

## BUSINESS DEVELOPMENT

Business Concept for Railway

Vehicle Interior Lighting

Refurbishment projects

LAHTI UNIVERSITY OF APPLIED  
SCIENCES

Degree Programme in International  
Business Management

Master's Thesis

Spring 2017

Jukka Kärkkäinen

Lahti University of Applied Sciences  
Master's Degree Programme in International Business Management

KÄRKKÄINEN, JUKKA: Business development.  
Business Concept for Railway  
Vehicle Interior Lighting  
Refurbishment projects

62 pages, 50 pages of appendices

Spring 2017

ABSTRACT

---

Nowadays vast majority of the new trains' interior lighting systems use Light Emitting Diode (LED) technology but the technology is rather new in this market sector. The LED technology's advantages are indisputable and therefore it has superseded fluorescent lighting and other older technologies. LEDs' small size, long life time, low energy consumption and high reliability enable the best possible solutions from the design and life cycle costs point of views.

Most of the new build train projects start from a scratch. An interior design is tailor made for a certain project and customer. This results long lead time and high development costs. Competition is the most intense on these projects. Assumable new build projects' tailoring requirement will not change in the future.

This thesis concentrates on passenger train refurbishment markets and LED upgrading projects. The aim of this study is to find a new market space for the case company, Company x, by using a Blue Ocean strategy for a new business concept development. The new business concept is developed especially for the UK railway refurbishment markets and targeted to the platform A and B trains. LED lighting products, marketing material and plan are created to standardize and accelerate an approach, as far as possible.

Theoretical part of this thesis explains business strategy's importance and the Blue Ocean strategy development process. Railway's share of the global transportation is studied. Energy usage and CO<sub>2</sub> emissions are compared to other transportation methods, to explain railways importance in global emission reduction initiatives. The UK railway and refurbishment markets are researched, expected passenger growth evaluated, and its specific characteristics explained. A questionnaire is completed to enlighten refurbishment project stakeholders' requirements, expectations and special characteristics.

The outcome of this thesis is business concept that will be tested in the refurbishment markets and further developed based on the results.

Key words: Railways, Refurbishment, Blue Ocean strategy, LED lighting

# CONTENTS

## ABBREVIATIONS

1	INTRODUCTION	1
1.1	Background	1
1.2	Research questions, objectives and scope	3
1.3	Limitations	5
1.4	Theoretical framework	5
1.5	Structure of the research report	6
2	THEORETICAL FRAMEWORK	7
2.1	Strategy and Strategic business management	7
2.2	Blue Ocean Strategy	8
2.3	Six principles of blue ocean strategy development	9
2.4	Strategic pricing and target costs.	13
2.5	Exceptional benefit for the customer and customer experience	14
3	GLOBAL RAIL INDUSTRY	16
3.1	Transportation modes and their shares from the global transportation	16
3.2	Transport sector's energy usage	17
3.3	CO <sub>2</sub> emissions in transport sector	18
3.4	Railway Transportation Development	19
4	UK RAIL INDUSTRY AND REFURBISHMENT MARKETS	21
4.1	UK Railway sector	21
4.2	Passenger railway vehicles age	23
4.3	Railway lines electrification and future growth	24
4.4	Passenger trains' service life and reliability	25
4.5	Train refurbishment markets in the UK	26
4.6	Train Life extension project	28
4.7	Reasons for the refurbishment projects in the UK	29
4.8	Traction Electricity Charges	31
4.9	Enhanced Capital Allowance (ECA) Scheme	31
5	EMPIRICAL RESEARCH CONTEXT AND METHODS	33
5.1	Research context	33
5.2	Research Methods	33

5.3	Questionnaire	36
5.4	Validity and reliability	38
6	RESULTS AND ANALYSIS OF THE SURVEY	40
6.1	Questions and analysis	40
7	SUMMARY AND CONCLUSIONS	47
7.1	Railway industry and environment	47
7.2	Business development	48
7.3	Blue Ocean	49
7.4	Results	52
7.5	Conclusions	56
	REFERENCES	58
	APPENDICES	63

## ABBREVIATIONS

CO <sub>2</sub>	Carbon Dioxide
DfT	Department for Transport
ECA	Enhanced Capital Allowance
EU27	European Union of 27 Member States
EU28	European Union of 28 Member States
GDP	Gross Domestic Product
LED	Light Emitting Diode
OEM	Original Equipment Manufacturer
PKM	Passenger – Kilometre. Unit of measurement, representing the transport of one passenger over a distance of one kilometre.
PRM TSI	Technical specifications for interoperability relating to accessibility of the Union's rail system for persons with disabilities and persons with reduced mobility
ROSCO	Rolling Stock Operating Company
TKM	Tonne – Kilometre. Unit of measurement of goods transport which represents the transport of one tonne of goods over a distance of one kilometre.
TOC	Train Operating Company

## 1 INTRODUCTION

In this chapter, the background, basis, case company, targets and structure of the thesis are defined.

The aim of this study is to find new market space for the case company, Company x, by using the blue ocean strategy for developing a new business concept for their vehicle lighting business unit. The blue ocean strategy is explained in the chapters 2.2 and 2.3.

Company x manufactures interior lighting systems for railway vehicles, busses and other commercial vehicles. For railway vehicles, company x provides also exterior lights and interior aluminium ceiling panels and structures. The new business concept is developed for the railway refurbishment markets. Refurbishment projects' stakeholders, requirements and products are slightly different compared to the new rolling stock manufacturing projects and by developing a different approach to these projects, it could form a competitive edge for the company x.

Company x's strategy emphasizes necessity to invest on refurbishment markets and recognizes an opportunity for substantial business growth through that sector.

### 1.1 Background

Nowadays, business is global and companies are facing harder and harder competition. The Fortune Global 500 list ranks corporations worldwide by their revenue. Number of Chinese companies on the list has increased by 20-fold and Indian companies by 8-fold. This means that developing countries not only provide new markets, but also significant number of competitors. (Kim & Mauborgne, 2015, 21)

Companies need to find ways to differ from the competition and reduce operation costs. How to offer added value to the customer and at the same time value for the money, which is superior compared to the competitors?

Continuous product and business development is an essence. Differentiation from the competitors is important and reduces importance of the pricing in the buyer decision making process. Companies should be thinking how to offer some value that competitors don't have. Differentiation increases profitability and creates new markets spaces. (MacMillan & McGrath, 1997)

Global warming and environmental issues are important and they are accelerating sustainability in business.

*"We use more of the Earth's resources than Earth can regenerate, and natural systems can't cope with the waste from an economy built on ever-rising throughput of materials (DNV GL, 2015, 6)."*

We have to take account how we treat the planet and what steps we need to take, to save it to the following generations. Climate change encourages governments to ratify global agreements to reduce CO<sub>2</sub> emissions. Paris Agreement, which was negotiated at the climate conference in December 2015, defines a global plan to limit global warming well below 2°C (European Commission, 2015). These imperative actions limit some businesses but at the same time, it breeds new sustainable business and business models for example relating to solar and wind technologies (Crane & Matten, 2016, 527).

Railways are highly important for the people and industry all around the world. Due to the globalization and urbanization, more and more goods and passengers are transported daily, by all transportation means, including railways, road transportation, sea and aviation. According to the Railway handbook 2014, railways is one of the most environmental friendly transportation methods, so it benefits on the CO<sub>2</sub> emission reduction requirements and will be increasing its share of transportation. (IEA & UIC, 2014)

The case company, Company x, is a high technology electronics manufacturer that has been involved in the public transportation markets over 45 years. Company x is family owned and its turnover in 2015 was 52

million Euros. Company x has 340 employees. It all started from the fluorescent lighting inverter that was developed for the bus industry. Vehicle lighting business unit's portfolio is expanded ever since and includes now full interior lighting systems, ceiling panels and their structures and exterior lights. Company x is based in Finland and it has manufacturing sites also in Poland to provide better service to central European customers and in the USA for the North-American markets. (X, 2016)

Company x is the market leader in this niche B2B sector. To be able to maintain market leader position, and to increase revenue and profitability, Company x needs constantly develop their product range and business model.

## 1.2 Research questions, objectives and scope

The aim of the study is to research global railway and the UK refurbishment markets, in order to develop a new business concept for an interior lighting system LED upgrade projects, for the selected train platforms. The new business concept's best practices should be reproducible for other train platforms in the UK. The new business concept is developed for the case company, Company x. Selected market area is the UK due to author's own experience in this market area. Selected train types are Platform A and Platform B manufactured by the train manufacturers Y and Z. These two platforms were selected due to their large fleet sizes.

Importance of a strategic business management and blue ocean strategy concept are explained. The size of the UK refurbishment market is evaluated and refurbishment projects' characteristics are researched by using a questionnaire. Ultimate goal is to increase revenue and profitability of the Company x, and to secure market leading position in the railway vehicle interior lighting sector globally. To ensure growth in the future, Company x should find more business in addition to the OEM markets, which are limited and where the competition is the most hardest.



This is believed to be possible by using the blue ocean strategy to create a new business concept that is developed especially for the refurbishment markets.

The main research problem of the study:

- How to win more business in the railway vehicle refurbishment markets in the UK and later globally, to increase Company x's revenue and profitability?

In order to respond to this ultimate research problem, following questions are answered in this study.

- What are the roles of the strategic business management and blue oceans strategy for the company's profitability and growth?
- What is the future of the railway transportation globally and in the UK?
- What is the size of the refurbishment markets in the UK?
- What are the key drivers in the railway vehicle refurbishment projects and how they need to be taken account in an interior LED lighting system?
- What are the most important factors for a customer in a refurbishment project that are relating to an interior LED lighting system?
- Is a customer interested to explore new pricing structures and/or Enhanced Capital Allowance (ECA) scheme's tax relief option?

Objectives of the study are to create an efficient, focused business concept for the UK refurbishment projects and to develop a LED lighting product ranges for the Platform A and B trains. Potential customer base list is developed for the new business concept. Interest in innovative pricing structures and possible tax relief opportunities will be evaluated.

### 1.3 Limitations

This research is limited to the UK railway markets and a business concept development for two train fleets. Product development process, and products itself, are not presented in this study in details. Innovative pricing structure models will be introduced in the idea level, but their functionality and development are excluded from this study. Research method used in this thesis was action research by using qualitative and quantitative methods. Distribution of the questionnaire was limited and it was assigned to the UK based stakeholders only. Due to these restrictions and UK railway markets' special characteristics, findings and results might not be transferrable directly to other market areas.

### 1.4 Theoretical framework

Theory is based on the global rail industry researches as well as business management, blue ocean strategy and sustainable business related literature, articles and electronic information sources. Company x's employees, local representatives and key customers' discussions, are used to understand present situation, outlook for the future and key requirements driving the industry on refurbishment projects.

Questionnaire will be providing in depth information about the refurbishment projects requirements and characteristics.

Author's own experience in the business and customer interface is extensive and forms part of the knowledge base. Author has been working for the Company x since 2004 in the project department as a Project Engineer, Project Manager, Senior Project Manager and present in the sales department as an Area Sales Manager for the UK and Ireland.

Action research method has been used on this thesis first to describe the problem and later in the business concept development process. Often action research method is described as a problem solving method but was considered to be effective tool for a business concept development as well. Action research, and its four activities; planning, acting, observing

and reflecting, are important steps in any business development and implementation of the new business concept.

### 1.5 Structure of the research report

Theoretical background is explained in the chapter two. Chapter three introduces the global rail industry. Chapter four concentrates on the UK refurbishment markets' potential, its special characteristics and requirements. Chapter five presents empirical data and results of the survey. Chapter six presents the results and analysis of the survey. Last chapter, chapter seven, includes conclusions, results and summary of this study. The new business concept, marketing material, design concept documents, customer listing, and franchise map to support marketing activities of the company x, are presented in the appendices.

## 2 THEORETICAL FRAMEWORK

In this chapter the importance of a company strategy, strategic business management and business development are explained. Blue oceans strategy is described and its relation to a new market space and business concept development is defined.

### 2.1 Strategy and Strategic business management

Strategic business management leads a company towards strategic goals and objectives. Often strategy details company's long term objectives, present situation in the markets, strengths, weaknesses, opportunities and threats. Strategical business management then implements developed strategy by using organization resources. (Analoui & Karami, 2003)

*“The term Strategy is derived from the Greek ‘strategos’ meaning a general set of manoeuvres carried out to overcome an enemy” (Eden & Ackermann, 1998, 3).*

Traditionally a company strategy is developed by analysing industry and environmental conditions, in which they operate. Strengths and weaknesses are assessed against competitors and based on these analyses, companies try to find a position where they can outperform their rivals. Typically a company chooses then to differentiate itself from the competition for a premium price or to pursue lower costs. Organization sets their procurement, manufacturing, marketing, budgets and financial targets accordingly. So the environment defines company's strategy. When one company wins, another company will lose, as they are tied in the same market space. (Kim & Mauborgne, 2009)

Porter (1996) says that companies must be flexible and respond rapidly to a competition and market changes. It should also be remembered that operational effectiveness is not strategy but both are essential to superior performance. A company must deliver greater value to customers or comparable value at a lower cost. (Porter, 1996)

Companies concentrating to beat their rivals in the known market space, red oceans, end up to compete with the price and quality. Number of buyer groups is limited and known by the rivals. Creating a new market space requires different strategical approach and thinking. Managers should be looking systemically across the market space boundaries, to be able to find new territories and buyer groups. Companies finding these new market spaces and buyer groups, are building their brand equity and that can last for decades. (Kim & Mauborgne, 1999)

Differentiation from the competitors is important and reduces importance of the pricing in the buyer decision making process. Companies should be thinking how to offer some value that competitors don't have.

Differentiation increases profitability and creates new market spaces. (Macmillan & McGrath, 1997)

## 2.2 Blue Ocean Strategy

Often companies' strategies are concentrating too much on the known market space, existing competitors and how to cope in the competition. It is called red ocean strategy. Competition is in the core of the strategy, instead of a customer. More valuable for the company would be finding a new market space, blue ocean, where the demand is created instead of fought over. Often the blue ocean is created within the red ocean and there is only little or no competition at all. Blue oceans are not all about technology innovation, although they might be involved, but they are developed by studying market space a company is operating. Figure 1 compares red and blue oceans strategies. (Kim & Mauborgne, 2004)



Figure 1: Red Ocean Strategy versus Blue Ocean Strategy (Kim & Mauborgne, 2004)

Sometimes a blue ocean will be created far away from the industry boundaries, but more often a blue ocean can be found within a red ocean, by expanding boundaries of an existing industry. (Kim & Mauborgne, 2015).

A company faces good and bad times, based on their strategical decisions. Organization needs to understand how to reshape their blue ocean, because every blue ocean will be copied and it becomes a red ocean over a time. By understanding reshaping process, blue ocean creation can be repeated and be part of a company's strategic processes. (Kim & Mauborgne, 2015).

### 2.3 Six principles of blue ocean strategy development

Companies should be trying to find ways to develop a gap to their competitors and to get out from the red ocean. Blue ocean strategy development helps to change industry boundaries to build the distance. Challenge is to recognize economically strong blue ocean opportunities. (Kim & Mauborgne, 2015).

A company needs to get rid of a commonly agreed industry boundaries which are determining competition. A company needs to acquaint with

alternative industries, strategic and buying groups, supplementary product- and service solutions, different timing and how alternative industries are highlighting functionalities and emotional factors. This way a company understands how to reshape industry and move towards a blue ocean. (Kim & Mauborgne, 2015)

#### Principle 1: Explore alternative industries

Product or service, which is different, but does the same task or functions, is a replacement. Alternative product or service is different, fulfils different tasks, but responds to the same need. For example, cinema and restaurant are alternatives for each other's. They both offer leisure time enjoyment, but totally different way. It should be remembered that a company is competing not only against own industry rivals but also with alternative industry rivals, who are offering alternative products or services. (Kim & Mauborgne, 2015)

Similarly, by understanding alternative industries, a company can reshape their products and services to offer buyers a whole new experience and additional options. (Kim & Mauborgne, 2015)

#### Principle 2: Explore strategic groups within an industry

Strategic groups are the group of companies, within the same industry, who has similar strategy. Most of the companies are concentrating improving their position within the group. Jaguar, BMW and Mercedes concentrate to compete against each other's within the luxury car segment, and family car manufacturers concentrate to beat each other, within their own segment. Neither of the groups concentrates to other group's activities as they do not seem to be in competition. Blue oceans can be created in between the strategic groups by examining strategic groups within the industry and finding out what is influencing buying decisions, to buy within the group. (Kim & Mauborgne, 2015)

#### Principle 3: Explore buying groups

Companies within the same industry, often define the target customer or buyer same way. Buying decision is done by chain of buyers and influencers, who are involved directly or indirectly. Buyer, who buys the product or service, might not be the same who uses it. There might also be significant influencers behind the buying decisions. These groups are overlapping each other's and often they value product or service differently. (Kim & Mauborgne, 2015)

A blue ocean can be found if commonly accepted target customer or buyer definition is contested and a company refresh their products or services to offer value for the buyers who has not been taken account in the past. (Kim & Mauborgne, 2015)

Principle 4: Explore supplementary products and services.

Product and service value is influenced by other, supportive products and services offered. Companies within the same industry, quite often offer similar product- and service packages, and there is very little differentiation. (Kim & Mauborgne, 2015)

Supplementary products and services can offer an opportunity for higher valuation. It is important to evaluate and understand if the buyer seeks service or product packages. A company needs to evaluate what happens before the purchase, when the product or service is used and afterwards. (Kim & Mauborgne, 2015)

Principle 5: Explore Functional and emotional appeal to buyers.

In some industries companies are competing with price and functionality, when in another industry competition focuses in emotions and feelings. However, often decision is not based only another of these set of factors but both of them counts. Companies who do a business in the same industry often have the same vision of their customers' needs and a customer has learned what to expect to get from the industry and wants to have it, at a lower cost. (Kim & Mauborgne, 2015)

Principle 6: Explore timing



Trends and megatrends change industries. Internet, music downloading through iTunes and importance of the environmental friendliness are good examples. A company needs to investigate trends and find a correct timing for their products or services. Or alternatively, adjust their products or services, to respond current trends. Most of the companies are reactive instead of proactive and they adapt new technologies too slowly and only if it is imperative for them. (Kim & Mauborgne, 2015)

Figure two explains what is required when shifting the focus of strategy from head to head competition towards new market space creation.

The conventional Boundaries of competition	Head to head competition	→	Creating new market space
Industry	Focuses on rivals within its industry	→	Looks across substitute industries
Strategic group	Focuses on competitive position within strategic group	→	Looks across strategic groups within its industry
Buyer Group	Focuses on better serving the buyer group	→	Refines the buyer group of the industry
Scope of product and service offerings	Focuses on maximizing the value of product and service offerings within the bounds of its industry	→	Looks across to complementary product and service offerings that go beyond the bounds of its industry
Functional orientation of an industry	Focuses on improving price-performance in line with the functional-emotional orientation of its industry	→	Rethinks the functional–emotional orientation of its industry
Time	Focuses on adapting to external trends as they occur	→	Participates in shaping external trends over time

Figure 2: Shifting the focus of a strategy from head to head competition to creating a new market space. (Kim & Mauborgne, 1999)

Industry and competition boundaries need to be stretched, being able to do new strategic decisions, which could lead to a blue ocean. Being able to create a blue ocean you don't need to foresee a new trend nor be a first to utilize it. Instead, creation of a blue ocean is a process, where you evaluate market space systematically from a different angle. When a

company looks over the present market space and competition boundaries, it is able to move away from the red ocean. (Kim & Mauborgne, 2015)

#### 2.4 Strategic pricing and target costs.

Large clientele is willing to buy if the pricing is strategically correct and they feel they get value for the money. This is ensuring greater revenue although it could be appealing to price the product or service higher when it is introduced in the market. This is giving only short term profits and it is important that the pricing is correct from the beginning. Price should be developed from the strategic price point of view, instead of cost of providing this product or service, as shown on the figure 3. When strategic price and profit are known, then the target costs can be calculated. Product or service development this way, gives an advantage to a company and complicate rivals replication. This creates a value innovation and the customer, company and society benefits of it. (Kim & Mauborgne, 2015)

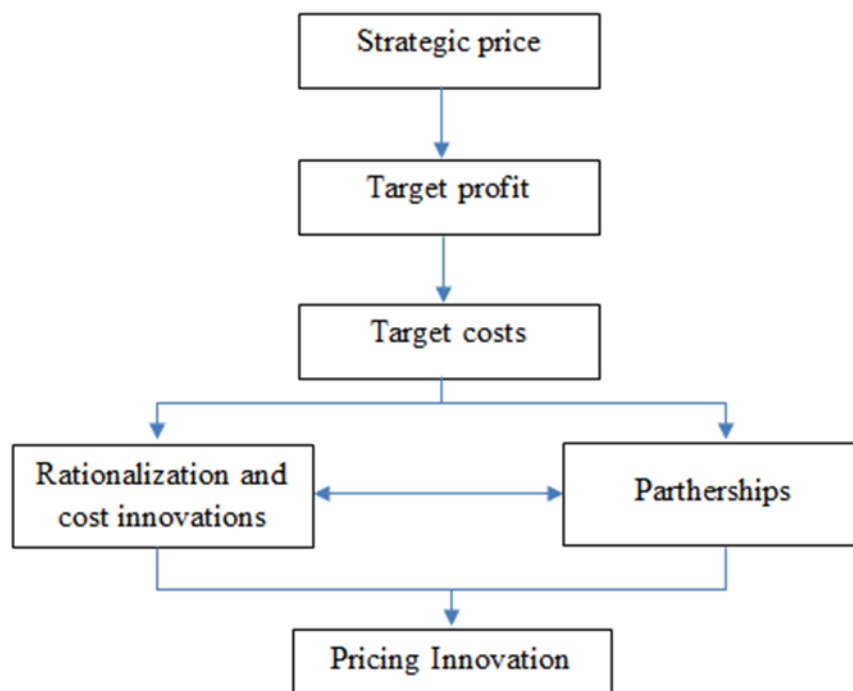


Figure 3: Profit model of Blue Ocean Strategy (Kim & Mauborgne, 2015)

Companies have two key levers to achieve target costs. They are; Rationalization of operations and cost innovations from manufacturing to distribution and another is partnering. If the target pricing cannot be met by using these two levers, then the third lever, pricing innovation should be used to profitably meet the strategic price. (Kim & Mauborgne, 2015)

There is no such a business model, innovation or blue ocean strategy that would ensure that a company succeeds. Any new development threatens present balance and might cause fear and opposition. A company should keep their employees, partners and customers informed and trained about the new idea, before it starts to invest on it. It is crucial to win stakeholders confidence and have discussions with them, explaining benefits and consequences. A company, who has these discussions, recognizes that it pays out and strengthens cohesion. (Kim & Mauborgne, 2015)

## 2.5 Exceptional benefit for the customer and customer experience

A company needs to create benefits for the customer. Still, many of the companies, when introducing a new product or service, fail to create exceptional benefits for them. Customer benefits should be in the centric of the new product or service development. New product technology or service must help customer business profitability, safety or simplicity, otherwise it does not sell. (Kim & Mauborgne, 2015)

Understanding the customer experience is a key to a long term success in the business.

*“Eighty percent of companies believe they deliver a superior customer experience, but only 8 percent of their customers agree” (Allen et al., 2005).*

This proves that companies do not understand their customers' thoughts as well as they think they do, and delving into the issue is important.

Based on Kerry Bodine (2014), we are moving to the “Age of the Customer”. Companies that will be succeeding in the future will be those who truly understand their customers. Customers who trust and are

satisfied with the product they have bought, and with the service they got from their supplier, will be most likely using the same supplier in the future as well. (Bodine, 2014)

But, it should be remembered that at the same time when companies are looking for a new customer, they should keep hold of their existing customer base as well. Keeping the old customer is easier and more cost effective than finding a new one. When a customer is satisfied with the supplier, they will stay with that supplier. But, a supplier has to earn its customers loyalty continuously, because they don't owe it to the supplier. (Lawrence, 2012)

### 3 GLOBAL RAIL INDUSTRY

This chapter introduces global rail industry and its share of the transportation. Railway industry's energy usage and CO<sub>2</sub> emissions are compared to other transportation methods to explain its importance in the future by its implication to achieve emission reduction goals.

Passenger trains' expected service life is defined by considering reliability aspect. Last section explains reasons for passenger trains' refurbishment projects and lists factors to be considered in decision making process between a refurbishment and a new train purchasing.

#### 3.1 Transportation modes and their shares from the global transportation

Transport is movement of goods and people. It is divided into road, rail, sea and aviation sectors. The economy growth and society are tightly connected with the transportation. The transportation sector in the EU employs directly around 10 million people and generates 5% of the GDP. Also companies' competitiveness is heavily affected by the logistics, as it causes 10-15% of the costs of a product for the European companies. Transportation is important for the citizen as well, because, on average, more than 13% of the European household's budget is spend on transportation of goods and services. (European Commission, 2014)

Globally, road transportation's share is the biggest in the passenger transportation and majority of the goods are transported by sea. Railway sector's share of the global passenger transportation is 6,3% (pkm) and freight transportation 9% (tkm) as shown on the figure 4. (IEA & UIC, 2015)

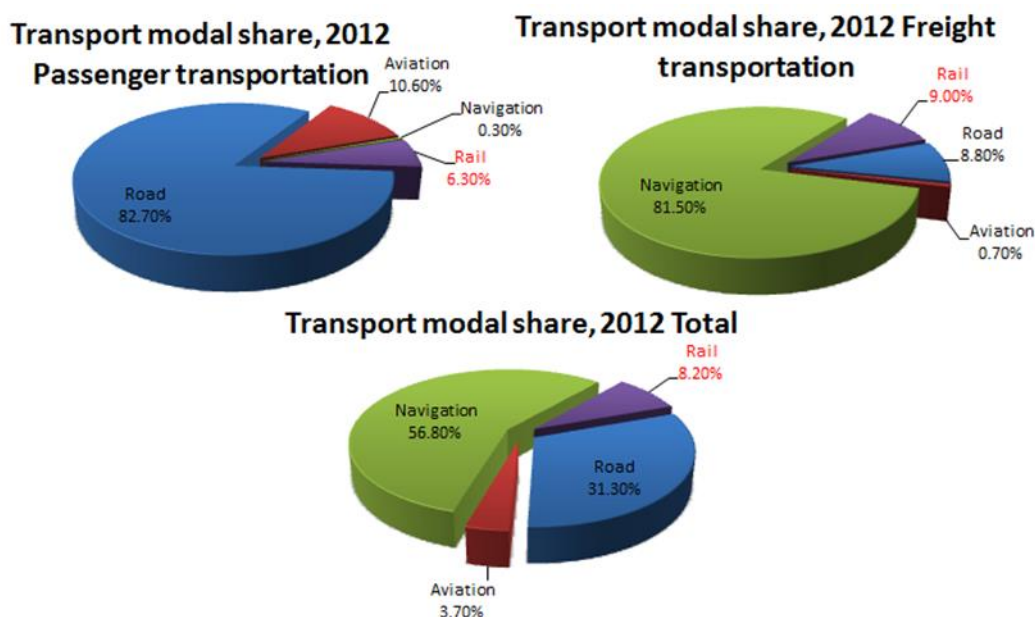


Figure 4: World Transport Modal Share 2012 in passenger-kilometres (pkm) and tonne-kilometres (tkm). (IEA & UIC, 2015)

Based on the Eurostat (2016) freight transport statistics, within the EU-28, road transportation has 74,9% share and rail has 18,4% share of the freight transportation total tonne-kilometres. Remaining 6,7% of the freight is transported on inland waterways. There are noticeable differences on the shares between the countries. For example, in Ireland road transportation share is 98,9% and rail only 1,1%, when again in Latvia, figures are other way around, and road transportation's share is 18,8% and rail 81,2%. Rail transportation's relatively high share, in the Baltic countries, is mostly caused by the Russian energy products' transportation to Baltic ports. (Eurostat, 2016)

### 3.2 Transport sector's energy usage

Transport sector consumes 28,1% and rail sector 2,1%, of the global energy usage. It means that less than 0,6% of the world's energy is consumed in railways. Between 1975 and 2011 railway specific energy consumption has decreased by around 50% in both, passenger and freight sectors. (IEA & UIC, 2015)

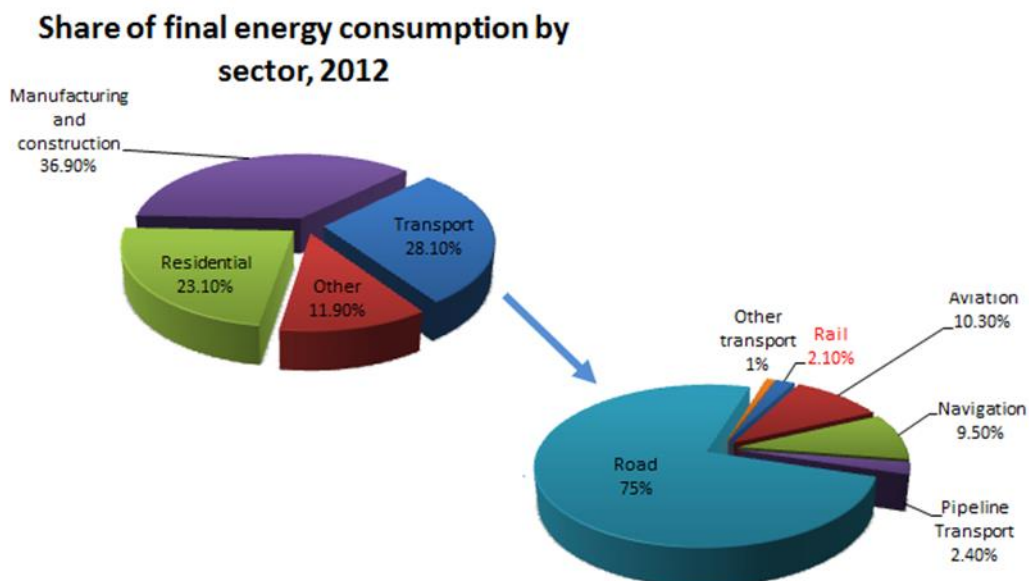


Figure 5: Global share of final energy consumption by sector, 2012. (IEA & UIC, 2015)

Shares are slightly different within the EU-28. Transport sector has 33,2%, industry 25,9%, residential 24,8%, services 13,3% and others 2,8% share of the final energy consumption as shown in Eurostat (2016) consumption of energy statistics. (Eurostat, 2016)

### 3.3 CO<sub>2</sub> emissions in transport sector

According to IEA & UIC (2015), transport sector caused 23,1% of the global CO<sub>2</sub> emissions in 2012 and railway sector's share of this is 3,6%. It means that railway sector generate less than 1% of the total CO<sub>2</sub> emissions. Energy usage per passenger-kilometre decreased by 62% and energy required to move tonne-kilometre decreased by 46% from 1975 to 2012. (IEA & UIC, 2015)

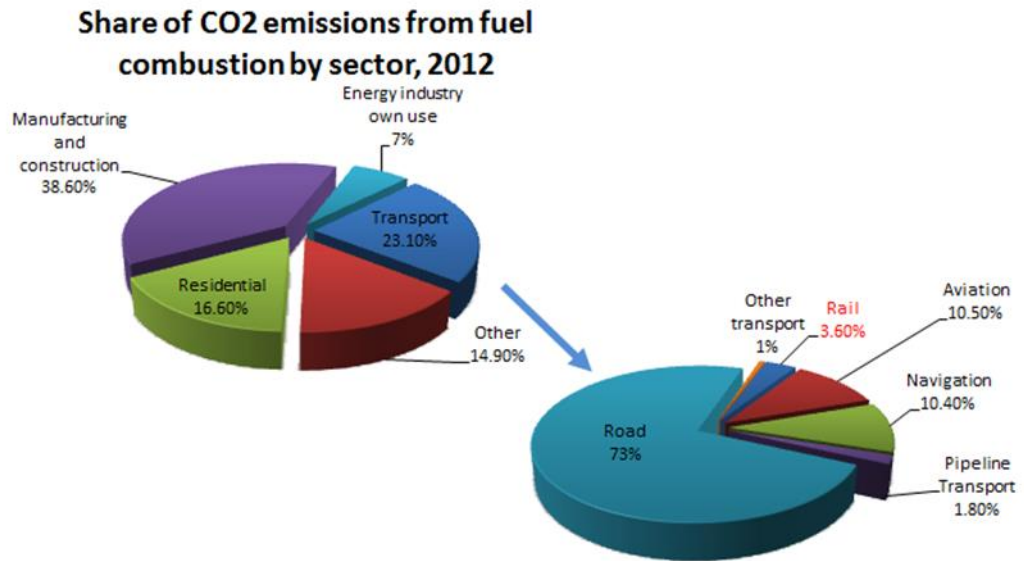


Figure 6: Share of CO<sub>2</sub> emissions from fuel combustion by sector, 2012. (IEA & UIC, 2015)

Generally, greenhouse gas emissions are dominated by CO<sub>2</sub>. For example in the UK, the carbon dioxide represent 82% share of their greenhouse gas emissions in 2013. Since 1990 CO<sub>2</sub> emissions in the UK, have increased by 74%. Transport sector generates around 21% of the greenhouse gas emissions and 25% of the CO<sub>2</sub> emissions in the UK. Transport sector's emissions are the second biggest after the energy supply sector. The main source of the emissions from the transport sector comes from the petrol and diesel usage in road transport and especially in passenger cars. (DECC, 2013)

### 3.4 Railway Transportation Development

Railway passenger transportation grew by 130% in the world since 1975. Within the Europe, increase has been quite moderate, only 4% within the last 20 years. Freight transportation, in EU27 area, decreased by 11% in the last 40 years but for example in the China and Latin America it increased by 500% within the same period. (IEA & UIC, 2014)

*“From an emissions standpoint, every dollar invested in railway infrastructure results in one-third the emissions generated by rail traffic than would have been produced*



*had that dollar been spent on road infrastructure. Shifting transport activity to rail would be instrumental in reaching global targets in support of a 2 degree Celsius emissions trajectory by 2050.” (IEA & UIC, 2014, 5)*

As described on the previous chapter, from the emission point of view, investing in railways is efficient way to reduce emissions (IEA & UIC, 2014). By investing in the railway network, it makes network itself greener and encourage people and freight to use trains, instead of cars (House of Commons, 2010).

There are many reasons which are increasing usage of the public transportation in the future. Larger relative share of the population is older, due to the fertility declining and longer life expectancy. Older people will be travelling more than they do nowadays, as they are healthier and they have more money to spend. Increasing retirement age increases daily work travelling of this group as well. Due to urbanization more people are living in the cities instead of rural areas. Owning a car in the cities becomes more difficult and expensive and varying fuel price reduces attractiveness of the private motoring. Wellness is increasing which means that people become more individualistic, who spends more money to themselves and leisure time and travelling is more important. (Sessa & Enei, 2009)

EU White Paper (2011) introduces a plan to build a competitive transport system in the Europe that will, among other goals, reduce carbon emissions in transport by 60% by 2050. One of the goals is to shift 50% of the medium distance (over 300km) intercity passenger and freight transportation from road to rail, or to sea transport. (European Commission, 2011).

## 4 UK RAIL INDUSTRY AND REFURBISHMENT MARKETS

In this chapter UK railway sector's construction is explained and passenger trains' quantity and age are reflected to the expected passenger growth.

### 4.1 UK Railway sector

Railway sector privatized in the UK in 1993 but still the Government has a strong role in this sector. Department for Transport (DfT) sets overall strategic policy for the railway network in England and Wales, funds investment in infrastructure through Network Rail, regulates rail fares and manages major rail projects. Most of the passenger franchises are also awarded by them in England and Wales. Procurement of new vehicles, especially for major projects, is supported by the Government. (Brooks Events Ltd, 2016)

Network Rail is responsible for control and regulation of train services, and track and other fixed assets in Great Britain, excluding Northern Ireland and most of the London Underground lines. It owns 15,753km of tracks and 2,550 stations. It operates 17 biggest stations, but the rest are managed by train operating companies. It is public sector Company that operates as a regulated monopoly. (Brooks Events Ltd, 2016)

Typically trains are owned by the Rolling Stock Operating Companies (ROSCO's) and leased to the Train Operator Companies (TOC's). There are three main ROSCOs in the UK; Angel Trains Ltd, Eversholt Rail Group and Porterbrook Leasing Company Ltd. Ownership of the rolling stock fleets are shown on the figure 7. (Brooks Events Ltd, 2016)

## Ownership of the existing rolling stock fleet

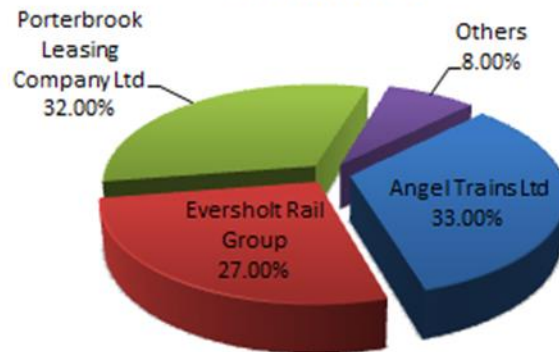


Figure 7: UK railway rolling stock fleet ownership (Rail Delivery Group, 2016).

Rail services are provided either through open access operators or franchises. Majority of the services are franchises, which operate on a specific route or area, by a government specified specification and time period. Open access operators provide their own, supplementary rail service, on chosen routes. (Butcher, 2015)

Franchisees have right to charge passenger fares, which are regulated, and receive financial support from the authority, or pay a premium to run the most profitable services. Subsidy can be paid for the services which are socially necessary and wouldn't be otherwise provided. Service level is monitored continuously by the authority. In 2016 there were 16 franchises operating in England and Wales and two in Scotland. (House of Commons Library, 2016)

Open access operators have to apply to run their proposed service. They are operating on a commercial basis, without financial support from the authority. Open access operators' fares are not regulated. (House of Commons Library, 2016)

The maximum length of the rail franchise is set to 15 years by the European law, articles 4.3 and 4.4 of the regulation 1370/2007/EC. In certain circumstances length of the franchise can be extended to 22,5

years. The UK government has followed recommendations given by the Brown Report in 2013, that the longest franchises should be avoided and shorter initial franchises, with potential extensions used instead. (House of Commons Library, 2016)

Department for Transport (DfT) is franchising authority for the rail network. DfT is responsible for designing and procuring new and replacement rail franchise services on the national rail network, targeting value for money services for passengers and taxpayers. DfT provides annually updated rail franchise schedule which presents start and end dates of franchises and timings for competitions. Latest rail franchise schedule has been released in December 2016 and is shown in appendix 2. (Department for Transport, 2016)

At the end of 2015 there were 18 active franchised or concessioned and five non-franchised passenger train operating companies in the Great Britain. They are: Abellio Greater Anglia, Arriva Trains Wales, c2c, Chiltern Railways, CrossCountry, East Midlands Trains, Eurostar, First Hull Trains, First TransPennine Express, Gatwick Express, Grand Central Railway Company, Great Western Railway, Heathrow Express, London Midland, London Overground Rail Operations Ltd, Merseyrail, Northern Rail, ScotRail, Southeastern Trains, Southern/Thameslink/Great Northern, South West Trains, Stansted Express, Virgin Trains and Virgin Trains East Coast (Brooks Events Ltd, 2016)

#### 4.2 Passenger railway vehicles age

Based on the figures presented by the Rail Delivery Group (2016), presently there are 12,968 passenger vehicles in the UK. 6,247 of those are built in the last 20 years and remaining 6,271 are more than 20 years old. Present age of the rolling stock fleet is shown in the figure 8.

## Age of the existing Rolling Stock fleet

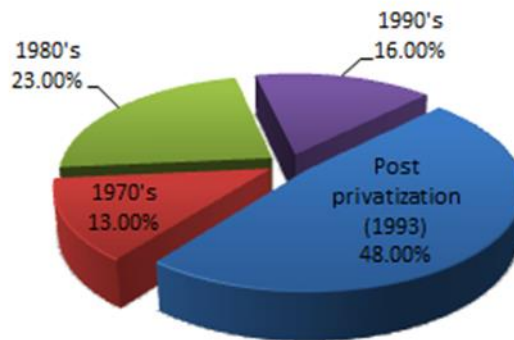


Figure 8: Present Age of the National Passenger Rolling Stock Fleet. (Rail Delivery Group, 2016)

Out of 12,968 passenger vehicles in the UK, 3,925 are diesel trains and 9,043 electric trains. None of the present diesel trains are compliant with the latest EU emission requirements, Stage IIIB, set for the diesel engines used in railways. Nevertheless, existing UK or EU legislation does not prevent continued operation of these existing diesel trains and Rail Delivery Group believes that it will not be economically sound to replace old diesel engines by Stage IIIB compliant engines. (Rail Delivery Group, 2016)

### 4.3 Railway lines electrification and future growth

Electrification of the railway lines has a major role in the railways development in the UK. Presently, 42% of the rail track mileage is electrified and by 2045 this is estimated to be 72% (high scenario). It is important to increase electrification level of the railway lines because electric vehicles reduce CO<sub>2</sub> emissions. In addition their total maintenance and capital leasing costs are significantly lower (-37%) compared to diesel vehicle. Also their reliability and availability is higher and noise level is lower compared to diesel vehicle. (Rail Delivery Group, 2016)

There is a high demand to increase railways capacity in the UK, to cope with the average 3,9% passenger miles growth per year. Rail Delivery

Group (2016) estimates that, 13,000 to 20,000 new electric and bi-mode rail vehicles will be required over the next 30 years. This would increase an overall passenger fleet size by 51-99% and increase electric fleet's share from present 70% to 90-95%. New, self-powered vehicles will be needed as well, as some part of the tracks will remain non-electric and rolling stock fleets operating on those tracks, need to be replaced before route electrification. Requirement for self-powered vehicles is estimated to be 1,300 – 1,900 vehicles by 2045. Number of these self-powered trains is highly dependent on the electrification programme progress and development of the battery-powered train technology. (Rail Delivery Group, 2016)

#### 4.4 Passenger trains' service life and reliability

Typical life of the passenger train is 30 years for diesel trains and 35 years for electric trains. Technical researches suggest that life extension of the train is, in some cases, feasible and could provide better life cost solution than buying a new train. Life extension project that lengthens train's service life by five years, increases typical leasing costs by around 4% per year, if the costs were spread over the total life of the train. Increased leasing cost is anyway less than buying a new train. Life extension might also reduce initial purchasing costs of a new rolling stock fleet by phasing manufacturing over the longer period. (Network Rail, 2011)

It needs to be remembered that the operation costs of the old train are higher compared to a new or refurbished train. By a life extension project, that is in other hand increasing leasing costs, operation costs will be reduced, due to the lower power consumption, lower maintenance costs and better reliability and availability.

Reliability is often described by a "bathtub curve". It shows the failure rate over the time. More failures occur in the early age of the product, reduce in the midlife and start to increase again at the end of the life. (Bull, 2010)

*"The Curve can be (and often is) applied to a wide range of items – be it software, superconductors or, as is the*

case here, rolling stock. It can also be broken down broadly into three distinct time periods – early operation, normal operation and late operation. During each period, a number of factors affect reliability to a greater or lesser extent, ultimately contributing to the failure distribution that gives the Curve its distinctive shape.” (Bull, 2010).

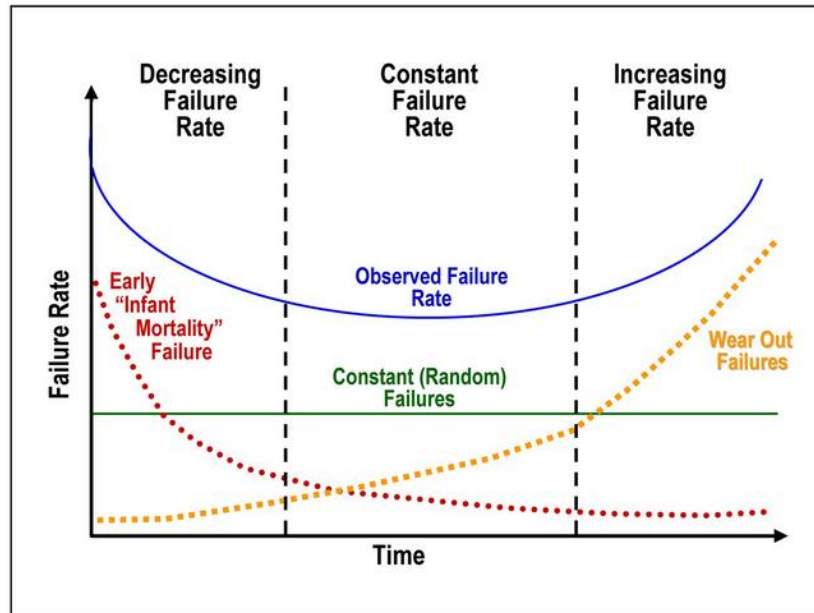


Figure 9: Bathtub curve. (Bull, 2010)

When a railway vehicle reaches an age, when the failure rate starts to increase, according to bathtub curve presented, it is the time when the decision should be done whether the vehicle should be refurbished or replaced by a new train. Then again, it needs to be remembered that the vehicle reliability is not the only factor that affects to the decision, whether the vehicles should be replaced or not.

#### 4.5 Train refurbishment markets in the UK

Significant share of the trains in the UK are at the end of their useful life, at the age of 30 to 35 years old, and requiring to be replaced or refurbished within the next 10 to 15 years. Figure 10 shows the forecasted fleet size based on the life expiry of the existing fleet. It does not take account new vehicles that will be introduced. It shows that between 2010 –2030, more than 6,000 vehicles will reach end of their useful life and need to be replaced or refurbished. (Network Rail, 2011)

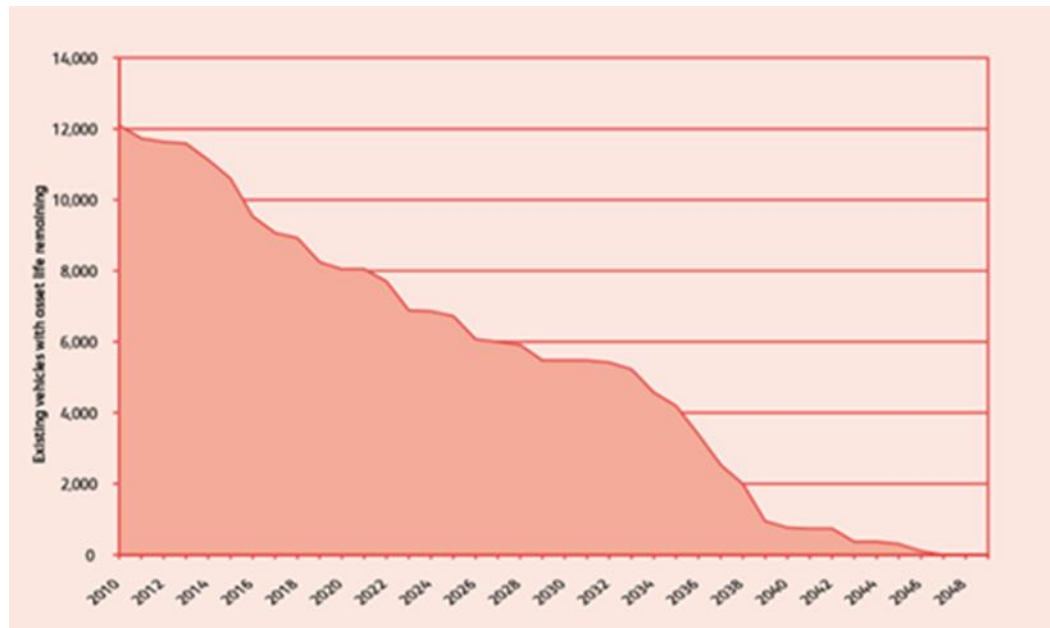


Figure 10: Scenario of life expiry of the existing UK passenger rolling stock fleet. (Network Rail, 2011)

Table 1 shows annual vehicle requirement quantities by railway market sector; without traffic growth and with, very moderate, 1,25% growth. It does not take account a factor that some new trains might have lower passenger capacity than an old train. This is caused by the new legislation requiring better accessibility as well as by higher passenger expectations. (Network Rail, 2011)

Market sector	Average annual vehicle replacement at selected annual traffic growth rates	
	Replacement due to life expiry only, no traffic growth (new vehicles per year 2010-2049)	Replacement due to life expiry plus additional vehicles to accommodate long-term traffic growth at 1.25% (new vehicles per year 2010-2049)
Long distance high speed	74	122
Interurban	36	62
Regional	36	60
Outer suburban	62	96
Inner suburban	163	274
Rural	11	19

Table 1: Average annual vehicle replacement at selected annual traffic growth rate. (Network Rail, 2011)

In the previous chapters it was explained that the researches indicates traffic growth to be an average 3.9% per year. According to the Brooks



Events (2016) and their Rail Market in the UK report, growth is even quicker. Number of passengers' journeys growth by 4,2% in the year ending March 2015. Therefore figures shown on table 1, with 1,25% growth, that requires 633 new vehicles in total per year, to cover rolling stock fleet expiry and traffic growth, should be considered to be minimum requirement.

#### 4.6 Train Life extension project

Trains' life extension projects can be divided into two groups; Vital Technical or operational driven projects and enhancement projects. Technical reasons affecting vehicle's safe operation or lacking compatibility with the signalling and/or rail traffic management system are prescriptive reasons. Vehicle enhancement- or refurbishment projects then again are mostly concentrating system and energy efficiency improvements, as well as passenger experience improvements, but are not considered to be imperative. (Network Rail, 2011)

There are many factors affecting to the decision whether the rolling stock vehicles should be replaced or lifetime lengthened by a life-extension program. Network Rail (2011) has listed following factors which are affecting to the decision:

- Technical condition. Evaluation required if the vehicle's life can be extended, at reasonable costs, from the technical point of view.
- Economic. Operational and maintenance costs compared to new train's investment.
- Operational & legislation. It needs to be considered if the existing fleet can meet operational and legislation requirements in the future.
- Maintenance. Ensuring spares availability for the extended period and their costs. Are the maintenance costs higher compared to a new train?

- Performance. Are the performance requirements achievable without high investments?

- Passenger aspiration. Passenger needs and expectations change over time. Are they achievable by a refurbishment? (Network Rail, 2011)

Above mentioned factors are weighed differently by the groups affecting to the decision. For example passengers' expectations are not that important to an assets owner as they are for an operator. Maintenance costs then again are the most important for the maintenance contractor.

#### 4.7 Reasons for the refurbishment projects in the UK

Many reasons act as a trigger for the refurbishment projects. These reasons are naturally comparable to the reasons presented by the Network Rail (2011) for new train procurement or existing train's life extension options. If new train procurement is not a viable option, following reasons might launch a refurbishment project.

1. Updating the vehicle to fulfil latest legislation requirements. As an example, Rail Vehicle Accessibility legislation (PRM TSI) must be met by 1<sup>st</sup> of January 2020, if an exemption has not been granted (The Stationery Office Limited, 2010). Rail vehicle accessibility standard set requirements for disabled people accessibility. It requires, for example, wheelchair user access accommodation, handrails, handholds and control devices sizes and locations as well as passenger information system provision. (DfT, 2015)

2. Remarkable change in the fuel price. Engine could be replaced by more fuel efficiency version. (Network Rail, 2011)

3. Maintenance costs have increased above the acceptable level or availability is un-acceptable. Maintenance costs are affected by many factors like age of the train and traction type (Network Rail, 2011). Costs can be reduced and availability increased by introducing more reliable components.

4. Signalling or train interface systems not supported anymore. (Network Rail, 2011)
5. Aspiration to reduce energy consumption, to cut down operation costs. For example energy metering system implementation in the trains has been partly funded by the UK government. With the energy metering, the operator can change the energy billing system from the modelled (average) consumption, to metered consumption. Metered energy billing is encouraging operators to save energy and to implement the most energy efficient systems. (Network Rail, 2013)
6. Requirement to phase new rolling stock procurement by lengthening the existing fleet's life. This might be justified from the investment funding as well as by initial investment costs point of views. (Network Rail, 2011)
7. Attracting more passengers in the train. Refurbished (or new train) introduction on the route slightly increase passengers in the train. According to Sheldon R. et al (2006) analysis, this increase is between 0,7% - 11%, depending on the operator. (Sheldon et al, 2006)
8. Affordability. "Life extension of rolling stock may be a better whole life cost solution than purchasing new rolling stock in the short term."(Network Rail, 2011). Leasing costs for the life extended rolling stock could be one third of the new rolling stock leasing costs. (Arup, 2011).
9. Route's utilization rate and expected growth. If there is a high demand to increase capacity on a specific route, life-extension project could be quicker option to cope with it. For example rolling stock could be transferred from another route, where it might have been replaced by a new rolling stock, and refurbished to accommodate necessary features for this specific route (Brooks Events Ltd, 2016).

Above mentioned reasons are affected by TOC, ROSCO and DfT and they have their own view points and objectives. Anyway, often life-extension project provides comparable option, at a fraction of the cost of the new train. (RailEngineering 2016).

#### 4.8 Traction Electricity Charges

Although the wholesale energy prices have been decreasing and energy suppliers in the UK have got the pressure to reduce their prices accordingly, there is still uncertainty what happens to the overall cost. This is caused by the plans of increasing infrastructure costs. Therefore UK government is encouraging consumers to improve their energy efficiency. (House of Commons library, 2016)

Railway operators pay Traction Electricity Charges to Network Rail. Charge is based on the electricity price, the amount of electricity consumed, transmission losses and the electrified vehicle miles operated. Railway operators are able to choose between modelled traction electricity charge and metered, actual consumption charge, if the energy is metered. As Network Rail buys the electricity on behalf of railway operators, at the end of each financial year, those train operators that are not using metered electricity charges, might get supplementary charges or rebates based on the Network Rail's total estimated and actual electricity consumption. Energy metering encourages an operator to save energy as it will be seen directly in reduction in their operation costs. Efficient driving and switching off any auxiliary equipment, like air-condition and lighting, when the train is not in service, saves money. (Network Rail, 2017)

#### 4.9 Enhanced Capital Allowance (ECA) Scheme

The Enhanced Capital Allowance (ECA) scheme is one of the UK Government's tools to manage climate change. It has been introduced in 2001 for the companies or organizations that pay corporation tax in the UK. Aim is to encourage businesses to invest in energy saving technologies by providing enhanced tax relief for these investments. The ECA scheme compensates price difference between less efficient, cheaper product and more expensive highly efficient product by allowing businesses to write off the whole cost of the eligible equipment and direct installation and freights costs against taxable profit in the year of the purchase. (The Carbon Trust, 2015)

*“So if your business pays corporation or income tax at 20%, every £10,000 spent on qualifying equipment would reduce its tax bill in the year of purchase by £2,000. In contrast, for every £10,000 spent, the generally available capital allowance for spending on plant and machinery would reduce your business’s tax bill in the year of purchase by £360. In other words, an ECA can provide a cash flow boost of £1,640” (The Carbon Trust, 2015, 3)*

Lighting and their controllers’ performance requirements are published in the Energy Technology Criteria List (ECTL) and they are reviewed annually. White light emitting diode lighting units’ and lighting controls’ criteria lists are shown in appendixes. Criteria lists set e.g. efficiency, light quality, lumen maintenance, testing and minimum power saving requirements. Products need to be CE-marked and LED tubes and MR16 low voltage lamps are excluded. All the requirements must be fulfilled and manufacturer needs to provide a statement of compliance stating that the purchased product meets the relevant criteria on the date of purchase. (DECC, 2015)

Lighting criteria’s have been originally developed from the building lighting point of view and some of them might not be the most suitable for the rolling stock interior lighting equipment but are still achievable when taken into account at the design phase. White light emitting diode light unit and lighting control requirements are shown in the appendixes 3 and 4.

## 5 EMPIRICAL RESEARCH CONTEXT AND METHODS

In this chapter, the research context and methods, which have been used in this thesis, will be introduced.

### 5.1 Research context

Empirical data were collected by using email questionnaire and discussions with various people involved in the railway markets. Recipients of the email questionnaire were carefully selected from the company x customer base, in order to have respondents from the refurbishment projects' different stakeholders. Aim of the questionnaire and discussions was to understand refurbishment projects' execution process, benefits and requirements from the stakeholders' point of view, as well as gain assessments for the alternative pricing options and ECA scheme's recognisability and applicability in the railway markets.

### 5.2 Research Methods

Research method used in this thesis is Action Research by using qualitative and quantitative methods.

Action research procedures can be used, among other applications, by businesses to improve organization efficiency or to work more effectively with the client groups. Action research uses continuing investigation cycles designed to reveal effective solutions to issues and problems experienced in specific situations, providing the means by which businesses may increase the effectiveness and efficiency. Action research includes people who affect, or are affected by the issue investigated in the process of inquiry. It provides clear understanding of the situation and aims to solve problems effectively. Basic action research routine is shown in the figure 11 and is based on the simple framework; Look, Think, Act. (Stringer, 2014).

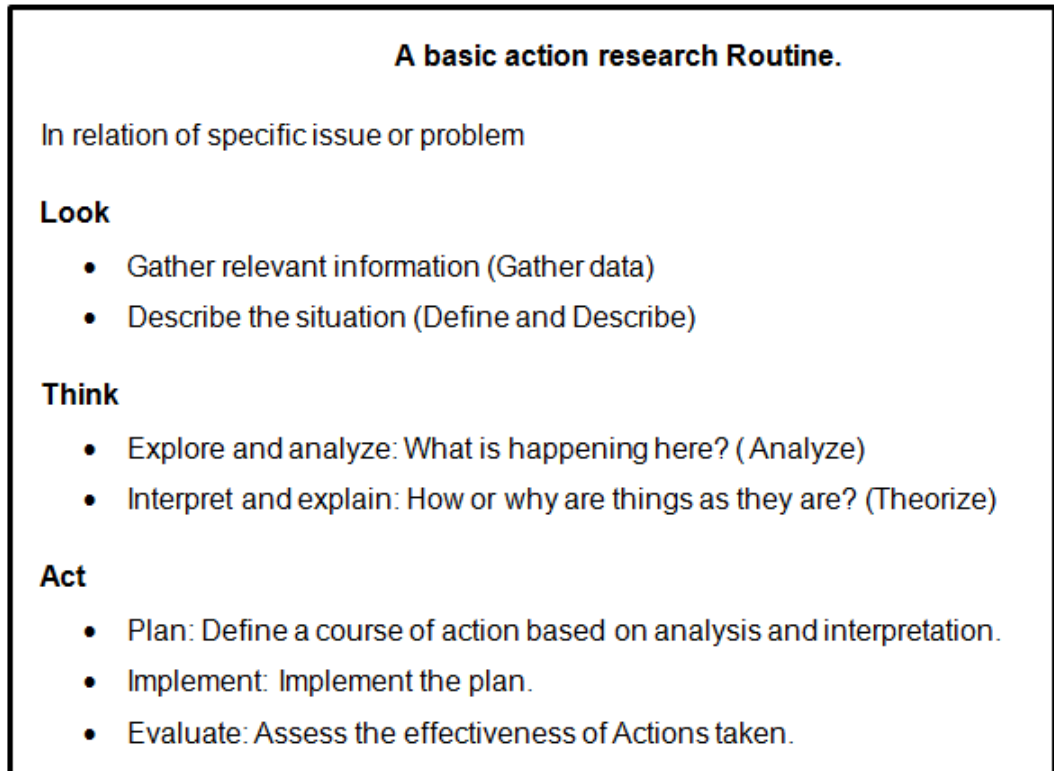


Figure 11: A basic Action Research routine. (Stringer, 2014).

Kemmis and McTaggart (1999) proposed parallel method to look, think, act framework by introducing spiral of activity with four continuous steps: Planning, acting, observing and reflecting. The spiral of activity is presented on figure 12.

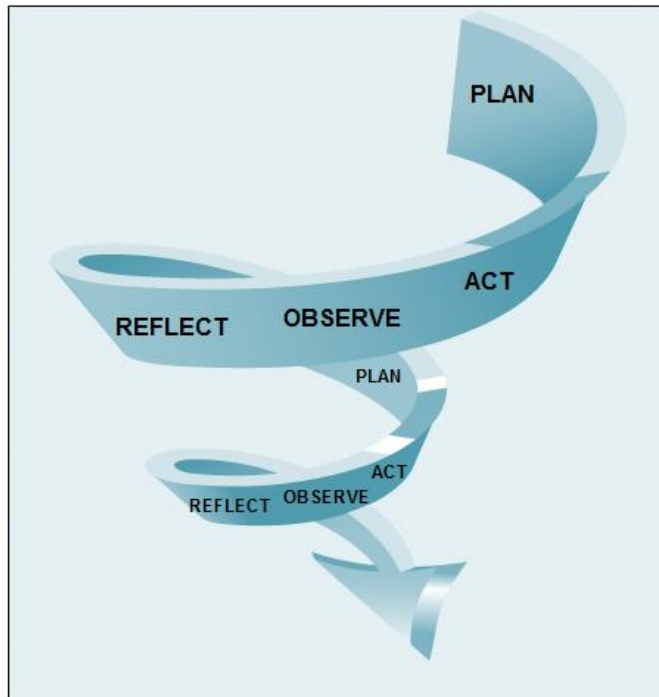


Figure 12: Activity spiral. (Kemmis & McTaggart, 1999)

Action research routines should be continually repeated to achieve continuous improvement. Actions might not every time follow the pattern of a spiral but all those actions are important to do. (Kemmis et. al, 2014)

*Traditionally, research projects are completed when a report has been written and recommendations presented to the contracting agency or published in an academic journal. An action research project can have these organizational or academic outcomes, and also provide the basis for rich and profound theorizing and basic knowledge production, but its primary purpose is as a practical tool for developing solutions to problems experienced by stakeholders in the context. If an action research project does not make a difference, in a specific way, for practioners or their clients, then it has failed to achieve its objective. The analogue of hypothesis testing in action research is some form of change or development tested by its ability to move toward the resolution of the problem under study. (Stringer, 2014, 10-11)*

Qualitative data is typically open-ended text data with no predetermined responses and while quantitative data tends to be closed-end responses and numeric data (Cresswell, 2014). Differences between qualitative and quantitative methods are significant and therefore either of the methods



should be chosen to be primary, if mixed method is used (Metsämuuronen, 2006). In this thesis, more weight is on the qualitative research method as the numeric data available is limited, due to the number of the responses, type of questionnaire and time that was available for the research.

Action research is not a problem solving tool only. In this thesis it used as a process to improve organization efficiency and co-operation with the customers.

1. Planning a new business concept. Aim is to develop a business concept that is efficient and profitable and it would response to customer needs.
2. Act. Research the continuity in the railway business and assess railway refurbishment projects needs and customer expectations by a questionnaire.
3. Observe results by analysing questionnaire responses.
4. Reflect observed results by adjusting the business plan.

Work continues after this thesis by planning marketing activities based on fleet A and B customer listing and franchise schedule, which are shown in appendix 10 and 11. Results of the marketing activities and feedback from the customer will be observed and business concept adjusted accordingly.

### 5.3 Questionnaire

Questionnaire is useful instrument for information collection without researcher's presence. Questionnaire's general purposes should be clarified and then primary objectives specified. The size of the sample generally affects to the types of questionnaire. Larger sample size requires often more structured, closed and numerical type of data and questions. Smaller sample size allows less structured and more open type questionnaire. Very structured and closed questionnaire for large sample generates useful data for statistical analysis. Qualitative and less structured questionnaire allows respondent to explain and qualify their

responses. Therefore it may be preferable method to record the specific information of a particular case. (Cohen et. al, 2005)

Email questionnaire was considered to be decent approach and easiest method for a recipient to respond. Distribution of the questionnaire was limited and assigned to individuals who were considered likely to give a response and having in-depth knowledge of the railway sector. Recipients are representing different stakeholders in the railway refurbishment projects. Questionnaire was sent to 12 professionals in two lots in May and July 2016. Various discussions with the responders have been giving more background information and deepen the knowledge-base of the analysis. Table 2 below details recipients' organization types and number of respondents of each group. Sampling should have been wider being able to complete quantitative analysis from the results and therefore more weight was given on qualitative data.

<b>Organization type</b>	<b>Number of recipients</b>	<b>Responses</b>
Train maintaining & manufacturing company	3	2
Train Leasing Company (ROSCO)	1	1
Design company	1	1
Operator (TOC)	7	3
<b>Total</b>	<b>12</b>	<b>7</b>

Table 2: Questionnaire responds by organization type

Questions were chosen to respond for the research questions and to enlighten stakeholders' viewpoints. Aim was to understand when the refurbishment projects' are typically completed, who are financing them, what are their scopes, what are the most important factors relating to products, if there is an interest in a new pricing structures and to find out ECA scheme's applicability. Questionnaire is shown in the appendix 1.

#### 5.4 Validity and reliability

*“Validity is an important key to effective research. If a piece of research is invalid then it is worthless. Validity is thus a requirement for both quantitative and qualitative research” (Cohen et. al, 2005 p.105)*

Qualitative research validity can be evaluated for example by the honesty, depth, richness and scope of data gathered as well as by the participants approached and objectivity of the researcher. With quantitative data the main issue considering validity is sampling and it can be improved by careful sampling and appropriate statistical processing. In qualitative research respondents opinions, attitudes and perspectives affects to a degree of bias. Therefore validity should be seen as a degree instead of an absolute state and understanding could be more suitable term than validity. (Cohen et. al, 2005)

Questionnaire tends to be more reliable compared to interviews due to its anonymity, encouraging greater honesty. On the other hand, often return percentage of the questionnaire might be too low and misunderstanding of the question might lead to unreliable data. Questionnaire responses are also often filled in hastily when again interviews could be completed at an appropriate speed. (Cohen et. al, 2005)

My personal approach to questionnaire and whole thesis has been objective and honest, despite my role as an employee in the Company x and sales responsibility of the researched market sector. Respondents were chosen carefully from the company x's customer base, but I had no influence on their questionnaire responses. Some of the recipients responded to the questionnaire from a specific project point of view and not on general level. One of the responds was relating to a refurbishment project that company x completed for the responder's company approximately a year before and another one was relating to a refurbishment project that was offered recently by the company x. This was not considered to be a problem as they were refurbishment projects and they were giving in-depth information relating to these specific projects. Number of responds is low and further survey should be

completed with a larger sampling to gain better understand and more reliable results. Anyway, already with this limited number of responds, we can see that ECA scheme is not very well known in the railway industry and on the other hand, there is quite good consensus with the factors affecting to the buying decision.

## 6 RESULTS AND ANALYSIS OF THE SURVEY

In this chapter, the questionnaire responses are analysed, question by question. Further discussions were completed with the responders and other people within the industry and they are giving more in-depth information. Responders' organizations and names are confidential information and are not published in this thesis. Table below shows responders organization types and responders' position in the organization.

<b>Organization type</b>	<b>Responder position</b>
Train maintaining & manufacturing company	Buyer
Train maintaining & manufacturing company	Engineering
Train Leasing Company (ROSCO)	Engineering & Supplier Development Manager
Design company	Lead Rail Designer
Operator (TOC)	Rail Engineering Procurement Manager
Operator (TOC)	Technical Service Engineer
Operator (TOC)	Fleet Project Engineer

Table 3: Questionnaire responders' organization type and position.

Respondents are representing different stakeholders of the refurbishment projects. Questionnaire responses are shown in the appendix 5.

### 6.1 Questions and analysis

*Question 1. When and why will be a train refurbishment project completed?*

Based on the responses, refurbishment of a train is often tied up with other activities. Franchise period and C6 overhaul of the train are often acting as a trigger for the interior refurbishment. There are various reasons encouraging completing the interior refurbishment. These are: outdated interior, obsolete components and systems, changed legislation, investment funding availability, brand requirements and operating costs savings etc. Franchise period is typically 6-7 years and C6 overhaul is undertaken every 6-8 years. Interior refurbishment won't be completed at every C6 overhaul but it is linked to other influencing factors and on the age of the train. Train leasing companies have their overhaul plans for their fleets and the UK government has the rail franchise schedule. These should be used as a tool to focus marketing to correct operators, fleets and train leasing companies at the correct time.

Correct timing is important on refurbishment projects. Appendix 11 shows a rail franchise schedule linked to the Platform A and B train fleets. Assets owners and operators are presented on the appendix 10. This schedule can be used as an effective tool to plan marketing activities to reach correct stakeholders at the correct time.

*Question 2. Who is financing refurbishment project; Train owner, operator, maintenance provider or is it financed jointly together?*

Based on the responses, refurbishment project is often financed by the train owner. At least part of the refurbishment costs is then paid by the TOC through higher leasing costs but as the refurbishment is also increasing value of the assets, costs can be spread out on a longer time than the TOC's franchise period. TOC can also finance a refurbishment project and then the costs will be offset from the leasing costs, paid to the train owner. UK government and EU funding are available for the refurbishment projects and as mentioned on the question 1, these funding might influence project completion.

*Question 3. If there are benefits achievable by the operator and maintenance provider, for example by introducing equipment with lower*

*power consumption and less maintenance requirement, can they jointly make an investment?*

There is possibility for a joint investment if the business case proves benefits for the ROSCO and TOC. However, this is affected by the leasing contract in place. It looks that often in these cases, ROSCO will finance the project and higher leasing costs is then compensated to TOC by reduced maintenance and/or operating costs.

Responses show close relation between TOC and ROSCO. Both of the parties should be involved and their viewpoints taken account.

*Question 4. What is influencing to the decision if and when an interior lighting and / or full interior refurbishment will be completed?*

According to the answers, operating and maintenance costs, aesthetics and obsolescence, are key drivers for the interior lighting upgrade decision. TOC defines requirements based on the passenger feedback and franchise obligations. TOCs are competing against each other's for a franchise and they need to be competitive. Government chooses the winner based on overall plans and costs to operate the franchise.

Passenger satisfaction, service regularity and punctuality are very important factors, which can be improved by an interior and equipment refurbishments.

*Question 5. If the interior lighting will be refurbished, what are the most important factors which are affecting to the buying decision process?*

*Please rank following factors from the most important to less important (From 1 to 7, number 1 being the most important); Price, Warranty period, Delivery time, Maintainability, Ease of installation, Fulfilment of railway specification, Appearance to the passengers. Is some important factor missing?*

Responds overall scoring were calculated by giving one point to most important factor, two points to second important, and three points to third

important and so on. Therefore the factor that got less points is the most important factor overall. Overall scoring is shown in the table 4.

<b>Score</b>	<b>Order. Most important has lowest score</b>
8	Fulfilment of railway specification
17	Price
25	Maintainability
29	Appearance to the passengers
35	Ease of installation
40	Delivery time
42	Warranty period

Table 4: Overall scoring

Six out of seven responders said that fulfilment of the railway specification is the most important factor. This is quite obvious, because you should not be able to introduce equipment in the train, if that is not fulfilling applicable requirements.

Price was the most important factor for one responder and second important for four responders. It has been noticed also on other questions' responses that the price is highly important. There must be proven business case if the interior lighting only will be upgraded. If the whole interior is refurbished, then lighting will be part of the package.

Maintainability was seen third important overall and by three responders individually. According to one responder, it was second important factor. It could have been believed that this factor was more important for the responders who were closer to daily operation activities, but there was no clear sign of this trend. This is possibly caused by the limited number of responds and could be the case if the number of responds were higher.

Appearance to the passenger was second important for one, and third important for three responders. Overall it was fourth important factor. On



the other hand, according to one responder this was the least important factor. Appearance or design of the lighting might not be important factor if the light source only is upgraded to LED technology, but if the whole interior will be upgraded, then the overall interior appearance is important.

Delivery time or warranty period was the least important factor for six out of seven responders. This reflects to rather slow realization of the projects in the railway business and high quality of the products in this market sector. Slow realization of the projects removes importance of the delivery time as the projects can be planned well in advance.

Warranty period's unimportance could be explained by the most important factor; fulfilment of demanding railway specification. It assures reasonable quality and reduces importance of the warranty period. This is different on the market sectors where the requirements are lower. For example in the bus industry, where the requirements are less stringent, the warranty period length is considered one of the most significant factors affecting to the buying decision. This outcome means that the warranty period is not that important criterion on the railway refurbishment projects and might not give a competitive edge to a supplier that provides notably longer warranty period, compared to other suppliers.

Responders were asked to list missing important factors. Reliability, additional technical features, trialing to demonstrate final appearance and history of using the same supplier before were seen important. These are the topics that should be highlighted in the marketing materials and communications with the customers.

*Question 6. Is Enhanced Capital Allowance (ECA) scheme for energy-saving technologies known and considered to be used or have already been used with an investment?*

Enhanced Capital Allowance scheme for energy saving technologies is not well known in this market sector. Five out of seven responders did not know the ECA scheme. This has been evidenced on the discussions with the other people within the railway markets. Then again, there is more and

more interest about the ECA scheme's availability and tax relief option. Lighting components fulfilling ECA scheme's criteria, could form a competitive edge for the company x and therefore It is important to raise awareness of the ECA scheme.

*Question 7. Can equipment leasing be an option for typical purchase? If leasing could be an option, what would be suitable leasing time?*

Based on the responses, there is contradictory if the leasing could be an option for the operator or not. If the leasing period would be the same as the franchise period, then the leasing option may be possible. Operator should find savings for the maintenance and operation costs by a leasing option.

Leasing option should have been explained more carefully in the questionnaire as there are many ways to interpret this term. For example, what is included in the leasing price and what is the ownership of the material after leasing period, should have been explained. Leasing option should be further investigated, developed, costed and then discussions with the customer continued.

*Question 8. Can combined lease and purchase be an option? With this option, buyer would be able to use ECA scheme by paying residual value of equipment upfront, which is left after an agreed leasing time. This cost is naturally lower compared to normal purchase price. With this option, buyer would also achieve fixed monthly fee and still, after an agreed leasing time, equipment would be fully owned by the buyer.*

Leasing options proposed on questions 7 and 8 needs further investigation, development and discussions with the customers. Based on the answers, leasing is not used at this moment in the railway industry for the smaller equipment like lighting and being able to offer this option, it could form a competitive edge for the company x.

*Additional thoughts and comments.*

One responder highlighted that the price and appearance are the most important factors. Passenger satisfaction is important for the TOC but naturally everything is cost driven.

Enhanced passenger experience and trials with the end customer to show the difference achievable are important for the one responder. Sometimes trials are difficult to arrange because light units are tailor made products and new tooling might be required. Rapid models and proto models can be used in some cases but quality of the samples will not reflect to the serial production items. The new business concept and product ranges developed for the Platform A and B trains allows company x to complete trials more easily.

Importance of timing was highlighted. Franchise period and C6 overhauls are important milestones that should be taken account.

One responder commented that most of the questions were out of his responsibility and he's been looking only after engineering side. Purpose of the questionnaire was to enlighten different stakeholders view points and therefore engineering opinion is important as well. Questions relating for example to finance and ECA scheme, might not be valid for the engineering people, but their views on daily operation, maintaining and reliability issues are valuable and should be taken account.

## 7 SUMMARY AND CONCLUSIONS

This chapter summarizes the study and presents conclusions. The aim of the study was to create efficient, focused business concept for the UK refurbishment projects and to develop LED lighting product ranges for the train manufacturers Y and Z Platform A and B trains. The results and conclusions are compared to the main research problem and objectives.

### 7.1 Railway industry and environment

Urbanization has a major role in the future and it sets demands for the public transportation to increase its capacity to meet increasing number of passengers. Climate change has an important role and it has been forcing countries to reduce their CO<sub>2</sub> emissions. Two third of the transportation related emissions are caused by the road transportation. The most efficient way to reduce transportation related emissions, and cope with the increasing number of passengers, is to increase rail transportation share of the freight and passenger transportation, by providing more trains and rail tracks. The EU White Paper sets a plan to build a competitive transport system in the Europe and aims to shift passenger and freight transportation from road to rail or sea.

Passenger journeys increased in the UK by 4.2% in 2015 and in the longer term, average growth has been 3.9% per year. Being able to respond to higher number of passengers, capacity in the railways should be increased. In addition to capacity driven need for the new trains, by 2030, more than 6,000 existing train cars will reach end of their useful life and need to be replaced or refurbished. This demand can be partly satisfied by procuring new trains, but there will also be need for the life extension projects.

Life extension of the trains can be used as a tool to phase new trains procurement and support train manufacturers' capacity limitation and it spreads the funding over the longer period. Often refurbishment project is considerable option, compared to new rolling stock procurement and for

the authorities, it is not exclusionary but supportive option, with good, long term planning and timing. Franchised rail operation system encourages improvements for the trains as the passenger satisfaction and trains' reliability are important factors on the franchise competition. Being able to respond to the increasing number of passengers, their higher needs and ageing of the trains, big share of those 6,000 trains, reaching end of their useful life by 2030, will be refurbished instead of replaced by new trains.

Train operators, rolling stock operating companies and authorities, have important role in the UK's public transportation. Authority needs to guide the railway sector to the right direction, by having a clear, long term plan for the future. It allows operators together with the rolling stock leasing companies effectively plan, how to provide the service they have committed to, in the best possible way. By taking account climate change, urbanization, increased capacity requirement and today's living standards, it has been presented in this study that there is continuity in the railway business globally and in the UK. Special attention was paid on the UK train refurbishment projects and based on the results of this study, refurbishment projects have an important role in the UK railway's future development.

## 7.2 Business development

In today's business, companies need to be able to refresh their business concepts and follow industry trends. Company x has a great history and their strong results over the years could easily let to believe, that there is no reason to change anything. This would be devastating and in the long term, it would cause reduction in their market share. It is obvious that the competition is tough and a company, that is not able to update their strategy and business concepts, will not be able succeed in the long term.

In addition to business and strategy development, being able to succeed, a company should be looking across the industries, being able to find blue oceans where the competition is not as hard. Being able to get out from a red ocean, where the market share is fought over and pricing is the main

factor, thus reducing profits, differentiation is important. Based on Macmillan & McGrath (1997) differentiation from the competitors reduces importance of the pricing in the buyer decision making process. By offering some value that competitors don't have, a company is able to increase profitability and create new market spaces.

Kim & Mauborgne (2015) has presented that when developing a new product or service, a strategically correct pricing from the beginning, ensures greater revenue. Developing price from the strategic point of view, it creates value innovation and gives an advantage to a company and complicate rivals replication. Customer benefits should be remembered and a new product or service must help customer business' profitability, safety or simplicity and provide exceptional benefits. Based on Kerry Bodine (2014), companies who truly understand their customers, and therefore are able to provide exceptional benefits for them, will be succeeding in the future.

### 7.3 Blue Ocean

Refurbishment projects will have an important role and the new concept developed especially to this market sector, could create a blue ocean and competitive edge for the company x.

Blue ocean strategy's six principles were explored in the new business concept development. The six principles are: Explore multiple industries, Explore strategic groups within the industry, Explore buying groups, Explore supplementary products and services, Explore functional and emotional appeal to buyers and Explore timing. These six principles are presented below from the company x and new business concept's point of views.

**Explore multiple industries.** LED tubes are substitutive products. They are light sources just like a fluorescent tube, but their lifetime is longer and power consumption lower. Many of the company x's competitors offer LED tubes only. LED tube uses the same, existing tube holders which have

been used with old fluorescent tube that is to be replaced. These tube holders might be brittle and cause problems in the long term. Existing inverter, that is required with the fluorescent tube, needs to be removed when the LED tube is introduced. Therefore assembly takes time and requires additional wiring harness to bypass removed inverter.

Being able to differentiate from the competition, company x offers, in addition to LED tubes, whole LED light unit which assembly is quicker and easier. Energy efficiency is comparable to LED tubes and by taking account assembly time and whole life costs, the total pricing is on the same level. Lighting uniformity is better with the complete LED lights because the light source's length can be matched and dark sections caused by the tube holders avoided, unlike with the LED tubes. Integrated emergency lighting and intelligent dimming system options are available with the complete LED lights but not with LED tubes. With well-designed LED light units, maintenance and cleaning costs can be reduced significantly and appearance improved.

**Explore strategic groups within an industry.** Strategic groups within the railway industry are listed below.

- Replacement product manufacturers or importers. Typically these companies offer basic LED tubes and very little tailoring possibilities. Often products are manufactured in the low cost countries and they might not fulfil all the requirements.
- Interior lighting system manufacturers. These companies manufacture and design their products by themselves. They offer both, an individual replacement products and full systems which are tailored according to the customer needs. Products fulfil requirements but are higher in cost.
- Companies who offers installation services of the replacement products and systems. Products are manufactured or imported by a third party and these companies are just offering installation services.

- Companies who offer full train refurbishment turnkey solutions, including design, material acquisition, installation and repair.

Company x is targeting to create a blue ocean in between these strategic groups. LED lights that are quick and easy to install, can be introduced during the normal maintenance activities. Installation can be completed by the operator or maintenance provider or alternatively the company x can offer installation service through their local partners. Offered products are fully railway approved and additional features can be incorporated.

**Explore buying groups.** Buying groups for the company x are typically train manufacturers and full train refurbishment turnkey solutions providers. The new concept will be offered for the typical buying groups but is targeted mainly for the ROSCOs, TOCs and maintenance providers, who are operating with the Platform A and B trains. These are new customers for the company x which have not been approach in this extent in the past.

**Explore supplementary products and services.** Life cycle costs has an important role in the decision making process. LED products' lower power consumption and longer lifetime reduces life cycle costs remarkably. Promoted savings, which are achievable, are pretty much the same between the manufacturers and LED technologies. Of course there are companies who are offering empty promises but awareness of the LED technology has been growing over the last years and customers are able to evaluate offered products' capabilities quite well. Therefore the new concept is concentrating to ease and speed of the installation, reduction of maintenance activities, additional features which will improve safety and increase savings, predictable life cycle costs and supporting services. Tailoring possibility is important feature for the operators allowing them to differentiate from the other operators and increase possibilities to succeed in the franchise competition.

**Explore functional and emotional appeal to buyers.** Railway industry is very traditional and competition focuses on price, functionality and life



time. Emotions have not been in the centre of the competition. With the new concept, company x is highlighting environmental impact and passenger experience enhancements on the marketing materials because these are important features for the TOCs.

**Explore timing.** LED technology is the most important change in the lighting industry at this moment. It enables significantly better energy efficiency as well as smaller and more sophisticated lighting systems. Environmental friendliness is also important trend that changes the industry. Privatization of the railways, urbanization, CO<sub>2</sub> reduction goals and governments' supportive financing programs, to achieve improvements in these sectors, are forming the industry. Alternative pricing structures, like leasing, are not available in the railway industry at the moment for the interior lighting sector and being able to offer this option first, it could create a competitive edge for the company x.

#### 7.4 Results

The main research problem of the study was to define; *How to win more business in the railway vehicle refurbishment markets in the UK and later globally, to increase Company x's revenue and profitability?*

The main research problem was approached by reviewing theoretical background of the business development, blue ocean strategy, strategic pricing and customer experience. Then the future of the railway was studied globally and special attention was paid in the UK railway markets to understand its structure and special characteristics. Train refurbishment projects' role and expected volume in the UK was researched. Then the survey was completed to gain deeper understanding of the refurbishment projects' execution process, benefits and requirements from the different stakeholders' point of views, as well as gain assessments for the alternative pricing options and ECA scheme's recognisability and applicability in the railway markets.

From the Company x point of view, refurbishment and new build project requires slightly different focus on their products and marketing materials. New build projects, where everything is started, in most of the cases, from the scratch and timing is not that easily predictable, development costs are high and lead time is long. For the refurbishment markets, company x can create products and marketing materials, together with a marketing plan, more efficiently.

As an OEM supplier, company x has an information available of many existing rolling stock fleets and their interior lighting systems. Company x should choose the most common train types and aim on those. Developing direct replacement products which are improving customers' profitability, safety and/or simplicity and provide exceptional benefits for them, allows company x to differentiate from the competition. Competing only with the price against LED tube manufacturers, which are often based in low cost countries, results low profits and hard time in the future and therefore, differentiation is crucial. Questionnaire's responds emphasize importance of the pricing and therefore it cannot be ignored by concentrating exceptional benefits and differentiation only. Strategic pricing should be calculated by using commonly accepted pricing level, which is often LED tube pricing and taking account lower installation and maintenance costs over the lifetime, lower power consumption when using automatic dimming feature, ECA scheme's benefits and possibly accepting slightly lower profit margin at the start when aiming to a larger volume. Installation service of the new lighting systems can be offered through local partners if a customer requires this service. By creating well thought marketing materials, company x can aim marketing and sales activities' more efficiently. As highlighted by the questionnaire responders, timing is important, and in the UK, the correct timing can be ensured by targeting marketing activities with the rail franchise schedule. Rail franchise schedule with Platform A and B trains is presented in the appendix 11.

Company x is differentiating itself from the competitors and LED tube manufacturers by providing bespoke LED lighting solution for the platform A and B trains. These LED lighting solutions are presented in the design

concept documents shown in the appendices 8 and 9. The LED lighting solutions are fully railway approved, easy to install and they are providing exceptional benefits for the customer. The new interior LED lighting systems can incorporate automatic lighting intensity controlling for further savings and passenger comfort improvements. Automatic lighting intensity controlling system has one controller and two sensors inside the rail car and lighting intensity is automatically adjusted to the customer specified lighting level. During day time, when there is natural light available, interior LED lighting intensity is automatically adjusted to a lower level providing further savings and longer lifetime. Safety could be a factor that a customer wants to highlight and it can be improved by introducing incorporated emergency lighting system option to fulfil latest local requirements. ECA scheme can be used, if a customer is allowed to use it, with the new LED lighting systems developed for the platform A and B. ECA scheme's tax relief options, automatic interior lighting intensity controlling and emergency lighting options are not available, at least at the moment, with LED tubes so these are creating exceptional benefits for the customer and a competitive edge for the company x.

Maintenance and operation cost reductions have been in the centric of the both platforms' LED lighting system development, but especially on the platform B system development. Opinions of the train operating companies and maintenance providers were listened carefully during development process. As a result, platform B interior lighting system is replacing, not only a light source, but also a metal grill diffuser which has been increasing maintenance costs significantly. Cleaning process of the metal grill is time consuming and difficult. They are also easily damaged by the passengers' luggage when placing them on luggage racks. New LED lighting systems has a polycarbonate diffuser that is easy to keep clean and light unit itself is protected against dust ingress and therefore requires wiping only from outside. Diffuser has non-transparent section allowing operator to choose the colour that suits for their brand's colour scheme and allows them to differentiate from other operators. Platform B system development process is explained in details on the appendix 12.

It needs to be considered if the platform A approach should be changed to be similar to platform B to include the diffuser as well. Decisions of the redesign should be made after testing the markets and observing results. This would be following spiral of activity as presented by Kemmis and McTaggart (1999) with four continuous steps: Planning, acting, observing and reflecting.

Marketing leaflets were developed for both platforms A and B LED lighting systems and they are shown in the appendices 6 and 7. These will be used as a first contact material with the potential customers. These leaflets can be used as a template for the new similar leaflets created in the future. Customer listing with Platform A and B trains in operation is shown in the appendix 10. This list is detailing trains' class number and size, operator and owner of the fleet, current franchise's start and end dates, and calculating potential estimated value of the refurbishment project of that fleet. Rail Franchise schedule with platform A and B trains, shown in appendix 11, is giving clear overview of the franchise timings and highlighting franchisees operating with platform A and B trains. All these material will be used as a tool by the company x to explore a new blue ocean.

Alternative pricing options could be developed to give more choices to the buyers and to create competitive edge for the Company x. Full leasing and spares agreement options require further calculations, development and discussions with the customers, to understand their applicability.

Complexity of the UK train services and several stakeholders' involvement might cause challenges in alternative pricing options introduction. If they will be deemed to be viable option, then Company x's unique LED tube solution, which can be used with existing fluorescent tube inverter, could form technical base for the alternative option development. Leasing and spares agreement options could help in moving away from the price and length of the warranty period competition.

Enhanced Capital Allowance scheme is not very well known in the railway markets at the moment. Further studies need to be completed to see if the

scheme can be used widely in the railway business. The lighting systems developed for the new concept, are fulfilling ECA scheme's requirements and it should be marketed because it creates clear advantage against competitors and LED tube technology which is clearly excluded by the criteria.

## 7.5 Conclusions

From the railway market supplier point of view, increasing demand in the passenger railway sector is creating great business opportunities. New build trains and refurbishment projects, are providing high number of projects to compete.

This study and results gained from the markets have demonstrated that it is justified to introduce the new focused business concept and development process for the refurbishment markets. With this concept, company x can differentiate itself from the competitors who offer LED tubes only. The new concept enables Company x to explore the new blue ocean. TOCs and ROSCOs operating with the Platform A and B trains form a new customer group for the Company x. For this customer group, Company x is able to offer competitively priced LED upgrading packages with additional passenger satisfaction enhancement, operation cost reduction and safety options. Tax benefits through the ECA scheme are also available to further improve competitiveness. Installation services can be offered by using Company x's local partners in the UK.

If the customer requires quick and easy LED upgrading solution, which is based on the LED tubes, and additional enhancement options are not deemed to be important, then Company x's unique LED tube solution could be offered.

At the moment refurbishment market's share of the Company x turnover is rather small. It is believed, and recognized in the company x's strategy, that by creating a new blue ocean, within the known markets and exploring it by using the new concept, turnover gained from the refurbishment

projects can be increased significantly. Platform A and B in operation listing, shown in the appendix 10, details that the potential, estimated revenue gained from these two fleets could be 15,6 – 17,5M€. At the time of publication of this thesis, company x has already received the first order for the platform B system, which is encouraging to continue on this path.

On the other hand, now when the refurbishment projects are highlighted, company x must remember that the new build projects are still the strongest areas for the company x, and worldwide reputation is gained on these projects, therefore they must not be forgotten.

## REFERENCES

Allen J. et al. (2005), The Three “Ds” of Customer Experience. Harvard Management Update. [Accessed: 16.10.2016] Available at:

<http://hbswk.hbs.edu/archive/5075.html>.

Analoui, F. & Karami, A. (2003), Strategic Management in Small and Medium Enterprises. Thomson Learning

Arup, (2011). Rail Value for money study Rolling stock whole life costs-final report.

Bodine, K, (2014). From User Experience to Customer Experience, <https://www.youtube.com/watch?v=ZT8zLx2ydqo>

Brooks Events Ltd, (2016). The Rail Market in the UK. Brooks Reports Publication.

Bull, J. (2010). London reconnections. The Victoria Line: Bathtubs and Breakdowns. [Accessed: 12.04.2015] Available at: <http://www.londonreconnections.com/2010/the-victoria-line-bathtubs-and-breakdowns/>

Butcher, L. (2015) Railways: Passenger Franchise. Standard notes SN1343. House of Commons Library.

Cohen, L., Manion, L. & Morrison, K. (2005). Research Methods in Education. Fifth Edition. Taylor & Francis e-Library.

Crane, A & Matten, D. (2016). Business Ethics. Managing Corporate Citizenship and Sustainability in the Age of Globalization. Fourth Edition. Oxford University Press. p.527

Cresswell, J.W.. (2014) Research design: A qualitative, quantitative, and mixed method approaches - 4th ed. Sage Publications Inc.

Department for Transport (2016). Rail Franchising. [Accessed: 15.04.2017] Available at: <https://www.gov.uk/government/collections/rail-franchising>

Department for Transport (2015). Policy Paper. Accessible rail transport. [Accessed: 16.04.2017] Available at: <https://www.gov.uk/government/publications/accessible-rail-transport/accessible-rail-transport>

Department of Energy and Climate Change, DECC, (2013) 2013 UK Greenhouse Gas Emissions, Final Figures. A National Statistics publication.

Department of Energy and Climate Change, DECC (2015), Enhanced Capital Allowance (ECA) Scheme for Energy Efficient Technologies; Energy Technology Criteria List, July 2015

DNV GL, (2015). Global Opportunity Report 2015

Eden, C. & Ackermann, F.(1998). Making Strategy. The Journey of Strategic Management. Sage Publications Ltd.

European Commission (2015). Paris Agreement. [Accessed: 16.10.2016] Available at: [http://ec.europa.eu/clima/policies/international/negotiations/paris/index\\_en.htm](http://ec.europa.eu/clima/policies/international/negotiations/paris/index_en.htm)

European Commission (2014). Transport sector economic analysis. The European Commission's in-house science service. [Accessed: 20.04.2015] Available at: <https://ec.europa.eu/jrc/en/research-topic/transport-sector-economic-analysis>

European Commission (2011). White Paper. Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system. [Accessed: 20.04.2015] Available at: <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52011DC0144&from=EN>



Eurostat (2016). Freight transport statistics – Modal split. [Accessed 16th October 2016] Available at: [http://ec.europa.eu/eurostat/statistics-explained/index.php/Freight\\_transport\\_statistics\\_-\\_modal\\_split](http://ec.europa.eu/eurostat/statistics-explained/index.php/Freight_transport_statistics_-_modal_split)

Eurostat (2016). Consumption of energy. [Accessed 16th October 2016] Available at: [http://ec.europa.eu/eurostat/statistics-explained/index.php/Consumption\\_of\\_energy](http://ec.europa.eu/eurostat/statistics-explained/index.php/Consumption_of_energy)

House of Commons library, Briefing paper number 04153, 2016

House of Commons Library, Briefing paper number SN06521, 2016.  
Passenger rail services.

House of Commons (2010). Transport Committee - Third Report. Priorities for investment in the railways. [Accessed 16th October 2016] Available at: <http://www.publications.parliament.uk/pa/cm200910/cmselect/cmtran/38/3802.htm>

Kemmis, S. & McTaggart, R. (1999). The action research planner (3rd ed.) Australia: Deakin University Press.

Kemmis, S., McTaggart, R. & Nixon, R. (2014). The action research planner. Doing critical participatory Action Research. Springer Science +Business Media. Singapore

Kim, W. C., & Mauborgne, R. (2015). Sinisen meren strategia. Löydä markkina-alue kilpailun ulkopuolelta. 8. revised edition. Helsinki: Talentum Media Oy

Kim, W. C., & Mauborgne, R. (1999). Creating New Market Space. Harvard Business Review. January-February 1999. p.83-93

Kim, W. C., & Mauborgne, R. (1999). How Strategy Shapes Future. Harvard Business Review. September 2009. p 73-80

Lawrence, A. (2012). Five Customer Retention Tips for Entrepreneurs. [Accessed 24th October 2016] Available at:

<http://www.forbes.com/sites/alexlawrence/2012/11/01/five-customer-retention-tips-for-entrepreneurs/#23a51db117b0>

MacMillan, I. C., & McGrath, R. G. (1997). Discovering New Points of Differentiation. *Harvard Business Review*. July – August 1997. p.133-145

Metsämuuronen, J. (2006). Tutkimuksen tekemisen perusteet ihmistieteissä: opiskelijalaitos. 2. laitos. 4. painos. Helsinki. International Methelp Ky

Network Rail, (2011). Network Route Utilisation Strategy: Passenger Rolling Stock

Network Rail (2013). Periodic Review 2013: Traction Electricity and Electrification Asset Usage Charges in CP5 – Conclusions of Network Rail's Consultation

Network Rail, (2017). Network Statement 2017.

Porter, M. (1996). What is Strategy? *Harvard Business Review*. November-December issue 1996.

Rail Delivery Group, (2016). Long Term Passenger Rolling Stock Strategy for the Rail Industry- Fourth Edition. London: Rail Delivery Group.

RailEngineering, (2016). Lower-cost fleet upgrade. [Accessed 16th October 2016] Available at: <http://www.railengineer.uk/2016/07/22/lower-cost-fleet-upgrades/>

Sessa, C. & Enei, R. (2009). EU transport demand: Trends and drivers. ISIS, paper produced as part of contract ENV.C.3/SER/2008/0053 between European Commission Directorate-General Environment and AEA Technology plc; see [www.eutransportghg2050.eu](http://www.eutransportghg2050.eu)

Sheldon, R., Heywood, C., Meaney, A., Robins, N., & Wardman, M. (2006). Estimating the demand impacts of new rolling stock. In European Transport Conference (ETC)

Stringer, E.T. (2014), Action Research, 4<sup>th</sup> Edition. Sage Publications Inc.

The Carbon Trust (2015), The Enhanced Capital Allowance scheme for energy-saving technologies, April 2015

The International Energy Agency (IEA) & International Union of Railways (UIC). (2014) Railway Handbook 2014. Energy Consumption and CO<sub>2</sub> Emissions - Focus on Infrastructure

The International Energy Agency (IEA) & International Union of Railways (UIC). (2015) Railway Handbook 2015. Energy Consumption and CO<sub>2</sub> Emissions - Focus on Infrastructure

The Stationery Office Limited. (2010), 2010 No. 432 DISABLED PERSONS TRANSPORT. The Rail Vehicle Accessibility (Non-interoperable Rail System) Regulations 2010.

## LIST OF APPENDICES

Appendix 1: Questionnaire

Appendix 2: Rail Franchise Schedule

Appendix 3: White light emitting diode light units criteria

Appendix 4: Lighting controls criteria

Appendix 5: Questionnaire responses

Appendix 6: Marketing Leaflet – Platform A

Appendix 7: Marketing Leaflet – Platform B

Appendix 8: Design Concept Document – Platform A

Appendix 9: Design Concept Document – Platform B

Appendix 10: Platform A and B in operation

Appendix 11: Rail franchise schedule with Platform A and B fleets

Appendix 12: Development process in details – Platform B system

## APPENDIX 1 – Questionnaire

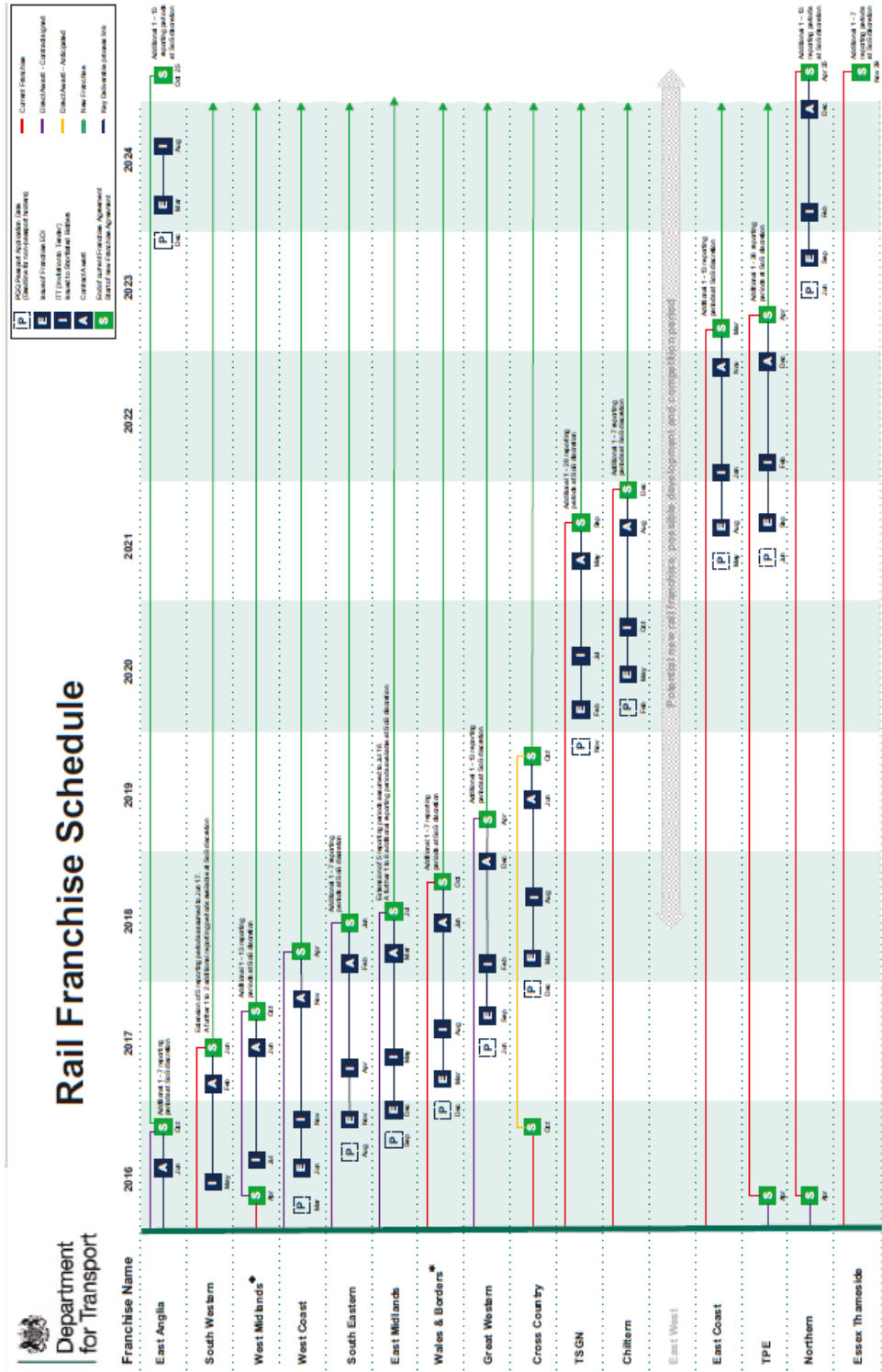
1. When and why will be a train refurbishment project completed?
2. Who is financing refurbishment project; Train owner, operator, maintenance provider or is it financed jointly together?
3. If there are benefits achievable by the operator and maintenance provider, for example by introducing equipment with lower power consumption and less maintenance requirement, can they jointly make an investment?
4. What is influencing to the decision if and when an interior lighting and / or full interior refurbishment will be completed?
5. If the interior lighting will be refurbished, what are the most important factors which are affecting to the buying decision process? Please rank following factors from the most important to less important (From 1 to 7, number 1 being the most important);
  - Price
  - Warranty period
  - Delivery time
  - Maintainability
  - Ease of installation
  - Fulfilment of railway specification
  - Appearance to the passengers
  - Is some important factor missing?
6. Is Enhanced Capital Allowance (ECA) scheme for energy-saving technologies known and considered to be used or have already been used with an investment?

7. Can equipment leasing be an option for typical purchase? If leasing could be an option, what would be suitable leasing time?

8. Can combined lease and purchase be an option? With this option, buyer would be able to use ECA scheme by paying residual value of equipment upfront, which is left after an agreed leasing time. This cost is naturally lower compared to normal purchase price. With this option, buyer would also achieve fixed monthly fee and still, after an agreed leasing time, equipment would be fully owned by the buyer.

9. Additional thoughts and comments.

# APPENDIX 2 – Rail Franchise Schedule



• During the next franchise, the Department expects to take steps to allow for the potential of greater local control over the West Midlands local services.

\* The schedule shown reflects standard DfT franchising timings. The UK Government has agreed in principle to extend franchising powers to the Welsh Government to lead on procuring the new Wales & Borders franchise. In anticipation of this, the Welsh Government are developing their procurement approach which is planned to start earlier than shown on this schedule.

**THIS RAIL FRANCHISE SCHEDULE REFLECTS THE INFORMATION IN THE QUALIFICATION SYSTEM NOTICE (QSN). SEE THE OFFICIAL JOURNAL OF THE EUROPEAN UNION (OJEU) FOR THE MOST UP TO DATE VERSION.**

**FOR MORE INFORMATION ON THE DEPARTMENT'S APPROACH TO RAIL FRANCHISING PLEASE REFER TO THE RAIL FRANCHISING PAGES OF THE GOV.UK WEBSITE (www.gov.uk/government/collections/rail-franchise-bid).**

## APPENDIX 3 – White light emitting diode light units criteria

### White Light Emitting Diode Lighting Units

Date added to ETL 2008 (Revised 2015).

#### 1. Definition of Technology

White light emitting diode lighting units are products that are specifically designed to provide white light by means of solid-state lighting devices.

#### 2. Technology Description

White LED lighting units are products that consist of one or more white LEDs, incorporated into a light fitting (or luminaire) and includes associated electronic control gear. The luminaire generally also includes an optical system that reflects and/or focuses the product's light output onto the item(s) being illuminated. White LED lighting units may also incorporate lighting control devices such as light regulation (dimming) and 'presence' controls. Luminaires designed to incorporate or supplied with LED based 'lamps' that retrofit to traditional light sources such as LED T8 replacement tubes or MR16 Low Voltage Lamps are not included in the scope.

White LED Lighting Units have been included in the Enhanced Capital Allowance (ECA) scheme because they offer substantial energy and carbon savings. A wide variety of LED lighting units are available in a range of designs with different performance levels. The ECA scheme aims to encourage the purchase of higher efficiency products.

The ECA Scheme covers four categories of products:

1. Amenity, accent and display lighting
2. General interior lighting
3. Exterior area lighting
4. Exterior floodlighting

Where:

- **Amenity lighting** is decorative lighting intended to enhance the appearance of a building or outdoor area in order to promote the activities of a business. It can include 'mood' lighting of hotels, bars and restaurants and other leisure activities; and decorative lighting for public areas of buildings and parts of buildings or the surrounding grounds (where such lighting is necessary to the enhancement of the business function). It does not include lighting to provide general illumination or circulation, or building lighting that would be present regardless of the type of business being carried out.
- **Display lighting** comprises lighting intended to highlight displays of exhibits, signs associated with the business function, or merchandise. It includes spot or projector lighting in shops, theatres, galleries and studios; and display case lighting.
- **Accent lighting** comprises lighting that is intended to provide additional light over a specific small area in order to carry out or promote the activities of a business. This may include lighting required for a particular task (e.g. medical or dental examination, supplementary lighting for fine machining work or critical inspection work). It does not cover general lighting for an entire room or a large part of a room.
- **General interior lighting** covers all other interior lighting.



- **Exterior area lighting** covers all exterior lighting which is intended to provide downward light onto horizontal or near horizontal surfaces, including roadways, car parks, paths, stairs, ramps, gardens and other open spaces. This includes illuminated bollards and post-top lanterns.
- **Exterior floodlighting** covers exterior lighting that is intended to light vertical or near vertical surfaces, including floodlighting of buildings, monuments and statues.

Investments in products containing white light emitting diode lighting units can only qualify for Enhanced Capital Allowances if the products meet the eligibility criteria set out below. The individual products purchased do not need to be named on the Energy Technology Product List.

### 3. Eligibility Criteria

To be eligible, products must:

- Include one or more solid-state LED devices, luminaire and associated electronic control gear.
- Be capable of producing white light. White light is defined in Annex 2, paragraph 3b of EC Regulation 245/2009 "Implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements for fluorescent lamps without integrated ballast, for high intensity discharge lamps, and for ballasts and luminaires able to operate such lamps".
- Be CE Marked.
- Not be luminaires designed to incorporate or supplied with LED based 'lamps' that retrofit to traditional light sources such as LED T8 replacement tubes or MR16 Low Voltage Lamps.
- Not be emergency lighting.

In addition, control gear must comply with the following performance standards (where relevant):

- BS EN 61347-2-13:2014, "Lamp control gear. Particular requirements for d.c. or a.c. supplied electronic control gear for LED modules".
- BS EN 62384:2006 (as amended), "D.C. or A.C. supplied electronic control gear for LED modules. Performance requirements".

### Performance criteria

All products must:

- Have a luminaire efficacy (i.e. lighting efficiency) that is greater than, or equal to, the thresholds set out in Table 1 below, after 100 hours of continuous operation.
- Be able to provide a light output (in lumens) after 6000 hours of continuous operation that is not less than 90% of their initial light output (in lumens).
- Have a colour rendering index that meets the requirements of Section 2.2 of Commission Regulation (EU) no 1194/2012 (implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for directional lamps, light emitting diode lamps and related equipment)
- Have a power factor that is greater than, or equal to, 0.7 at all levels of product light output.

In addition:

- General lighting units installed indoors must comply with the glare and angular exclusion zone recommendations in paragraph 94 of HSG 38 (1997), "Lighting at work" (ISBN: 9780717612321).
- Individual control gear must have a standby power not exceeding 0.5 Watts when the lighting unit incorporates an electronically addressed dimming or switching circuit. If the product is not fitted with an automatic switching or dimming circuit, the product must not consume power when it is switched off.
- Amenity, accent and display lighting units to be installed indoors must have a minimum light output of at least 100 lumens after 100 hours of continuous operation. All other fittings must have a minimum light output of at least 200 lumens after 100 hours of continuous operation.

Table 1 - Minimum luminaire efficacies for white LED lighting units

Category	Minimum luminaire efficacy (In luminaire lumens per circuit watt)
Amenity, accent and display lighting units	$\geq 75$
General interior lighting, using downlighting units (DLOR/LOR $\geq 0.9$ )	$\geq 82$
General interior lighting using uplighting units (DLOR/LOR $< 0.1$ )	$\geq 100$
General interior lighting using combined up and down lighting units (DLOR/LOR $\geq 0.1$ and $< 0.9$ )	$\geq 100 - (18 \times \text{DLOR/LOR})$
Exterior area lighting units	$\geq 82$
Exterior floodlighting units	$\geq 82$

" $\geq$ " means "greater than or equal to".

Where:

- Luminaire efficacy is defined in terms of the lumens of light output emitted by the luminaire per circuit watt of electrical power consumed.
- The electrical power consumed (in circuit watts) is defined as the total power consumed by the whole lighting unit from main circuit connection point to 'LED module', including losses in the power supply and constant current source, and losses due to the effects of temperature. It is not the 'rated wattage' of the LED chip.
- The product must perform at the minimum required efficacy at each drive current for which the product is designed to operate, when tested after 100 hours of continuous operation. If the product incorporates dimming control it shall be tested at its highest light output level.
- For amenity, accent and display lighting units, general interior lighting, and exterior floodlighting units, light output is defined as the total light output in all directions (TLO), which is the sum of:
  - a) Light output in a downward direction (DLO) i.e. below the horizontal as installed, and

b) Light output in an upward direction (ULO) i.e. above the horizontal as installed.

- For exterior area lighting units only, light output is defined as total light output in a downward direction (DLO) only i.e. below the horizontal as installed (i.e. light output in an upward direction is not included in the calculation of product light output or luminaire efficacy).

#### Required test procedures

All products must be tested in accordance with the procedures laid down in one of the following:

- BS EN 13032-1:2004 (as amended), "Light and lighting. Measurement and presentation of photometric data of lamps and luminaires. Measurement and file format".
- IES LM-79-08, "Electrical and Photometric Measurements of Solid-State Lighting Products".
- DD IEC/PAS 62722-2-1:2011. "Luminaire performance Part 2-1: Particular requirements for LED luminaires".

However if a product is sold solely for use in refrigerators or freezers with a declared application temperature of 5°C or below, its efficacy and luminous flux may be measured at a temperature of between 0° and 5°C on its external casing. The light output measurements at 0 and 6000 hours shall both be made at the same temperature.

- The following test conditions must be observed:
  - Testing of efficacy, minimum light output, power factor and standby power must be conducted on the complete product (i.e. solid state LED device(s), luminaire and associated electronic control gear) and under normal operating conditions.
  - Measurements of the reduction in product light output with time shall be made over a period of 6000 hours according to the methods in either DD IEC/PAS 62722-2-1:2011 "Luminaire performance Part 2-1: Particular requirements for LED luminaires" or IES LM-80-08, "Measuring Lumen Maintenance of LED Light Sources". These measurements may be carried out on the complete product.
  - Measurements of the product's light output and electrical power consumption at different drive currents must be taken after the junction temperature has stabilised to a constant level after selecting the particular drive current.

For the avoidance of doubt test data should be presented to zero decimal places. As an example, an efficacy of 74 lumens per circuit watt for a display lighting unit would be deemed to be a fail.

#### 4. Scope of Claim

Expenditure on the provision of plant and machinery can include not only the actual costs of buying the equipment, but other direct costs such as the transport of the equipment to site, and some of the direct costs of installation. Clarity on the eligibility of direct costs is available from [HMRC](#).

## APPENDIX 4 – Lighting Controls Criteria

ECA ENERGY TECHNOLOGY CRITERIA LIST 2012 – LIGHTING CONTROLS

---

### Lighting Controls

Date added to ETL 2001 (Revised 2012).

#### 1. Definition of Technology

Lighting controls are products that are specifically designed to switch electric lighting on or off, and/or to dim its output.

#### 2. Technology Description

Lighting controls switch lighting on and off and enable electric lighting levels within specific areas to be adjusted, as and when required by changes in daylight or occupancy, or individual activities.

A wide variety of lighting control products are available, and these range from simple manual switches to fully automatic control systems that adjust electric lighting levels to reflect planned operating hours, occupation levels and the availability of daylight in specific areas.

The Enhanced Capital Allowance scheme aims to encourage the purchase of lighting controls that realise energy savings by automatically switching or dimming lighting in these ways.

Five different categories of lighting controls are covered by the ECA Scheme:

1. Time controllers that automatically switch off lighting, or dim it down, at predetermined times.
2. Presence detectors with associated switching controllers that monitor occupancy or movement of personnel, and automatically switch off lighting, or dim it down, when the area is unoccupied.
3. Daylight detectors with associated switching controllers that monitor daylight availability, and automatically switch off lighting when daylight is sufficient to illuminate the area.
4. Daylight detectors with associated dimming controllers that monitor daylight availability, and automatically dim lighting, by reducing its power consumption, to the level needed to sufficiently illuminate the area.
5. Central control units that provide the facility to manage the overall operation of electric lighting installations that include some or all of the categories of lighting controls above.

The above categories of lighting controls may be installed either individually or in combination.

Investments in lighting controls can only qualify for Enhanced Capital Allowances if the product meets the criteria as set out below. The individual products purchased do not need to be named on the Energy Technology Product List.

**3. Eligibility Criteria**

To be eligible, products must:

- Incorporate one or more of the categories of lighting controls set out in Tables 1 to 5 below, and comply with the specific eligibility criteria in the relevant table(s).
- Be CE Marked.

Products may also incorporate the facility that permits the automatic switching of lights to be overridden on a central basis for maintenance or security purposes, or to ensure the safety of occupants during particular events or activities.

Table 1 Time Controllers
<b>SECTION 1A -ELIGIBILITY CRITERIA</b>
To be eligible under this category of Lighting Controls:
<ul style="list-style-type: none"> <li>• The product must automatically switch the lighting off, or dim it down, at predetermined times of the day or week, or after a predefined interval.</li> </ul> <p>Where automatic dimming controls are used, they must be capable of reducing the power consumption of the controlled lamps by at least 50%.</p> <p>Where fluorescent lighting is being dimmed, it must incorporate high frequency dimmable ballast and electronic control gear. Other forms of lighting may incorporate either mains frequency or high frequency dimmable ballasts and associated controls.</p>
<b>SECTION 1B -Notes</b>
<ol style="list-style-type: none"> <li>1. The product may also be set to automatically switch on the lighting at predetermined times.</li> <li>2. Products may incorporate the facility for local users to manually switch on and off lighting in a local area and thus to override the predetermined lighting levels at that particular time. However products that allow local users to locally override subsequent predetermined times for the lighting to be automatically switched off, or dimmed down, are not eligible.</li> <li>3. If the product is designed to control any form of heating, ventilation or air conditioning (HVAC) equipment then, it must be listed under the HVAC Zone Controls part of the Energy Technology Product List (ETPL).</li> </ol>

<b>Table 2 Presence detectors with associated switching controllers</b>
<b>SECTION 2A -ELIGIBILITY CRITERIA</b>
To be eligible under this category of Lighting Controls:
<ul style="list-style-type: none"> <li>• The product must automatically switch off the lighting, or dim it down, after the area has become unoccupied.</li> </ul> <p>Where automatic dimming controls are used, they must be capable of reducing the power consumption of the controlled lamps by at least 50%.</p> <p>Where fluorescent lighting is being dimmed, it must incorporate high frequency dimmable ballast and electronic control gear. Other forms of lighting may incorporate either mains frequency or high frequency dimmable ballasts and associated controls.</p>
<b>SECTION 2B -Notes</b>
<ol style="list-style-type: none"> <li>1. The product may also automatically switch on the lighting when the space becomes occupied. Alternatively local users may manually switch on the lighting at the start of occupancy.</li> <li>2. Products may incorporate the facility for local users to manually override the presence detector/controller and to switch the lighting off at any particular instance. However products that allow local users to override the ability of the presence detector/controller to automatically switch off the lighting, or dim it down are not eligible.</li> </ol>

<b>Table 3 Daylight detectors with associated switching controllers</b>
<b>SECTION 3A -ELIGIBILITY CRITERIA</b>
To be eligible under this category of Lighting Controls:
<ul style="list-style-type: none"> <li>• The product must monitor the availability of daylight and automatically switch the lighting off when sufficient daylight is available to illuminate the area.</li> </ul>
<b>SECTION 3B -Notes</b>
<ol style="list-style-type: none"> <li>1. The product may also automatically switch on the lighting when daylight has fallen below the required level. Alternatively local users could be allowed to switch on the lighting manually, when daylight has fallen below the required level.</li> <li>2. Products may incorporate the facility for local users to manually override daylight detector/controller and switch the lights off at any particular instance. However products that allow local users to override the ability of the daylight detector/controller to automatically switch off the lighting are not eligible.</li> </ol>

Table 4 Daylight detectors with associated dimming controllers
<b>SECTION 4A -ELIGIBILITY CRITERIA</b>
To be eligible under this category of Lighting Controls:
<ul style="list-style-type: none"> <li>• The product must monitor the availability of daylight and automatically dim the electric lighting to the level just needed to sufficiently illuminate the area.</li> <li>• The product must be able to reduce the power consumption of the lamps being controlled by at least 50% through dimming.</li> </ul> <p>Where fluorescent lighting is being dimmed, it must incorporate high frequency dimmable ballasts and electronic control gear. Other forms of lighting may incorporate either mains frequency or high frequency dimmable ballasts and associated controls.</p>
<b>SECTION 4B -Notes</b>
<ol style="list-style-type: none"> <li>1. The product may also automatically switch on the lighting when daylight has fallen below the required level. Alternatively local users could be required to switch on the lighting manually, as and when needed.</li> <li>2. Products may incorporate the facility for local users to manually override the dimming controller at any particular instance and to set the lighting to a lower level than it would be under automatic control, or switch it off. However products that allow local users to override the ability of the daylight detector/controller to automatically dim the lighting are not eligible.</li> </ol>

Table 5 Central control units (for lighting)
<b>SECTION 5A -ELIGIBILITY CRITERIA</b>
To be eligible under this category of Lighting Controls:
<ul style="list-style-type: none"> <li>• The product must be able to manage the overall operation of the electric lighting installation that includes some or all of the categories of lighting controls set out in Tables 1 to 4 above.</li> </ul>
<b>SECTION 5B -Notes</b>
<ol style="list-style-type: none"> <li>1. The product may make use of pre-programmed "scenes" that configure the lighting levels in different areas for a particular activity or daylight level or occupancy status in the most energy efficient manner. However products that are only capable of manual scene setting are not eligible.</li> <li>2. Products may also incorporate the facility to monitor lighting energy consumption.</li> <li>3. If the product is designed to control any form of heating, ventilation or air conditioning (HVAC) equipment then, it must be listed under the HVAC Zone Controls part of the Energy Technology Product List (ETPL).</li> </ol>



#### 4. Scope of Claim

Expenditure on the provision of plant and machinery can include not only the actual costs of buying the equipment, but other direct costs such as the transport of the equipment to site, and some of the direct costs of installation. Clarity on the eligibility of direct costs is available from [HMRC](#).

## APPENDICIES 5 – 12

Appendicies have been removed by the request of the case company