in energy consumption and CO2 in processes, focus on recycling or cradle-to-cradle processes.
For Maintenance and Asset management this means on the short-term upgrades of systems with energy-efficient components. On the long term, it could impact maintenance strategies such as asset lifetime extension and remanufacturing. It will require a further increase of awareness and transformation of the production processes into low carbon use and energy efficiency as well as implementing new agile maintenance approach.

Key areas for innovation

The most relevant technology areas for innovation in maintenance and asset management are robotics, ICT, advanced materials. In the manufacturing industry, additive manufacturing could replace individual pieces of manufacturing equipment. ICT in combination with mechatronics allows for continuous monitoring of the condition and performance of the manufacturing system at process, component and machine level. In the Process industry, robots could execute inspection and cleaning tasks in continuous process or areas with high temperatures and remains of hazardous or corrosive materials. Novel materials such as wear-resistant and corrosion- resistant materials can significantly contribute to the extension of durability.

INDUSTRIES & ASSET TYPES

INDUSTRY CATEGORISATION

From an asset management perspective, six main industrial sectors can be defined; Process, Manufacturing, Infrastructure, Buildings, Food and Fleet. This SRA focuses on the first three.

ASSET TYPES

From the maintenance perspective, industrial assets, or technical systems, can be classified in four major groups (Smit, 2011), each requiring its own maintenance approach. Among the static assets, these are decentralised assets such as networks for transport (roads, railway systems, but also pipelines and electricity networks). Centralised structures include a broad range of assets, including major infrastructures like dams to industrial plants and most production assets. A different class are dynamic assets. This includes transportable assets, such as machinery and lighter equipment, and mobile assets, including assets for road, rail, water and air transport.

TECHNOLOGY AREAS

As an integrative business function, Maintenance and Asset management is impacted by advances in many different technology areas. Five technology areas are expected to have the largest contribution to solving challenges in asset management. The research priorities of the Maintenance and Asset Management research agenda will focus on the development, application or integration of these – often related - technologies.

SMART ROBOTICS

Industrial robots have enabled industries to run cost-effective and high quality production due to mitigation of labour costs and great precision. Future developments are expected to enable a wide variety of uses for Asset Management. Preventive maintenance and asset managements requires periodic or continuous inspection of asset status. Inspection robots are expected to enable analysis of large-scale or difficult to access infrastructures, or at higher level of detail than humans can achieve. Use of technical systems in harsh environments needs not only repair, but also cleaning. Robots could support humans in cleaning of assets that are hard to reach (such as pipelines) or dangerous to access (such as chemical plants).

ICT

Information and Communication Technologies – growing complexity of processes and supply networks as well as increasing customer expectations in terms of quality require strong collaboration in the field of remote service management and system intelligence in order to assimilate huge amounts of data and information. That consists of modeling solutions, data mining, open service platforms etc.

ADVANCED MATERIALS

Industrial assets often have an economic life of decades, during which systems are managed to be in near continuous operation, or during which mechanical movements are repeated millions of times. Often, equipment is used under stressful circumstances, such as elevated temperatures or to process corrosive matters. Improved wear and tear of performance of materials could significantly reduce the need to maintenance or replacement. Improvements of materials will play a broader role, in particular through creating multi-functionality, and by incorporating “Life Cyle Thinking” in development and design phases.

MECHATRONICS

Mechatronic systems combine precise mechanical systems with telecommunication and control engineering in order to improve manipulation and control of dynamic (moving) constructions to the required high degree of accuracy. It is closely related to robotics and ICT In industrial environments, the main challenge in mechatronics for maintenance is in integration and optimization for self-diagnosis of machine conditions.

Main recommendations

Beyond the agenda, this SRA calls upon the sector, and in particular the EFNMS to take the following actions;

Create an international cross-disciplinary network on Maintenance R&D Between Europe’s major research groups, only incidental contact, alignment and collaboration takes place. Collaboration in a network would allow for knowledge sharing, development of partnerships, and acceleration of research efforts.

Support the development of Maintenance ´Living Laboratories´ To bridge the gap between basic research and innovation, new instruments for collaboration between asset owners, innovators and researchers is needed. a network of ´Living Laboratories´, where novel technologies can be tested and validated in real operational environments is proposed.

Integrate the Maintenance SRA in the agenda of established EU platforms

To create R&D opportunities on the short term, a deeper collaboration with established European platforms is proposed. In particular the creation of work groups and operational agendas with the PPPs SPARK (Robotics) and SPIRE (chemical/process industry) is proposed.

ELECTRABEL COOLING TOWER
CHARLEROI, BELGIUM

The power plant in Monceau sur Sambre (Belgium), also known as Power Plant IM, was built in 1921 by Intercom (now Electrabel) and was one of the largest in Belgium. It was centralised and expanded in the 50s and 60s and became the main supplier of energy in the region. Originally, this plant was fully coal fired. However, the newer part ran on gas and, for years, was on standby for any emergencies. Under the pressure of CO2 emission reduction, the plant was eventually closed in 2007. At the end of 2013, the Suisse journal, “La Tribune de Genève”, named the power plant of Monceau sur Sambre one of the 40 most beautiful forgotten places in the world.

Text: www.urbanexploration.nl / Picture: Ronnie Husson

WILHELMSTAHL
HALLERBACH, GERMANY

The former Wilhelmstahl factory lies west of the city on Hallerbach (Germany). From 1856, the site developed into a weaving and cloth factory. In 1866, the first five steam boilers and two steam engines were installed. In 1898, the factory was transformed into a factory for cardboard tickets and wallpaper. The factory equipment included a 650 horsepower tandem steam engine from the company MAN for driving the paper machine. In 1912, the factory was one of the first in Germany to be electrified. Its own power was generated by a steam generator. In 1927, the factory was taken over by the firm Ernst & Luh, one of whose associates, Wilhelm Ernst, had a few years earlier founded the 'Mittelbadische Papiermanufaktur'. His innovation was the production of paper bags for cement. In collaboration with equipment manufacturers, innovative tools and production machines for the cement bags were developed. During the Second World War and also after the war, the demand for cement bags was enormous. From the 50s, the factory produced paraffin paper. Because the production capacity at the site was considered too low, production was discontinued in 1970.

Picture: Ronnie Husson

MAINTENANCE HR AWARD MAGNET FOR TECHNICAL TALENT

BY WIM VANCAUWENBERGHE & KRIS VAN HERPE

HOW TO ATTRACT TECHNICAL TALENT?

THE SETTING

During the last 3 years, MORE4CORE, a European INTERREG IVB project, aimed at improving market integration, employee mobility and innovation within the Maintenance, Repair & Overhaul (MRO) sector in North West Europe. One of the most exciting and inspiring initiatives was taken by VOKA Chamber of Commerce in Antwerp-Waasland and BEMAS, The Belgian Maintenance Association. A Maintenance HR Award, named 'Magnet for Technical Talent', was set up based on a in depth survey of maintenance technicians working at asset owners and maintenance service providers. The Belgian branch of Alpro N.V. has won the first "Maintenance HR Award". The company showed itself stronger than the other candidates Actemium and Geyssen. Evonik Germany won "The European Maintenance Award" against competitors Alpro from Belgium and Nedtrain from the Netherlands.

The principle of contest was inspired by the Magnet Hospital concept of the American Academy of Nursing. They discovered in the 1980's that despite a severe national health care staffing shortage, some hospitals remained successful in recruiting and retaining nurses during these years. The reasons for their success? The hospitals maintained well qualified nurse executives in a decentralized environment, with organizational structures that emphasized open, participatory management. They offered an autonomous, self-managing, self-governing climate that allowed nurses to fully practice their clinical expertise. In addition, they provided flexible staffing, adequate staffing ratios, and clinical career opportunities (Valda V. Upenieks). Next to this HR-component, the ANCC Magnet Recognition Program® is also viewed around the world as a seal of quality and confidence. Magnet hospitals are recognized for superior nursing processes and quality patient care, which lead to the highest levels of safety, quality, and patient satisfaction (ANNC).

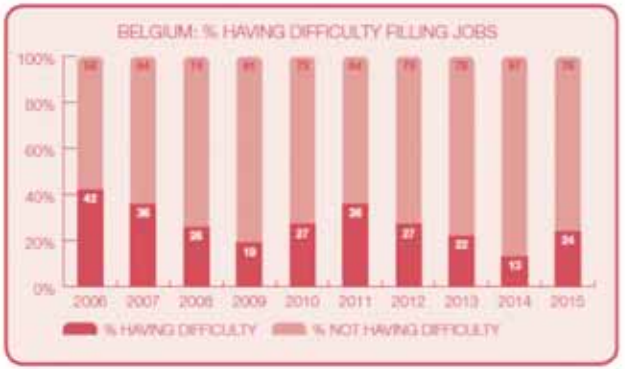
In the framework of the Maintenance HR-award contest, more than 300 technicians employed at 16 different companies completed a detailed survey related to the work reality of maintenance technicians. The survey covered different aspects of work satisfaction, organ-

ised in 5 'magnetic factors'. We also asked their opinion about the practical aspects of maintenance, safety, work quality and reliability culture. In this abstract we share some of the insights...

TECHNICAL TALENT IS IMPORTANT

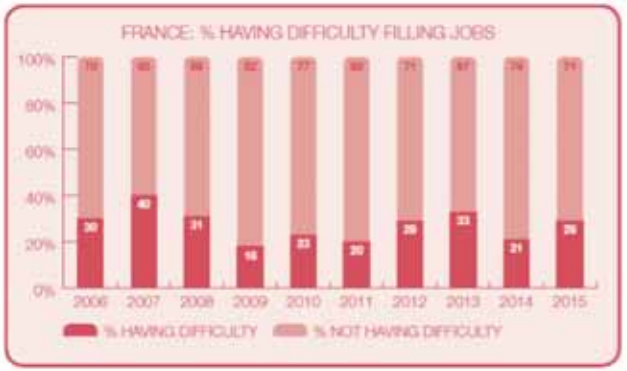
According the 2015 Manpower Talent Shortage Review, Worldwide, the percentage of employers who are experiencing difficulties filling job vacancies continues to rise in 2015. When compared with 2014, the proportion increases from 36% to 38%. Skilled Trade Workers, including mechanics and electricians, are the hardest to find. The category 'Other technicians' (not including mechanics and electricians) comes on the 4th place. According to the same research, technicians are the hardest jobs to fill in Argentina, Brazil, Costa-Rica and China, and figure in the top three in 18 of the 41 countries surveyed.

When looking at the situation of North-West Europe, we see that 'Skilled Trades', including electricians and mechanics, is the hardest to fill in job in Belgium, France, Germany and the Netherlands. The (other) technicians come on the 3rd place, except for in France. There technicians 'only' come in seventh place. Without any doubt the reason behind this is the fact that there are in France dedicated diploma's in maintenance, drawing a fair share of students into the profession. The French Public Education system emphasizes apprenticeship and co-op programs. Professional certificates and Professional baccalaureate degrees in maintenance are offered through high schools and are funded through agreements with small companies. The University system delivers a Maintenance Technician degree through a two-year program involving academic and practical training through apprenticeship or internship (Hines).
This proves that attracting and retaining technically skilled person-



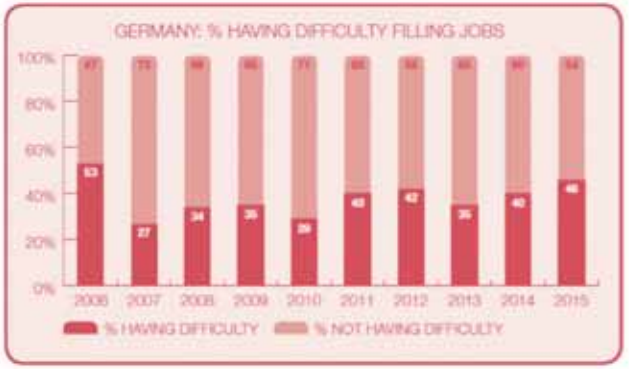
BELGIUM
TOP 10 JOBS EMPLOYERS ARE HAVING DIFFICULTY FILLING

1 | Skilled Trades
2 | Sales Representatives
3 | Technicians
4 | Accounting & Finance Staff
5 | Drivers
6 | IT Personnel
7 | Secretaries, PAs, Receptionists, Admin Asst. & Office Support Staff
8 | Engineers
9 | Project Managers
10 | Laborers



FRANCE
TOP 10 JOBS EMPLOYERS ARE HAVING DIFFICULTY FILLING

1 | Skilled Trades
2 | Drivers
3 | Secretaries, PAs, Receptionists, Admin Asst. & Office Support Staff
4 | Sales Representatives
5 | Management / Executive (Management / Corporate)
6 | Doctors & other Non-Nursing Health Professionals
7 | Technicians
8 | IT Personnel
9 | Restaurants & Hotel Staff
10 | Sales Managers



GERMANY
TOP 10 JOBS EMPLOYERS ARE HAVING DIFFICULTY FILLING

1 | Skilled Trades
2 | Management / Executive (Management / Corporate)
3 | Technicians
4 | IT Personnel
5 | Engineers
6 | Accounting & Finance Staff
7 | Sales Representatives
8 | Sales Managers
9 | Drivers
10 | Doctors & other Non-Nursing Health Professionals

Figure 2 - Top 10 jobs that are difficult to fill - source: The 2015 Manpower Talent Shortage Review

nel nowadays is a big and global challenge. And with increasing number of technicians retiring, the situation is likely to worsen in the near future. In order to become or stay an attractive employer for technical personnel, a company can work on the five magnetic factors:

1. The proper availability of resources, materials and tools;
2. The relationship between the (maintenance) technicians and operations;
3. Leadership, management and support of the technicians;
4. Management of the maintenance quality;
5. Bottom-up participation of the technicians in the policy.

Figures 3 and 4 demonstrate that scoring well in the above magnetic factors does lead to higher employee satisfaction, which in its turn leads to a lower intent to leave. Academic research and credible research suggest a strong link between employees who express an intention to leave and actual employee turnover (Jack J. Phillips, 2004). In 3 companies participating in the survey, none (0%) of the technicians was intending to leave the company. It goes without saying that these companies set the benchmark on the magnet factor scores.

The second very nice thing of scoring well at the magnet factors is that it ensures that your technical employees promote the company they are working for within their own personal network (of technicians working at other companies) as a good employer. In that way it becomes much easier for a magnet company to attract new technical personnel.

TECHNICIAN JOB SATISFACTION

Another interesting aspect of the survey is that we also investigated differences in magnet factor scores between technicians working at asset owners and technicians working for maintenance contractors. Service companies score on average 12% better on the magnet factors, resulting in higher job satisfaction. Based on the survey asset owners could do better by improving working relations between operations and maintenance and by allowing technicians to participate in decisions regarding the maintenance policies.

Technicians also complain that company management does not listen enough to their concerns. On the other hand, technicians working for asset owners appreciate most good and the fact that management expects high quality maintenance. It is interesting to see that the working relations with the customers' operations is scored very well by technicians working for maintenance contractors. Maybe lies here a keys for the higher satisfaction levels of the latter group.

Magnet factor	Technicians @ Asset owners	Technicians @ Maintenance Contractors	% difference
1. The proper availability of resources, materials and tools	2,81	3,07	9%
2. The relationship between the (maintenance) technicians and operations	2,77	3,24	17%
3. Leadership, management and support of the technicians	2,83	3,06	8%
4. Management of the maintenance quality	2,85	3,11	9%
5. Bottom-up participation of the technicians in the policy	2,6	2,95	13%
Average score on magnet factors	2,77	3,09	12%
Satisfaction score	3,13	3,36	7%
Intention to leave company %	16%	12%	-23%

Table 1 - Average magnet factor scores

In general 10 % of the maintenance technicians are not satisfied about their job and 16 to 17% intend to leave their current employer if there is an opportunity. It is however striking that more than a quarter (28%) of the technicians working for an asset owner, would leave the maintenance profession when changing jobs, versus only 7% technicians working for a contractor. On the other hand more than a third of the contractor technician job changers would change their job for a job at an asset owner.

Reliability culture on the shop floor

There are also some interesting insights emerging from the survey regarding the reliability culture in the companies involved.
First the good news: Up to 40% of the maintenance technicians think that the quality of the maintenance work carried out has increased over the last year. On the other hand, almost 15% of the technicians working at asset owners stated that the levels of quality of the work done has dropped. 30% of them are only slightly sure that equipment will run reliable after an intervention. 6-7% of the asset owner technicians have the impression work on unreliable equipment and 13% feels that company management does not act upon reported technical problems.
These numbers confirm the findings of the More4Core benchmark study that there is still room for improvement in asset performance.
The survey also reveals that maintenance technicians understand the importance of taking action to prevent repetition of breakdowns.
However, some significant sore points remain: access to information, including technical information, and a lack of communication be-

tween the different shifts, resulting in essential maintenance information for the equipment not being shared. Furthermore, it is clear that a lot of companies could avoid unnecessary standstills by taking a number of simple measures such as removing contamination and also preventing wear through improved lubrication and replacing components as soon as necessary.

Things NOT executed during the most recent shift (due to time pressure)	% of asset owner technicians
Analysis of possible root causes of a defect	32%
Planning and preparation of the work to be executed	28%
Updating technical documentation and diagrams	25%
Adequate reporting about the executed maintenance activities	23%
Preventing a potential next defect on the equipment / installation involved (eg lubrication, replacement of nearly worn-out parts, small adaptations in the PLC program)	22%
Instruction and 'education' of the operator to prevent recurrence of breakdowns / failures	22%
Removing of dirt/contamination/foul from (parts of) the equipment	19%
Consultation with the operator involved at the start of or during the maintenance activities	19%
Careful assembly (correct aligned, labeling ...)	18%
A thorough inspection after completion of the work, in order to be able to start safely and without difficulties.	18%
Adequate inspection of (parts of) an equipment / installation	17%
Safe stop and lock-out/tag-out of the equipment / installations before an intervention	13%
Use of lifting equipment to lift (heavy) parts	13%

Finally, a few significant figures that show there is still a lot of room for improvement: Among the technicians, 32% stated that they had insufficient time to work out the actual cause of the defect. One quarter did not have sufficient time to update technical diagrams and

documentation, or being able to take the necessary steps to prevent the same defect occurring again in the future. Because of the pressure of time, almost 15% of the technicians failed to shut down the machine to be worked on, and also did not use the proper lifting equipment with heavy components.

TIME FOR ACTION

In conclusion, the survey reveals that in our production companies there is still a lot of room for improvement with respect to maintenance and reliability, which in turn also means productivity and competitiveness. It is anyhow clear that technician survey results can constitute interesting leading indicators for future reliability performance of a plant and is able to provide very interesting input on what points a company can work in order to attract and retain technical talent.

Citations

ANNC. (n.d.). ANNC Magnet Recognition Program. Retrieved from American Nurses Credentialing Center: http://www.nursecredentialing.org/magnet.aspx

Hines, D. J. MAINTENANCE AND RELIABILITY EDUCATION. The University of Tennessee, Maintenance and Reliability Center.

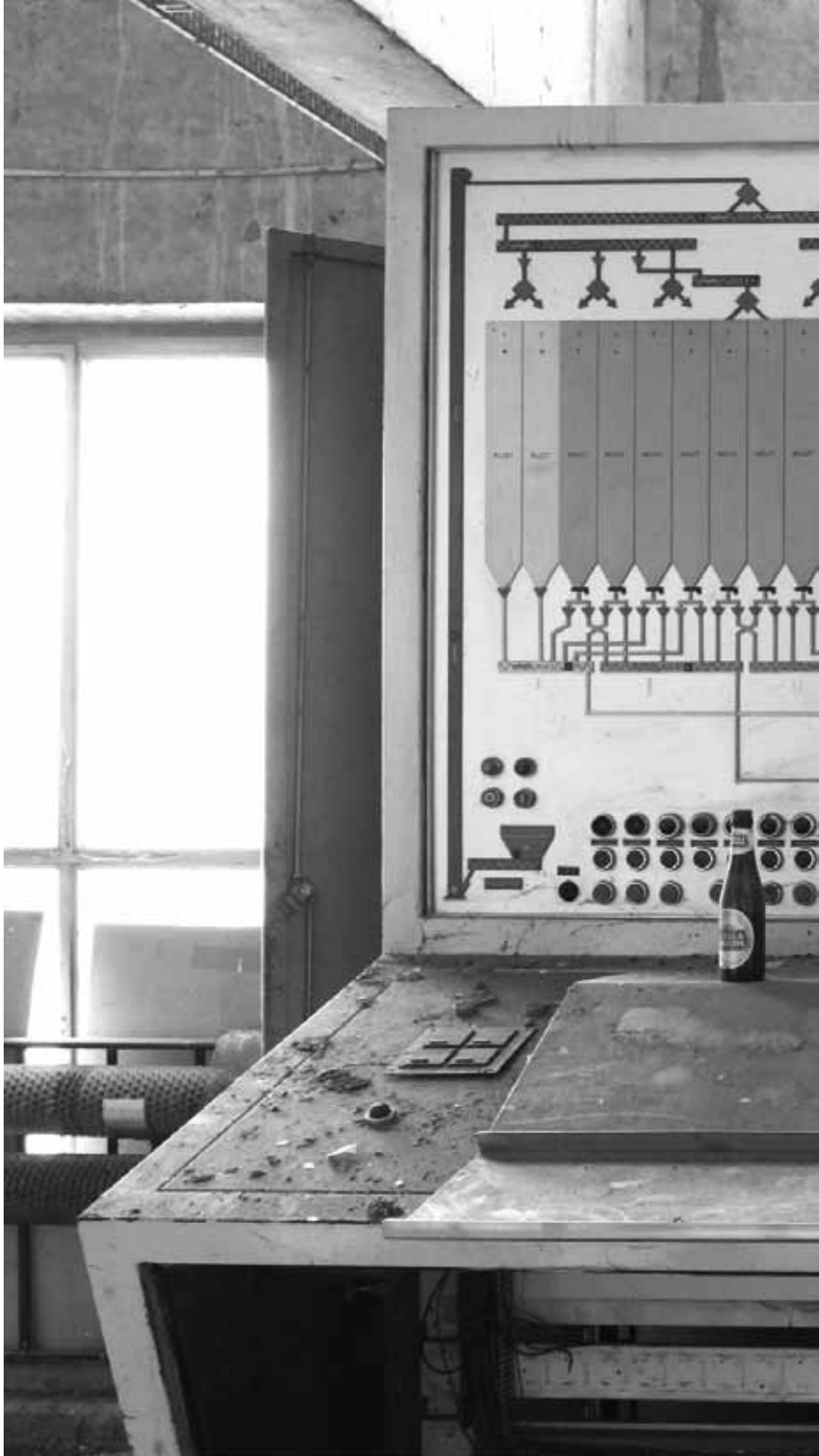
Jack J. Phillips, A. O. (2004). Managing Employee Retention. Elsevier.

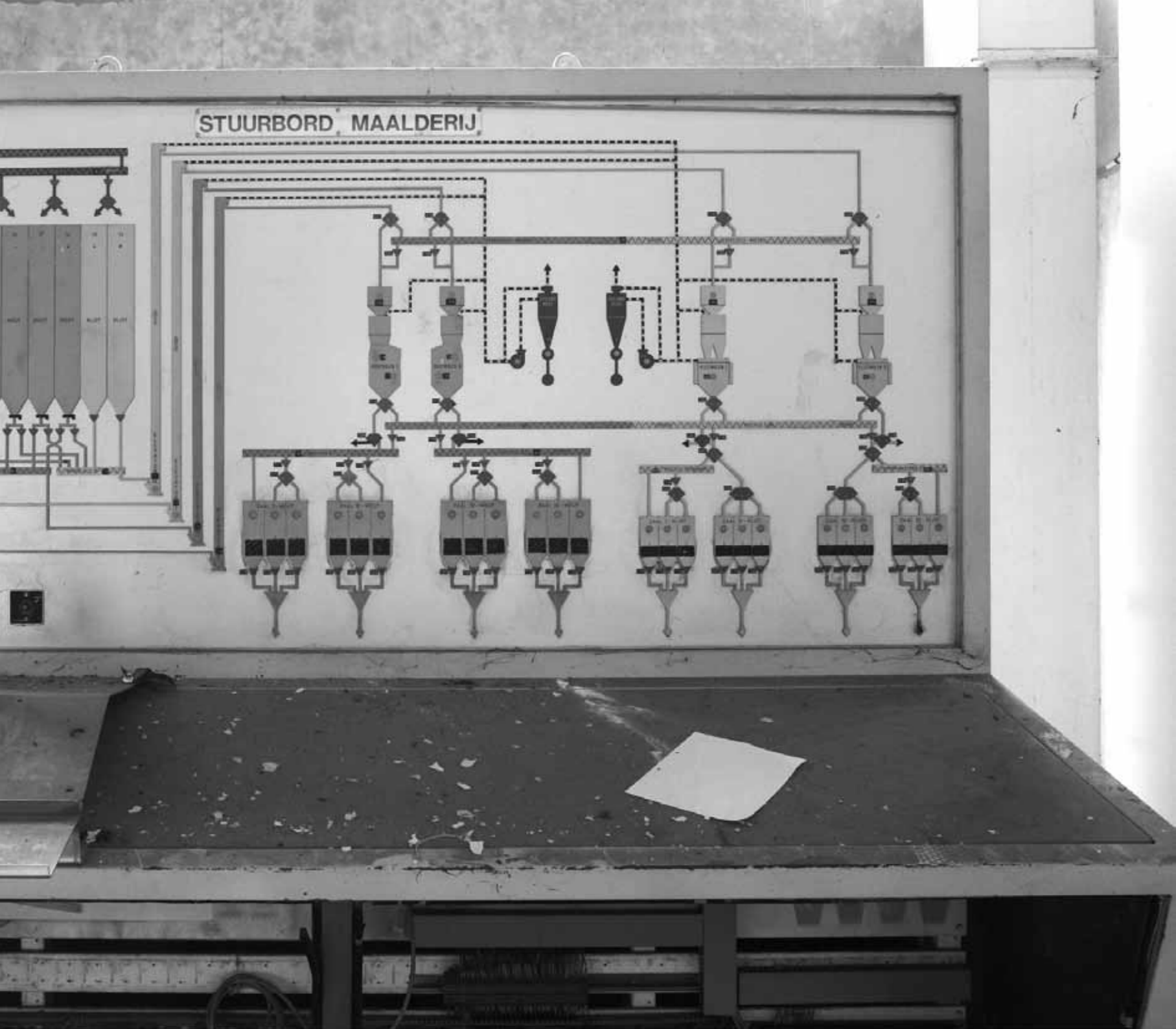
Valda V. Upenieks, R. P. (n.d.). What's the attraction to Magnet hospitals? Retrieved from Lippincot Nursing Center: http://www.nursingcenter.com/journalarticle?Article_ID=402847

STELLA ARTOIS
LEUVEN, BELGIUM

Artois was a brewery in Leuven, Belgium, best known for its lager, Stella Artois (now part of the AB InBev portfolio). The original history of this beer goes back to 1366, a year still present on the label of the beer. Tax registers of the city of Leuven show that Inn-Brewery Den Hoorn, the original brewery, already existed. On 13 June 1708, Sebastian Artois won the coveted Master Brewer title. Since then, the name Artois is connected to the beer. Production sites in Leuven have undergone more than 250 years of renovations and modernisations. The mill in the brewery building 'De Dijle' at the Vaartkom provided rice, malt and ground corn. This picture shows the controls of the mill. The buildings were partially demolished in 2012 to make way for residential buildings, offices and the AB InBev headquarters.

Text: www.wikipedia.org and www.inventaris.onroerenderfgoed.be
Picture: Ronnie Husson




STUURBORD MAALDERIJ

BREWERY CALLEWAERT
ZWEVEZELE, BELGIUM

Filling machine in brewery Callewaert in Zwevezele (Belgium). The brewery was started in 1897 in a converted schoolhouse. Between 1935 and 1951, it was gradually expanded. Production consisted of beer (lager, table beer, special beer) as well as lemonade and water under the name White Star. All activities ended in 1998.

Text: Spectrum-West-Vlaanderen Werkt 2, 2014 / Picture: Ronnie Husson

MAINTENANCE MARKET INTEGRATION, NORMS & STANDARDS FOR MAINTENANCE

BY JEAN-PIERRE AVELLANDEDA

FOREWORD

WHO IS AFIM ?

A non-profit organization

AFIM = “Association Française des Ingénieurs et responsables de Maintenance”

~1500 adherents, 80 years existence

Website with 600000 unique clicks per year

- 2000 documents, standards, articles and references
- Yellow pages since 20 years
- Webzine sent to 15000 people
- Etc.

Afim has a strong visibility, it is the spokesperson for maintenance in France
http://www.afim.asso.fr/

Specific communication done by AFIM about Norms & Standards

Afim delivers every year a “panorama” of maintenance regulations and standards for France.

Afim delivers a specific zoomed panorama about leverages equipment and tools regulations.

The EFNMS

EFNMS specific role

The EFNMS, the European Federation of National Maintenance Societies, was established in 1970. The EFNMS transformed to a formal non-profit organization (“Vereniging zonder Winstoogmerk”) according to Belgian law created on January 18, 2003, in Amsterdam.

The EFNMS objectives are the following: the improvement of maintenance for the benefit of the peoples of Europe.

By the term ‘maintenance’ is meant: the combination of all

- technical
- administrative and
- managerial

Actions during the lifecycle of an item intended to retain or restore it to a state in which it can perform its required function.

Maintenance is of utmost importance for trade and commerce, for the environment, and for general health and safety. In order to pursue its goals, the EFNMS shall be an umbrella organization for the non-profit National Maintenance Societies in Europe.
http://www.efnms.org/

The EFNMS specific role for M4C WP5

EFNMS shall use M4C works to highlight a NWE panorama of maintenance, establish priorities up to maintenance stakes and strategic vision, and the lobby some selected actions and policies at European level.

For M4C-WP5 :

- Simplification and harmonization actions & policies (e.g. merge/ suppress regulations)
- Reinforcement actions & policies (e.g. propose some standard creation)

PURPOSE AND HOW/WHY USE THIS DOCUMENT

WP5 initial purpose

More 4 Core and Work package 5

M4C main objective is to promote maintenance issues and stakes to a European level.

The objective of WP5 is to support transnational integration of Maintenance markets by improving the transparency, comparability and visibility over standards, regulation and offer of services in the NWE region

One of the annoying point when some company wants to cross the borders are the foreign local standards and regulations…

What we are trying to do in M4C-WP5

1 Identify, in a common reading grid, the main standards and regulations that applies to maintenance
   - Overview of national and international norms and standards on MRO in NWE
   - Overview of national and international regulations on MRO in NWE
2 Pinpoint the ones that prevents or annoy companies to work in the other European countries
   - Industry & SME case studies of conflicting national MRO regulations in NWE
3 Raise some documented suggestions (illustrated with case studies) then support them with an European lobbying

Standards or Regulations ?

Standards & norms is a powerful lever of market mastering and control. As a regulation is the expression of public power, a standard is more the expression of a market need.

It is much easier to define a standard at an European level than to gather and harmonize several countries regulations.

- Because the rules of a standard creation or modification are lighter and the process quicker
- Because only a relative majority is needed
- Because there is much less historical material and existing documents
- Because there are fewer actors involved...

Using and lobbying standards sounds more efficient than trying to align regulations.

So what?

Is there a so big issue ? Who cares ? What shall be lobby at European level ?

Are these differences a so big issue? Who cares?

<table>
<tr><th></th><th>Stakeholders</th><th>Services Maintenance Enterprise</th></tr>
<tr><td rowspan="2">Medium sized</td><td colspan="2">• Risk is increased to any foreign project
• Have to hire specialists and build a project team</td></tr>
<tr><td>• Product export, plant purchase or building are already seen as big and strategic subjects already seen as big and strategic subjects</td><td>• Progressive extension of activity in other countries is difficult
• Development is risky</td></tr>
<tr><td>Big sized</td><td colspan="2">• Local employees are hired to ensure compliance with regulations and standards
• This compliance is a big issue = company survival
• Regulations is seen as a constraint and extra-costs, and in the other hand as a way to protect from low cost countries actions
• Countries S&R differences are annoying for group vision and actions : benchmark, managers relocation, supply policy, transversal optimizations</td></tr>
</table>

REGULATION, NORMS & STANDARDS

Regulation, Norms & standards

In short…

Standards are voluntary-based; everyone is free to respect it or not… Unless norms explicitly referenced in regulations. These are mandatory norms.

Regulation, Standard & Norm

Regulations are issued by public authorities. They are the expression of a law or rule. Their application is mandatory. Standards are voluntary in nature. Conforming to them is not mandatory. They represent companies' commitments to satisfying a recognized and approved level of quality and safety. Standards can support regulations by being cited as reference documents. Only 1% of standards are mandatory.

European standard (EN)

European EN standard is valid for all European Member States. National standardization bodies are obliged to implement nationally the European standards.(implementation duties).
For the Dutch market this means that the European Standards carry the codes: NEN-EN. For Germany the code is: DIN-EN , for France .

International standard (ISO or IEC)

An international standard has been developed internationally by ISO or IEC.
These implementation requirements for global standards do not apply to other countries.
Documents that are accepted by The Netherlands gain the coding NEN NEN-ISO or IEC.
Some international standards are accepted in Europe. These are identified by the code: NEN-EN-ISO.

Technical Specification (CEN/TS or ISO/TS)

The technical specification is composed for provisional application. The technical situations of the consensus is still insufficient to publish a standard. Also, a technical specification can be used for a quick interim publication of the result of the standards development process.

Technical Report (CEN/TR or ISO/TR)

A Technical Report (TR) has an informative character. It is published in order to provide certain information, such as technical data or an inventory of regulations and standards are made available for each country.

Normalization

Certification

Main Actors

Institute of standardization linked to this INTERREG project

	ISO	International Organization for Standardization
	CEN (Europe)	European Committee for Standardization
	AFNOR (France)	Association Française de Normalisation
	DIN (Germany)	Deutsches Institut für Normung
	NBN (Belgium)	Bureau de Normalisation/Bureau voor Normalisatie
	NEN (Netherlands)	Nederlands Normalisatie-instituut

Sectors institutes

Big industrial sectors have their own institutes, like Aerospace, Automotive, Petro-Chemical, Food… That edit adapted or specific standards.

Technical rules published

There are numerous institutes (e.g. 58 listed only for Germany) that sustain normalization work on their own field of expertise (e.g.). Some of them are international consortium some at national level…. E.g:

IEC International Electrotechnical Commission

EEE Institute of Electrical and Electronics Engineers)

Standards published by international organisations

ISO International Organization of Standardization

CEN European Committee for Standardization

CATEGORIZATION

Classification principles

Appliance of regulations, norms and standards

A shared breakdown in order to allow comparison

Why did not use the same categorization for Norms, Standards and regulation?

Usage proof us that it was difficult to categorize items

- up to a single category
- up to a single view categorization

Most of standards, norms and regulations would be with benefit categorized

- up to technical view (equipment, product, characteristics…)
- up to stake (HSE, reliability…)
- up to life cycle state (conception,use, disposal…)
- etc.

So we suggest a modern use of multiple tags, but unless full free text entry, we recommend to improve our categorization trial, and to link every item to all relevant categories (multiple entries per axis and multi-axis classification).

Mapping tool

A matrix…

Both Norms-Standards and regulations have been classified in a (MS Excel spreadsheet) grid. However, giving the quantity of lines and columns, reading “in a single glance” is not easy.

… to adapt for further dissemination

We suggest to transfer the information in an online database, allowing easy sorting and querying. Adding new countries will dramatically raise the number of lines (mostly for regulations).

However we strongly recommend that the future system allow- after a query, a report or an export in a grid that allow cross-countries comparison.

CATEGORIZATION OF NORMS & STANDARDS

Classification for Norms & Standards

This breakdown allows classifying all norms in a same grid, in order to be able to group and compare them. Common concepts of maintenance are used: This categorization was built by Afim and the partners.

Lines: maintenance areas and sub-areas

What is the main subject/goal of the standard listed ?

Columns: description and use of the norm & standards

Who use it ? i.e. which country or group of countries

For what ? i.e. for what kind of maintenance process purpose ?

The classification of maintenance areas & sub-areas

Maintenance areas	Maintenance sub-areas
Maintenance process during the Design /Development /Manufacturing /Installation Phase	1.1 Maintenance activities during design phase
Maintenance process during Operating Phase	2.1 Maintenance planning
	2.2 Maintenance Support
	2.3 Maintenance implementation
	2.4 Maintenance during shutdown
	2.5 Maintenance techniques
	2.6 Maintenance & Equipment history
Assessment & improvement of equipment & maintenance	3.1 Equipment reliability
	3.2 Equipment maintainability
	3.3 Maintenance assessment
Life cycle management	4.1 Asset Maintenance Management
Health, safety and environment	5.1 Health, safety and environment in maintenance

The classification of maintenance areas & sub-areas

Area	Sub-area	Themes
Maintenance in design to Install	Maintenance activities during design phase	• Reliability, Availability, Maintainability and Safety management during design • Integrated Logistic Support • Service concept • Design out maintenance…
Maintenance process during Operating Phase	Maintenance planning	• Criticality analyses (RCM, …) • Maintenance and risk management (RBI, …) • Value Based Maintenance • Plant Maintenance Optimisation • Lean Maintenance • Decision making in maintenance • Replacement investments
	Maintenance Support	• Spare part management • Obsolescence management • Maintenance Tools management • Maintenance documents • Instrumentation & Wireless techniques • Maintenance Information System (CMMS, ERM, …) • Benchmarking systems • Education & training in maintenance • Certification of maintenance personnel • Traceability • Qualification of equipment • Maintenance standards…
	Maintenance implementation	• Contracting & outsourcing & insourcing • Total Productive Maintenance • e-maintenance • Operator Based Maintenance • Remote maintenance • Relations Operational / Maintenance staff …

Area	Sub-area	Themes
Maintenance process during Operating Phase	Maintenance during shutdown	• Shutdown & turnaround management • Work preparation & scheduling…
	Maintenance techniques	• Condition monitoring techniques • Non Destructive Testing • Diagnosis & Prognosis • Maintenance and repair technology (mechanical and electrical methods for repairs)…
	Maintenance & Equipment history	• Maintenance data collection • Human error analysis • Maintenance knowledge & best practices • Tools for expert evaluation …
Assessment & improvement of equipment & maintenance	Equipment reliability	• Root Cause Analysis • Equipment health analysis • Ageing and degradation mechanism modelling • Remaining useful life assessment …
	Equipment maintainability	• Maintenance tasks simulation • Augmented reality techniques • Robotics and remote handling …
	Maintenance assessment	• Benchmarking • Performance Indicators & Dashboards • Maintenance process diagnosis & audits • Modelling and simulation of maintenance strategies • Customer satisfaction surveys • Best practices identification …
Life cycle manage-ment	Asset Maintenance Management	• Maintenance process description – roles & responsibilities • Maintenance excellence • Life cycle management • Life cycle extension • Rebuilding & Reinvestment strategies • Relations with auditing & safety organizations …
Health and safety	The classification of maintenance areas & sub-areas	• Occupational diseases and accidents • Good practices in safety • Good practices in environment preservation …

The description and use of the norms & standards

Maintenance breakdown	Area
	Sub-area
	Themes
Standards related to maintenance	Standard reference
	Title (English)
	Title (DE)
	Title (FR)
	Title (NL)
	Date of : publication / revision / or state
	Level (international, European, National, local...)
	Language(s) available
Level of use	Belgium
	France
	Germany
	Netherlands
Maintenance processes	Manage maintenance
	Prevent dreaded events
	Restore items in required state
	Guarantee HSE in maintenance
	Budget maintenance of items
	Manage data
	Optimise the results
	Consider maintenance during items design & modification
	Deliver operational documentation
	Deliver spare parts
	Deliver manpower and outsourcing
	Deliver tools, supports equipments and Info syst.
	Provide needed infrastructures

THE MATRIX OF NORMS & STANDARD

Cf. related document M4C.WP5.A5.1M

Norms & Standards collected

Per categorization

NB : 5.1 Is HSE theme

Per Country

Per maintenance sub-process

NB : On standard is related to on to several sub-processes

CATEGORIZATION OF REGULATIONS

Classification for regulations

This breakdown allows classifying all norms in a same grid, in order to be able to group and compare them. Common concepts of maintenance are used:

Lines: maintenance items

What is submitted to the regulation? i.e. On which topic (technical field) do the regulation refers?

This categorization is used since more than ten years by Afim for French regulations.

Columns: description and appliance of regulation

What is the regulation? i.e. description, reference…

When use it ? i.e. life cycle of equipment appliance, country appliance, frequency…

The classification of maintenance items

#	Topic
1	lifting Equipment and accessories
2	Non- ionizing radiation
3	Lifts and hoists
4	Work atmospheres
5	Noise (and vibration)
6	Buildings
7	Shipyards
8	Chemistry (Chemical Hazard)
9	Tanks
10	Ladders, Stepladders, Running boards
11	Lighting
12	Electricity

13	Sub-contractors
14	Personal Protective Equipment
15	Pressure Equipment
16	Explosives
17	Movies (Operations or production)
18	Lightning (Protection against lightning)
19	Ovens with liquid or gaseous fuel
20	Fruits and vegetables (maturation)
21	Hyperbaric (Midfielder hyperbaric)
22	Fire
23	Refrigerants Fluids
24	Thermal Installations
25	Legionella
26	Machines
27	Fat Raw materials (extraction by flammable solvent)
28	Vessels containing or having contained flammable liquids or liquefied gases fuels
29	Doors and gates
30	Radon
31	Ionizing Radiation
32	Signalling
33	Silos
34	Sport and playgrounds
35	cable
36	Road Transport

The description and use of the regulations

Topic	Topic categorization
REGULATION	Regulation reference
	Title (English, Native)
	Date of : publication / revision / or state
	Level (International, European, National, Regional)
	Language(s)
LIFE CYCLE APPLIANCE	Acquisition / Design / Installation…"
	(Operation) Maintenance
	Modernization
	Disposal
COUNTRY APPLIANCE	Belgium / France / Germany /Netherlands
Frequency	

THE MATRIX OF REGULATIONS

Cf. related document M4C.WP5.A5.2M

Regulations collected

Per life cycle state

Per level of use

Per country of use

Topic/Country

TOPIC	Σ	BE	FR	DE	NL
1 - Lifting Equipment and accessories	25	18	5	1	3
10 - Ladders, Stepladders, Running boards	6	4	3	2	3
11 - Lighting	14	8	9	3	3
12 - Electricity	45	35	10	1	2
13 - Sub-contractors	8	5	2	1	
14 - Personal Protective Equipment (& HSE fundamentals)	41	17	17	27	19
15 - Pressure Equipment	40	33	6	1	3
16 - Explosives	16	9	9	2	2
17 - Movies (Operations or production)	1		1		
18 - Lightning (Protection against lightning)	12	3	9	2	4
19 - Ovens with liquid or gaseous fuel	3	2	3	2	2
2 - Non-ionizing radiation	6	3	5	3	4
20 - Fruits and vegetables (maturation thru fire)	1		1		
21 - Hyperbaric (Midfielder hyperbaric)	7	1	6		
22 - Fire	38	13	22		3
23 - Refrigerants Fluids	5	3	4	2	2
24 - Thermal Installations	15	14	4	3	3
25 - Legionella	12	2	8		2
26 - Machines - Work equipment	19	4	13	2	6
27 - Fat Raw materials (extraction by flammable solvent)	1		1		
28 - Vessels containing or having contained flammable liquids or liquefied gases fuels	12	9	1		2

29 - Doors and gates	7	5	3	2	3
3 - Lifts and hoists	24	9	15	1	2
30 - Radon	6	2	4	2	4
31 - Ionizing Radiation	8	4	7	3	3
32 - Signalling	3	1	1		1
33 - Silos	4	1	3	1	2
34 - Sport and playgrounds	11	9	3	1	1
35 - cable	15	7	12	4	4
36 - Road Transport	11	10			1
4 - Work atmospheres	38	7	32	4	5
5 - Noise & Vibration	16	10	11	9	10
6 - Buildings	33	14	19	2	2
7 - Shipyards	3	1	2		
8 - Chemistry (Chemical Hazard)	8	3	6	1	1
9 - Tanks	17	12	7	2	2
Total général	**531**	**278**	**264**	**84**	**104**

MAIN LEARNING OUTCOMES

This chapter is an introduction. More developed analysis will be found in the linked document M4C.WP5.A5.1CS "Case studies and policies suggestion".

Collection of regulations, norms and standards

Data source

For norms and standards, the data source was the national normalization institute(s).

For regulations, the data source was the national and regional regulation reference legal source.

Scope and way of data collection

The scope of the query (how to collect and what to collect) strongly reflects cultural and historical issues. Perimeter is definitely huge. When we talk about maintenance we care about all assets: industrial, buildings, non-physical assets, energies, job, purchase and contracting…

Most countries have online searching tools, with keywords. The point is which keyword use and what text select? The need of a maintenance expert is required to select relevant regulations items.

Country specific "how to"

Normalization institutes offer websites with an online research international tool with free access to everyone: e.g.- in Germany the DIN, in France AFNOR

Update issues

Matrix where built year 2015, regulations and standards are constantly changing. Updates, creations (rarely suppressions) are done every year. The job needs a yearly update in order to be usable. In all case we suggest to query in the target country regulation and standards before any decision.

Norms and standards, a strategic tool for countries?

Influencing on normalization is a strategic tool for countries and organization.

- Create / influence on content and process of a certification
- Create / influence on content of a standard
- Block a creation / update
- Proactive surveillance

Master a (raising) standard is a competitive advantage. Companies that want to export at international level have strong interest in it. Some countries like Germany, that have a macro-economic model based on exportation, have a specific policy and are strongly involved in normalization.

Source: International Barometer of Normalization - 2014

Conflicting Standards / Norms or regulations?

Normalization is already a worldwide structured organization. ISO federates all national normalization & certification institutes. They are few conflicts in this area. However some improvements could be suggested:

Clarify frontiers between normalization institutes

It is often difficult for a neophyte and sometimes for an expert to understand which normalization entity cares of a specific subject. Again, common categorization and meta-rules would be a benefit. Sometimes frontiers between these entities are not well defined, because of authority and policies competition.

Define a common and shared categorization

Due to the "spontaneous generation" of texts: every normalization commission has right to suggest a specific text; laws are emitted at European, national and regional levels... It is very difficult to grasp and see the "big picture" of standards, norms and regulations.
A (common) categorization of documents could better their access, use, share and understanding. Today a maintenance manager can only use keywords and has to "navigate" between numerous of documents. Some Certification & Control institutes (like Apave, Bureau Veritas, Lloyd's, TÜV…) are compiling the regulations, but they do not have a common categorization. An European categorization rule would be welcome.
It is also difficult to know if something more accurate (related text / guideline / linked subject...) exists. It is partially due to the "heritage" rule: "son" text mandatory quotes it's "father" text; not the reverse.

A more "Democratic" vote for norms?

For norms, nowadays, rule is to vote (it means validate) in a 1 country 1 vote rule. It sounds strange that there is no relationship between the "size" of the country (population is roughly linked to activity and so the expected perimeter of use).

Moreover, big industries and MRO companies are over-represented. Small and Medium sized industries have often not enough weight (resources), time, lobbying levers… face to big companies. However they are the one that suffer the more standards and regulations multiplication.

Regulation policies

Regulation is the armed wing of public authorities' policies. The progressive transfer of power from National to European level

Superfluous standards / norms or regulations?

"Real" use of the Standards & Norms

Technical Standards

Technical standards are the most used norms, they are often the mandatory key for accessing market.

Organizational Standards & Norms

Technical standards are the most used norms, they are often the mandatory key for accessing market.

Statistics about use

The most interesting and factual clue could be the number of Norms sold (paper or electronic version). However, this information is not public.

For France (because AFIM leads the X60 AFNOR normalisation group), we can say that, after querying AFNOR, some standards where very rarely bought… We so decided in the commission to

suppress them (in fact to merge their content in “father” or “son” standard).
However this information is very difficult to obtain from the organism…

What about some continuous improvement based on facts?
The measure of bought texts could be a good entry when thinking about evolutions. Another clue is the number of affiliates and the presentism in meetings. International comparison of use between countries shall be also a good reading. Only normalization institutes have this information.

“Missing” standards / norms or regulations?

Due to the collection process (a maintenance expert selects relevant documents), completeness is not guaranteed. However, due to the European harmonization, and the similar cultural background of the 4 countries of the project, regulations and standards perimeter and appliance are almost the same. Differences are mainly in the details (and can raise non-conformity).

LEXICON

Acronym	
CEI-IEC	Comité européen de normalisation électrotechnique
ASTM	The American Society for Testing and Materials
CD:	Committee Draft
CEN	European Committee for Standardization
CENELEC	European Committee for Electrotechnical Standardization
DIS:	Draft International Standard
EN:	European norm from CEN
ETSI	European Telecommunications Standards Institute
FDIS:	Final Draft International Standard
IEC -CEI	International Electrotechnical Commission
ISO	International Organization for Standardization
ITU	International Telecommunication Union
IWA:	International Workshop Agreement
NEN:	Dutch norm from NEN
NF	French Norm / Norme Française
NPR:	Dutch Practice Guideline / Nederlandse Praktijk Richtlijn
NVN:	Dutch For Standard / Nederlandse VoorNorm
ÖNORM / OENORM	Austrian Standards Institute
SAE	Mobility engineering industry (Aerospace, Automotive, Vehicles)
TR:	Technical Report
TS:	Technical Specification

DE NAEYER PAPER FACTORY
WILLEBROEK, BELGIUM

In 1860, Louis De Naeyer started with the production of paper in Willebroek (Belgium). He did not shy away from new challenges and expanded his industrial complex constantly. Apart from the production of paper pulp and paper products, he also started manufacturing steam boilers, first for his own use, and later also for sale to other industrial manufacturers. Paper factory De Naeyer stopped its activities in 2004.

Text: www.willebroek.info / Picture: Ronnie Husson

IMPERIA
NESSONVAUX, BELGIUM

Imperia moved in 1907 these facilities in Nessonvaux(Belgium), constructed by the German Henri Pieper. Pieper invented the Auto-Mixte, the first hybrid vehicle, also called at the time the “petro-electric” engine. With its own circuit on top of its Nessonvaux plant, Imperia showed boldness and innovation during the 50 years of its epic existence. Between 1900 and 1950, Imperia wrote one of the finest pages in the history of the Belgian automotive industry. The brand experienced both commercial and sporting success, but unable to recover from the aftermaths of the second world war, the factory was closed in 1958. Specialising in the development of cleaner prototypes, Green Propulsion is currently reviving the Imperia brand, with the Imperia GP, a sports car with a hybrid motorisation.

Text: www.imperia-auto.be

Picture: Ronny Husson

ANALYSIS OF THE MRO SERVICE MARKET IN GERMANY

WVIS – BRANCHENMONITOR 2015

Management Summary

WVIS-Branchenmonitor 2015: industrial services will grow with their customers regarding “Industrie 4.0” trend

- Business for industrial service providers is still growing.
- Industrial Services become more and more important due to “Industrie 4.0”

Since 2010 the annual WVIS-Branchenmonitor is held and provides information on trends and development for the industrial services sector in Germany. Growth forecasts, service portfolio and labor market developments are representative queried and evaluated for industrial services. The survey for this publication took place on the basis of company data from 2014 and 2013, their forecasts and assessments of the companies reported in spring, 2015. Therefore the WVIS-Branchenmonitor delivers a comprehensive impression of the economic environment in Germany and Europe, pointing to development and trends as well as providing information on the current market situation in industrial services. The next evaluation started in February, 2016.

According to the WVIS-Branchenmonitor 2015, services trend to an increase of almost 10 percent in Germany 2014 - from 2 percent in 2013. Europe was even around 11 (2013: 2.3) percent. The world market had a turnover increase of 7.5 (2013: 3.8) percent. On average the industrial service providers in 2014 improved their sales by 9.8 percent.

All, small and medium industrial service providers improved their business – due to their specialization. For large companies, the sales growth reached a value of around two percent.

The industrial service sector is in good shape thus can significantly improve from the previous year. Especially in Germany and Europe, the industrial service providers present themselves at their best. This positive impression must be seen specifically differentiated for the bigger companies. Especially the consequences of the “Energiewende” have a negative impact on the business related to power transmission and effects the energy market.

Industrial service companies are in a positive mood. Recognizing good opportunities for the growth in Germany which, according to the current WVIS-Branchenmonitor, is expected at 9 percent in long term. Compared to last year expectations there were only 5.4 percent. Thus Germany among the potential growth markets ranks third - after the USA and China, for which 15 and 14 percent the greatest expectations are found. In contrast, the growth forecasts for Russia have declined. After 5 percent in 2013, there are now only 3 percent.

Markets for industrial services and development of companies

Industrial services providers still focus to the process industry to a large extent. The chemical industry remains the main clientele for industrial services. In 2014 this sector headed the industry average 39 percent of total revenue of the industrial services providers. In average 34

percent went to the power plants, energy and environmental technology segment, followed by the automotive customers with 30 percent. The demand for services dominated the classic maintenance tasks. This area made in 2014 an average of 13.5 percent of total sales of industrial service providers. The segment “Assembly / Installation” came to an average of 11 percent, “Technical cleaning / insulation / scaffolding” to 9.5 percent. This is reflected in the distribution of revenue in the industrial services market. Thereafter, “maintenance” and “technical cleaning / insulation / scaffolding” reached a share of 24 percent. On “assembly / installation” accounted for 14 percent to 11 percent “engineering”.

In the future main drivers for growth are primarily maintenance, engineering and assembly/installation. In terms of the sectors there is still potential seen for both the automotive industry and for the mechanical engineering, as regards the use of professional industrial service. At the same time the top issues for industrial services companies remain, security and occupational safety in large-scale plants and the difficulty due to broad need for qualified employees. The provision of personnel continues to increase, and the shortage of skilled workers will require enhanced cooperation of industrial services in the future, for example, on major projects such turnarounds and revisions. In addition to that industrial service providers need highly qualified and motivated employees because of their specialization and despite the trend to offer also multidisciplinary services

New Smart Services

In context of “Industrie 4.0” or the “Internet of devices” the demand for specialist and their know-how are of increasing importance for services.

The automation leads with digitization and Big Data. This may lead to increasing efficiency in “Industrie 4.0” resulting in flexible value chains, such as by means of preventive maintenance. However, the networking and flexible value chains also lead to a fragmentation of processes and supports the trend towards integration of industrial services into core processes. Even services that are not part of the core business of the customer, will give more and more opportunities for industrial services. Especially when customized solutions are developed together with the customer.

In future intelligent services are integrated on platforms into the processes of customers. These networked processes within the overall responsibility of the service provider will need a holistic project management as “managed services” for clients of the “Industrie 4.0”.

About WVIS - Wirtschaftsverband für Industrieservice e.V.gen_Folgeblatt

The WVIS (German Economic Association for Industrial Services) is a sector-overlapping interest grouping for enterprises on the industrial services sector. The objectives of WVIS are to represent the economic interest of the fast-growing industrial services sector and, in close cooperation with our member firms, to achieve quality and sustainability by uniform standards as well as to create a common representative appearance. In Europe, the industrial services branch represents a market volume of approximately 100 billion Euro, and about 20 billion Euro in Germany. WVIS is also member of EFNMS – European Federation of National Maintenance Societies vzw. and participated as a partner in the EU-project More4core funded by interreg. The WVIS was founded in 2008 and is domiciled in Düsseldorf.

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WVIS Members by Feb 2016

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Branchen und Dienstleistungen als Wachstumsträger für Industrieservice

Welche Branchen sind für Ihr Unternehmen die drei wichtigsten Wachstums-branchen?

1. Chemische Industrie
2. Kraftwerke, Energie- und Umwelttechnik
3. Automobil- und Fahrzeugbau
4. Maschinenbau
5. Petrochemie

Welche Dienstleistungen sind für Ihr Unternehmen die drei wichtigsten Wachstumstreiber?

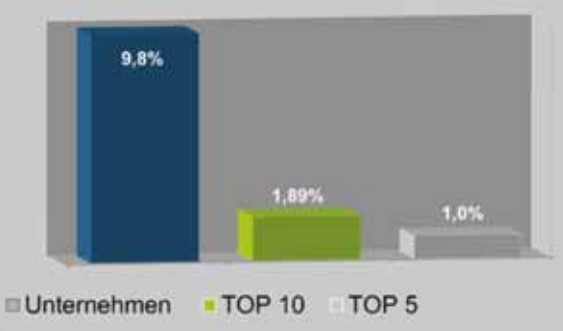
1. Instandhaltung (Wartung, Instandsetzung, Inspektion)
2. Engineering
3. Montage Installation
4. Technische Reinigung / Isolierung / Gerüstbau
5. Standortbetrieb

Bedeutung von Services für das Unternehmen

Segmentierung der befragten Unternehmen

Entwicklung des Umsatzes für Industrieservice (IST)

Umsatzentwicklung für die führenden Unternehmen im Industrieservice in 2014
Durchschnittliche Veränderung (IST) in %



Vergleich der Stimmung für die Branche Industrieservice und das eigene nternehmen:

Wie wird sich das Auftragsvolumen voraussichtlich entwickeln?
durchschnittlich von den Befragten für die Branche Industrieservice und das eigene Unternehmen prognostiziertes Wachstum/Umsatzentwicklung

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Bilfinger SE

Bohle Isoliertechnik GmbH

Borsig Service GmbH

Buchen UmweltService GmbH

BU Bücker & Essing GmbH

CONEXA GmbH - Präzisionsarmaturen

DB Services GmbH

Duale Hochschule Baden-Württemberg

DH+P Gesellschaft für Unternehmensberatung mbH

Ebert Hera Holding GmbH

Eichler GmbH

ETABO Energietechnik und Anlagenservice GmbH Bochum

Euro-Tech GmbH

EVONIK Industries AG

Fachhochschule Dortmund

FAG Industrial Services GmbH

FVI – Forum Vision Instandhaltung

Fraunhofer Institut IML

G.I.S. Gesellschaft für Industrieservice AG

GFIN e.V.

Hammann GmbH

HANSA-FLEX AG

Henkel AG & Co. KGaA

Hochschule Aalen

HRW Hochschule-Ruhr-West

IFÜREL EMSR-Technik GmbH & Co.KG

InfraServ Gendorf Technik GmbH

Infraserv GmbH & Co. Höchst KG

InfraServ GmbH & Co. Knapsack KG

ISS International Business School of Service Management

KIEL Montagebau GmbH

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GATSBY

TERRE ROUGE
ESCH-SUR-ALZETTE, LUXEMBOURG

The Terre Rouge was a big part of the iron ore industry in Esch-sur-Alzette (Luxembourg). The history of the site began in the year 1870 when, after the discovery of iron ore in the soil, authorisation was given to start the construction of the “Brasseur” factory. In 1872, the first iron ore furnace was fired up, and by 1899, three more were constructed and production started. In 1911, the factory was connected to the mill in Esch-Belval, forming a massive steel complex. In 1937, the factory, consisting of a power station, blast furnaces and ore bunkers, was taken over by ARBED (now part of the ArcelorMittal Group). On the site, ARBED established one of the world’s biggest and most modern blast furnaces on 10 June 1965. Production reached its peak in 1974. The blast furnaces were shut down in 1977 and were eventually dismantled and partly sold to Asian countries and are still in use today. As the area’s raw materials began to dry up, the remaining activities on the site were shut down in 1997.

Text: www.industrie.lu, www.off-limits.eu , www.darbiansphotography.com and www.28dayslater.co.uk / Picture: Urbanexploration.nl

Picture: Ronnie Husson

PROJECTPARTNERS M4C

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AFIM

AFIM is the French Maintenance Society, one of the largest and most established associations of Europe. It was created in 1901, and has 1600 members (of which 1100 companies).

AFIM aims to promote and support development of the sector through the work areas: Health and safety, Education, Representation with government stakeholders and Promotion. Among its activities are the annual Maintenance monitor, a analysis of MRO-related work and expenses in France, representation of industry with normative institutions and education boards, and support in the development of standards for classification of Maintenance services and products.

The objective of AFIM in the project is to benefit of the increased scale of the network to further develop norms and standards.
www.afim.asso.fr

BEMAS, The Belgian Maintenance Association vzw-asbl

BEMAS is a dynamic non-profit organisation for Maintenance Professionals in Belgium, addressing both maintenance managers in the industry and the suppliers of maintenance services and related products. The mission of BEMAS is 'to help our members to become better in maintaining their physical assets and to create a larger awareness and appreciation for maintenance activities and the responsible maintenance managers, by sharing knowledge on maintenance, production reliability & asset management'. In the past 10 years they have grown from 50 to more than 650 members active in +/- 450 companies.

BEMAS an active member of the EFNMS, the European federation of National Maintenance Societies, where we exchange ideas and develop knowledge and practices related to maintenance on a European level (eg training, certification, safe maintenance, KPI's in maintenance).
www.bemas.org

BOM, Development agency of the province of Noord-Brabant, The Netherlands

Regional development agency for the province Noord-Brabant
BOM is the regional responsible for establishing public-private partnerships in the areas identified to be of strategic importance for the province. Maintenance is one of them.

As such, BOM was one of the founding fathers of what now is the Dutch Institute – World Class Maintenance. BOM played a crucial role in supporting Business to develop structural, productive partnership with Government, Research and Education institutions in the region. In 2010 this lead to the approval by a broad consortium that includes major businesses, but as well national government (Ministry of Economic Affairs) and all major national research institutes to create the physical cluster for the Maintenance sector in Breda, south of the Netherland.
http://www.bom.nl

DIWCM, Dutch Institute – World Class Maintenance

Maintenance has been earmarked in the national economic development agenda as a priority area. Based on a regional network in the south of the Netherlands, in 2010 the Dutch Institute World Class Maintenance was created. It is a public-private platform with membership from major asset owners, national research and education institutes and government, located in the south of the Netherlands. The program manages 15M Euro budget for the period 2010-2015.

DI-WCM represents asset owners from the aviation, energy, infrastructure, maritime and process industries.
The main objective of DI-WCM is to support cross-sectoral initiatives in Research & Development, Education and to support business development.

After the subsidized period of our foundation DI-WCM, is the new foundation World Class Maintenance (WCM) now as a house. Through intensive collaboration with five founding partners ' - NedTrain Sitech Manufacturing Services , Stork Asset Management , Tata Steel and SPIE - there is now an organization that is going to ensure that there is also innovated in the future to maintain.
www.worldclassmaintenance.com

EFNMS, European Federation of National Maintenance Societies

EFNMS is the European Federation of National Maintenance Societies. It represents about 10.000 MRO companies, organised in 21 national societies. The current activities of EFNSM include coordination of maintenance matters between National Maintenance Societies, with a focus on exchange of experience on good maintenance management practices, awarding prizes and distinctions related to maintenance, promote the publication of the results of scientific and practical work in the maintenance field and drafting maintenance guidelines. EFNMS organizes bi-annual international conferences and conventions about maintenance.

The Objective of EFNSM in this project is to develop the organisation into the EU-platform for policy development related to MRO. It aims to match this broadened scope with organisational expansion that includes permanent, dedicated staff in order to better represent the MRO sector at EU-level.

www.efnms.org

MEC, Maintenance Education Consortium

The Dutch foundation Maintenance Education Consortium (MEC) was created in 2009 as platform for schools to develop and implement ´World Class Education´ on Maintenance, Repair and Overhaul. The MEC consortium currently consists of seven regional training centers (“ROC”), three University Colleges and centre of expertise Kenteq. MEC established a formal collaboration with five universities: TU Delft, TU Eindhoven, TU Twente, University of Tilburg and the Dutch Defence Academy (in collaboration with University of Groningen). Through this collaboration, the entire education (professional) column is represented.

MEC has become the expert in the Netherlands for cross-sectoral maintenance education, as well as the main centre of expertise for businesses. MEC is member of INN-MAIN, the only international network of education institutes focused on MRO, which aims to innovate and make comparable MRO education across Europe.

MEC was discontinued since 2015.

VOKA, Chamber of Commerce Antwerpen - Waasland

VOKA is the Chamber of Commerce of Antwerp-Waasland, covering the region of Antwerp and the surrounding port area. Voka aims at stimulating economic activity and intends to create an optimal framework for successful enterprises. We contribute to supporting the economic development of our region by lobbying, networking and offering specific services to businesses.

Its membership consist of 3.000 companies, of which 90% are SME's. It membership in large industrial companies represent more than 80% of employment in the region. These companies are mainly active in the chemistry, contracting and logistics sectors. VOKA key roles are to formulate Industry viewpoints on a wide range of issues, and represent these at local, national and European level. It organizes competence networks on topics relevant to the region.

www.voka.be/antwerpen-waasland

Kamer van Koophandel Oost-Vlaanderen

WVIS

WVIS is the German Economic Association for Industrial Services. It is a cross-sectoral interest group in the industrial services sector, created in 2008. It has 31 members, which in total represent 20 billion euro business in Germany and 100 billion in Europe, and employ over 100.000 people. WVIS aims to represent the interests of the fast growing sector, with a focus on (internationally) aligned standards and common voice towards policymakers.

WVIS has established a network of Universities and Vocational training centres with MRO programmes, and maps / ranks them based on detailed quality analysis. WVIS supports certification of service suppliers using a best-practice scheme, and coordinates annual market-research analysis in Germany.

www.wvis.eu

WVIS

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