

Nina Pirinen

# **Sustainable Construction Site Service and Rental Concept**

Case Temporary Factory in Ramirent Finland Ltd, Concept development for  
Finnish markets

Thesis

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## **Thesis abstract**

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Author: Nina Pirinen

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Construction industry is lacking productivity. The development of productivity has been weak since 1970s compared to other industries. In building process there is a lot of waste. Waste can be time-bounded, resource-bounded or financial. Climate change and biodiversity loss are challenges which construction industry must also meet.

The purpose of this thesis is to find out what construction site could benefit by combining the site services and arranging them in turnkey conditions for all the subcontractors. Also, the aim is to understand what customers emphasis are when they order construction site services and equipment.

The research answers the question of which elements are most important in the implementation and development of the Temporary Factory -concept (Valmis Työmaa -konsepti) in Ramirent Finland Ltd. Temporary Factory is a temporary site service concept developed in Ramirent Sweden Ltd.

The knowledge base of the study consists of concepts of sustainability and circular economy, and theories of lean thinking. The empirical part for the research is made by interviewing customers of Ramirent Finland Ltd. Data analysis was made by combining answers in themes.

Study show that there is a need for a Temporary Factory -concept coming to Finnish markets. It gives an overview of most important elements of starting and implementing a temporary site service concept.

Construction industry is looking for new approaches to improve productivity and face the challenges of limited resources.

Keywords: sustainability, circular economy, lean management, supply chain management.

SEINÄJOEN AMMATTIKORKEAKOULU

## Opinnäytetyön tiivistelmä

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Rakennusteollisuus kaipaa tuottavuutta. Tuottavuuden kehitys verrattuna muihin teollisuuden aloihin on ollut heikkoa 1970-luvulta lähtien. Rakentamisprosessissa on paljon hukkaa niin ajankäytössä, resurssoinnissa tai taloudessa. Rakennusteollisuus joutuu kohtaamaan myös ilmastomuutoksen ja biodiversiteetin köyhtymisen haasteet.

Tämän tutkimuksen tarkoituksena on selvittää mitä rakennustyömaa voisi hyötyä yhdistämällä kaikki työmaan tilapäiset toiminnot ja järjestämällä ne avaimet käteen -periaatteella kaikille työmaalla toimiville urakoitsijoille. Tavoitteena on myös ymmärtää mitä asioita asiakkaat painottavat tilatessaan työmaapalveluita ja laitteita.

Tutkimus vastaa kysymykseen mitkä elementit ovat tärkeimmän Ramirent Finland Oy:n Valmis työmaa -konseptin (Temporary Factory -concept) toteuttamisessa ja kehittämisessä Suomen markkinoilla. Tilapäisten työmaatoimintojen konsepti ”Temporary Factory” on kehitetty Ramirent Ruotsi AB:ssa.

Tutkimuksen tietoperusta pohjautuu kestäväan kehityksen, kiertotalouden ja lean-ajattelun teorioihin. Työn empiirinen osa on tehty haastattelemalla Ramirent Finland Oy:n asiakkaita. Analyysiosa tehtiin yhdistämällä vastaukset teemoittain.

Tutkimus osoittaa, että Valmis työmaa -konseptille on tarvetta Suomen markkinoilla. Se antaa yleiskatsauksen tärkeimmistä elementeistä työmaapalvelukonseptin käynnistämässä ja toteuttamisessa.

Rakennusteollisuus etsii uusia lähestymistapoja parantaakseen tuottavuutta ja kohdatakseen rajallisten resurssien tuomat haasteet.

Asiasanat: kestävä kehitys, kiertotalous, lean-johtamisjärjestelmä, toimitusketjun hallinta

## TABLE OF CONTENTS

Thesis abstract.....	2
Opinnäytetyön tiivistelmä.....	3
TABLE OF CONTENTS .....	4
Tables, Figures and Pictures .....	6
Terms and Abbreviations.....	7
<b>1 INTRODUCTION .....</b>	<b>8</b>
1.1 Ramirent Group.....	8
1.2 Thesis background.....	9
1.3 Research problem and objectives .....	10
<b>2 SUSTAINABLE DEVELOPMENT .....</b>	<b>12</b>
2.1 Sustainability and sustainable development .....	12
2.2 Economic sustainability .....	13
2.3 Social and cultural sustainability .....	15
2.4 Technological sustainability .....	16
2.5 Environmental sustainability.....	17
<b>3 CIRCULAR ECONOMY .....</b>	<b>18</b>
3.1 The concept of circular economy by Ellen MacArthur Foundation .....	18
3.2 Circular economy business models.....	19
3.2.1 Circular supply chain.....	20
3.2.2 Recovery and recycling.....	20
3.2.3 Building products to last.....	20
3.2.4 Sharing platform .....	21
3.2.5 Product as a service .....	21
3.2.6 Circular economy business models in circular value chain .....	22
3.3 Circular economy and carbon footprint of renting construction equipment.....	23
<b>4 LEAN MANAGEMENT .....</b>	<b>24</b>
4.1 Lean tools .....	25
4.2 Waste.....	26
4.3 Lean management and circular economy .....	26
<b>5 SUPPLY CHAIN MANAGEMENT .....</b>	<b>28</b>

5.1 Circular and lean supply chain management .....	28
5.2 Supply chain management in construction industry .....	30
<b>6 CASE TEMPORARY FACTORY IN RAMIRENT FINLAND LTD: CONCEPT DEVELOPMENT FOR FINNISH MARKETS .....</b>	<b>31</b>
6.1 Research method and structure .....	31
6.2 Results .....	33
6.2.1 Current situation of machine and equipment rental services .....	33
6.2.2 Health, safety and sustainability .....	35
6.2.3 The future of the machine and equipment rental services and construction industry .....	36
<b>7 CONCLUSION .....</b>	<b>40</b>
7.1 Temporary Factory process overview .....	40
7.2 Temporary Factory -concept in brief .....	41
7.3 Temporary Factory -concept; management and business model.....	43
<b>8 REFLECTION AND LIMITATIONS.....</b>	<b>44</b>
8.1 Limitations and topics for further research .....	45
<b>9 BIBLIOGRAPHY .....</b>	<b>46</b>
<b>APPENDICES .....</b>	<b>49</b>

## Tables, Figures and Pictures

Table 1. Waste and Value as per Lean and Circular Economy.....	27
Table 2. Four roles of construction supply chain management.....	30
Table 3. Interviewees' professional title and interview dates.....	32
Figure 1. Four dimensions of sustainability .....	13
Figure 2. The hierarchy of economic sustainability .....	14
Figure 3. Three roles of culture in sustainable development .....	16
Figure 4. Linear economy versus Circular economy .....	18
Figure 5. Drivers to circular economy .....	19
Figure 6. Circular business models in circular value chain .....	22
Figure 7. Elements of Lean Culture .....	25
Figure 8. SCM and Lean integrated .....	29
Figure 9. Benefits of the Temporary Factory -concept.....	41
Figure 10. Construction project timeline.....	42
Figure 11. Temporary Factory management and business model .....	43

## Terms and Abbreviations

<b>3D</b>	Three dimensions; x, y, z
<b>4D</b>	Four dimensions; x, y, z, time
<b>5D</b>	Five dimensions; x, y, z, time, cost
<b>BIM</b>	Building Information Model
<b>CSCM</b>	Circular Supply Chain Management
<b>CSCMP</b>	The Council of Supply Chain Management Professionals
<b>ERA</b>	European Rental Association
<b>LCA</b>	Life Cycle Assessment
<b>OECD</b>	Organisation for EconomicCo-operation and Development
<b>Sitra</b>	Suomen itsenäisyyden juhlarahasto, The Finnish Innova- tion Fund

# 1 INTRODUCTION

This research is a continuation for Ramirent Group Ltd.'s strategy work from year 2017. In that work Ramirent interviewed customers from construction industry in Finland, Norway and Sweden. These interviews were analysed and as a result Ramirent's a new customer strategy was created. In this research only Finnish interviews are analysed further to reach the goal to develop a concept for Finnish markets.

## 1.1 Ramirent Group

Ramirent is a company offering equipment rental for construction and other industries, the public sector and households. The company has around 3,500 employees and more than 300 customer centers across nine countries in Northern and Eastern Europe (Finland, Sweden, Norway, Estonia, Latvia, Lithuania, Czech Republic, Slovakia, and Poland). Ramirent also operates through the 50% owned joint venture company Fortrent in Russia. Ramirent belongs to the Loxam Group, which is the third largest equipment rental company in the world. (Ramirent, This is Ramirent 2020)

Company's product portfolio contains large variety of machinery, scaffolding and weather shelters, tools, site modules, safety equipment, lightning, electricity and heating systems with related plans and assemblies. Services are a key part of Ramirent's operations. Company offers worksite planning and traffic arrangements, condition monitoring, on-site support, logistics and fuel services, qualification training required on construction sites and safety planning. (Ramirent, This is Ramirent 2020)



## 1.2 Thesis background

Construction industry is lacking productivity. The development of productivity has been weak since 1970s compared to other industries. In building process there is a lot of waste. Waste can be time-bounded, resource-bounded or financial. Subcontracting can occasionally reduce profits and blur areas of responsibility. In a typical construction site, there are areas where nobody is willing to take the responsibility. It is also hard to follow the utilization of resources. Often same resources, f. ex. machines or transportation, are ordered separately by each subcontractor instead of combining and planning the actual need.

The biggest challenges of our lifetime are climate change and biodiversity loss. Actions are required now to ensure acceptable living conditions to future generations and all living species. From the perspective of future generations, companies must also be able to create economic growth and prosperity. All this needs to be done not only environmentally, but also socially and economically sustainable. Everybody bears their own responsibility for sustainable economic growth, and construction industry is no exception.

Safety of co-workers and people living and working around the construction site is the most important issue. Today, safety requirements are demanding, and it has paid off. The number of accidents has been significantly reduced thanks to the long-term safety work carried out by the entire construction industry. Still there is a lot to do within construction industry to achieve the desired safety targets.

Complexity of construction work and continuously increasing requirements can be overwhelming for project owners and managers. Construction sites are undergoing constant change and project managers need to be able to manage risk.

These challenges among many others were often discussed during strategy interviews, although they were not all directly asked in that context. Strategy interviews were used as a basis for Ramirent's new strategy creation.

In our strategy, we focus on capital efficient profitable growth in our core business - machine rental and related services. We aim at to continuously increase our market share, especially for small and medium-sized companies in all our countries of operation. Ramirent is an industry

leader in large construction sites as a total service provider, and we want to confirm further enhance our position among large customers as well. (Ramirent 2018, 8)

Around same time period had Ramirent Sweden Ltd. started to work with a concept called Total Solution. This concept gathered all the temporary site services under one project and made agreement with the owner of the construction project instead of main contractor. The concept is now called Temporary Factory.

In autumn 2019 Ramirent Finland Ltd. decided to start development of Temporary Factory -concept for Finnish markets. The concept for Finnish markets is called “Valmis työmaa”.

### **1.3 Research problem and objectives**

The aim of this research is to find out what construction site could benefit by combining the site services and arranging them in turnkey conditions for all the subcontractors. Also, the aim is to understand what customers emphasis are when they order construction site services and equipment. The views expressed in the interviews are examined under conceptual framework of circular economy and lean management. The final objective is to create a business plan for Temporary Factory – concept (Valmis työmaa) in Finland by taking advantage of this research’s results.

The starting point of the study is to find out the current state of the equipment rental services and how they should be developed, so that Ramirent could improve its own services and contribute to improving the productivity of construction projects. The research answers the question of which elements are most important in the implementation and development of the concept.

The research is a qualitative and it is made by structured thematic interviews. The research is limited to the construction industry and mainly to the general contractor level. No project management companies, or owners of large construction projects have been interviewed for the study.

After answering the research questions, an overview of the most important elements for the implementation of the concept is presented. The research work was commissioned by Ramirent Finland Ltd.

## 2 SUSTAINABLE DEVELOPMENT

### 2.1 Sustainability and sustainable development

The concept of sustainability is rather complex. It can be viewed as two different points of view. As a plain concept of sustainability, it is focused on the present moment, while the concept of sustainable development is focused on to the future. Sustainability describes the state where conditions are right now and how the situation can continue as it is in a long run. Sustainable development describes improvements and alterations which aim to reach more sustainable circumstances compared to current situation.

The most referred definition of sustainability is United Nations Brundtland Commissions (1987), where the commission defined sustainability as “meeting the needs of the present without compromising the ability of future generations to meet their own needs.” (United Nations, Academic Impact 2020)

According to United Nations to achieve sustainable development, “it is crucial to harmonize three core elements: economic growth, social inclusion and environmental protection”. (United Nations, Sustainable Development Agenda 2020) Helping to achieve these objectives, has United Nations member states set 17 goals for sustainable development. (United Nations, Sustainable Development Goals 2020)

Goals for sustainable development:

1. No poverty
2. Zero hunger
3. Good health and well-being
4. Quality education
5. Gender equality
6. Clean water and sanitation
7. Affordable and clean energy
8. Decent work and economic growth
9. Industry, innovation and infrastructure
10. Reduced inequalities

11. Sustainable cities and communities
12. Responsible consumption and production
13. Climate action
14. Life below water
15. Life on land
16. Peace, justice and strong institutions
17. Partnerships



Figure 1. Four dimensions of sustainability

## 2.2 Economic sustainability

Long-term economic growth without impacting negatively social, cultural or environmental aspects is considered economic sustainability. Economic priority or assumption of the present is that short-term growth cannot be sustainable. (Ikerd, 2012, 10)

Economic sustainability expects that companies and states utilizes resources sensibly so that they can act in a sustainable manner to create an operational profit.

Operational profit is vital for business to continue their activities, but if they will not act responsibly and use resources reasonably, they cannot sustain activities in the long run. According to Ikerd (2012, 1) the essential question of economic sustainability is how can we meet the economic needs of the present without diminishing economic opportunities for the future?

Ikerd (2012, 7) writes that, “the emergent properties of social relationships evolve into an ethical commitment to protect, preserve, and promote the common good and the good of the commons, a commitment that is essential for economic sustainability”. It is a property of trusting and caring relationships with every aspect of living factor. Every economic action has an impact in society, culture and nature. The size of effect is related to the size of an economy.

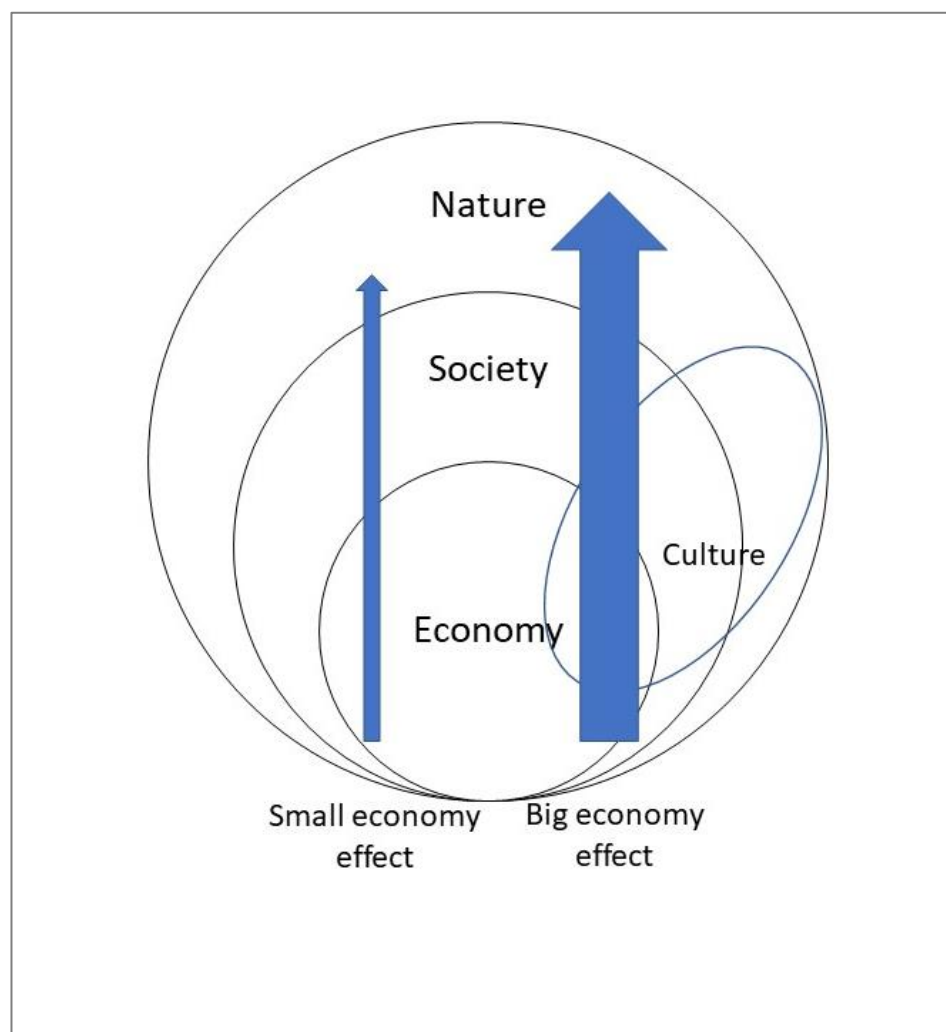


Figure 2. The hierarchy of economic sustainability

### 2.3 Social and cultural sustainability

Definition of value and the relative importance of economic development, environmental preservation and social welfare is problematic, because it varies according to people, scale and viewing angle. Figuring out what we want to sustain and act towards it is a social issue. According to Anna Littleboy social sciences give us understanding to culture and history of societies and furthermore to the way of interring course in and between them. (Schandl & Walker 2017, iii)

Human activity, individually, organizationally, institutionally and systemically, forms all sizes of ecosystems. Sustainable sciences review how human systems and ecosystems interact and construct with each other.

Social sustainability ensures that everybody has a right to nutrition, education and freedom of expression. It can be defined as determining impacts of systems, processes, organizations, and activities on people and social life. The issues social sustainability compounds are like health and social equity, human rights, labor rights, practices and decent working conditions, social responsibility and justice, community development and well-being, product responsibility, community resilience, and cultural competence. (Balaman 2019)

Cultural sustainability involves preserving language, cultural beliefs, practices and heritage. It tries to answer the question if any given cultures will survive in context of the future. Dessein et al. (2015, 14) highlight that most of the planet's environmental problems and certainly all its social and economic problems have cultural aspect within human actions and their roots.

The role of culture in sustainable development is often bypassed among three other dimensions of sustainability (economic, social and environmental). The role of culture in sustainable development has been reviewed often as a part of social sustainability. Only recently has several international organizations displayed culture as an explicit aspect of sustainability. It has also been introduced implicitly in many other policy publications both globally and locally. (Dessein & Soini & Fairclough & Horlings 2015, 15)

Soini et. al (2014, 215) suggest that cultural sustainability moves across social sustainability, but cultural dimensions of sustainability do not have to be understood as a separate fourth pillar of sustainability. Culture can also be the foundation or essential position for meeting the goals of sustainable development. Or it can be a perspective through which understandings of social, economic, and environmental sustainability may indicate. (Soini & Birkland 2014, 215)

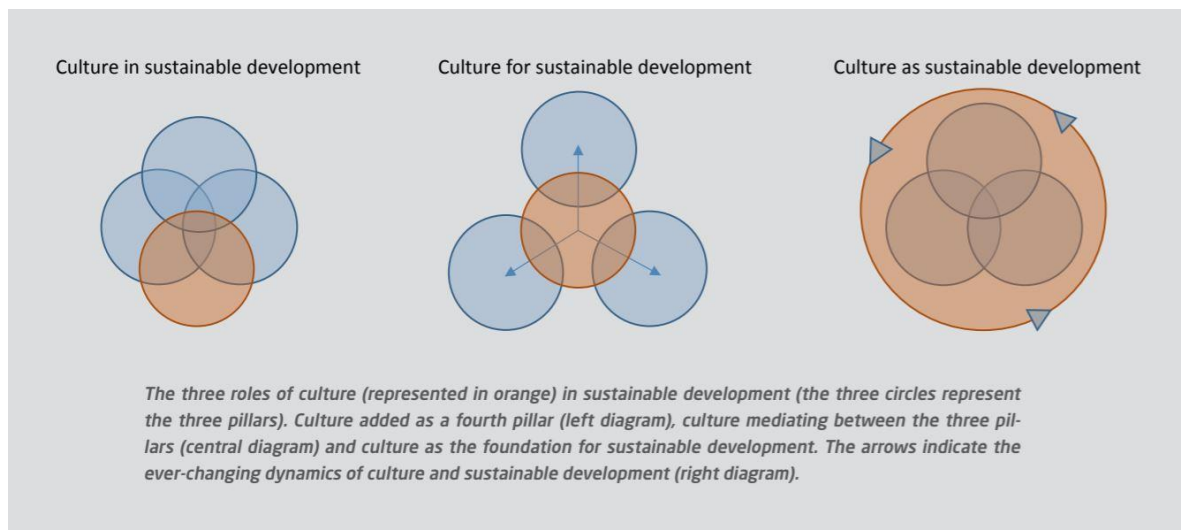


Figure 3. Three roles of culture in sustainable development (Dessein et al. 2015, 29)

## 2.4 Technological sustainability

Due to technological development, the world is in this state, but technological development is also the solution to get out of this. The world is ruled by technology and it is everywhere. The role of technological development is crucial to sustainable development and there is no sustainable development without technological sustainable development. Technological innovations can give solutions for environmental, social, cultural and economic challenges of sustainability. Innovations offer new sustainable and profitable business possibilities. (Wilenius 2015, 61, 65)

Another aspect of technological sustainability is wealth of societies and people. Technological solutions must be affordable and realistic to implement. To diminish poverty and reinforce sustainable development affordable technological innovations need to be developed extensively in the future. (United Nations, Technology 2020)



## 2.5 Environmental sustainability

Environmental sustainability relates to protecting and maintaining natural resources for future generations and mankind. It defines boundaries for satisfying human needs without risking the quality of environment and ecosystems so that they remain capable of supporting the future generations.

Environmental sustainability concerns many issues which influences maintaining our environmental resources. As Tjevan Pettiger (2018) points out in his blog post, there are several issues how to ensure environmental sustainability

- Protecting long-term health of ecosystems to meet economic and social needs
- Ensuring intergenerational decision making by focusing to the future instead of the present
- Shifting energy sources from non-renewable to renewable sources
- Preventing the consequences of man-made global warming
- Protecting diversity of species and ecological structure
- Treating environmental resources and nature as if they have intrinsic rights and value
- Targeting social welfare and environmental sustainability above measures of economic welfare

### 3 CIRCULAR ECONOMY

Circular economy is an economic system that targets to eliminate waste and reuse existing resources. Circular economy is a contrast to traditional linear economy, which is usually described as “take-make-dispose” model of production. Scientific literature has over 100 different definitions for circular economy (Kirchherr & Reike & Hekkert 2017), because researchers approach the issue from different angles.

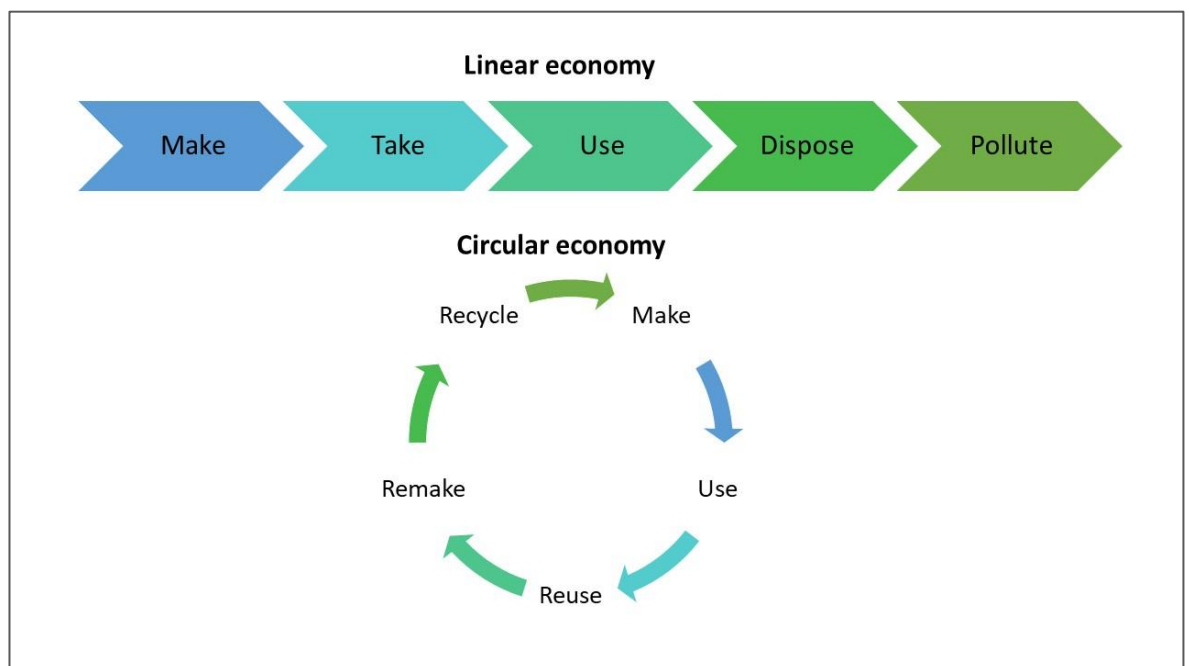


Figure 4. Linear economy versus Circular economy

Elements of the circular economy are rethinking, reducing, reusing, repairing, refurbishing, recovering, redesigning and recycling. (Kirchherr & Reike & Hekkert 2017).

#### 3.1 The concept of circular economy by Ellen MacArthur Foundation

Most well-known organization working with circular economy is Ellen MacArthur Foundation. It was founded in 2010 to promote and speed the transition from linear to circular economy. Their definition for the concept of circular economy is that economic activity builds and rebuilds overall system health. The concept identifies the significance of the economies need to work effectively in all scales, sizes and levels. (Ellen MacArthur Foundation 2020)

A change to a circular economy does not only mean reducing the negative effects of a linear economy. Instead it is a systemic change that strengthens long-term resilience, creates new business and new opportunities while it allocates environmental and social benefits. (Ellen MacArthur Foundation 2020)

### 3.2 Circular economy business models

There are three drivers that support companies to move from linear to circular economy. These drivers are customer-centricity, sustainability and technology. Putting customer-centricity on focus companies can achieve better results by selling outcomes instead of products. Depletion of natural resources drives decision-making and investments towards sustainable business. Fast technological development enables companies to fulfill on circular economy objectives. (Sitra 2018, 12-15)

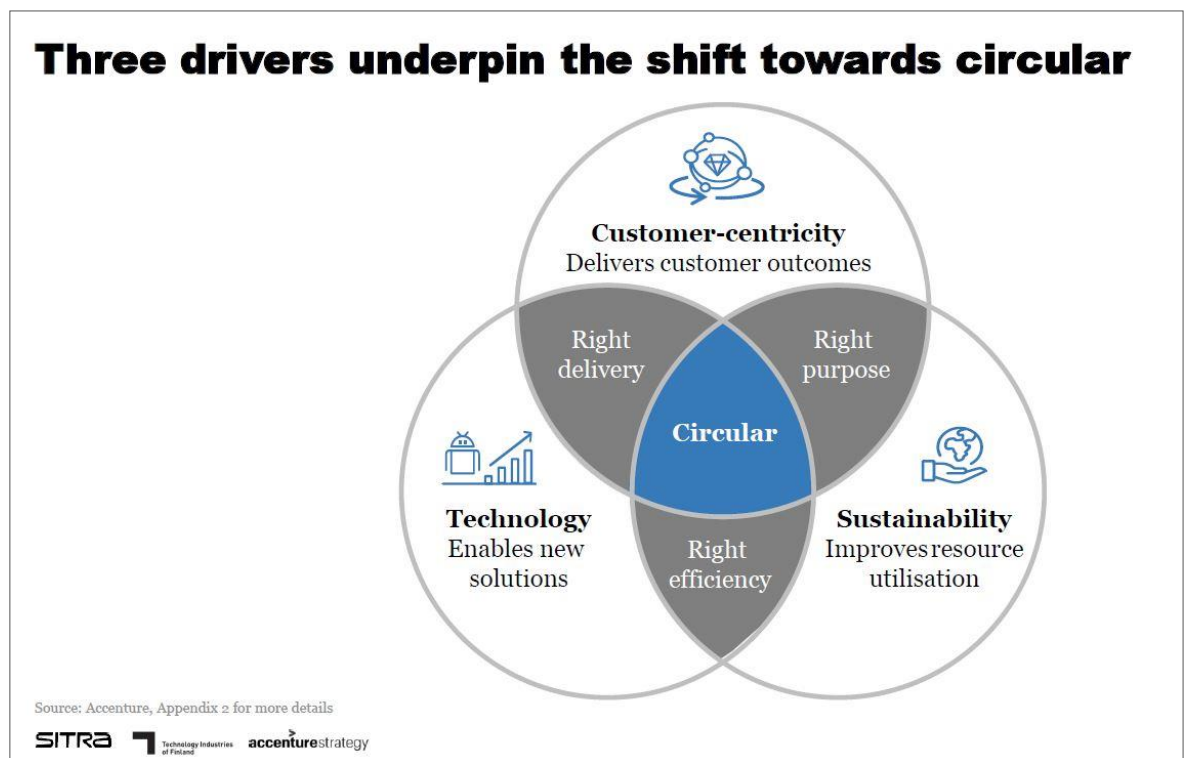


Figure 5. Drivers to circular economy (Sitra 2018, 12)

In theory, circular economy business models differ significantly, but in practice they are not so distinct, and companies often adopt combinations of business models. Circular economy business models are not new. Recycling, reusing and repairing have always existed. People have always shared assets and renting products is

nothing new. The novelty comes from the fact that the ways in which these business models are applied and how diverse the product range can be. (OECD 2019, 25)

### **3.2.1 Circular supply chain**

Circular supply business model reforms use of resources to renewable energy and bio-based or recyclable raw materials (Sitra 2018, 24). Strategic sourcing decisions help companies to reduce environmental pressure in their supply chains and eventually lead to waste-free production. (OECD 2019, 26)

Circular supply model is often called as “cradle to cradle” product design. This is to create a separation with “cradle to grave” material flows, where the materials used in a product end their lives in incineration or landfills. Instead materials become contribution to new manufacturing. (OECD 2019, 26)

### **3.2.2 Recovery and recycling**

Resource recovery business models involve creating value from waste. It can be either usable products or energy produced from production by-products or waste. (Sitra 2018, 24). Adoption of recovery and recycling business models require that waste and by-products are available and that there is a market for waste.

There are three different variations of recovery and recycling business models, which are downcycling, upcycling and industrial symbiosis. Downcycling means that the end- products quality is not as good as the source of raw material. Upcycling means that the end-product is much more valuable than the raw material. Industrial symbiosis involves the use of production by-products from one company as production inputs by another. (OECD, 2019, 28)

### **3.2.3 Building products to last**

Product life extension models extend the life of products. From circular economy perspective this is very beneficial business model, because products and materials

used in them remain longer in the economy. Extension of life cycle can be done by repairing, maintenance, upgrading, reselling and remanufacturing. (OECD 2019, 29-31)

There are four different product life extension models. In classic long-life model product is designed for better quality to last longer. Direct reuse model redistributes product to second-hand use. Maintenance and repairing models extend product life with replaceable components and product care. Refurbishment and remanufacturing models restore products to their original condition and sells them as new ones with lower price. OECD 2019, 29)

### **3.2.4 Sharing platform**

Optimizing and increasing usage capacity with different collaborative models is called sharing platform business model. Sharing platforms can be either virtual or physical. (Sitra 2018, 24-25)

There are three types of closed-loop circular systems; inner circles, decentralized systems, and open systems. These systems exemplify different approaches to collaboration, the management of information resources, and innovation for sustainable recycling. The composition of collaboration in closed-loop ecosystems range from extensive partnerships to industrial systems and platforms that provides marketplaces for transactions across the life cycle of a product. (Rajala, Hakanen, Mattila, Seppälä & Westerlund 2018, 21)

According to Rajala et al. (2018, 28) different types of platforms have alternating logics for value creation. Platform can serve to market, platform can operate, and platform can co-create products, components and material.

### **3.2.5 Product as a service**

Product as a service business model combine a physical product with a service component. Some variations of models place more emphasis on the physical product, and others focus on the service aspect. Product as a service business models

can be divided into three main variants: product-oriented, user-oriented, and result-oriented models. (OECD 2019, 33)

Product-oriented product service system are focused mostly on the product life end, where manufacturer offer additional after-sales service for value submission. In user-oriented model customers acquire a temporary license to use certain product (f. ex. leasing), but product is still owned by the service provider. In result-oriented model companies are not selling products, but instead they are selling results of products they provide. (OECD 2019, 33-34)

### 3.2.6 Circular economy business models in circular value chain

Different circular economy business models set place in different timeline in circular value chain. Sharing platform and product life extension are usable business models in use phase including sales & marketing phase and end of life phase. Circular supply chain model is used in the beginning of value chain (sourcing, manufacturing and logistics). Recovery and recycling can be used in the end of value chain. Product as a service business model is applicable in every phase of circular value chain. (Sitra 2018, 24)

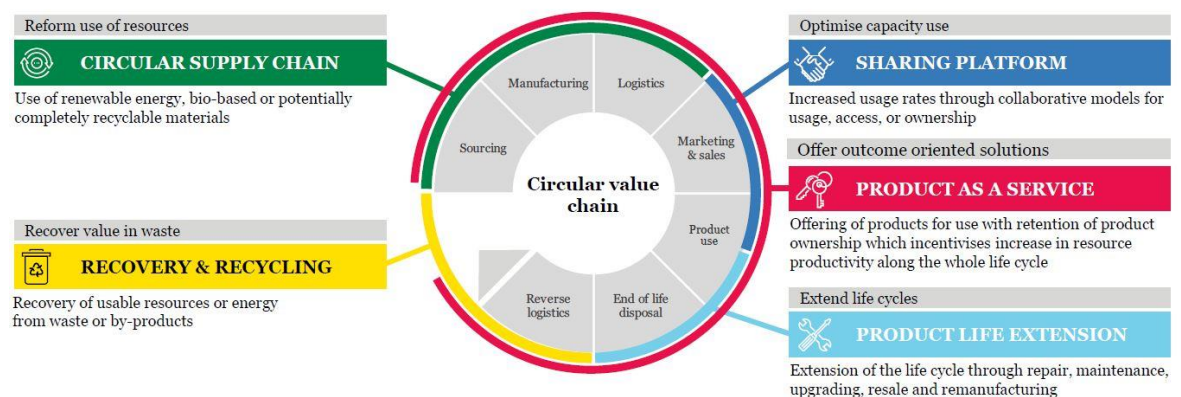


Figure 6. Circular business models in circular value chain (Sitra 2018, 24)

### **3.3 Circular economy and carbon footprint of renting construction equipment**

Renting represents circular economy by handling the assets in very effective way. In 2019 European Rental Association (ERA) commissioned an independent study on the impact of machine rental on reducing carbon emissions. They selected 10 different construction equipment for the study. The selection of equipment is frequently both rented and owned by contractors. (European Rental Association & Climate Neutral Group 2019, 5)

The carbon footprint consists of three different phases; production phase, the operational phase and the end of life phase. In ERA's carbon footprint study the operational phase was only calculated. (European Rental Association & Climate Neutral Group 2019, 5)

The five biggest effects on carbon footprint in use of equipment are; intensity of use, energy consumption, transportation, recycling and innovation. Life Cycle Assessment (LCA) conclude most significant impacts for total CO<sup>2</sup> emissions:

- Use of fossil fuel
- The heavier the machine, the bigger carbon footprint on production phase
- Use of recycled materials on production phase
- Recycling the product or the parts of the product after use
- Transportation

ERA's study concludes that there are two main factors to contribute reduction of CO<sup>2</sup> emissions. Those factors are avoiding production by enabling shared use and efficiency of organizing the handling of construction equipment. (European Rental Association & Climate Neutral Group 2019, 5)

## 4 LEAN MANAGEMENT

History of lean management can be traced as far as the industrial revolution. First well-known lean production lines were created by Henry Ford in Henry Ford Motor Company. However, the triumph of Lean thinking is thought to have begun in Japan by Toyota Company, who had to rebuild production to compete American auto industry such as Ford and General Motors. (Womack & Jones 2003)

According to Lean Enterprise Institute Inc. the core of lean is to maximize customer value by minimizing the waste, so that company can create more value with less resources. Lean thinking focuses on optimizing the product and service flow through complete value stream instead of optimizing separate technologies, assets and divisions. Lean thinking views the whole value chain horizontally instead of vertically. (Lean Enterprise Institute, What is lean 2020)

Pioneers of lean thinking James P. Womack and Daniel T. Jones (2003) introduce five principles of lean in their book Lean Thinking.

Those five principles are:

- Specify value from customers point of view
- Identify value stream
- Make a continuous product flow
- Introduce pull between production steps
- Manage towards perfection

Key words in lean principals are value, value stream, flow, pull and perfection.

Weakness of these principles is that they are process-oriented and focused mostly on manufacturing. Lean management in modern information and service society demand wider thinking.

Lean is to achieve operational excellence, but achieving it requires work design (Fredendall & Thürer 2013, 2). To have lean work design, it must be based on lean operations, but without lean work design lean operations have no meaning. According to Fredendall and Thürer (2013, x) the first step to lean work design is to



recognize how different elements and knowledge sources are aligned to common objective.



Figure 7. Elements of Lean Culture

#### 4.1 Lean tools

Lean itself is not a method. With a help of different tools and concepts organizations can adapt lean thinking in their operations and culture. In lean methodology there are numerous different technical tools to analyze the process and to design the system change. Each change process is different, so the selection of tools is also different each time. (Plenert 2006, 153)

## 4.2 Waste

Lean thinking comprises waste as everything that does not add value to a product or service. Waste is every caused cost in a process which does not benefit the final user. So, customer comes first and only the end users can define real value and what they are willing to pay for it. Taichi Ohno (Womack & Jones 2003) defines seven wastes or *muda*, as they are referred in the Toyota Production System.

- Transport - unnecessary transport of materials between workstations, unplanned shipments, half-loaded trucks f. ex.
- Inventory - there is more goods in stock than is needed
- Motion - employees are looking for material, goods, parts, help ect.
- Waiting - for example, waiting for the next steps, materials, tools
- Overproduction – producing products which would not be needed
- Overprocessing - the product is processed unnecessarily
- Defects - defective products

Some practitioners also include eight waste which is unutilized talent or creativity. In addition to seven wastes, failure of making the best out of employees is crucial in global competition. (Lean Enterprise Institute, Jean Cunningham 2020)

When defining waste, it can be noticed that it is always a consequence of something. Acknowledging waste is a way of raising issues. Identifying the waste indicates that there are problems with the operation. The waste is the result of poor variation control. (Pirainen 2014)

## 4.3 Lean management and circular economy

Lean management and circular economy have synergy to advantage business operations. Both concepts aim to reduce waste and create value, though from different point of view. Combining these concepts for producing effective outcome is both natural and reasonable. (Nadeem & Garza-Reyes & Anosike & Kumar 2019, 1082)

Lean management and circular economy have, as mentioned two common elements; waste elimination and value creation, which have different approaches within those concepts. Circular economy has a holistic approach and a closed-loop system, which are distinguishing factors compared to lean management. (Nadeem & Garza-Reyes & Anosike & Kumar 2019, 1084)

Table 1. Waste and Value as per Lean and Circular Economy (Nadeem et al. 2019, 1084)

	Lean approach	Circular Economy approach
<b>Waste</b>	<ul style="list-style-type: none"> <li>• Is an activity that does not add value to the customers (Campos and Vazquez-Brust, 2016)</li> <li>• <i>“anything other than the minimum amount of equipment, materials, parts, space and time which are absolutely essential to add value to the product”</i> (Russell and Taylor III, 2011)</li> <li>• Is inefficiency and is measured by KPI's (Sternberg et al., 2013)</li> </ul>	<ul style="list-style-type: none"> <li>• Waste = food (raw material) (Ellen MacArthur Foundation, 2015b; Webster, 2015)</li> <li>• Is seen in 4 dimensions: Wasted resources, wasted lifecycles, wasted capability, wasted embedded values (Lacy and Rutqvist, 2015).</li> </ul>
<b>Value</b>	<ul style="list-style-type: none"> <li>• Value is perceived from customer's perspective (Martínez León and Calvo-Amodio, 2017)</li> <li>• Customer's requirement (Hines et al., 2004)</li> </ul>	<ul style="list-style-type: none"> <li>• Reduce waste by recycling and source from waste (van Buren et al., 2016)</li> <li>• Prevent resources from exiting the economy (van Buren et al., 2016)</li> <li>• Has 4 dimensions: Cost reduction, revenue generation, resiliency, legitimacy and image (Park et al., 2010).</li> </ul>

Lean itself focuses on process optimization, but when added to the circular economy perspective, the focus expands beyond a single lifecycle and it continues to evolve. Circular economy is to preserve natural resources and it can be achieved with lean principles like value stream mapping, creating flow in a closed loop system and seeking perfection. (Nadeem & Garza-Reyes & Anosike & Kumar 2019, 1084)

## **5 SUPPLY CHAIN MANAGEMENT**

A supply chain is a network between a company and its suppliers to produce and distribute a specific product or a service to the customer. Supply chain management is organizing and supporting this network of resources, activities, people, entities and information. The Council of Supply Chain Management Professionals (CSCMP) highlight the importance of collaboration and coordination between different stakeholders in supply chain. Every action in supply chain must be undertaken with the demands of the final user of the product or service. (Drake 2011, 3)

Innovative supply chain management operations can provide long-term competitive advantage. Although advantages are usually temporary, it is very hard for competitors to copy and replicate an effective supply chain. This is because it depends on technological integration and significant collaboration between stakeholders of the supply chain. (Drake 2011, 12)

Exchange of information between different channels is crucial for supply chain to be effective. This requires trust and transparency among stakeholders. For competitive advantage it is important that entities can monitor the performance of every other entity in the supply chain. (Plenert 2007, xiii)

### **5.1 Circular and lean supply chain management**

One of the key elements of lean management is elimination of waste, which can be identified in large amount of resources areas. And all the resource areas of supply chain contain waste. With lean methodology the waste can be identified and with lean tools the waste should be eliminated. (Plenert, 2007, xiii)

Looking at both supply chain management and lean principles in parallel, a dynamic synergy can be found. In broader perspective supply chain management is surroundings that insists integration and optimization, while lean is the optimizer offering tools for optimization. (Plenert 2007, 292)

TOPIC	SCM and Lean Integrated
Purpose of the System	Optimize movement of resources from supplier to customer by eliminating all non-value-added (waste) activities in the supply chain.
Primary Goals	Minimize cycle time, improve on time performance, and optimize quality.
Secondary Goals	Avoid control systems, focus on reducing inventories in the supply chain, manage the capacities of the supply chain, and optimize the supply chain flow so as to maximize customer satisfaction.
Culture Change	Create an organizationwide Lean-based change culture. Analyze the current and future state of our organization using step charts and Value Stream Mapping, identify a future state of the organization, and perform a gap analysis, thereby creating a plan of operation for implementing the identified changes.
Participation at all levels	Acceptance process requires that we get buy-in from all employees—participative, team-based change process.
Tools	Extensive collection of SCM and Lean tools that are selectively chosen and customized to fit the environment—many of the tools, like JIT, are in both environments.
Education and Training	Education and training are critical in order to establish the process and for sustainment to occur.
Performance Measures	Motivation using time-based measures.

Figure 8. SCM and Lean integrated (Plenert 2007, 292)

Philosophy of circular economy integrating with supply chain management is circular supply chain management (CSCM). Farooque et al. (2019, 8-9) defines circular supply chain management as follows:

Circular supply chain management is the integration of circular thinking into the management of the supply chain and its surrounding industrial and natural ecosystems. It systematically restores technical materials and regenerates biological materials toward a zero-waste vision through system-wide innovation in business models and supply chain functions from product/service design to end-of-life and waste management, involving all stakeholders in a product/service lifecycle including parts/product manufacturers, service providers, consumers, and users.

Circular supply chain management can be implemented both in the manufacturing industry and in the provision of services. In CSCM companies and organizations co-operate to maximize the use and recovery of commodities. This can happen in and outside of the companies' operational sector and it can lead to success in resource efficiency and profitability. (Farooque et al. 2019, 9)

## 5.2 Supply chain management in construction industry

Supply chains in construction industry are complex, when orders are made in both main contractor and subcontractor level. Also, every project has a different outcome, so they are usually creating something new and repetition in construction projects is minor. (Vrijhoef & Koskela 2000, 171)

Vrijhoef et al. (2000, 171) defines four roles for construction supply chain management depending if the focus is in supply chain, in constructions site, or both.

Table 2. Four roles of construction supply chain management (Vrijhoef et al. 2000, 171)

<b>Focus</b>	<b>Goal</b>	<b>Actor</b>
<b>1. Impact of the supply chain on site activities</b>	Reduce cost and duration of site activities	Contractor
<b>2. Supply chain itself</b>	Reduce costs; esp. logistics, lead-time and inventory	Material and component suppliers
<b>3. Transferring activities away from site to earlier stages of supply chain</b>	Reduce costs and duration	Suppliers and contractors
<b>4. The integrated management and improvement of the supply chain and the site production</b>	Site production is subsumed into SCM	Clients, suppliers or contractors

## **6 CASE TEMPORARY FACTORY IN RAMIRENT FINLAND LTD: CONCEPT DEVELOPMENT FOR FINNISH MARKETS**

Megatrends drive Ramirent's business; circular economy, digitalisation and productivity improvement as well as safety and accountability requirements, urbanization and an aging of population (Ramirent 2018, 10-11). This case study sought answers on how to achieve these goals with the customer at the centre when the product was just right and in the right place at the right time.

### **6.1 Research method and structure**

This study is made by qualitative research methods and the research material is gathered by structured thematic interview.

In 2017 Ramirent Group created a new company strategy. One of the tools used for developing the new strategy was interviewing construction industry customers in Ramirent's biggest markets in Finland, Norway and Sweden. This research is based on the same interviews, but the study only looks at interviews with Finnish customers. The number of interviews used for this study is nine (9) and they were made in February and March 2017.

Interviewees are on different levels in their own organizations. Three of them are working on production level as production manager or project manager. Four of them are purchase managers. Two of them are on management level as a managing director or a deputy managing director.

In the original questioner there were 28 open questions and three (3) multiple choice questions. This study analyses only 11 open questions which are chosen by given answers. Multiple choice questions are not analyzed in this research.

In the answers the researcher is trying to find cross-references to theoretical frame and Temporary Factory -concept. All those answers which have elements of Temporary Factory -concept and are relevant in this context have been analyzed in this study. Interviewees are numbered from one to nine (1-9).

Table 3. Interviewees' professional title and interview dates

Interviewee	Position in the company	Interview date
<b>Interviewee No. 1</b>	Project Manager	3 February 2017
<b>Interviewee No. 2</b>	Sourcing Manager	14 February 2017
<b>Interviewee No. 3</b>	Sourcing Manager	15 February 2017
<b>Interviewee No. 4</b>	Managing Director	15 February 2017
<b>Interviewee No. 5</b>	Sourcing Manager	15 February 2017
<b>Interviewee No. 6</b>	Project Manager	17 February 2017
<b>Interviewee No. 7</b>	Deputy Managing Director	28 February 2017
<b>Interviewee No. 8</b>	Head of Production	2 March 2017
<b>Interviewee No. 9</b>	Purchaser	2 March 2017

The material is dealt with in three different themes, which are the current state of machine and equipment rental services, health, safety and sustainability, and future of machine and equipment rental services. Processing the answers by theme makes it easier to structure the issues raised in the interviews into the themes of the theory part. When analyzing the material, the aim is to find things that appear both in the frame of reference and in the service content of the Temporary Factory -concept. The analysis also considers the interviewee's position in his or her own company, as it may be relevant to the content and perspective of the responses. By analyzing the material, a view is formed as to which emphases in the development of the concept are significant for the customer.



## 6.2 Results

### 6.2.1 Current situation of machine and equipment rental services

The first part of the interview sought to find out in general the current state of machine rental services from the customer's point of view. The interview asked to review on the current state of cooperation between Ramirent and the customer, how well Ramirent is meeting the needs, what products do they rent, what are their expectations and how well rental companies meet those expectations.

Grade 8 from 1 to 10, good communication, regular meetings with management level, long relation, reliance. We should reach together for better cost efficiency for both parties. (Interviewee No. 2)

Ramirent is meeting our equipment needs well. (Interviewee No. 4)

From my point of view cooperation works, Ramirent has urge to develop operation, we wish to have some digital solutions f. ex. returns. (Interviewee No. 9)

All the interviewees were quite satisfied or satisfied for the cooperation between them and Ramirent. Although the expectations for digital tools and design integration came up early in many discussions. Basic elements of good cooperation are relevant range of products and good communication. Using same designs is resource-efficient when reviewing it in contexts of circular economy approach and lean approach. With a help of digital tools this can be achieved. Solving challenges together is interesting and rises the level of partnership.

Ramirent is meeting our needs well. In general, we need rails, supports, heating, scaffolding... More design integration with Ramirent's services. Concept package for "bulk" production (heating, electricity, rails...) Usually every special challenge has been solved and it is interesting to solve them together. It is important to have a named contact person in renting company who can take the challenge. (Interviewee No. 1)

Most important is the quality of rental equipment, right tools for right price, partnership. (Interviewee No. 2)

Companies plan to reduce the use of their own equipment and focus more on their own core business. On the other hand, renting equipment on behalf of a subcontractor may also increase, ensuring its condition and suitability for the current job. Customers value product information f. ex. tracking, price and user information. Everyday actions like rentals, returns, inventory and invoicing with a help of customer portal gives time for personal communication and development work.

Little bit internal fleet, but goal is to get rid of them, our core business is not with equipment. (Interviewee No. 4)

We have all alternatives; some use own equipment and some use our own/rental. Trend is to rent equipment for subcontractors, for safety reasons. (Interviewee No. 2)

Also, the portal for customer information is very important, when we know where the equipment is and how much it costs. (Interviewee No. 1)

Interviewees highlighted package solutions and new services to support rental equipment. A whole new way of thinking is needed for the construction industry. The customer wants to increase the integration of processes and information, including with machine renters. Interviewees who work on the operational level introduced concrete proposals for the necessary services, while senior management talked more on a general level. Services like cleaning and security were mentioned. logistics was clearly a topical issue for many, as it was thought of as one important ancillary service.

In general, we need rails, supports, heating, scaffolding... More design integration with Ramirent's services. Concept package for "bulk" production (heating, electricity, rails...). I don't see any reason why Rami should not start to offer site services (security, cleaning etc.), when they are already providing modules. (Interviewee No. 1)

Whole construction industry needs new thinking. (Interviewee No. 5)

Logistics is an interesting service. (Interviewee No.6)

Processes and information integration with rental companies (Interviewee No. 7)

Overall, customers see the collaboration as a partnership and not just a supplier-customer relationship. They want to maintain cooperation and increase the efficiency of their own operations with the support of machine rental companies.

### **6.2.2 Health, safety and sustainability**

The second section of the interviews dealt with health, safety and sustainability issues. Interviews were inquired about general expectations from machine rental companies regarding health, safety and sustainability matters. Opinions were also sought on Ramirent's performance in health, safety and sustainability matters.

All the interviewees emphasised the importance of safety. Companies have high expectations on safety issues, and they have zero tolerance for accidents at work. Machine rental companies are expected to have a similar approach to occupational safety and health.

Good quality and currant equipment, responsibilities are clear, safety equipment and clothes, safety rules, safe assembly ect. (Interviewee No.1)

We require same values for sustainability as we have. (Interviewee No. 2)

Ramirent takes care of quality and inspections so that we don't have to worry, and we can trust everything is in order. (Interviewee No. 8)

Safety training and other safety services was considered important and was seen as both a default in collaboration and a potential service for Ramirent to offer. Customers require training and education to prevent improper use of machinery and equipment. Preventing black markets in construction industry by regulation is important. Subcontractors must fulfil their obligations in order to gain access to work on construction sites.

Safety issues are on good level, perhaps one service Ramirent could offer. (Interviewee No. 5)

Offer more training to prevent mis use for tools and equipment. (Interviewee No. 5)

Other aspects of sustainable development were hardly mentioned. Only one interviewee addressed sustainability in a broader picture. Situation could be different, if same questions were asked three years later. Another assumption is that in daily work CO<sup>2</sup> emissions and environmental issues are not in the foremost sense, when making production decisions. However, sustainability is seen in the big picture as an important issue in the top management of companies.

We talk about environment friendly solutions, no child labour, energy savings and attitude. (Interviewee No. 7)

Overall, the sustainability discussion was very limited, and the protection of the environment did not become a significant issue. On the other hand, environmental issues were also not specifically mentioned in the interview questions.

### **6.2.3 The future of the machine and equipment rental services and construction industry**

The last part of the interview dealt with the future of construction industry and machine rental services. Interviewees were asked what is the most important thing that Ramirent should improve in operations and what message they would send to Ramirent's management for future cooperation. Interviewees were also asked how customers believe their equipment and service needs and the role of rental companies might change in the future. Effects of digitalization in the future equipment and service needs was also asked.

Digitalization and design integration became a central issue in every interview. Customers are looking for digital tools and portals for daily rental operations. And the assumption is that future generations expect that basic operations will be handled digitally and online. Strategically, digitalisation also plays a key role for customers in future decision-making. Building information model (BIM) and other digital solutions for planning and design integration are in focus with every interviewee. 3D, 4D

or even in 5D design is becoming more commonplace and plans viewed on paper are a thing of the past.

Digital tools will be most important in the future. Planning and design integration with suppliers are the way we are heading at. (Interviewee No. 1)

ERP from master data, one place where is all the information, suppliers utilizes same designs, integration. (Interviewee No. 3)

4D and 5D planning is the future. (Interviewee No. 4)

BIM and other digital solutions are the most important strategic goals for our company. Better planning with master data and younger generation is expecting digital solutions for working life. (Interviewee No. 5)

Looking for integration with BIM and other digital tools. (Interviewee No. 7)

Construction industry is cooperation and knowledge can be more valuable than just iron and concrete. Companies are willing to develop business together with rental companies. They seek for key suppliers and partnerships. While things can be handled more and more digitally in the future, the value of personal contact should not be underestimated. When construction sites become more complex, understanding the customer needs is essential.

We want good services with a competitive price. And if Ramirent is willing to put effort for planning and design. Personal contact is always important. (Interviewee No. 1)

We believe that everybody wants to focus on their key business and collect key partners, in the future we might not even build, but we are the platform for different operators. Information is the main product. We might even start own start-ups. (Interviewee No. 3)

Wake up with digitalization, more personal contact and developing business together (Interviewee No. 5)

Understanding our needs is most important. (Interviewee No. 7)

In the future, the construction industry must also change. Construction sites will be more in urban downtown areas or otherwise in logistically challenging places. Level of prefabrication rises, and more elements are done in factories instead of construction sites. Building sites need to operate 24/7, because there might not be space to operate at normal working hours. Interviewees look for better productivity and rental companies have an essential role in leaner and smoother production. Rental companies can have more independent role in the future. Total savings matter more than unit price.

Construction business is growing rapidly, and it is same time a possibility as a threat. Digitalization is the future. Sites will be in town centres and in other logistically challenging places. Space for building is limited. Warehouse areas could be one option for Ramirent's new business. (Interviewee No. 1)

logistics, safety issues, trainings, digital tools, more international worksites, 3D-virtual glasses (Interviewee No. 2)

We want suppliers taking part of the project at the right time, key suppliers are strategic partners, unit prices matter, but with good planning and concepts the total saving matter more. (Interviewee No. 3)

Prefabrication level rises, some operations will move away from sites. (Interviewee No. 5)

More prefabrication, more 24/7 operations, building in tight places require more specified equipment. (Interviewee No. 6)

We need to increase productivity and growth. We are developing a reasonable price housing -concept and we are looking for better solutions, and smoother sites. (Interviewee No. 7)

Our order book is full, so the needs for equipment will grow also, more capacity, more work, leaner workflow, more robots, just-in-time, no production breaks, lean deliveries, portal for customer information. (Interviewee No. 8)

More independent role for rental companies. (Interviewee No. 9)

Climate change and the challenges it brings to the development of construction were not mentioned much in the interviews. If the interviews had been conducted three years later, the importance of environmental protection would certainly have been reflected more in the future prospects of the construction industry. Today, all major industrial companies have plans to reduce emissions and save energy.

One thing to consider is construction companies' and especially project managers' actual ability to influence costs and CO<sup>2</sup> emissions during entire supply chain. It would be important to make visible the whole value chain. Unit price is a challenging concept to define when it comes to construction industry. For services and rental equipment defining unit price is even harder. The cheapest unit cost can be different for individual contractor compared to project owner.

## 7 CONCLUSION

### 7.1 Temporary Factory process overview

Based on these interviews, it is important to find suitable projects for the concept in good time. Initially, the Temporary Factory projects are certainly larger than the average construction project. Once enough experience has been gained, the concept can be scaled to projects of all sizes. This requires more information about the customer's cost structure and emphasis on responsibility and emission reductions. Sustainable companies are better prepared for risk management.

Design expertise and finding a real need for customers is the starting point for implementing the concept. Design integration with all the contractors and designers working on a project help to reduce duplication of work. Cooperation gives more opportunities to find the best solution for each stage of the work.

Proper organization and constant presence on site, especially in large projects, is a basic condition for success. In Temporary Factory projects there is a dedicated organization to serve the site with temporary services. Customer has same contact personnel who will then find out the best expert to solve the current issue. All the necessary information then passes through the same organization to and from the customer. Also, the resource efficiency of site services can be ensured the best possible way. Project organization make sure that every contractor and other operator working on project will follow the ground rules and safety regulations.

Centralized site operations reconcile the goals of the project companies. In the long run, everyone's goal is to get the construction project completed. At times, however, short-term goals are difficult to achieve due to lack of resources or schedule challenges. The concept makes it possible to better reach the parties to the project. Coordinating logistics and committing to a commonly agreed operating model is a basic precondition for the timeliness of deliveries. Intelligent rental solutions together with intelligent logistics contributes to the efficient use of equipment and improves cost-effectiveness.



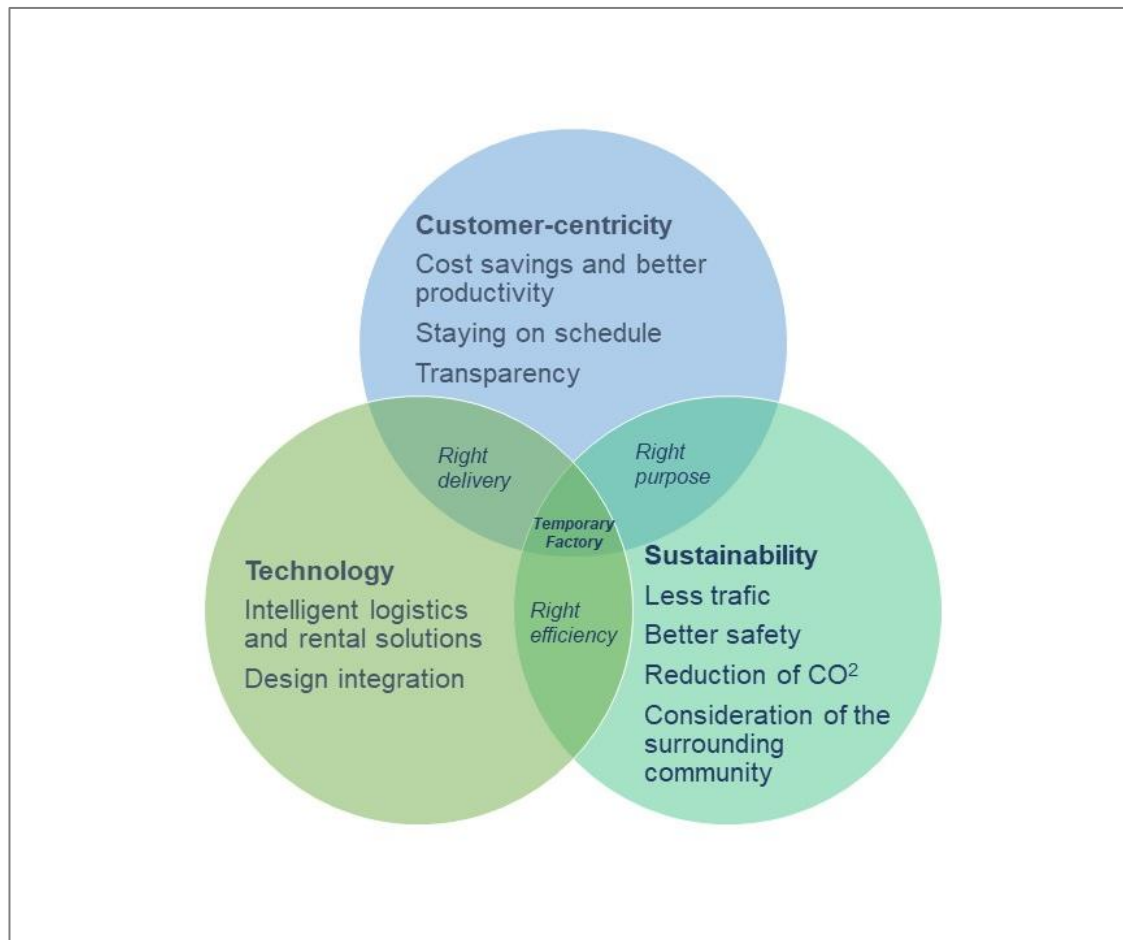


Figure 9. Benefits of the Temporary Factory -concept

## 7.2 Temporary Factory -concept in brief

The Temporary Factory -concept is a service where an external operator is responsible for site support functions, allowing the contractor to focus only on its core functions. Site support functions consist from physical products, such as machinery, modules for locker rooms and site offices, fall protection, site fences and cranes. Temporary Factory also includes digital design, logistics solutions, security, trainings and other intelligent site services.

As a concept, Temporary Factory adopts a comprehensive approach to the temporary elements on construction site. A dedicated project organization coordinates all the site support functions. Traditionally, site support functions are not entirely in the care of anyone, but contractors procure the necessary services independently. This

usually leads to duplication and the use of resources is not optimal. Uncontrolled flow of goods and poorly optimized resources increases unnecessary site traffic and warehousing.

Concept helps the customer with the growing safety and environmental requirements of the construction site. Site productivity increases and when waste and traffic amounts decrease.

A significant change in the traditional way of working and purchasing is taking place on the project timeline. Pre-planning and designing have significant share in the process. The final objective is to choose the best possible solutions for the whole project, not just from the perspective of an individual contractor.

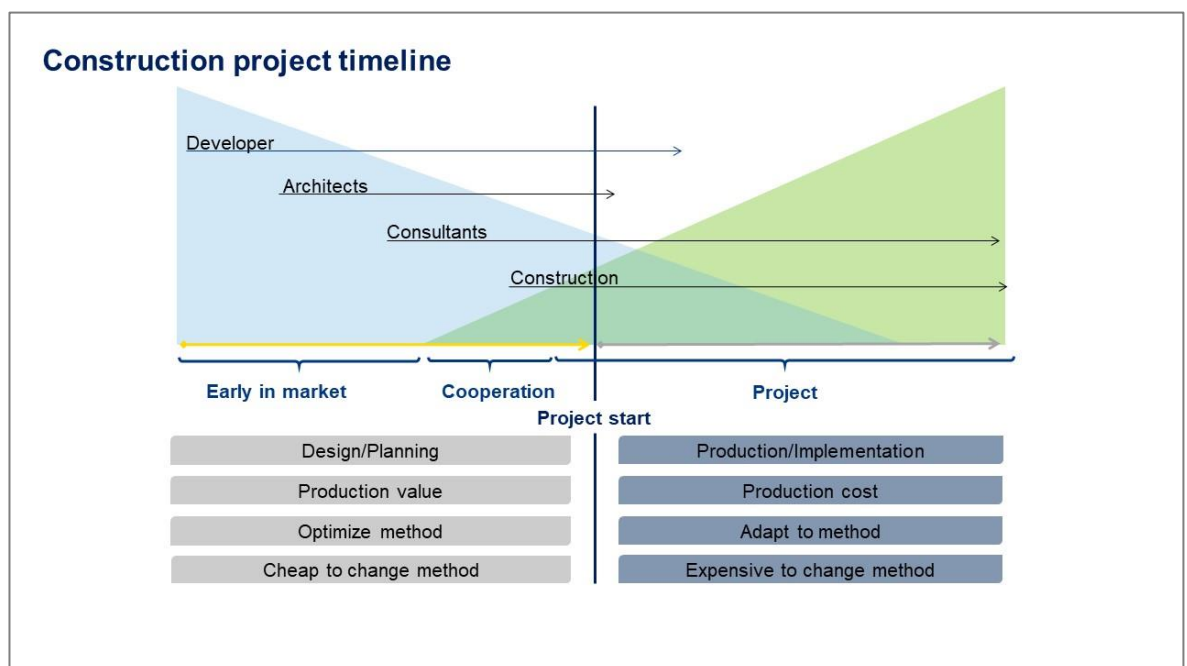


Figure 10. Construction project timeline

Temporary facilities are estimated to account for as much as 25% of the costs of construction projects.

### 7.3 Temporary Factory -concept; management and business model

The management model of the Temporary Factory -concept is based on lean management. Value creation and waste elimination are basic elements of this concept. The process optimizes supply chains for temporary services as well and improves the resource efficiency of construction sites. The concept's business model is built on a circular economy. Company's business idea is to rent, and renting is in the heart of circular economy. Temporary Factory -concept refines the idea further by rethinking the usage and purchasing of temporary elements of construction site.

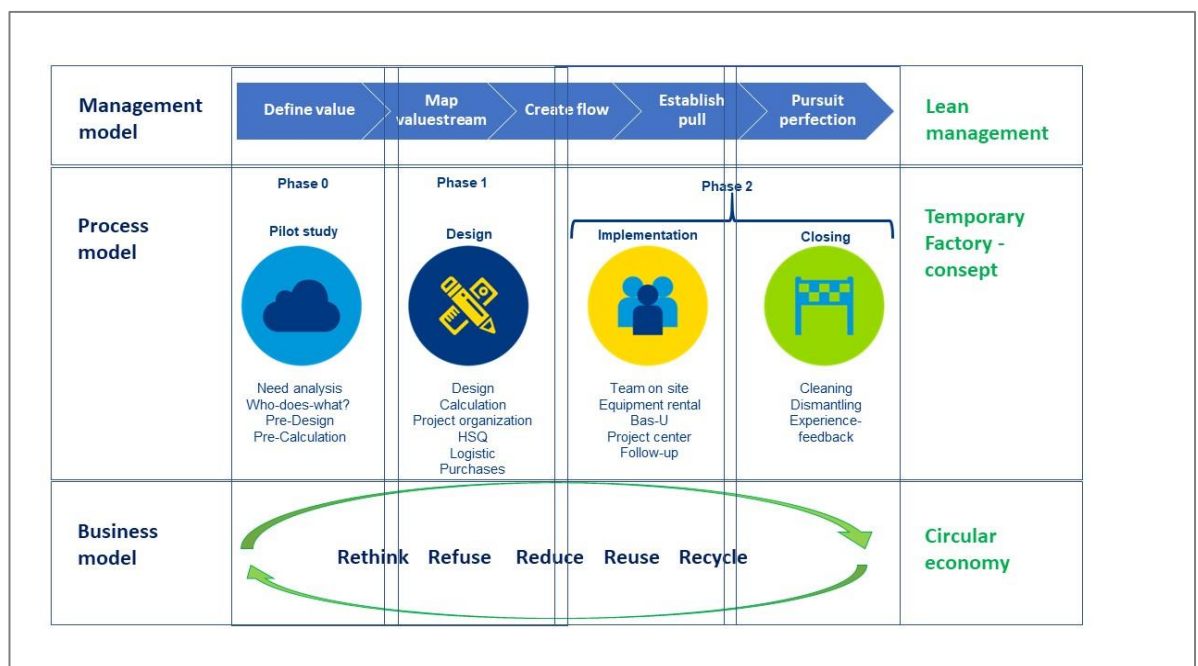


Figure 11. Temporary Factory management and business model

## 8 REFLECTION AND LIMITATIONS

In conclusion, there is a need for a Temporary Factory -concept coming to Finnish markets. The industry is clearly looking for a change in usual practices, at least according to the interviews analysed for this study.

Design integration and planning together and at an earlier stage was the main theme of discussions. Planning is done at all different levels, so it would be natural to use the same platform to share and combine information. Design collaboration and better information sharing can identify potential problems at an earlier stage. When problems are identified in time, they are easier and cheaper to deal with.

The construction industry is also digitizing at a rapid pace. To this day, pdf files are still used on construction sites. The information produced in different ways should be coordinated. Applications, user tracking, location tracking and cloud services offer limitless possibilities for data sharing and verification. Sharing information and accessing a common database reduces the amount of email and wastage.

Construction industry is focusing more to their core business and they are looking for partners instead of suppliers. Also, the prefabrication level is rising, so services for sites will change. Work phases that have previously been done on a construction site will be increasingly done in factories and production facilities in the future. It changes equipment and working needs and requires new skills. Filling construction sites with machines does not make sense. Instead, it makes sense to develop machine sharing and increase utilization rates.

Logistics services for sites were an interesting theme. At that time site logistics was a so-called hot topic in construction industry and they started to notice the effects of good logistic planning in productivity. In three years, the interest in site logistics has emerged amongst universities, research workers and students. So far construction sites have not put significant effort to site logistics, because the material deliveries are usually included to contracts made with subcontractors. The impact of the entire logistics chain on the amount of value-creating work has only recently begun to be considered.

## 8.1 Limitations and topics for further research

On the other hand, it is necessary to consider how much opportunities an individual site project manager has to centralize temporary site functions. Not all temporary costs are visible in the site cost calculation, as a large part of them are included in separate subcontracts. Against this background, it might make sense for temporary site functions to be segregated in the construction project outside the main contract. The cost calculation should be able to be opened for the whole production chain so that the real costs and savings can be verified. This could be the subject of further research. The contract models between Ramirent and the customer must also be changed, because the implementation of the concept requires cooperation. This means sharing both responsibility and results.

Another aspect that might get more into discussions is climate change, if the interviews were made on year 2020. Although we talked about sustainability, it was focused on safety issues. Today construction companies have many environmental objectives. One example is Green Deal -agreements between the Finnish Ministry of Environment and corporate advocacy organizations.

Increasing efforts are being made to reduce CO<sup>2</sup> emissions during construction, and many projects aim to be carbon neutral or even carbon negative. Further research could be used to find out how much emissions are generated by temporary site support functions and how the Temporary Factory -concept could reduce emissions.

The position of the respondents in the organization certainly also affects the answers received. Answers at site foreman level could have different emphases. From the point of view of workflow, it could be interesting to study at the site level how much centralized site operations affect the efficiency of work performance itself. The topic is being researched at Aalto University in cooperation with Ramirent and SRV Construction Ltd.

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## **APPENDICES**

### APPENDIX 1. Interview Questions

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### ***Interview Questions***

*Question 1. Please explain how satisfied you are with the current cooperation with Ramirent.*

*Question 2. How well is Ramirent meeting your needs for different equipment and services?*

*Question 3. What products do they rent & what services do they buy?*

*Question 4. What are your expectations on rental companies regarding health & safety and sustainability?*

*Question 5. What is your opinion regarding Ramirent's current performance regarding health & safety and sustainability?*

*Question 6. What are your expectations on equipment rental companies?*

*Question 7. Is there anything that rental companies are currently not doing that you think they should be doing?*

*Question 8. What is the most important thing that Ramirent should improve in the future?*

*Question 9. How do you believe your equipment needs (machines and services), and the role of rental companies, might change in the future?*

*Question 10. How will digitalization affect your equipment and service needs in the future?*

*Question 11. What message would you like to send to Ramirent's management for future co-operation?*

*Question i. Free conversation outcome (points that came out in a free discussion after the interview)*