

LAPPEENRANTA-LAHTI UNIVERSITY OF TECHNOLOGY LUT

School of Business and Management

Master Program of Strategy, Innovation and Sustainability

CLIMATE CHANGE AND THE TRANSITION TO LOW CARBON BUILDING IN
FINNISH CONSTRUCTION INDUSTRY

CASE: SAINT-GOBAIN FINLAND OY

Master's thesis 2020

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ABSTRACT

Author	Omid Gabriel Sediqi
Title	Climate change and the transition to low carbon building in Finnish construction industry
Master's Thesis	Lappeenranta-Lahti University of Technology LUT 117 pages, 18 figures, 39 tables and 2 attachments
Year of completion	2020
Degree programme	Strategy, Innovation and Sustainability
Faculty	School of Business and Management
Examiners	Associate Professor Laura Albareda
Keywords	Construction industry, Environmental Product Declaration (EPD), Circular Economy (CE), Low-carbon building, Life Cycle Assessment (LCA), Environmental Sustainability, Carbon CO ₂ , Sustainable Procurement

The aim of the thesis is to research, how climate change, limiting Carbon dioxide (CO₂) and sustainability regulations of The European Union (EU) and The Ministry of the Environment in Finland will transform Finnish construction companies' sustainability criteria, goals and roadmaps in short term and how they will affect the construction industry in long term. As sustainability and climate change becomes more and more important in the future, the research will articulate how ready Finnish construction companies are and whether they contest the future issues regarding sustainability. The research will dive deeply in how the companies will change their goals, how they will drive their criteria and goals through sustainable procurement and how they will control and make sure their sub-contractors adapt the same criteria and goals as them. For this study 21 experts of the industry were interviewed and PESTEL analysis and circular economy related frameworks were used to attain the outcome of the study. The results of the study suggest that there is a need for effective data sharing, deeper collaboration and education of all the members of the value chain in order to reach carbon neutrality.

TIIVISTELMÄ

Tekijä	Omid Gabriel Sediqi
Otsikko	Ilmastonmuutos ja siirtyminen vähähiilirakentamiseen suomessa
Pro gradu -tutkielma	Lappeenrannan-Lahden teknillinen yliopisto LUT 117 pages, 18 figures, 39 tables and 2 attachments
Valmistumisvuosi	2020
Tiedekunta	Kauppätieteiden koulutusohjelma
Maisteriohjelma	Strategy, Innovation and Sustainability
Tarkastajat	Associate Professor Laura Albareda
Avainsanat	Kestävä rakentaminen, EPD ympäristöselosteet, Kiertotalous, Hiilijalanjälkilaksenta, Hiilidioksidi CO2, Kestävä hankinta

Tämän Pro gradu -tutkielman tavoite on tutkia, miten ilmastonmuutos ja hiilidioksidi (CO₂) sekä muiden päästöjen rajoittaminen tulevat vaikuttamaan rakennusteollisuuteen tulevaisuudessa sekä että pitkällä aikavälillä. Kestävän kehityksen merkityksen korostuessa ja sen tullessa yhä merkittävämmäksi rakentamista ohjaavaksi tekijäksi, tutkimus tuo esiin, kuinka valmiita suomalaiset rakennusyrietykset ovat ottamaan huomioon tulevaisuuden ympäristöhaasteet sekä minkälaisin keinoin ja työkaluin niiden ratkaisemiseen on varauduttu. Tutkimus tuo esiin, kuinka Euroopan unionin ja Suomen ympäristöministeriön kestävän kehityksen säännökset on otettu huomioon rakennusalan yritysten toimintasuunnitelmissa tällä hetkellä ja jatkossa, tuoden esiin muun muassa niiden käyttämät kestävän kehityksen kriteerit, ja tavoitteet. Käsiteltävän aiheen mitattavuuden ja paremman tulkinnan mahdollistamiseksi tähän tutkielmaan haastateltiin 21 kestävän kehityksen asiantuntijaa, sekä käytettiin PESTEL –analyysiä ja erilaisia kiertotalouden viitekehyksiä. Tutkielman osoittamien johtopäätösten perusteella rakennusallalla on selkeä tarve tiedon tehokkaalle jakamiselle, syvemmälle yhteistyölle ja tietoisuuden kasvattamiselle rakennustoiminnan arvoketjun eri vaiheissa hiilineutraaliteetin saavuttamiseksi.

ACKNOWLEDGEMENTS

Firstly I would like to thank Lappeenranta-Lahti University of Technology LUT for providing me appropriate courses that gave me a good base in Sustainability and the fundamentals in Economic, Social and Environmental sustainability, furthermore courses on business ethics that will keep me on the right track in my future career in sustainability.

I am thankful to my teachers for sharing their knowledge and giving me the right tasks that have helped me learn, develop and prepare for the future sustainability challenges that I will face. I would like to extend my special thanks to my academic supervisor, Professor Laura Albareda for her support, her recommendations and perspectives on my thesis topic.

I am grateful to Saint-Gobain for providing me a current, yet interesting topic in Environmental Sustainability and helping me along the way with my thesis. My special thanks go to the Sustainability Manager of Saint-Gobain, Anne Kaiser for her invaluable time mentoring me in her way of thinking towards sustainability in business and helping me take my first career steps in sustainability.

Finally, I would like to thank my family and friends for support and encouragement. This accomplishment would have been impossible without them.

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LIST OF SYMBOLS AND ABBREVIATIONS

Carbon dioxide (CO₂)

Greenhouse gas emissions (GHG)

Circular economy (CE)

Corporate Social Responsibility (CSR)

Triple Bottom Line (TBL)

Carbon Footprint (CF)

Life Cycle Assessment (LCA)

Global warming potential (GWP)

Environmental Product Declarations (EPDs)

Non-governmental organizations (NGOs)

Gross Domestic Product (GDP)

International Organization for Standardization (ISO)

European Committee for Standardization (CEN)

Product Category Rules (PCR)

1. INTRODUCTION

In this thesis sustainability and the transition to low carbon building in construction industry in Finland is discussed. I will closely investigate how companies are cutting environmentally harmful greenhouse gas emissions (GHG) and toxics from their processes currently, and how they will adapt to changes in legislation and regulations regarding environmental sustainability. Especially, legislation and regulations, regarding minimizing carbon emissions, other environmental stressing materials and toxic waste, that will affect the companies. This also connects to the industry's transformation towards circular economy (CE), which is one of the main goals of the Finnish government. Furthermore, the thesis will investigate the construction industry's preparedness towards environmental targets set by the European Union (EU) and the Ministry of The Environment of Finland.

The thesis will disclose short-term and long-term criteria and goals set by large construction companies in Finland. Construction is one of the oldest and biggest industries to exist; it is still conservative and very dispersed. A contract can be divided between the companies and variety of tasks are outsourced to sub-contractors. The thesis researches how goals, criterions and other information are communicated between the companies and to their sub-contractors.

The thesis topic was provided by Saint-Gobain Finland Oy and the purpose of the thesis is to gain market information and perspective from the construction companies and have an insight of their road maps to be able to produce and provide construction material according to the market needs. Additionally, the significance of the thesis is also to raise awareness towards the Global and National sustainability goals. Moreover, the thesis can cultivate construction-oriented companies towards value cocreation, shared sustainable goals and drive data sharing between all parties.

Sharing data, knowledge and expertise can not only benefit the material providers, construction companies and their subcontractors in becoming more sustainable by cutting down emissions and other environment harming waste, but it can also propel commerce and help the economy.

1.1 Background

The Confederation of Finnish Construction Industries (CFCI) articulates that buildings account for almost 40% of all energy consumed in Finland and generate more than 30% of Greenhouse gas (GHG) emissions, meaning that there is a lot of pressure and expectations to reduce consumption and emissions of buildings. The building process and building materials account for almost 20% of the whole life cycle of the buildings, but the relative share may increase in the future as the buildings will become more energy efficient in the future.

According to Global Status Report 2017 published by World Green Building Council's (WGBC) in 2017, building sector creates a massive amount of CO₂ emissions and it is growing rapidly. Even though the energy intensity has improved recently, building-related CO₂ emissions have continued to rise around 1% yearly since 2010. The report asserts that the rapid growth is not without consequences. (WGBC, 2017).

There is a growing urgency to address energy demand and emissions from buildings and construction. Current policies and investments fall short of what is needed, and what is possible [...] Ambitious action is needed without delay to avoid locking in long-lived, inefficient buildings assets for decades to come.

Fortunately, many opportunities exist to deploy energy-efficient and low-carbon solutions for buildings and construction. These solutions will necessitate greater effort to implement strategic policies and market incentives that change the pace and scale of actions in the global buildings market.

Dr Fatih Birol, Executive Director International Energy Agency

The World Green Building Council (WGBC) says: To drive change and achieve climate ambitions to mitigate greenhouse gas (GHG) emissions in across the buildings and construction sector will require intensified policies, regulatory tools, incentives, financial tools, successful business models and innovative solutions to attract private-sector investments (WGBC, 2017). The Intergovernmental Panel on Climate Change (IPCC) describes greenhouse gas emissions as gases that exist in the atmosphere, that can absorb infrared radiations that trap heat in the atmosphere, gases such as carbon dioxide, methane, nitrous oxide and water vapor. (IPCC, 2019)

The sources above indicate that buildings and construction is one of the biggest industries that have a major impact in global warming, through direct and indirect greenhouse gas emissions. Even though there are low-carbon and energy-efficient solutions, they need to be made appealing to private sector through different supportive business tools, incentives and through intensifying regulations and policies.

Construction industry is affected by Environmental Product Declarations (EPDs) labels that communicate transparent and comparable information on environmental impact of a product during its life cycle that is registered and documented in a credible, comparable and understandable way, and it is required that EPDs should be verified independently (The International EPD® System, 2019).

This research also focuses on low carbon building and Finnish construction industry, additionally the research discloses the effects of the EPDs and other international, regional and national regulations and policies that are in junction with EPDs that are about to come into force in near future regarding construction industry from building material providers perspective. Construction materials can directly impact environmental sustainability, if they produce less emissions during production; and indirectly through energy efficiency throughout the life cycle of the building and later on if they are recycled or reused.

1.2 Research Goals and Objectives

Construction industry affects the environment and climate change through land use changes, resource materials extraction and production. The industry creates a substantial amount of

greenhouse gas emissions. Now that effects of climate change have increased, and public awareness and concerns are rising, there is a need for change in construction industry.

Sustainability and low carbon economy oriented changes in construction industry are driven by different incentives, tools, policies and regulations. The main scientific goal of this thesis is to study how the construction industry changes towards low carbon economy and find out how sustainability regulations and policies that are pushed internationally by Non-Governmental Organisations (NGOs), regionally by The European Union (EU) and nationally by Finnish Ministry of the Environment will impact the Finnish construction industry.

The thesis also aims to raise awareness and evoke Finnish construction industry towards the importance of product labels and EPDs, get insights in low-carbon road maps of the construction companies and get a view where the industry is heading. Furthermore, the thesis objective is to improve communication and data sharing between the material manufacturers and construction companies.

The ultimate goal of this thesis is to raise curiosity of all stakeholders in the construction industry towards co value creation and benefit from each other's knowledge and expertise that can make a positive impact on the environmental sustainability.

Main research questions:

1. What are Finnish construction companies' sustainable development goals, criteria and low-carbon road map?
2. What kind of collaborations can be built between members of the value chain to maximize environmental sustainability and cut down emissions?

Sub research questions:

1. How does Finnish national carbon neutrality and circular economy related goals will affect the industry?

2. What are the requirements of Finnish construction companies from construction material providers regarding EPDs and sustainable development of the industry?

Since the case company Saint-Gobain produces materials to construction companies, the second sub research question aims to bring value to Saint-Gobain as well as construction companies and other stakeholders.

Sustainability in Finnish construction industry can be narrated by figure below:

In his book “Restart Sustainable Business Model Innovation” Jørgensen S. (2019) says economy cannot keep growing forever if we do not stop degrading social and ecological systems upon which it depends. He mentions that organizations will always have room to reduce their environmental impact, improve their productivity and lately more than ever before, it is important for organizations to adopt wide spectra of environmental and social prerequisites into their practices and strategies. (Jørgensen, S. 2019).

Based on the statement above, construction sector’s ultimate limit is the environment and according to the (IPCC, 2019) global warming over 1,5 Celsius can harm the natural ecosystems permanently. Then there are goals and limitations that are set by The United Nations, The European Union and The Finnish Ministry of Environment. Even though the goals and limitations concern the building companies, in between there are material providers who can affect the sustainability of the construction industry heavily.

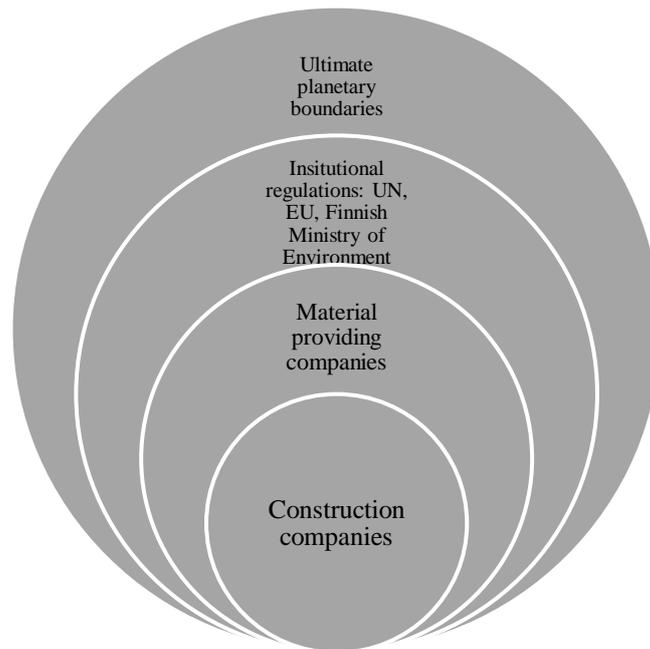


Figure 1: Narration of the Finnish Construction Industry's Boundaries

Our wants and needs are rising and the earth's capacity to meet these needs is decreasing. As a result, over time all renewable and non-renewable resources are diminishing, but this chain cannot continue at the same pace forever. "Economy can only keep growing forever only if we stop degrading the social and ecological systems upon which it depends." (Jørgensen S., 2019).

According to (Rockström et al., 2009) "anthropogenic pressures on the Earth System have reached a scale where abrupt global environmental change can no longer be excluded." They have identified nine planetary boundaries and propose quantifications for seven of them.

1. Climate change (CO₂ concentration in the atmosphere <350 ppm and/or a maximum change of +1 W m⁻² in radiative forcing)
2. Ocean acidification (mean surface seawater saturation state with respect to aragonite >= 80% of pre-industrial levels)
3. Stratospheric ozone (<5% reduction in O₃ concentration from pre-industrial level of 290 Dobson Units)

4. Biogeochemical nitrogen (N) cycle (limit industrial and agricultural fixation of N-2 to 35 Tg N yr(-1)) and phosphorus (P) cycle (annual P inflow to oceans not to exceed 10 times the natural background weathering of P)
5. Global freshwater use (<4000 km(3) yr(-1) of consumptive use of runoff resources)
6. Land system change (<15% of the ice-free land surface under cropland)
7. The rate at which biological diversity is lost (annual rate of <10 extinctions per million species)

The two additional planetary boundaries for which we have not yet been able to determine:

8. Chemical pollution
9. Atmospheric aerosol loading.

It is estimated that we have already transgressed planetary boundaries for climate change, rate of biodiversity loss, and changes to the global nitrogen cycle, furthermore they believe planetary boundaries are interdependent and transgressing one may both shift the position of other boundaries or cause them to be transgressed. (Rockström et al., 2009).

It Is axiomatic that global warming is the ultimate problem to all members of the Finnish construction sector and it would only make sense for all the parties to take environmental sustainability into consideration in their operation, at least if it does not cost them or they do not have to use any of their assets.

Global warming is threatening irreversible changes to environment. Authorities find the cause of the problem and make decisions on what actions should be taken to solve the problem. In case of global warming, the GHG emissions that propels global warming should be reduced.

1.3 Research Gap

In the last decade, there has been a growing corpus of literature exploring how the construction industry's has adopted Corporate social responsibility (CSR) and how the industry could be

more sustainable and harms to the environment cut down to minimum. However, no previous researches on low carbon economy and construction industry explain how this transition can be done. This research aims at a specific market, that is Finland. The reasons why there does not exist similar knowledge are the new regulations and limitations that have come into effect lately and the ambitious regional and national targets that affect the construction industry and the need to be react upon these sanctions. There existed an apparent knowledge gap that was filled by this research distinctly.

In this research, there were large amount of research papers, journals and other materials utilized and the four books that were extremely helpful for this thesis were “Sustainable Construction Processes” by Steve Goodhew, “RESTART Sustainable Business model Innovations” by Sveinung Jørgensen, “Green to Gold” by Daniel C. Esty, and “Strategic Corporate Social Responsibility: Stakeholders, Globalization, and Sustainable Value Creation” by David Chandler and William B. Werther, Jr.

Additionally, many organizations had useful materials in their webpages that were utilized, and a lot of valuable information was gained from the interviews with specialists and experts of the construction sector in Finland. Those experts include Matti Kuittinen from the Ministry of Environment whose task description includes material and resource efficiency of construction, development of guidance related to the environmental impact of buildings and the environmental properties of building materials, development of guidance related to property management and life cycle management of buildings, as well as taking part and contributing to the development of EU governance procedures (Ymparisto.fi, 2020).

1.4 Scope and Limitations of the Research

The research scope was limited strictly from many angles. This research focuses on specific industry; the construction industry and more specifically, the study analysis is based on interviews and opinions of multiple experts and specialists of medium and large sized Finnish construction companies. If the company was international or had operations abroad, it was made sure that the expert interviewed was responsible for the Finnish branch of the company.

The findings of the research might not apply to smaller Finnish building companies or subcontractors.

The research was geographically limited to Finland. The findings of the research can be utilised elsewhere fully or partially. For example, Nordic countries have very similar climate and similar sustainability goals regarding low carbon building.

While reading this research, it is important to take into consideration that businesses have different decision-making processes and strategies, different interests and backgrounds. Their corporate culture is built around different internal and external stakeholders. Also, their business models might be different if they are operating or concentrating on specific segment. Some concentrate on residential buildings, some on public buildings while some build wooden buildings in a factory and transfer it to its final location.

It is also important to recognize that sustainable business involves trade-offs and firm's resources, capabilities and other limitations might add to the complexity of their actions. So, this research focuses to illustrate the overall sustainability of the Finnish construction industry's current situation and estimate the future direction, problems and challenges the industry will face and future sustainability trends. The research will not propound how Finnish construction companies should change their sustainability strategy or what the right practice for the Finnish construction industry is.

1.5 Thesis Structure

This thesis starts with an introductory chapter which is followed by literature review to build a research framework. In the third chapter a research framework based on low carbon building and circular economy are presented.

The fourth chapter discloses research method and methodology and discuss how data was collected and analysed, furthermore it clears out the reliability and validity of the collected data

that is presented in chapter five. In chapter five the questionnaire for the interviews can be found, additionally it is visualized data analysis processes, including the codification process grouped into aggregate dimensions, using the Gioia et al. (2013) methodology.

The sixth chapter presents all the answers and discusses them individually. In the seventh chapter conclusions based on all the answers that are discussed in sixth chapter are made and the implications, limitations and further research topics are presented.

2. Literature Review

The theoretical background section of this paper discusses the main theories and academic literature linked to the research topic. The topic is low carbon construction and sustainable development of the Finnish construction industry. The topic is approached through Corporate Social Responsibility (CSR) especially through the environmental pillar of Triple Bottom Line (TBL). This research will discuss Carbon Footprint (CF), Life Cycle Assessment (LCA), Global warming potential (GWP), Environmental Product Declarations (EPDs).

The paper discloses Finnish construction industry's sustainability from many aspects, like how authorities like The European Union and the Finnish Ministry of Environment are trying to guide the industry towards low carbon building by forcing legislations and strict policies; how sustainability can benefit construction companies economically and specially why they should not fall behind competition in environmental sustainability.

Academic literature, compatible theories, and other frameworks including PESTEL and Circular Economy (CE) that are related to the topic are discussed and disclosed, why they are related to the topic, what are the aspects of and parts of the theories that can be benefited from in this paper and what frameworks suits best to bring maximum understanding of the research topic and benefit the readers who are interested in the topic.

2.1 Corporate Social Responsibility

United Nations' World Commission on Environment and Development defines sustainable development as "The development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (United Nations General Assembly 1987, 43).

According to GOV.UK, organizations' Corporate Social Responsibility (CSR), can show that an organization is environmentally sustainable and socially responsible. For a company to be considered environmentally sustainable and socially responsible, they should not harm the environment and company's activities should benefit the society. (GOV.UK, 2014)

In their book “Strategic Corporate Social Responsibility: Stakeholders, Globalization, and Sustainable Value Creation”, Chandler and Werther, Jr. emphasize on importance of CSR. They say CSR defines the future of our society and influences all aspects of business, and create much of our society’s wealth and wellbeing. Societal expectations and business goals are constantly evolving. Business ethics, corporate governance, environmental concerns and other issues that society creates, affects the field where businesses operate, and CSR is becoming increasingly crucial to business and social success. (Chandler and Werther, Jr., 2013).

In addition to businesses, Non-profit or Non-governmental organizations (NGOs) and Governments are crucial in creating wealth and driving progress within society. However, the system is interconnected, because without innovations and wealth-producing business taxes charities would die out and our standard of living would drop to some primitive level. Basically, everything around us is produced by businesses. (Chandler and Werther, Jr., 2013).

Much of what is good in our society is produced by businesses but simultaneously they harm the society tremendously through pollution, toxic by-products, industrial accidents, layoffs, economic crises and more. When business become troublesome and distressing to society, NGOs and governments step up and react with regulations to cut the most harmful operations and waste. Legislations tend to follow public consensus is reached, so they might not always be effective, and they are time consuming. (Chandler and Werther, Jr., 2013).

As the technological innovation and globalization expands there lies a concern about the role of businesses in society between all the benefits and drawbacks they are accounted for. After the high-level of scandals that have emerged, corporation’s role in society have gained more attention. As a result, in addition to employees, shareholders and their supply chain, corporations are expected to take into consideration the needs and concerns of customers, communities and the environments where they operate increasingly. (Chandler and Werther, Jr., 2013).

Based on references above and the term itself “Corporate Social Responsibility” indicates that it is responsibility of the corporations to provide the best business case for a sustainable society that maximizes societal benefit and welfare. CSR’s role is to optimize businesses in balance with today’s society and it will only become more important in the future.

United Nations Industrial Development Organization (UNIDO) describes CSR as a “management concept whereby companies integrate social and environmental concerns in their business operations and interactions with their stakeholders”. UNIDO’s CSR program is based on Triple Bottom Line (TBL) approach that is understood as achieving balance of economic, social and environmental imperatives and addressing expectations of stake- and shareholders. (United Nations Industrial Development Organization, 2017)

2.1.1 Triple Bottom Line (TBL)

The most common framework companies approach the sustainable development and sustainable business model is the Triple Bottom Line (TBL) framework. Sustainable strategies are long-term oriented and aim to develop and regenerate different company resources to achieve economic, environmental and social performance. The interrelationships among social, environmental and economic development are the three “pillars” of the ‘Triple Bottom Line’ (Elkington 1994 cited in Longoni, A. 2014)

TBL is an accounting framework that goes beyond traditional measures of profits and incorporates social and environmental dimensions of performance. The triple bottom line is an important tool to support sustainability goals, because it encourages firms to seek win-wins, where they search for profitable activities that benefits all three dimensions of sustainability. The TPL reporting includes the effect of business on people, planet and profit and it is also called the 3Ps. (Slaper and Hall, 2009).

TBL or 3Ps concept was introduced by John Elkington. He suggested that businesses need to measure their success not only by the traditional bottom line of financial performance but for businesses to claim that they are sustainable they should be measured also by their impact on

broader economy, the environment and the society in which they operate. (Savitz and Weber, 2013)



Figure 2. The Triple Bottom Line Framework (Change in Context, 2016)

Construction industry influences all the pillars of sustainability widely and the industry is substantial to European Union economy. The sector drives economic growth and contributes to around 9% of the EU's Gross Domestic Product (GDP). Furthermore, the industry provides 18 million direct jobs and create new ones while providing solutions for social and environmental challenges. European Commission's goal is to help the industry become more sustainable and energy efficient. (European Commission, 2016a)

2.2 Environmental Sustainability in Construction Industry

Based on references and topics that are disclosed so far CSR defines the future of the society; it is supposed to maximize welfare and societal benefit and it is the responsibility of businesses to lead CSR and take the benefits of the society into consideration in their operations. NGOs and businesses base their CSR on the TBL framework. Although the three pillars of TBL are greatly dependent on each other, this paper concentrates mostly on the environmental pillar of the TBL.

According to European Commission companies can become socially responsible by following the law and integrating social, environmental, ethical, consumer and human rights concerns into their strategy and operations. They have defined CSR as the responsibility of enterprises for their impact on society and, thus CSR should be company led. (European Commission, 2016).

As discussed before environmental sustainability is driven by NGOs and by the regional and local authorities through different incentives, tools, legislation, and regulations. Construction industry has major impact on our environment. The industry is one of the biggest contributors of GHG emissions and waste. There is a high pressure on construction companies to become more sustainable.

2.2.1 Green Buildings Market Creation

“A blend of regulatory, financial, and voluntary interventions will address barriers that prevent greater private investment in green buildings, including voluntary rating systems, building codes, tailored financial incentives and greater action by utilities.” (The World Bank, 2017)

According to the International Finance Corporation (IFC) and World Bank, the historic Paris Agreement on climate change will help to open up opportunities for climate investments. According to the report the investment in green buildings in 2015 was 388 billion dollars and will at least be a 3.4 trillion opportunity through 2025. Furthermore, The World Bank estimates growth in markets and openings of larger opportunities in the sector. They estimate a growth of 1.2 percent annually. Most of the growth is expected in residential buildings. (The World Bank, 2017)

Additionally, The IFC and The World Bank Group have made the green building market creation their priority and have created the strategy below to promote green building growth:

Green buildings market creation: A priority for IFC and the World Bank Group

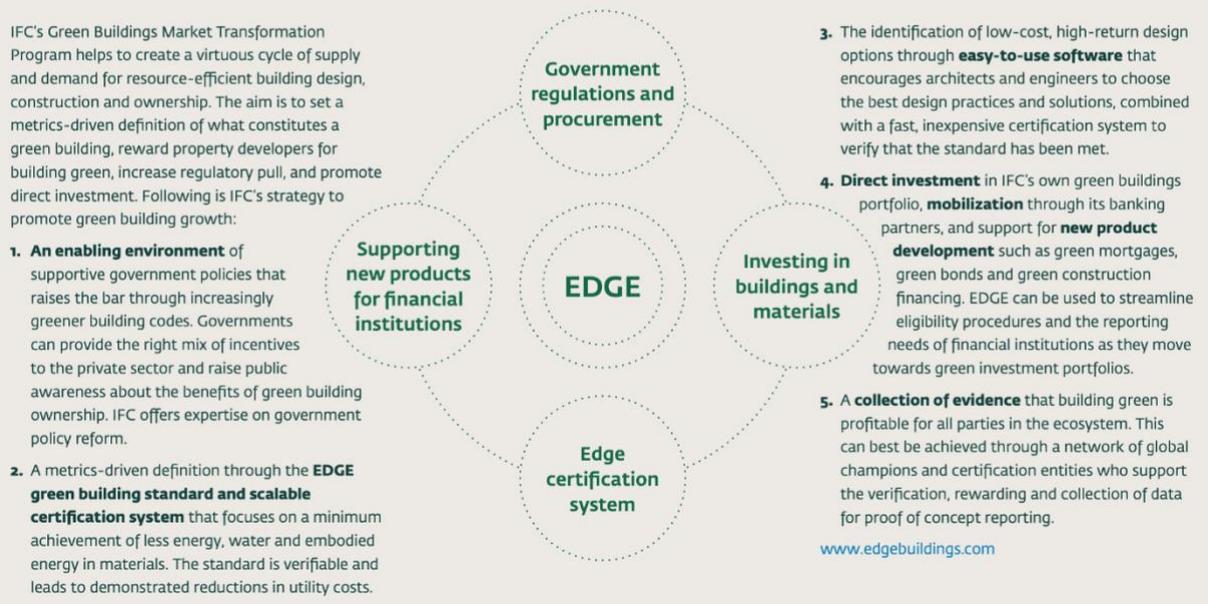


Figure 3. Green Building Market Creation Strategy (The World Bank, 2017)

2.3 Environmental Product Declarations

Among the other policies, tools and regulations The European Union forcing Environmental Product Declarations (EPDs) on construction industry is just another way to limit, control and direct construction industry towards more environmentally sustainable direction.

The International Organization for Standardization (ISO) defines three types of environmental declarations and labels. Type I (ISO 14024) refers to ecolabeling, Type II (ISO 14021) labels are manufacturers' self-declared environmental claims, and Type III (ISO 14025) Environmental Product Declarations (EPDs) are product labels that communicate environmental impact of a product through its life-cycle in a comparable credible way and are independently verified. (The Norwegian EPD Foundation, 2019).

This means EPDs does not directly indicate if materials are more sustainable, but it gives an honest, transparent profile of the product's environmental performance during its life cycle.

EPDs can be beneficial to customers when it comes to making sustainable choices between products, because the risk of greenwashing is minimized.

According to The Norwegian EPD foundation, it is expected that a size equivalent of new Japan every year or new Paris every 5 days will be built for the next 40 years. That makes up to 230 billion square meters of new construction. The industry already is responsible for consumption of large amount of raw materials and energy and furthermore, it is estimated that if no action is taken the energy consumption will grow by 50% by 2050. (The Norwegian EPD Foundation, 2019).

A movement has developed towards more sustainable buildings, in order to cut down the environmental impacts. The international and national legislations support the trend increasingly. Buildings are certified based on their social and environmental performance. Choosing sustainable construction materials can help in reducing the environmental impact of buildings' substantially throughout their life cycle. EPDs provide unbiased information about product's environmental performance transparently and they are based on a products Life Cycle Assessment (LCA). (The Norwegian EPD Foundation, 2019).

Product Category Rules (PCR) were developed to harmonize environmental declarations across EPD operators. PCRs are documents that provide rules, requirements and guidelines for developing an EPD. (The International EPD® System, 2019). The European Committee for Standardization (CEN) published the new standard EN 15804:2012+A2:2019 "Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products" on October 2019. (CEN, 2020).

The format of EPDs can differ between the EPD program operators. The EN 15804 compatible EPDs includes the details below:

GENERAL INFORMATION

- ☑ Exact name of the product
- ☑ Product image
- ☑ Name, logo and contact data of the owner
- ☑ Name, logo and contact data of the programme operator
- ☑ Underlying product category rules (PCR)
- ☑ Scope
- ☑ Date of the publication and beginning of the five-year validation period
- ☑ Declared unit of the product (e.g. m² or kg)
- ☑ Place of manufacture
- ☑ A statement that the EPD is based on EN 15804
- ☑ Name of the independent verifier

Figure 4. General Information (The Norwegian EPD Foundation, 2019)

DETAILED PRODUCT INFORMATION

- | | |
|---|---|
| ☑ General description of the product and its application | ☑ Installation of the product |
| ☑ Technical data and reference to the underlying product norm | ☑ Reference service life |
| ☑ A list of the product's components and/or substances | ☑ Information on behaviour in the event of fire, exposure to water and mechanical destruction |
| ☑ Information on substances listed in the SVHC ¹ Candidate List if their content exceeds 0.1 % | ☑ Information for use after the usage phase |
| ☑ Description of the manufacturing process | ☑ Naming of possible disposal routes |
| ☑ Environmental and health impacts during production and use phase | ☑ Information on where explanatory material can be obtained |
| | ☑ System boundaries (which phases of the LCA are declared) |

¹ Substances of Very High Concern for Authorisation

Figure 5. Detailed Information (The Norwegian EPD Foundation, 2019)

LCA BACKGROUND INFORMATION

- ☑ Information on background data used (LCA data sets) and rating of the data quality
- ☑ Period from which the manufacturer data used originate
- ☑ Estimates and assumptions made
- ☑ A statement that EPDs are only comparable if they comply with EN 15804
- ☑ Information on transports such as means of transportation, distances, and utilisation

Figure 6. LCA Background Information (The Norwegian EPD Foundation, 2019)

SCENARIOS AND ADDITIONAL TECHNICAL INFORMATION

- ☑ Installation of the product: auxiliary and operating materials for the installation, use of other resources, etc.
- ☑ Maintenance, repair, replacement and modernisation: number of inspections, maintenance, repair and cleaning cycles etc. per reference service life, waste materials from maintenance, energy use, water consumption
- ☑ Energy and water consumption during the use phase
- ☑ Disposal: collection procedure, return procedure, specified disposal type
- ☑ Reuse, recovery and recycling potentials

Figure 7. Scenarios and Additional Technical Information (The Norwegian EPD Foundation, 2019)

ENVIRONMENTAL PARAMETERS FROM THE LCA

- ☑ Table with the results of the LCA including the required parameter
- ☑ The scenario development
- ☑ In the case of an average EPD of multiple products, a range of environmental impacts must be reported

Figure 8. Environmental Parameters from the LCA (The Norwegian EPD Foundation, 2019)

2.3.1 EPDs in Nordics and Finnish Construction Industry

Nowadays EPDs are often required for new buildings, especially for the commercial constructions. In order for the buildings to be certified as green buildings, certain characteristics needs to be in its place. Buildings with EPDs certified materials can score higher in green building evaluations.

Furthermore, EPDs can be beneficial to all stakeholders of the construction industry directly or indirectly. EPDs provide LCA-based information and can improve the environmental performance of products, it can be used in buildings' ecological assessment and they can be the benchmark between products. Transparent data of EPD certified products can be gathered and used in development of new products and materials. They can be useful for improving public image, for marketing and bringing competitive advantage. (The Norwegian EPD Foundation, 2019). According to Finland's EPD program operator Rakennustietosäätiö RTS sr, the calculation of carbon footprint of buildings will become mandatory by 2025 (Rakennustietosäätiö RTS sr, 2019)

2.3.2 Reasons to Invest in Green Buildings and Use EPD Certified Construction

Material

Environmental issues are becoming increasingly important and vital for companies' strategy. People expect more environmental and social responsibilities from the businesses as society evolves. Companies can generate economic returns or competitive advantages by taking only a few actions toward environmental protection, but only a few companies from each industry are able to transform environmental investments into competitive advantage (Jørgensen S., 2019).

The possibility that business can profit from environmental investments or as Orsato, R. 2016 says "the win-win hypothesis" has captured the attention of academics, managers and the general public for a long time. Academics have persistently looked for casual relationships between environmental investments and business variables such as market share and stock prices. And they have proved that indeed the business case for sustainability exists. (Orsato, R. 2006).

Forest Reinhardt says that when corporations can offset the costs of eco-investments, they will most probably do so. In his view, the possibility for corporations to profit from eco-investments depends on "the economic fundamentals of the business, the structure of the industry in which

the business operates, its position within that structure, and its organizational capabilities”. (Orsato, R. 2006).

According to the International Finance Corporation (IFC) and World Bank the historic Paris Agreement on climate change will help to open up opportunities for climate investments. According to the report the investment in green buildings in 2015 was 388 billion dollars and will at least be a 3.4 trillion opportunity through 2025 (The World Bank, 2017). In conversation with Matti Kuittinen he added to the statement earlier that “according to the estimates of the world bank, the investments to green construction within the next 10 years are expected to increase to the level of 25 trillion dollars.”. This indicates that the investments in green buildings are increasing exponentially.

Investing in green buildings is not only beneficial for the environment but for all the stake holders. As mentioned earlier, it can bring competitive advantage and improve the public image of a company. The frameworks will be applied and outlined to the current situation of the construction industry and they will be vitalized to perceive the future effects of green investments and EPDs and sustainability regulations on the industry.

Recently there has been a development towards more sustainable buildings, and international and national legislations support the trend increasingly. Furthermore, buildings are certified based on their social and environmental performance - the better the environmental performance the higher ratings. EPDs provide unbiased information about product’s environmental performance transparently and they are based on a products LCA, so depending on the amount of EPD certified materials used in a building project they can help building score higher that will make them more attractive to the investors because certified buildings’ value will decrease slower than uncertified buildings in long term. (Green Building Council Finland, 2018)

According to Green Building Council Finland (GBC Finland) the two international building ratings that are most commonly used in Finland are LEED and BREEAM. Lately also two new

systems have emerged in Nordics and national level that are RTS and Joutsenmerkki “Nordic swan” (Green Building Council Finland, 2018).

LEED (Leadership in Energy and Environmental Design) is a green building rating system that is available for all building types. It provides a framework for healthy, highly efficient, and cost-saving green buildings. LEED helps buildings focus on energy efficiency leadership to deliver TBL returns of people, planet and profit. (U.S. Green Building Council, 2019)

BREEAM (Building Research Establishment Environmental Assessment Method) is a sustainability assessment method used in infrastructure and buildings that recognises and reflects the value in higher performance assets across built environment lifecycle of new and refurbished buildings. BREEAMs are third party certified and are more sustainable enhance the well-being of the people who live and work in them, help protect natural resources and make for more attractive property investments (The Building Research Establishment, 2019).

The Nordic Swan Ecolabel works to reduce environmental impact from production and consumption of goods. It is a Nordic voluntary license system in which the applicant agrees to follow the criteria outlined by the Nordic ecolabelling. Its purpose is to make it easier for the consumers to choose environmentally friendly products and services. (Nordic Swan Ecolabel, 2020)

The RTS environmental classification (Rakennustietosäätiö-ympäristöluokitus) is a Finnish environmental rating system that is developed taking Finnish conditions into account. Its purpose is to carry out environmentally responsible construction and property maintenance. Furthermore, The RTS environmental classification takes into consideration well-being of employees and comfort of the work environments and other domestic practices, such as indoor air classifications. (Rakennustietosäätiö RTS sr, 2020)

3. Research Framework

In this section, I build a research framework are used to articulate, why companies should invest in green and low carbon buildings and choose EPD certified materials. First PESTEL analysis is used to elucidate what pressure is directing the construction industry to cut down carbon and drive circular economy. Then Porter's Five Forces are used to adduce the benefits of concentrating on sustainability and to gain competitive advantage in the market. Eco-Advantage strategy framework is used to help visualise the importance and the benefits of being the forerunner in eco-sustainability. Finally the value uncaptured captured perspective and the Driver-Pressure-State-Impact-Response (DPSIR) framework is used to disclose the benefits of circular economy and how circular economy can be driven in the industry.

3.1 PESTEL Analysis

The integration of all stakeholders of the construction industry is getting concentrated (Larsson and Larsson, 2020). The integration of all members from the material extraction to material producers, to building companies to other stakeholders to end customers. This evolution reflects the transformation of the industry that has been spurred by a number of driving forces. These forces can be analysed through the P.E.S.T.E.L. framework. The PESTEL framework is used to analyse the impacts of the external market environment on an organization, in other words it measures and monitors the macro-environmental factors that have a profound impact on an organization's performance (B2U - Business-to-you, 2016).

The PESTEL framework distinguishes between the following six different drivers:



Figure 9. PESTEL Analysis Forces (B2U - Business-to-you, 2016)

1. Political

Political factors discourses, all the influences that the government has on a business. In case of Finnish construction industry also the formation of economic unions influences the Finnish construction industry. All the decisions that the UN, NGOs, the EU and the National Finnish government makes regarding the construction industry falls under the political driver of the PESTEL analysis.

Finland is reinforcing their climate goals with other Nordic countries. Nordic countries improve their Nationally Determined Contributions (NDCs) under Paris Agreement to meet the target of 1,5 degrees of global warming. They aim to be the pioneers in fight against global warming, become carbon neutral and encourage other parties to improve their performance. Finland's Minister of the Environment, Energy and Housing, Kimmo Tiilikainen says "we would like to lead by example and show that we can grow our economy, improve the welfare of our citizens and at the same time reduce our emissions remarkably". (Nordic Co-operation, 2019).

Among Finland's sustainable and ecological goals published by The Finish Government, Finland's goals are to become carbon neutral by 2035 and to become the leading country in circular economy. Their aim is to minimise the carbon footprint of housing and constructions by working with the industry to develop sector-specific plans for carbon neutrality, build regulatory plan based on carbon footprint and building's life cycle, enhance recycling and circular economy of the construction industry. (Valtioneuvosto, 2019).

2. Economic

Economic factors discourse topics like globalization, economic growth, customer centrality, cost pressure, vertical disintegration and other economical fluctuations that concerns the Finnish construction industry.

As discussed earlier, the sector contributes to around 9% of the EU's GDP (European Commission, 2016). Construction industry is the basis of prosperity, competitiveness and wellbeing of the Finnish economy. It accounts for more than 70% of the Finnish national wealth. Housing is the largest asset of the Finnish national wealth. All in all 565 billion of the Finnish national wealth is in buildings and infrastructure. (Vihmo, J. and Rakennusteollisuus RT ry, 2020)

Based on the interviews customer centrality in the industry is inevitable. Construction projects are always built from customers requisition. The customers set demands and standards to the builders. The companies have to go through the bidding process and the company which can serve customer demands the best with the lowest costs gets the project, so there is a huge cost pressure in the industry. Furthermore, the bigger the project the more subcontractors are used so the disintegration in the industry is also huge.

3. Social

The social factor of the construction industry is associated with the job market, with workers unions and their safety. Construction and the maintenance offer job to one fifth of people in Finland. The construction industry employs a quarter of a million people and includes more than half a million in the real estate sector and related services. The cluster is the largest employer in Finland. (Vihmo, J. and Rakennusteollisuus RT ry, 2020)

Construction industry is an essential job provider to foreign minorities. According to the labour force survey conducted last time in 2016 about one in four employees of building contractors in Helsinki area are foreigners. Elsewhere in Finland, foreigners account for about five per cent of the labour force. (Vihmo, J. and Rakennusteollisuus RT ry, 2020)

4. Technological

Construction industry is heavily attached to technological development. A huge portion of the capital of the industry is used to automatize processes and to develop new technological innovations and other R&D activities. On the other hand it can be a source of competition and

enable efficiencies. Technological factors may influence decision making, for example on buying new technologies or developing in house, outsourcing of activities and new technologies might help disrupt the industry and overtake competition.

Throughout the interviews the importance of technology in the industry was hard not to notice. Technology is used for the development of materials, for planning and designing the buildings. Software like Bionova's Oneclick LCA is used widely for counting carbon footprint of the buildings. Other software and technological tools are used for measuring humidity and optimizing energy efficiency and more.

5. Environmental

The environmental factors of the Finnish construction industry are the main topic of this research paper. Environmental factors have become progressively important due to increasing of greenhouse gas emissions of the industry, climate change, scarcity of the raw materials and sustainability targets and limitations that are set by authorities and governments. Furthermore, growing awareness of the potential irreversible changes to the environment and biodiversity is affecting the construction industry.

The industry creates 38% of the emission externalities in Finland directly and accounts for 42% of the overall energy usage of the country in their lifecycle (Vihmo, J. and Rakennusteollisuus RT ry, 2020). Finland's goals are to become carbon neutral by 2035 and to become the leading country in circular economy (Valtioneuvosto, 2019). As a result companies are continually forced to reduce waste, emissions and become energy efficient. Furthermore, they have to reuse materials and accelerate circular economy in their operations.

6. Legislative

The last force of the PESTEL analysis is legislatives or legal factors and other external factors that companies have to take into considerations that overlaps with the political factors that are the first force of the analysis. Furthermore, legislative factors include health and safety, equal opportunities, customer rights, product labelling. Specially for big organizations this might

become complicated since every country has their own targets, their own rules and regulations for their construction industry.

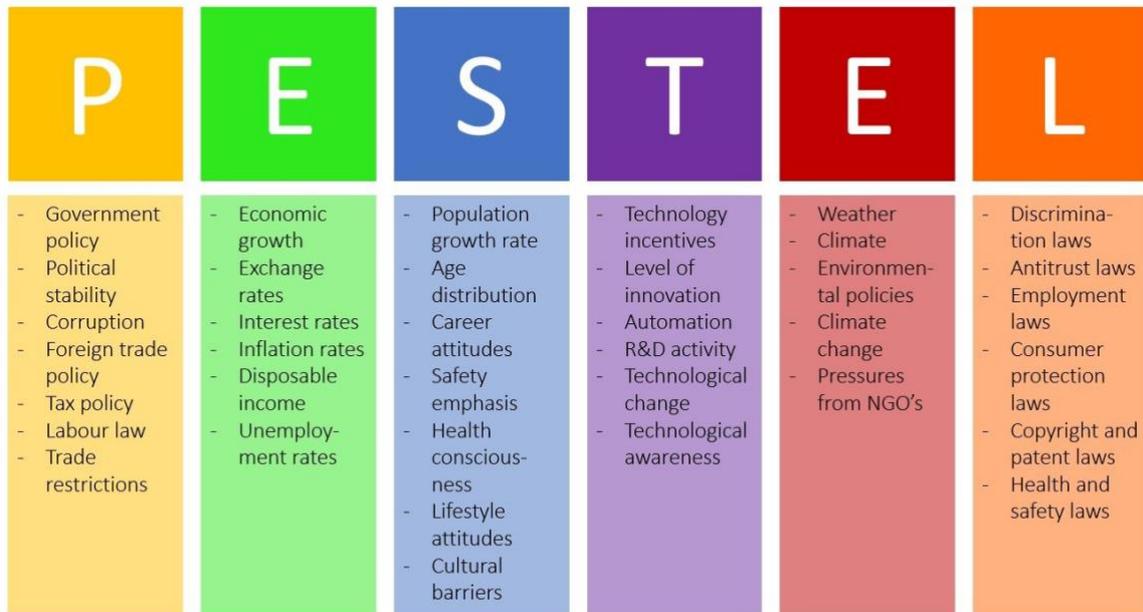


Figure 10. PESTEL Analysis Macro-environmental Factors (B2U - Business-to-you, 2016)

The PESTEL analysis is often used with Porter's Five Forces to give understanding of internal and external factors clearly. (Professional Academy, 2015)

3.2 Porter's Five Forces

The Five Forces analysis framework is one of the most famous business competitive strategies that was developed by Porter, M. E. (1998). The framework helps analyse the competition level of an industry. According to the framework competitiveness does not only come from other players in the market, but rather the state of competition in an industry. The five forces that affect the market are: threat of new entrants, bargaining power of suppliers, bargaining power of buyers, threat of substitute products or services, and existing industry rivalry. (Porter, M. E. 1998).

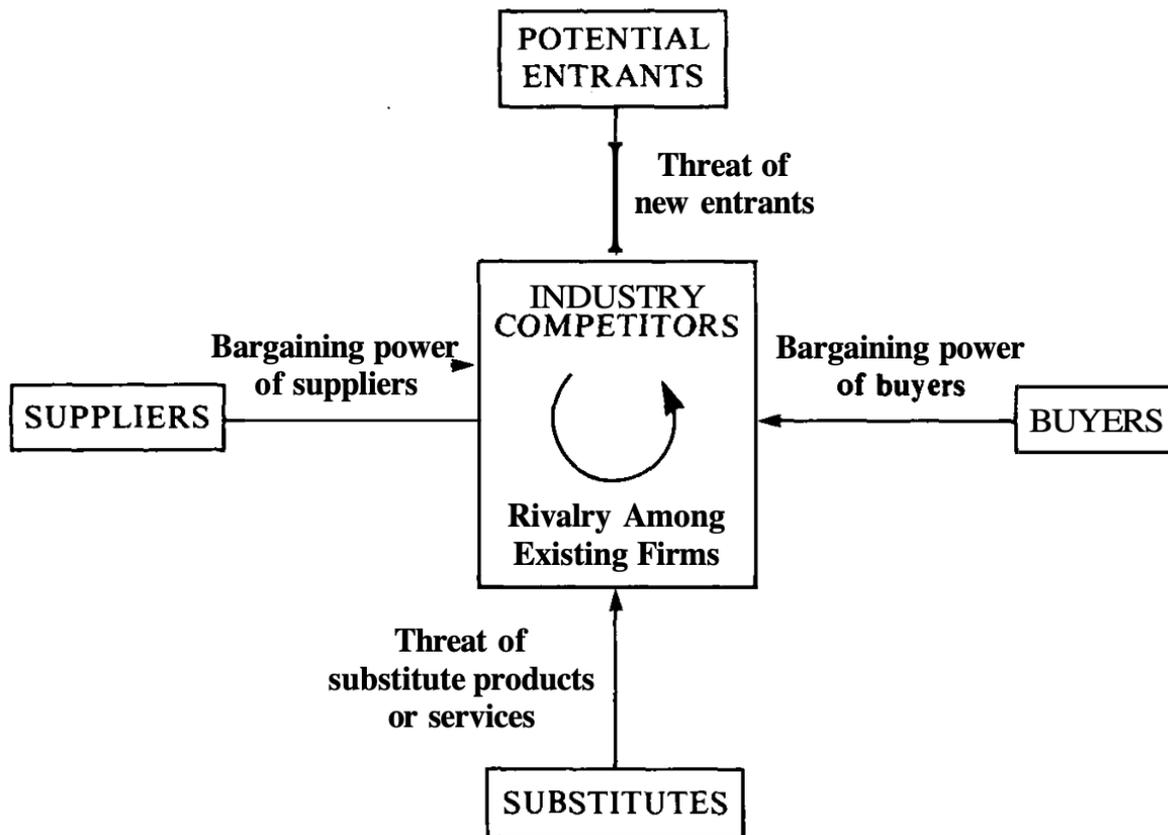


Figure 11. Forces Driving Industry Competition

The forces are explained below, and it is described how these forces can be used in pursuit of sustainability.

1. Threat of New Entrants

New entrants to an industry desire to gain market share. Prices can be bid down and costs might rise. As a result, the profitability will be reduced. New entrants might use their resources to shake up the market, also acquisition into an industry with intent to build market position adds up to the threat of new entrants. (Porter, M. E. 1998)

Bigger manufacturers can benefit from sustainability since they can benefit from economies of scale but it makes the production costlier for the new entrants. Furthermore, strong product differentiation makes it easier to advertise. Also, the industry requires strict sustainability related policies and restrictions that makes it harder for the new entrant to enter. (Murphy, 2018)

2. Bargaining Power of Suppliers

Powerful suppliers can exert bargaining power by rising prices or reducing quality (Porter, M. E. 1998). The more suppliers pursue sustainability the less control over prices and the less bargaining power they will have. The less differentiated the products the lower switching costs to other suppliers. (Murphy, 2018)

Differentiation in sustainability in construction industry gives bargaining not only to the material provider, but also to the builders since it helps them differentiate. This will also give more sustainable options to the end customer who will own the building.

3. Bargaining Power of Buyers

Buyers in an industry compete by forcing down the prices, demanding higher quality or more assortments. They make suppliers compete against each other. Again if there is no differentiation it is easier to switch suppliers and there will be cost pressure on suppliers and lower profitability. (Porter, M. E. 1998)

If the number of sustainable suppliers that operate in an industry is low and customers have to choose from few firms, they will not have control over the price, and they will have lower bargaining power over suppliers. If the product differentiation within the industry is high that can be translated to buyers that they are not able to find new alternatives and switching might not be an option or very expensive. Focus on innovation, differentiation and sustainability attracts larger numbers of customers. The larger the customer base who pursue sustainability the less their bargaining power. Furthermore, firms can take advantage of economies of scale to develop sustainable products with lower prices to sell to buyers with lower income. This way they can attract larger audience and the environment can also benefit. (Murphy, 2018)

4. Threat of Substitute Products or Services

All the firms of an industry compete with others which produce substitute products and services. Substitutes place a ceiling on the prices and limit the potential returns of an industry

and can affect the overall profitability of the industry. The better price performance of the alternatives the lower the profitability. (Porter, M. E. 1998)

Sustainability can make threat of substitute products weaker force. If there are only few sustainable substitutes available, there is no ceiling on the maximum profit that can be earned from the industry. If there are only few high quality more sustainable options and are sold at a lower price, this means buyers will less likely switch to other suppliers because buyers choose high quality products with lower price over high quality, high priced products. Furthermore, differentiation in sustainability will ensure buyers will be attracted to the unique product that is not easily substitutable. (Murphy, 2018)

5. Existing Industry Rivalry

“Rivalry occurs because one or more competitors either feels the pressure or sees the opportunity to improve position.” Existing competitors compete for their position in the market by advertising, increased customer service, extended warranties or price. Price competitions harms the entire industry and might lower the overall profitability of the industry. Movement of competitors in an industry affects the competitors. Other firms might make efforts to counter move and if countermoves escalate all the firms might suffer and disbenefit. (Porter, M. E. 1998)

If the number of the sustainable suppliers are low, it means there are only few bigger players and no movements and shifts will be done without being noticed. That will makes rivalry between firms a weaker force within the industry. If the companies pursue sustainability every year and it is expected to do so in the future, it means a positive growth in the industry and it is less likely for competitors to engage in other competitive actions like price wars. In other words, competing with sustainability will enhance the overall sustainability of the industry. (Murphy, 2018)

In pursuit of sustainability, cooperation between suppliers and demanders can prevent over production and cut down waste. Firms can focus on new customers who are interested in sustainability instead of trying to win each other customers. (Murphy, 2018)

3.3 Eco-Advantage Strategy

In Michael Porter's famous strategy model, corporations and companies achieve competitive advantage by lowering costs or differentiation. In today's world the competitive differentiations are tightened from all sides. Even small businesses have the opportunities to outsource or move to their production lower labour cost markets. Competitive advantages like access to low-cost raw material are disappearing from global markets. It is getting harder and harder to establish and maintain differentiation. (Esty, D. 2007).

Environmental strategy offers just this sort of opportunity. It is a relatively new variable in the competitive mix. It presents a new lense through which to examine a facility, company, or industry and provides a fresh way of thinking and approaching production. A company can reduce costs and risks by using environmental perspective carefully. It can also drive upside gains, increasing revenues and the value of hard-to-measure but important intangibles, such as reputation. It can help find new market spaces, satisfying customers' needs in new ways, and just plain doing the right thing, which stakeholders appreciate and reward all of these aspects can retain value. (Esty, D. 2007)

Economy and environment are deeply intertwined, and the business world is finally waking up to an inevitable and unavoidable truth. Without careful and responsible stewardship natural resources will become rare or vanish, that in itself means dormition to businesses. In the future it is expected that trends, laws, regulations and expectations will further drive these concerns. In this new globalized more complicated world environmental strategy emerges as a critical point of competitive differentiation. (Esty, D. 2007)

In his book "Green to Gold" Esty, D. (2007), goes as far as saying: "In the very near future, no company will be positioned for industry leadership and sustained profitability without factoring

environmental issues into its strategy”. He says only the companies which incorporate the initiatives that the “Green Wave” brings, into their core strategy will survive. (Esty, D. 2007)

The Green Wave will shape companies of the future. Companies can create enduring Eco-Advantage by thinking differently. By recognizing possibilities and adopting tools to cope and overcome the environmental challenges and embedding attention towards environmental stewardship in their corporate values. Esty, D. (2007)

The book introduces four foundational elements to Eco-Advantage strategy:

1. Eco-Advantage Mindset
2. Eco-Tracking
3. Redesign
4. Culture

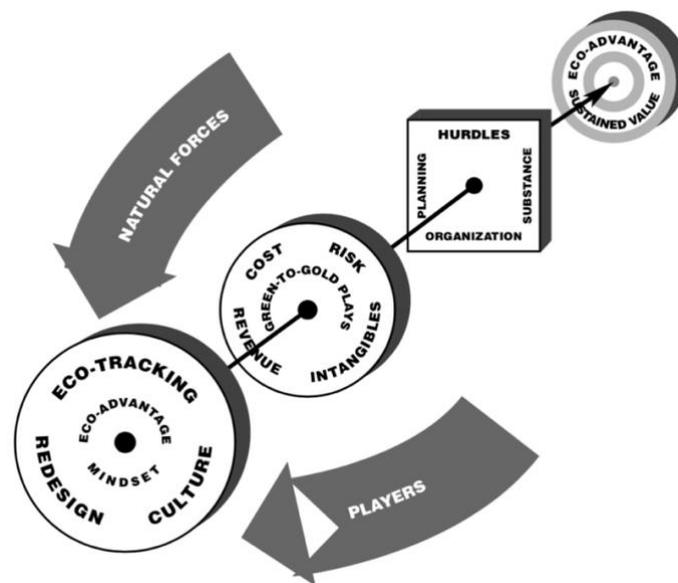


Figure 12. Eco-Advantage Strategy (Esty, D. 2007)

In the framework above natural forces can be climate change, energy, water, biodiversity and land use, chemicals, toxins, heavy metals, waste management, deforestations, oceans and fisheries. The players are the stakeholder who care about these issues and who would like to make impacts on the natural forces through Eco-Advantage strategy.

1. Eco-Advantage Mindset

Through interviewing multiple forerunners, as described in the book “WaveRiders”, the authors found out that there are five principles that are common in these companies: (Esty, D. 2007)

- Think beyond own boundaries, look at the whole value chain from raw materials, to customers’ environmental needs to product end-of-life.
- Start from the top down, so primarily the CEO should be committed to change.
- Do not take no for an answer. Companies have shown time and time again that they can solve intractable environmental problems with creativity and seeing their operations through environmental lens.
- Leading companies know that they have to deal with NGOs, and other stakeholders. Instead of blindly defending their own position or downplaying others’ concerns, they recognize the need to meet people where they stand.
- Do the right thing. To WaveRiders values do matter. (Esty, D. 2007)

2. Eco-Tracking

WaveRiders use issue-spotting tools, audio analysis, and LCA to understand their environmental impacts. They look at the eco-consequences of the whole value chain upstream and down. They track their metrics globally and locally. They track their data, benchmark and track their performance. They get outside perspectives set goals and know where they stand. They do not just throw-away ideas, they turn them into actions. (Esty, D. 2007)

3. Redesign

Tracking data helps define playing field. WaveRiders gain knowledge, understand the environmental market drivers and they use the knowledge to drive innovation and make changes to their production and other processes. They redesign their environments and supply chains to achieve the goals they set. Redesigning and estimating problems before they arise

helps save time and money in long term. It not only helps the company minimize their environmental footprints but also helps minimize consumers' environmental footprints. In a world where energy prices are rising embracing green buildings that are well-designed, energy-efficient not only saves money, but it also sends a signal about corporate values. (Esty, D. 2007)

4. Culture

Building a corporate culture that supports and promotes environmental thinking and innovating in Eco-Advantage is the most important step. The authors have found out four common approaches across WaveRiders. (Esty, D. 2007)

- WaveRiders set goals that seem symbolic and even uncomfortable, but they inspire innovation. In some cases the goal can be zero.
- They refine their goals, their strategies go beyond traditional cost-benefit analysis. They tweak and balance their operations in favour of environmental investments.
- They prioritize environmental issues. CEO's commitment gets the ball rolling. Engagements of senior managers keeps all the employees motivated to reach the common goal. "WaveRiders find ways to walk the talk and align their statements about environmental commitment"
- WaveRiders turn environmental goals, success and lessons learned into their stories and tell everyone who will listen. They share knowledge and inform stakeholders and particularly employees about what the company is doing right and wrong. (Esty, D. 2007)

3.4 Circular Economy

An important topic that arose during the research of environmental sustainability and low carbon construction was circular economy. Circular economy aims to eliminate waste and continual use of resources. The circular system's purpose is to create a closed loop system by recycling, remanufacturing, reusing, sharing, repairing and refurbishing (Geissdoerfer et al., 2017).

3.4.1 Value Uncaptured Perspective

The main idea on what sustainability stands on is to utilize better and capture greater value of the resources. Jørgensen S. (2019) mentions that organizations will always have the room to reduce their environmental impact, improve their productivity- Lately more than ever before it is important for organizations to adopt wide spectre of environmental and social prerequisites into their practices and strategies.

In their research “Value uncaptured perspective for sustainable business model innovation,” Yang, Miying & Evans, Steve & Vladimirova, Doroteya & Rana, P. (2016) points out that Sustainability has become one of the key factors for long-term business success. “To date business models have been examined mostly from the perspectives of value proposition, value capture, value creation and delivery. There is a need for a more comprehensive understanding of value in order to promote sustainability.” (Yang, Miying & Evans, Steve & Vladimirova, Doroteya & Rana, P. 2016).

In their paper they propose a framework of using value uncaptured for sustainable business model. Their findings show that:

- The perspective of value uncaptured can help manufacturing firms understand the negative aspects of their business models
- It can assist firms in identifying value uncaptured in a structured way
- The identified value uncaptured can trigger the discovery of new value opportunities which lead to new business models with higher sustainable value.

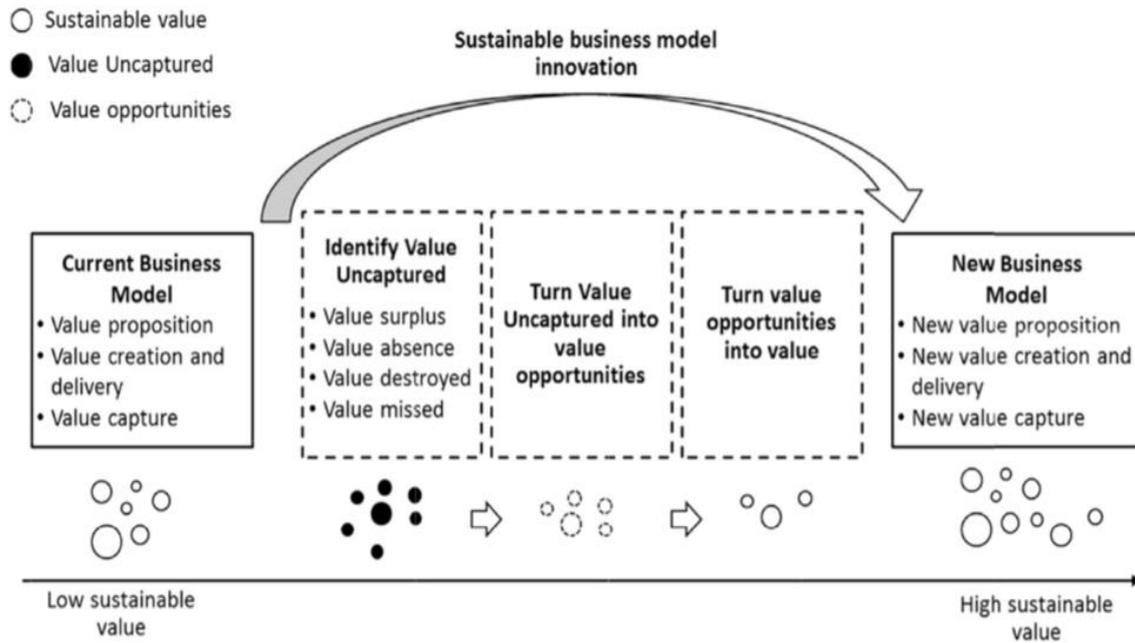


Figure 13. Framework of Using Value Uncaptured for Sustainable Business Model Innovation. Yang, Miying & Evans, Steve & Vladimirova, Doroteya & Rana, P. (2016).

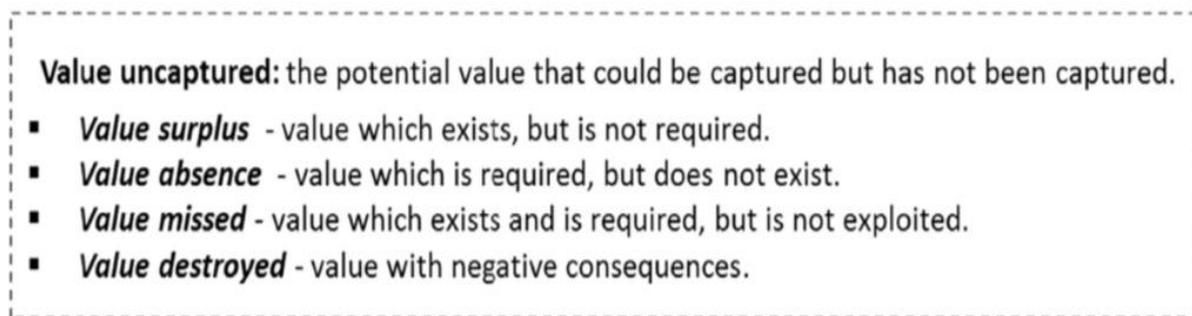


Figure 14. Four Forms of Value Uncaptured. Yang, Miying & Evans, Steve & Vladimirova, Doroteya & Rana, P. (2016).

The uncaptured value is the value that ends up in landfill or used for lower value objectives. The uncaptured value in case of dumping can be categorized as value surplus or value destroyed and if it ends in lower value objectives it can be categorized as missed value. The raw material curated and used for higher value objectives is the uncaptured value that is turned into opportunity. This can be interpreted as higher sustainable value.

3.4.2 Driver-Pressure-State-Impact-Response (DPSIR) Framework

The framework that is most used among the researchers of the circular economy is the Driver-Pressure-State-Impact-Response (DPSIR) framework that is based on the 3R principles “reduce, reuse and recycle”. (Anastasopoulou et al., 2010 cited in Sandoval, 2016).

Drivers of circular economy are the social, demographic and economic. DPSIR framework reveals six main drivers for a circular economy:

1. Interconnection capacity
2. Innovation and Technology
3. Global resource depletion
4. Market system
5. Regulation and policies
6. Consumer behaviour.

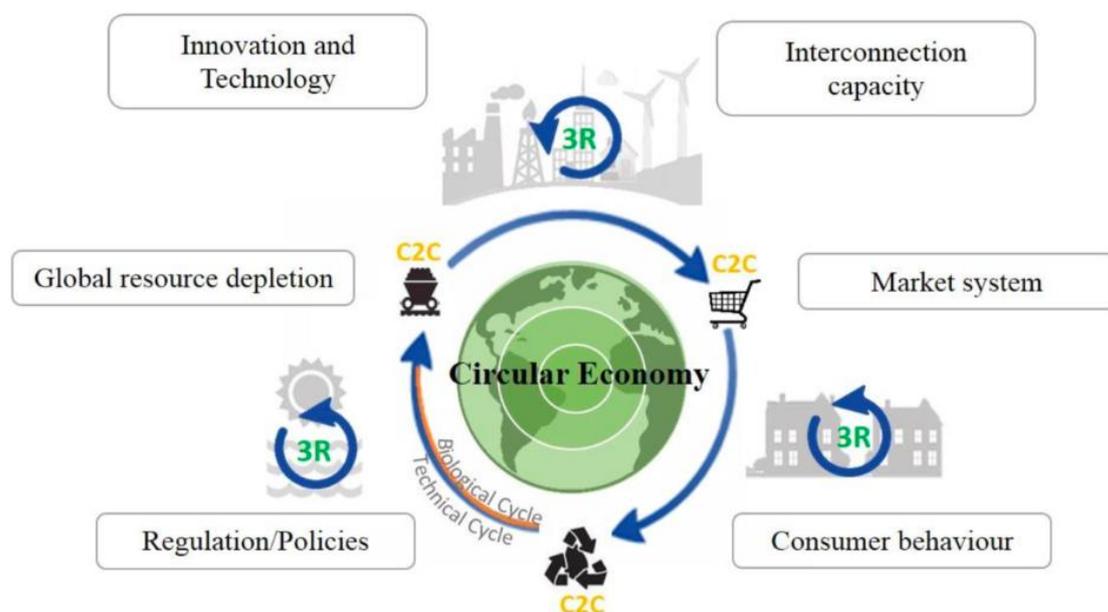


Figure 15. Circular Economy Principles and Drivers (Sandoval, 2016).

1. Interconnection Capacity

In this framework Interconnection capacity means successful symbiosis of compatible partners sharing resources, reducing transport costs, decreasing emissions and achieving greater collective benefits. Corporations can benefit from sharing their goals and invest in shared technologies, share knowledge and optimize resources and other benefits to form economy of scale. (Sandoval, 2016).

2. Innovation and Technology

Innovative technologies inside local businesses, institutions and the region are used effectively to close the industrial loops (Deutz and Gibbs, 2008 cited in Sandoval, 2016). Then, according to levels of integration, technological information and technological infrastructure can be used to embed ecological initiatives (Braungart et al., 2007; Thomas et al., 2003 cited in Sandoval, 2016). Additionally, some empirical cases show that the improvement of technologies and waste management can mitigate the unsustainable use of natural resources (Huang et al., 2014 cited in Sandoval, 2016).

3. Global Resource Depletion

Continual depletion of resources and growing demand of energy is afflicting natural resources. The scarcity of resources is changing the concept of waste. A significant portion of waste is underutilized according to many authors that can be curated and reused for the same or other purposes. Furthermore, the improvements in design and technologies can drive the extension of product life and reduce demand for curating first-hand raw material. (Sandoval, 2016).

4. Market System

The companies can change the whole market system and turn their businesses into sustainable, more competitive and profitable by using multiple business models that are compatible with circular economy. These can be the circular canvas (Lewandowski, 2016 cited in Sandoval, 2016), decrease ownership and add renting services and outsourcing.

5. Regulation and Policies

Regulation and policy drivers are directly related to acts of the macro level economy that is affected by regulations and policies that are set by NGOs, global and local political parties. These can be influenced by the awareness of government officials who tend to lead economic aspect and their priorities on financial and sustainable profits and their values. (Sandoval, 2016)

6. Consumer Behaviour

In long term circular economy system depends on consumers and their social perception of sustainable products. There is a growing trend in social awareness of consumers towards the sustainability of commodities. Also, the awareness towards transparency of firm's operations is growing that adds up to emerging environmental training programs of corporations. Consistent changes in fashion and customers tastes must be managed by firms. (Sandoval, 2016)

4. Research Method

This chapter discloses the research method. It describes the research approach and the methods of the study; including data collection and data analysis. The method of this research is qualitative and inductive, and the analysis primarily rely on qualitative data gathered by interviewing professionals from the Finnish construction industry. The research methodology includes data collection, the interview design and the analysis methods that are used in the research. The research includes analysis of multiple cases and interviews to ensure the quality of the data and furthermore, the reliability, validity and transparency is disclosed.

4.1 Research Approach & Design

A qualitative approach to the study was considered the most appropriate to conduct this study. Qualitative approach focuses on understanding and cause of a problem in their natural setting and interpret it following by the call for change (Creswell, 2013), when quantitative approach focuses on explaining and test a phenomenon in statistical manner (Eriksson & Kovalainen, 2008)

The aim of the research is to find out what the main low carbon building trends are and what environmental sustainability challenges the Finnish construction companies are facing. In addition, the study aims to holistically find out what the companies are doing to tackle these obstacles to reach the goals that are set by the EU and the Finnish government. The main national goals set by the Finnish National government that this research concentrates on are to be carbon neutral by 2035 and to be one of the leading countries in circular economy (Valtioneuvosto, 2019).

The phenomenon of low carbon building and circular economy studied in this research can be described as experts interviews since there are no clear boundaries. The research aims to study these phenomena in a real-life context. And there is no specific hypothesis set in advance (Yin, 2009, cited in Farquhar, 2012). The thesis starts with making observations and aim to find the patterns and the simplest way to explain them using abductive reasoning. The abductive

reasoning is used to find the best possible alternative out of many that are competing (Mantere and Ketokivi, 2013).

The research is built on elite experts interviewing and is limited to Finnish construction industry. All together 20 specialists and experts of the industry from 17 companies were interviewed including heads of sustainability, heads of procurement, building owners, designers and other experienced professionals of the large and medium-large Finnish construction companies and design managers. Additionally, building and construction expert of the Ministry of the Environment Matti Kuittinen who is working with development of laws and regulations in the EU and in Finland was interviewed for the study.

The interviews were semi-structured. According to Farquhar (2012) semi-structured interview allows a flexibility and contextual adaptation. Semi-structured form was chosen, so the experts could give their opinion on topics widely. The questionnaire for Matti Kuittinen was different from the other participants. However, not all the questions are used in this study, as some of the questions were on behalf of Saint-Gobain.

As one of the larger material providers that has the most EPD certified building materials in the world (The International EPD® System, 2020), Saint-Gobain actively wants to develop their sustainability strategy. They are interested to serve their customers better, further develop their own sustainability and simultaneously develop more sustainable materials to their customers. Some of the questions were channelled to bring value to Saint-Gobain. There will be an additional report written to Saint-Gobain where the rest of the materials will be used.

4.2 Data Collection and Target Sample

The target sample is an experienced expert who works with sustainability, material procurement, design managers, building owners or other tasks that are sustainability and low carbon construction related. It is important to take into consideration that the target is working in a large or medium-large Finnish company or the Finnish subsidiary of an international company. Most of the participants were already familiar with the case company, some of the

participants were their current customers who use the materials and have experience with case company's materials. Some of the participants knew the case company but were not familiar with case company's operations in sustainability neither had experience with the materials they provide.

The participants were chosen based on their experience in sustainability and low carbon building and their current responsibilities in the company they work for. Some of the contacts were provided by Anne Kaiser, the head of sustainability of the case company Saint-Gobain, some of the contacts were recommended by other participants and some were fetched through company webpages.

All the interviews were done via phone calls and video in calls. There was no face to face interviews done, because the interviews took place during Covid-19 pandemic. Some participants were easy to approach and most of them were happy to cooperate and be interviewed. Some passionate sustainability experts were very excited to be able to give their views and opinions and were happy to help and possibly raise awareness through this study, but not all the experts answered even after multiple contacts and a small number who were contacted were busy or were not willing to give their time for interviews. All together 21 interviews were done. The table below describes all of the interviewees.

Table 1. Descriptions of Interviewees

Ministry of environment Finland	Matti Kuittinen
Company 1	Head of sustainability
Company 2	Head of procurement
Company 3	Sustainability director
Company 4	Sustainability manager
Company 5	Real estate asset manager
Company 6	Development manager
Company 7	Project engineer
Company 8	Technology manager of low carbon design

Company 9	Head of sustainable development
Company 10	Expert on ecological sustainability
Company 11	Procurement director
Company 12	Sustainability communication & investor relations
Company 13	Purchasing manager
Company 14	Quality and sustainability manager
Company 15	Design manager expert in energy efficiency
Company 16	Real estate treasurer
Company 17	Chief sustainability officer
Company 18	Sustainability specialist
Company 19	Environmental manager plan and develop certified systems
Company 20	Advisor and expert of sustainability of construction projects.

The interviews started on 6th of April and the last interview was on 7th of May. One of the main priorities of data collection was that the interviewee was involved with company's sustainability operations, and preferably were responsible for sustainability related tasks. Some of the contacts who were not involved with company's sustainability or did not have insight on company's sustainability were not included in the collected data. The interviews were conducted via phone, Skype, Microsoft teams or the video software Zoom. The interviews took from 25 minutes to 2h 22min, but most commonly they lasted 40 minutes to one hour.

4.3 Data Analysis

The findings of the study are derived partially by abductive methodology (Merriam-Webster, 2019). The research process starts by theoretical framework and the data collected from the interviews. The data is analysed, and the result of the analysis is used to formulate the best possible explanation for the phenomenon.

The research analysis method is data-driven. The primary data that was used in this study was collected in form of interviews that were then transcribed and coded. The coded data was

grouped and categorized in a sensible way depending on the links the codes had. The coding process was based on the Gioia methodology. Gioia is a systematic approach to grounded theory articulation. Gioia methodology brings transparency and a qualitative accuracy to the research. (Gioia, Corley and Hamilton, 2012)

Gioia et al (2012) codification has 3 different dimensions:

1. The 1st order code analysis is based on a descriptive approach the transcriptions analysis where there is no limitation to how many categories are created.
2. The 2nd order analysis is where the first order codes are grouped based on their similarities and links they have.
3. In the 3rd and the last phase, the 2nd order themes are grouped into aggregate dimensions. (Gioia, Corley and Hamilton, 2012)

When interviews were coded for the first order of analysis it consisted of over 689; 614 of which were used in this thesis and the rest of the codes were used in a separate report for the case company Saint-Gobain. The 614 codes used in this report were categorized into eleven first order codes and then they were themed based on their links to second order themes and classified into one of the three aggregate dimensions. The Gioia methodology helps visualise and understand the data gathered from the interviews. From the table below it is easy to notice how the categories and themes were formed. Furthermore, the structure represents the data collected in a graphic manner and makes it easy to understand how the answer to research questions and the conclusions were made.

Table 2. Interviews Coded Based on Gioia Methodology.

1st order concepts	2nd order themes	Aggregate dimensions
Sustainable strategy and current sustainability objectives and goals	Current sustainable goals and actions that are taken in construction industry	Sustainability adaptation
Future short-term and long-term sustainability trends	Sustainability issues that will be rising to the surface	

	and readiness of the companies to battle the issues	
Low carbon roadmap of different stake holders	Roadmap for minimizing carbon footprint and carbon neutrality of the industry	Low carbon management
LCA calculations “tools used for calculations, calculation accuracy, consistency, in house or outsourced”	Tools and methods for counting footprint and how could be used to minimize footprints	
Sustainable procurement “material acquisition criteria, procurement priorities”	Priorities when procuring materials	
Prestige of EPDs, benefits and drawbacks of choosing EPD certified materials why sometimes it is resisted.	Image and reputation and reliability, benefits and drawbacks of EPD certified materials in the industry	
Circular economy	Role or circular economy in low carbon building	
Transparency and sustainability communication	Communication and transparency of the members	
Information retrieval “sources of information, information reliability”	Sources of information and their reliability	Value chain cooperation
Flow of information between members of the value chain, interests in collaboration and co-developing to improve overall sustainability.	Current status “how members collaborate, potential of collaboration benefits and drawbacks of cooperation”	

Cooperation and investing in common R&D	Resources and investments could be allocated for the better good	
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A tremendous amount of additional learnings and knowledge was gained from the interviews. As the interviews proceeded, a substantial amount of valuable views was gained that were not part of the original questionnaire. Some of the additional theories and wisdom that was gained from the interviewees, that were appropriate to the research topic, will also be disclosed in this research.

4.4 Reliability and Validity

The interview started with an introduction. It was made sure that the participants know that they can answer the questions without any limitations. Their names will not be mentioned, and the results will be based on an overall opinion of all the interviewees, with the exception of Matti Kuittinen. They do not have to answer to questions that they do not feel comfortable with, do not have enough knowledge or if it does not fall under their job description and their responsibilities, however they could recommend the right candidate that I could approach. Most of the obstacles that could have affected the reliability and validity of the research were removed.

The results of the study are reliable and valid to Finnish construction industry as the limitations were set geographically to Finland. The results can be valid to construction industry elsewhere and they will be valid better the closer geographically and politically situation is to that of Finland. It must be taken into account that there were other limitation and factors that influenced the research reliability and the validity.

First of all, the research was done during the Covid-19 pandemic. Even though the research is not directly related to the Corona virus and at first might not seem that the virus outbreak could affect the research results, it was proven to be the other way around. In many of the interviews Covid-19 pandemic was mentioned. As in “first we have to survive this virus situation then we

will think of that”. The virus outbreak affected the mentality of the people to the amount that some of the results might have been different, at least in small amounts.

The Corona virus brings out some challenges. In the interview Matti Kuittinen mentioned some of the challenges: “We are suffering pandemic that has huge effect on economy and employment. What sort of markets there can be in few years? Can the tax income that we collect from Finnish society, be enough for supporting the transition towards lowering the emissions, especially from our heavy industries?” He added “The biggest question is, that technologically we have pathways towards lowering the emissions, but economy wise and especially taxation side might be tricky. When you would need to play with subsidies: where shall we put our tax money- in low carbon subsidies or healthcare? And what would be the total cost of pandemic to Finland.”

Additionally, some of the questions had to be modified through the interview process. In some cases, they had to be put in other words or clarified because some of the interviewees found it hard to understand or difficult to answer. Furthermore, some of the questions were too big to answer or just too wide and had to be narrowed down

The interviews were conducted in English. However it was made sure that the participants can answer in Finnish if they desire so. And as mentioned earlier, some of the questions were repeated and explained. The language barrier might have affected the research outcome. There seemed to be benefits and drawbacks to doing the interview in English. Generally, the interviewee seemed to be more involved, the smaller number of participants who chose to pursue the interview in Finnish seemed less interested and talkative. This was noticed as a considerable difference between the length of the interviews.

Lastly, it is appropriate to mention that the reliability and validity might suffer also because of the researchers’ background and knowledge. I had only a little to no prior working experience in building construction industry.

The research still can be defined as a well reliable study. It is safe to say that if the research was conducted under the same circumstances again the results would not alter noticeably. The semi structured and flexible interviews seemed to be a reasonable method to do this study. It provided the space for the interviewee to answer without much obstacles, the questions could be repeated, clarified and especially it gave the opportunity for an open discussion where I got some great suggestions form the most passionate professionals of the industry after the interview questions were over.

5. Analysis of Study Data

This chapter analyses the primary data gathered from the interviews and the research topic related discoveries that were made based on the interviews. I have tried my best to stay on the track and follow the red line. For example the research concentrates on building phase and effects of the building phase on lifecycle of the building but does not dive deep on energy consumption during the whole life cycle of the building, it stays with new buildings and leaves out refurbishments of the building and the study discloses circular economy from a low carbon building perspective, but it does not examine other circular economy related topics like resource scarcity.

First the data that is used for the study is explained and opened up, then the results are discussed and implied. The questionnaire had questions related to building companies' sustainability strategy and goals. Emissions related questions like their roadmap for low carbon construction, LCA and carbon footprint related questions. Furthermore, building company questions include questions related to EPDs and sustainable procurement.

There were some questions related to the role of the building owner in a construction project and their involvement in low carbon construction. Other questions were related to transparency, communication between the members of the value chain and data acquisition channels that were aimed to all stakeholders, where I also asked companies' interest in cooperating with material producers, how could a cooperation like that be built and how could this type of cooperation benefit both parties and the environment. Also, depending on participants interest, with many we ended up exchanging experiences in open-ended topic related conversations that were proven very insightful for the study. Finally, there were questions related to the case company Saint-Gobain where I asked participants' experience with and perspective of Saint-Gobain that will not be included in this study.

Next I will discuss the questionnaire below and explain how the data was coded using Gioia methodology, the concepts were linked and themed and how the aggregate dimensions were formed. Based on these the research questions will be discussed and eventually the conclusions will be made.

All in all, I interviewed 21 persons, including Matti Kuittinen from the Ministry of Environment Finland. Participants from 17 different companies were involved in this study. The first remark to be mentioned is that interviewees' position in the company, years of experience and other attributes like gender and age did not seem to have any correlation to their knowledge on sustainability and low carbon construction. I had insightful conversations to a varying degree with many of the participants. Generally speaking, everyone's attitude towards the topic was positive. However, participants own enthusiastic and passionate attitude towards the topic reflected heavily on the interviews. As the reasons from the conversations I can bring up that building sector is conservative, and sustainability is a comparatively new topic in the history of the industry.

As discussed before, the interviews were coded to concepts that included over 689 concepts. 614 of them were used in this study. Repeated answers were excluded from the codes but they are indicated by parenthesis and numbers at the end of the code for example "We want to be pioneer in sustainability (3)". Discussing and describing all concepts would have been impossible without using the Gioia methodology. The codes were then transformed to 11 first order concepts and then second order themes, and finally they were combined to 3 aggregate dimensions.

Below I will open up the 3 aggregate dimensions, the questions they include and the answers that complied best with the study and gives the most insight to the readers. Furthermore, some of the questions could bring insight to multiple aggregate dimensions and that has been taken into consideration and some of them will be disclosed better in discussion section.

All answers will be visible so the validity and reliability of the research would not suffer. Furthermore, some of the answers might be valuable to the reader, especially if they have more experience from the field, even in this study only answers that are the most relevant to the topic will be discussed.

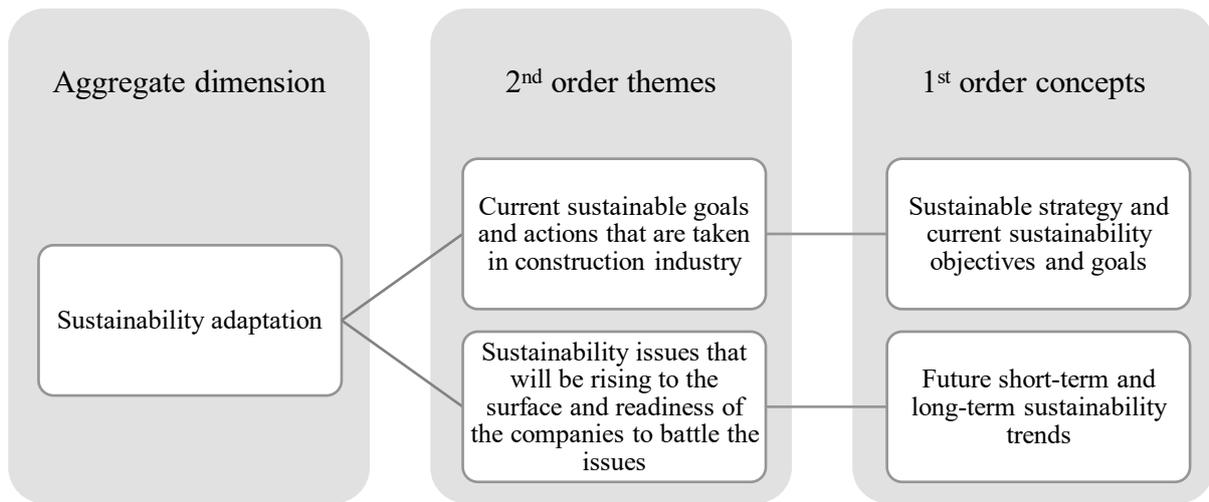


Figure 16: Sustainability Adaptation

The first aggregate dimension is the sustainability adaptation that includes topics like the companies’ and building owners current sustainability latitude, criteria and goals that are important for the companies, the challenges they are facing and adaptation to the changes that they will face, be it changes in regulations and legislations or changes in market trends and customer demands.

The questions and the answers that were related to this aggregate dimension were:

Table 3. Does Company X Have a Sustainability Strategy?

Sustainable strategy not yet published
Sustainable strategy Yes (10)
Sustainable strategy No (2)
Not yet, but in the future part of overall sustainability
Recently had a kick-off to start
Not a written strategy
Follow the city guidelines

Most of the companies already have a sustainability strategy, some companies are working on their sustainability strategies and will have a strategy in near future. Two companies did not have sustainability strategies at all, one company did not have a written strategy and one company followed the city guidelines. However, all the companies have to follow the national and city minimum requirements so they can operate in Finnish construction sector.

Table 4. What Are the Sustainability Objectives / Criteria for Company X?

Material use efficiency
Reducing waste
We build ecolabelled/certified houses
Recycle
Balanced overall sustainability
Engage customers project sustainability
Take climate and emissions into consideration
Social sustainability "workers' health", employee wellbeing,
Overall economic portfolio
Compliance with law
Energy efficiency
Renewable energy
LEED and BREEAM certifications
Social: happy neighbourhoods & affordability
Protecting the planet
Zero harm (health and safety)
Not only environmental but complete sustainability including health, safety and quality
Not only build sustainably but also can be used sustainably
Energy efficiency, the first 0 energy building will be built by us
Real estate sustainability and risk management
Net zero carbon as goal
We do not try new things often
We build easy to maintain structures
We have a CSR program that includes sustainability
Circular economy
Space efficiency and co-using of space
New more ambitious targets
Cut emissions 50% by 2030 vs 2019
Carbon neutral by 2030 with own compensations "building and using phase"
We want to be seen as an idea leader and promote sustainable development
Sustainability is one of our four corner stone of success that is becoming more important
Concentrate and take action on social development goals 8, 11, 12, 13 and 16
Want to be pioneer in sustainability (3)

From the answers above the themes that came out the strongest were material efficiency waste reduction and circular economy. Some of the companies brought up social sustainability like affordability, workers health and safety when asked about sustainability objectives while others kept the conversation only on environmental sustainability. To some company's sustainability was part of an overall strategy, or part of company's corporate social responsibility.

Building certifications like LEED and BREEAM have their own requirements that the building should fill before it can be certified. Other interesting and innovative topics that I came across during interviews were that space efficiency and co-using of space can actually be a big topic in the future and might have a bigger role in cutting down carbon. This topic can also be related to moving of the buildings and rejected buildings to a new location where they could be utilized better.

Table 5. Criteria of Building Owners

We don't have criteria for LCA and energy efficiency, but our criteria do include less cost of LCA
More criteria mean more price form us
Energy performance
Science based target "NCC as the only company with science-based targets"
Non hazardous materials
Half of production Joutsenmerkki certified
Re-evaluate strategy every 3 years to 5 years

While construction companies willingly discussed from building point of view, building owners see it from different perspective. For building owners running costs of the building matters more and they want to make sure their investment pays off. For example, they want to make sure there are no hazardous materials in the building, so the building is safe to use and if hazardous materials are found, they need to be removed. This not only means more costs for removing the hazardous materials but also, they will not gain any money from period that the building is not used.

- How do you see these criteria changing in the future?
 - In 3 years
 - In 5 years
 - In 10 years

I had to add another section to these questions, because some interviewees answered their perspective of future in general not the order that it was asked and again, I will have all the answers below and will go through the ones that are the most relevant to the topic.

Table 6. Criteria Changes in 3 Years

Cities will procure low carbon and green buildings more
Legislation changes
Companies need to provide solutions
Geothermal energy on rise "Building owners"

Table 7. Criteria Changes in 5 Years

Laws change the environmental ministry will make the CO2 footprint obligatory
Changes in customer demand
There will be more limitations and LCA calculations will be mandatory
It will not be enough to just own a green property anymore "Building owner"

Table 8. Criteria Changes in 10 Years

Maturity of people “what is good for the environment is also good for us will increase”
Biodiversity goals on rise
Goals regarding water use, treat and use rainwater
We can hope it’s not the investors who pay and do not get return on investment. When everyone sees that sustainability can save money, they will rethink.
We might not be afraid of trying something new or be scared that trying new things will come back to "bite us in the ass in 5 years" this goes to the officials as well who are making the decisions and regulations
circular economy will become important and a bigger component

Table 9. Criteria Changes in Future in General “Added Section”

The EU sets goals, Nordics and national goals will be changing constantly not only regarding carbon
Knowledge about carbon neutrality is important and in rise
More recycled materials in the future
Biodiversity is going to gain interest
Increase usage of certifications
Biodiversity is decreasing that might be important in the future
We should talk more than just waste
Social sustainability to rise

The codes above indicate that cities will procure more low carbon buildings and the awareness and knowledge towards low carbon and carbon neutrality is on rise among building owners. They will purchase environmentally friendly apartments, when they are mature enough to know

that “what is good for the environment is also good for us” and sustainable buildings can actually save them money. Participants were also sure that sustainability and emissions related regulations and legislations will become stricter and lifecycle assessments and carbon calculations of the building will become mandatory in near future.

The participants suggested that “we should talk more than just waste” and many thought that in future circular economy will be a bigger component and companies will have to use more recycled materials. Participants also thought biodiversity loss, water related treatment and waste will gain more attention in the future.

Table 10. What Is the Role of the Building Owner in a Construction Project?

Important
They set criteria
If they don't set low carbon criteria nobody will deliver lower emissions
They have to ask, otherwise no one will deliver
Some are active some are not at all towards sustainability
Price is more important to them
They are getting more and more interested towards sustainability
Housing companies has the most important role in LCA, sustainability and energy efficiency
Huge! They make all the decisions on costs and what to invest in and we would not exist without them
They pay the bill, so it's crucial
Anything they require we have to give them, like LCA, LEED or use EPDs, I mean ANYTHING
If they set any target except the money, then we go where the fence is low
The owner should make the goals for the building
Owners are more interested in life cycle costs
More problems if they don't own the building long term
If they are not planning to have the building long term, LEED and BREEAM helps in this situation. Ratings means more value then
Owners want to be educated
Discussing with clients makes it more realistic and can educate the owner
The government is making them cut carbon.
They decide everything
We select the players, decide the targets, we need to cooperate with cities, it is important that there are partners who work with us long term” Building owner”
Long term owners are more interested in sustainability and maintaining

Depends "active owner owns the building for its whole life cycle, investment company only for 10 years"
They decide everything and if costs are high, they won't invest
We aim to have high sustainability on our own self developed projects "Building company"
We do not have anything with EPDs "building owners"

Table 11. How Involved are the Building Owners in Steering the Low Carbon Construction?

Some are involved
Some have not heard about it
When they realize building environmentally friendly building can save money, they get more interested
Some are ambitious
Requirements are pending for procurement criteria "building owner"
Their awareness is rising, they are eager, and they see it as marketing value
There are a lot of variations among them
They are finally interested in sustainability
They have realised that we have to do it and we are running out of time
Younger owners are more involved, people over 50 are not that interested
Institutional people have longevity and think in long term it will pay off
They are interested, but no one is willing to pay for it
States have higher level of sustainability
Handful of cities and real estate companies have signed a zero-carbon building commitment

Table 12. What Are Building Owners' Interests?

Indoor air quality
Costs and price are their biggest interest
Sustainability
Megatrends
Climate change and low carbon
Some are interested in renewable energy solutions
Collaboration at the beginning of the project is crucial to be on the same page
Make sure buildings are future proved for resells down the line
Make sure they get value for their money
Cost cost cost
Profit that they get from the buildings
Location
Return on investments
How the value of the building can stand in the future
Low maintenance
As much value as possible

Green certifications, low energy consumption and other ratings can bring them more value
Energy savings
Cities are more interested and putting more effort in sustainability
Investors will be more interested in sustainability
Energy saving makes a case for saving money
They want to have materials that are maintainable and long-life buildings.
Materials have to be in sync with other materials and structures
Economy of the building
Income of the building long term
Big owners like x and cities do care
Provide good service to make money
Private owners more ambitious, cities and government not up to date and focus more on price
Location of the building and how close to public transportation is it and what kind of spare time activities are available close by
Costs are always important
Solutions that save costs

According to the building companies, the building owners decide everything and they set the goals for the building. Construction companies admit “If they set any target except the money then we go where the fence is low”. Based on comments like “Anything they require we have to give them, like LCA, LEED or use EPDs, I mean ANYTHING” and “They pay the bill, so it’s crucial” the role of the building owner is essential for the buildings to become more sustainable and finally to be carbon neutral.

Based on the codes above owners are mostly interested in returns on their investments, maximizing their profits and problems that can harm the building so the value might drop, like indoor air quality and location of the building are among their top priorities. Active owners who own the building long term are more interested in lifecycle and maintaining costs like energy efficiency of the building. If they own the building short term, they want the value of the building to sustain. If they have to future-proof the buildings by getting certain certifications like LEED or BREEAM, the buildings have to fill certain sustainability criteria. Furthermore, sustainability related regulations enforce them to invest in more sustainable buildings.

Cities and big investors are already ambitious and do care about sustainability of the buildings and fortunately, sustainability and energy efficiency can cut down on maintaining costs of the

building. Furthermore, building owners want to be educated and they are open towards the topic.

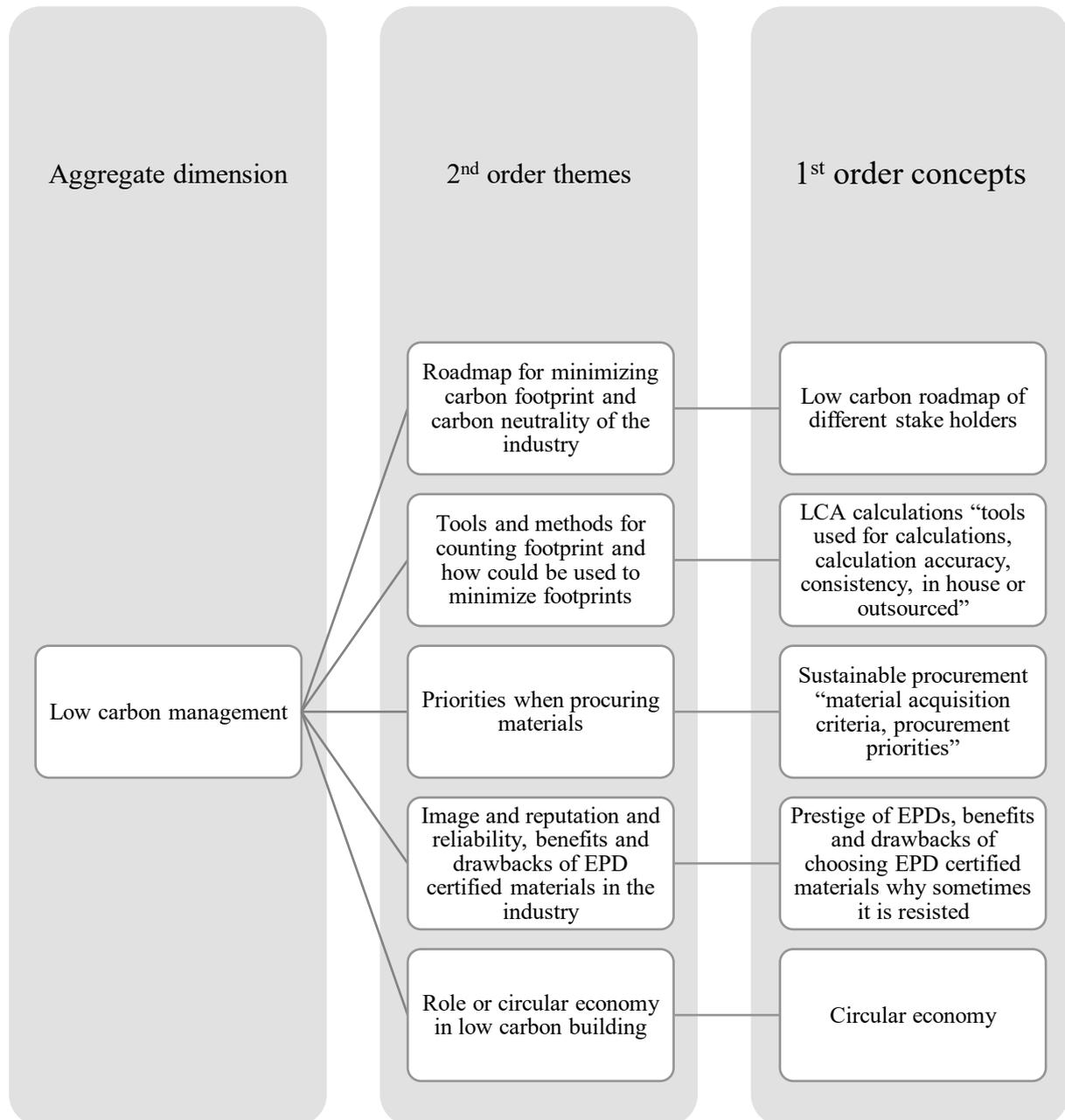


Figure 17: Low Carbon Management

The second aggregate dimension “low carbon management” discusses company’s regime on how they manage low carbon building; what is company’s roadmap to Low carbon management. Furthermore, this aggregate dimension contains topics related to lifecycle

analysis, carbon footprint calculations, low carbon building, low carbon related circular economy, sustainable material procurement and environmental product declarations.

The questions and the answers that were related to this aggregate dimension were:

Table 13. What Is the Roadmap of X for Low Carbon Construction?

Use mainly wood to be efficient
Max 5% waste
Transferrable buildings to cut down rebuilding
Moving the buildings cut emissions in half vs demolishing and building new
Taking part in pilot carbon footprint counting of the LCA
LCA will be important and we have started working on it
Already counted LCA for some buildings, but on learning phase to build the roadmap
2045 zero carbon and 2018 as baseline and 2030 to be half 50%
We try to find design solutions "Designer"
Make our own actions efficient "in worksite, in logistics and so on"
We try to affect property owners
Take smarter action
Minimise energy and water waste
We try new design solutions, new ways to build and new energy solutions "Designer"
We are working with consultants to make a roadmap for low carbon construction
We will cut down half of the carbon by 2030 and carbon free by 2045 baseline 2015
Our Finnish subsidiary aims to be carbon neutral by 2035, the whole group by 2040
50% from 2015-2030 and carbon free by 2045
It is our job to cut emissions "Designer"
Building sector need to be carbon neutral, it's not a question of like to do anymore "Designer"
City guidelines "carbon neutral by 2035"
National goals
Become carbon neutral
We provide designers and engineer; we help our customers reach their roadmaps and targets
Self-developed projects emissions cut by 50% by 2030, baseline is 2019

Table 14. Do You Have a Target for Low Carbon Building? For Example, CO2/ X Building Unit

No (8)
Internal classified projects have guidelines
We do have measurements library. The tool can rank the buildings
Not yet

We are starting to have baseline level of emissions.
--

Many of the building companies that were interviewed are taking part in carbon foot printing pilot of the Ministry of Environment and taking actions to minimize waste, use more environmentally sustainable materials, like wood instead of concrete, cut down waste and take smarter actions to be more carbon efficient. Designers are working on energy efficient solutions and sustainable buildings. At the moment not many companies have any specific low carbon target or limitations per unit of building, but some are starting to have such.

The national regulations of Finland are enforcing companies to be carbon neutral by 2035 (Valtioneuvosto, 2019), however, not all companies are aiming to be carbon neutral by 2035 and some did not even have clear goals. Luckily companies re-evaluate their criteria and goals often, so we can expect changes and more ambitious goals in near future.

Table 15. Do You Calculate the LCA for Building?

Yes, some buildings (6)
We calculate LCA for all new construction projects
Not yet constantly
LCA calculation will be part of building permit in the future
Calculate footprint for 50 years
All buildings and we also comparison footprint of the solutions "design institute"
Not at all

Table 16. How Accurately Do You Calculate CO2 Emissions of a Construction?

Building phase
Building phase and transportation
We calculate the footprint created on sight
To minimize carbon we should calculate and optimize materials in planning phase "building owner"
Whole LCA
Depends on rating of the building like BREAAAM, LEED
From raw material to ready building to demolition
Use generic values "design institute"
Follow city guideline
Follow the national guidelines set by the ministry of environment

Everything
Depends on customer needs
First and second scope fully and partially 3rd scope

Table 17. How Many Times Do You Count the Footprint and When?

Once (9) (includes the answers below)
Twice (3) (includes the answers below)
Depends on project and customer demand
Twice or more and we use 2 methods. The old one and the new standard of the ministry of environment.
First estimations then as build, if anything is changed, we re-evaluate (currently only once)
It is done to get building permit
Early draft, and an accurate as build calculation
Planning phase (4)
As built (1)
Planning phase and as built
To minimize carbon we should calculate and optimize materials in planning phase "Building owner"
Early design phase
Rough calculation in the beginning and detailed as build calculation
The sooner the better
Early calculations, during design phase and as built calculations
Method set by ministry of environment

Table 18. How Much of a Divergence Is There on Average Between the Calculations?
(Planning Phase vs. as Built)

Depends on how project develops. If we can stick to our original plan the footprint stays the same
Depends on project, but usually quite low
In my opinion it should be done at least 3 times to get a good picture of the carbon divergence
It varies but we consider energy efficiency more important
If materials are change it can affect the end result

Most of the companies have started counting carbon footprint calculation of some of their buildings and taking part in the carbon foot printing pilot of the Ministry of Environment. There are no specific borders as what the responsibility of a building company is, some builders count only footprints created in the building sight, some include transportation, some more extensively than others.

There are also inconsistencies on how many times LCA should be calculated and when. Most of the participants calculate the emissions and believe the earlier the LCA is calculated the better, but many believe it is not enough to do only once because after the design phase there might be changes in raw materials that might affect the outcome.

Table 19. What Tools and Methods Do You Use for Counting Carbon Footprint of Buildings?

Oneclick LCA "Everyone"
Arkicad
BIM model excel
Calculation tool by ministry of environment
All available methods
LEED and BREEAM have their own guidelines
Carbon designer tool "Designer"
Rekla
WWF ilmastulaskuri
Based on EN standards
Own optimization tool

Table 20. Do You Count the Footprint of the Buildings Yourself or Do You Use Third-party Consultants for Counting Footprints?

Count CF in the company (6)
Outsource CF calculation (2) "Building owner"
Outsource CF calculation only in some cases (2)
Depends on customer needs
Partially us, partially outsourced
Person in charge inside the company
Outsourced, in the future probably in-house calculation

Everyone who calculated carbon footprint used Oneclick LCA for calculating in some form. Additionally, some used other methods and software. Most of the companies calculated the LCA inside the company while in case customers needed calculations could be outsourced.

Table 21. Where Do You Get Product's CO2 Emission Details?

Emission details from Bionova Oneclick LCA (3)
From suppliers directly (2)
From EPDs
Search engines
Suppliers webpages
International material databases
From builders "building owners"
Generic values by Bionova or other Officials
We calculate ourselves
Dig from the internet
Consultants do it
Data bases
Gabi database

When asked where they get product’s emission details, most of the participants answered environmental product declarations, but when asked how many of the products that are used in their construction site is EPD certified, the answer was only a small amount.

Table 22. How Much Impact Does the Product's CO2 Emissions / Cost Have on Purchasing?

We follow customer demands
We have purchased more expensive product which creates less emissions
Hopefully owners care more and pay more for sustainability in the future, generally gut feeling and budget
In cases of price war we have to be cost efficient
It depends on how much load the material can carry
If we have certain goal in project, it can cost more but we need to take that into consideration.
LCA cost is more important
If otherwise similar we chose lower emissions "Designer"
Discuss with customer and we think at some point carbon might be taxed
We would not accept anything that is not as good as designed
We buy the whole building “Building owner”

The question above was proven to be more complicated because there are requirements and many other issues companies have to take into account before they can consider the price of the products compared to the amount of emission they create, unless the building owners require so and pay for it. Designers however choose the product with the lowest emissions if other properties of the product were similar.

Table 23. Is EPD a Criteria, When Comparing Similar Materials?

Not yet but more in the future
Not commonly yet today
We are in the process of learning EPDs
Compare the price of materials not EPDs
Not yet
It is a good way to compare, but there are not enough products with EPD certifications yet in the market
Yes (4)
In some cases yes (2)
The designers decide that
No
Buildings rate better in BREEAMs if they have more EPD certified materials "building owner"
When calculating yes, when building no

Table. 24. How Do You See the Progression of EPDs in Building Material Industry?

Customer demands will affect the increase of EPDs
If no customers want them, they won't exist
Still to become a document used in daily bases.
Cannot compare to CE markings yet
Compared to CE markings "they took long till they become usual"
It will take a while for procurement to understand what the document says
Pioneering companies develop criteria and use them to gain a competitive advantage "building owners"
There is a need for standardize methods in the industry so we can read and compare easily
EPDs are complicated and expensive
It will take a long time till EPDs can be business as usual "can be compared to CE marking"
They can be used for marketing
I would like to see more, since there is not enough at the moment
For some ratings there is supposed to be used at least for example 5 EPD certified material
If material providers want to be in the game, they have to have more EPD certified materials
They will become business as usual
They are useful but we need more information "building owner"
They are not reliable
They make it worse for us
They will be more relevant in the future because we have to calculate LCA of all buildings in near future

Certification schemes require more EPDs and the need for transparent information will be rising as well

Environmental Product Declarations are used for product comparisons, but according to participants there are not enough EPD certified products in the market. In some cases, EPDs are used for comparison but when building noncertified materials are chosen. However, according to building owners, buildings rate better in BREEAMs if they have more EPD certified materials. Furthermore, many believed that in the future EPDs will be used more commonly and compared EPDs to CE marking.

Product that are sold needs to be assessed by the manufacturer and meet the European Union safety, health and environmental protection requirements. The products that are manufactured elsewhere in the world that are marketed in the EU require CE marking (europa.eu, 2020). Since EPDs are new, they might seem complicated and all of the members of the value chain in construction industry need more information and knowledge on EPDs, but many believed EPDs will be business-as-usual like CE markings, but it will take more time for EPDs to be business-as-usual.

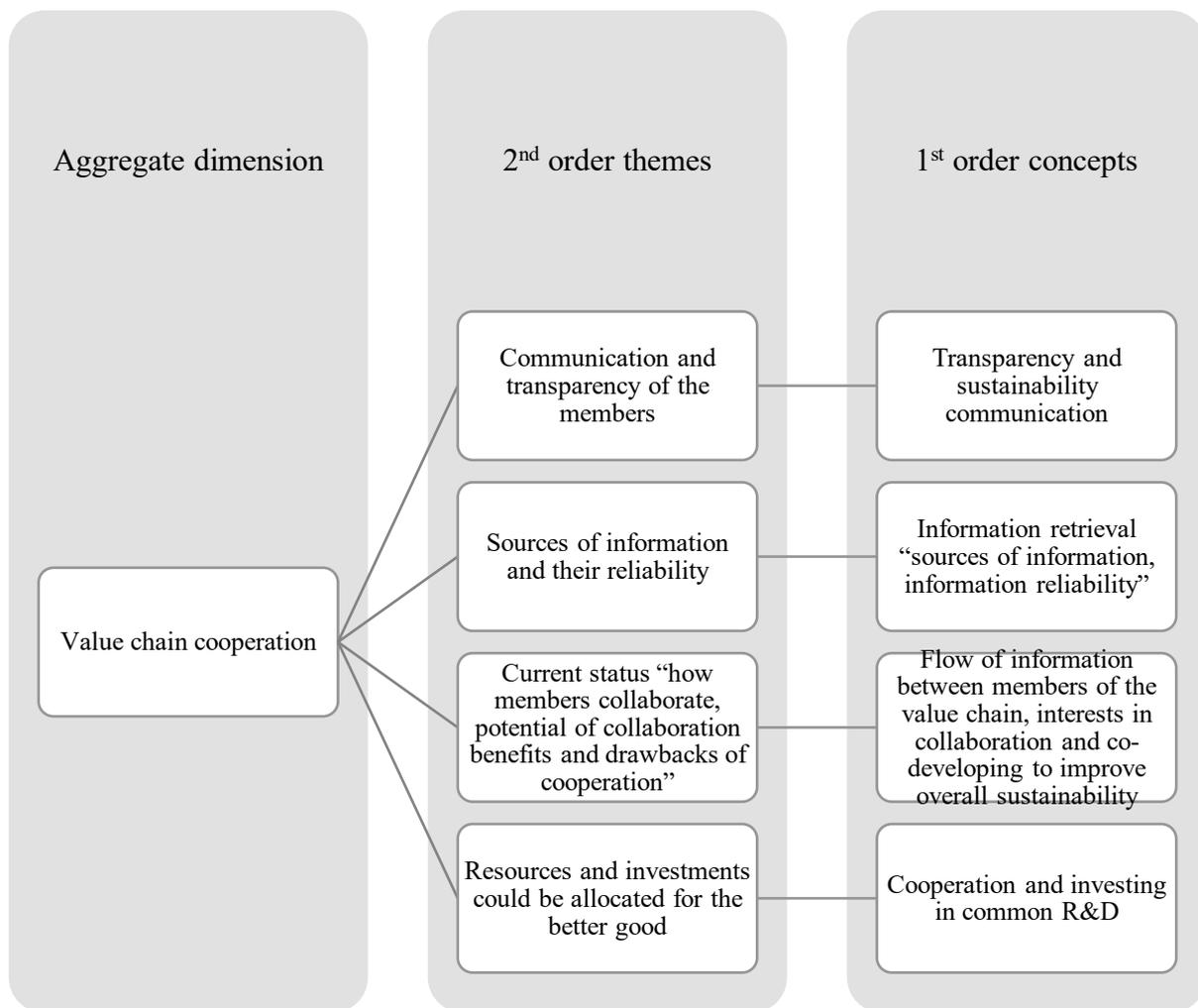


Figure 18: Value Chain Cooperation

The third and last aggregate dimension “value chain cooperation” discloses information management related topics like transparency and communication of the companies, how sustainability related information, sustainability goals and roadmaps flow between the main contractor, to their sub-contractors and to other members of the value chain and how interested companies are in collaborating with other members.

The questions that were related to this aggregate dimension were:

Table 25. How Transparent Are X:s Activities and Goals?

Transparent (14)
We are working on it (1) “Designer”

Table 26. How Are Goals Communicated to the Stakeholders?

Social media
Cooperation with Nordic ecolabels
Seminars
Print media
Newsletter
Companies that are in stock exchange has to be transparent
Stuff that are under development are not reported yet
Direct marketing to customers
Inside report everything, outside everything that law and stakeholders require
Prevent grey economy
Press releases
Information packages for investors
Construction sight information for people who pass by
Direct info to stakeholders
Environmental reports
GRI reporting
Through green building council and other organizations
Blog posts
We work tightly with city owned stakeholder
We develop with cities together and write instructions together
Monthly consumption reports
4 times a year meeting
Capital market day event

Like some of the other questions, not every participant could answer this question, but everyone who answered were happy to talk about them being transparent except some projects that are communicated internally only until they are launched. Companies held events, did press releases, newsletters, wrote blogs, and used all the channels to communicate their actions and goals including GRI, sustainability and consumption reports.

Table 27. How Do You Keep Your Project’s CO2 Goals Consistent from Start to Finish, Between Your Sub-contractors and the Whole Value Chain?

Subcontractors only work, material stream by company X
Train subcontractors 1-2 times a year to be more sustainable
Depends on project
Long term contracts
We are on the track of finding the best practices at the moment
Value chain approach to emissions

Construction sector is highly regulated, and contract binds everything to work as agreed
Design documentation and manufacturers are our source of information, because we know where materials come from
We choose materials early enough and not change suppliers
We don't have a method
We use consultants "Building owner"
Workshops with different parties where we discuss goals like energy consultants and structural engineer on how it will affect them and another workshop before the project starts
It is hard to supervise the actions of the subcontractors. We have a limit of how long chain we can have

Builders of the Finnish construction industry make sure their criteria matches with their subcontractors by making long-term contracts, by training them and limiting their supply chain so it is not too long. Building owners make sure their criteria match by hiring consultants to work on the matter. There are some inconsistencies as well because it is hard to supervise the actions of subcontractors, furthermore some contractors are still working on the matter or do not have a method at all.

Table 28. Does X Determine What Materials Are Used or Can Contractors Decide on Their Own?

Company x negotiate everything but only in special cases contractors can choose
Projects can vary
We decide the materials and we have to stick to the plan
In cases there are no specific requirements, subcontractors can choose the materials used
We have criteria for usability and durability "Building owners"
Mainly we decide
Depends on building and property owners
Subcontractors always need to negotiate with us and building owner on their suggested materials
The system is made so the specifications of the project goes through process and the situation is such that we order some ourselves and some by the sub-contractors.
We can suggest, but the builders decide it ultimately "Designer"
Contractors decide on their own, we chose contractors, meet regularly and check
We design if wood or concrete, contractors can choose what concrete they actually use and that can vary between manufacturers
There are some attitude problems and no they do not match "construction is a conservative field"
We chose, but contractors can suggest
They are specified by the designers based on their performance; contractors chose the final product

Typically contractors
Depends, but they need approval for the most important orders
They mostly do the right thing as long as you give info and not leave them alone with decisions

According to the designers, they suggest the materials while builders make the decision ultimately, but according to the builders, the designers choose the materials. All this can still vary widely. Some subcontractors need to negotiate before changing materials while others admit that subcontractors get to decide the final material used. A comment that we discussed more with the participant was that the construction is a conservative field so practical changes are hard and time consuming to drive in the field.

Table 29. Do X's Criteria Match Those of Their Subcontractors?

We make sure criteria matches
We have not done that type of follow up
Contract requirements regarding safety and sustainability
Inform sub-contractors of our criteria that they need to answer
We educate sub-contractors, and some educate us on info we did not know we needed
Any respected builders wont chose something with high maintenance. They understand where to put their money
It's on designers to check the materials
We don't have control over subcontractors
Criteria should be set before hand
We do not have to match; we make reasonable demands

When asked if criteria of builders' match those of their subcontractors, the answers varied again. Again, there was a room for interpretation here. There is not only one party responsible for this. Many mentioned that it is on designers to check the materials, while designers earlier mentioned that they can suggest materials, but they do not ultimately make the decision.

Comments like "we have not done that type of follow up" or "we do not have control over subcontractors" might be a matter of concern, but then there is a common understanding in the industry. The subcontractors have to make sure they keep up a good image in the market to operate in the industry long term.

Table 29. What Are Your Criteria for Sustainable Procurement?

Buy only certified wood
Use paints with Nordic ecolabels
Buy materials from Finland or close by
Buy energy efficient products
Swan labelled materials
Works according to our sustainability strategy overall
Comply with applicable laws and regulations "building owners"
Our partners have a responsibility to combat and prevent grey economy "building owners"
Partners are responsible for the commitment of their own subcontractors "building owners"
Raw materials providers have to answer to our requirements "for example report us how do they treat waste"
We do auditing
We look for ISO certifications
We look for EPD certifications
We work with big material providers and do auditing
Most important is optimal cost for the building like several calculations, total cost, future anticipations and maintenance cost "Designer"
We have supplier's code of conduct
Green guidelines for procurement
In every step we have 3rd party consultants for auditing
Common criteria and ethical rules
Distance of the source
Emission performance
We don't have those
Nontoxic materials
Purchase from local Finnish suppliers
We go by the law; Finnish laws are OK "building owner"

All the companies had different approaches for their sustainable procurement. Once again EPDs were mentioned multiple times, but most interesting topic, that I would like to point out, is that the building owners hold their partners responsible and expect them to procure responsibly and prevent grey economy in their actions.

Table 30. How Do You Guide Your Criteria Through Procurement?

Selects a partner according to its own criteria / compatibility of them to us "Building owner"
--

Construction projects are procured as total contracts, the contractor is responsible for procurement "Building owner"
We work together and they have to answer to our appendices
Negotiations and contracts
We ask questions and require answers before we consider them as partners
Depends what are the main criteria for the companies
Through agreements that we do with contractors
It's a part of our contract package
We audit risky ones
Maintainability and flexibility of the place "building owner"

Building owners have strict criteria and they select partners carefully and keep them accountable. They make sure they keep their end of bargain and audit if needed. Builders guide their criteria through contracts and negotiation.

Table 31. How Do You Compare Product's Carbon Emissions?

By EPDs if possible (7)
In case of energy we go for non-emission products
We compare buildings, not just products used "Optimization on their money and targets that they have to get the best one for themselves. "
We don't compare product vs. produce. We look at the big picture
We compare design solutions "some insulations work better with less amount, but might create more emissions in long run or some that create more emissions might save energy better"
Consultants do it

Even if EPDs are not widely used, when asked, how contractors compare products emissions, first thing most of the participants mentioned, was that they compare products emissions by EPDs if possible. EPDs have a trustworthy image in the market because they are third party certified. Others did not compare single products but all over solutions and performance.

Table 32. Where Do You Search Information From?

Suppliers
www pages
EPDs
Oneclick LCA

From materials-based declarations that are found in CE marked products. We don't suggest using products without CE marking
Consultants who are helping us
RTS has EPD portal about certified products
Generic information
If there is no product specific data, we use generic data or some other products data

Table 33. Do You Always Find the Information You Need?

No, not always, hopefully it will get better
We find at least rough estimations
Usually find something
We always find something "concrete is concrete"
Not always but suppliers who won't provide are off the list
Not always find information needed (2)

Table 34. How Do You Make Sure the Information Is Reliable?

20 years of experience and gut feeling
Too good to be true is not reliable.
We trust on information from EPDs
We calculate the footprint ourselves and, in some cases, we use 3rd party for verification
We look for public certifications
We hope for the best
Only way to make sure is 3rd party certifications
We believe that people are honest
If you see the information you can immediately spot wrong information
We don't recommend using products that's information can't be found
It has to have European label and approval, otherwise it cannot be used.
We just count on what information we get
We assume or ask the designers
If we use consultants, we use the ones with good references
Compare 2 different sources if they make sense and rely on your instincts
We need reliable information on products emissions

Builders got information from EPDs, suppliers, used generic values or information available on databases like Oneclick LCA. When asked if they always find the information they are looking for, the common answer was not always, or we find at least something. There were various ways, how they made sure information they found was reliable. For most experienced participants it was easy to spot wrong information, they had a gut feeling about the reliability of the information and relied on their instincts, while others hoped for the best and said they

have to just count on it. The most sustainability enthusiastic participants said unless there are labels and certifications, they would not use the information and heavily stressed on reliability of EPD certifications.

Table 35. What Do You Think of Saint-Gobain’s Environmental Sustainability?

They are ambitious
Easily approachable
Good products with circular economy
They have good reputation
They have good understanding
Good communication
Good environmental processes
Have been looking at these issues for longer
They have a good program going on, but I think all European manufacturers have good programs
They are quite high in that aspect
They have engaged in sustainability early
Good image brand
Leading manufacturer in sustainability
They are different
They are going forward
Not familiar with S-G
They seem active
They are putting a lot of efforts in sustainability
They should come out and tell more about their operations publicly
They are doing a great job
I see them as a key player in research and product development

All of the participants praised the case company Saint-Gobain for their environmental sustainability and their communication. Most of the participants had experience with the case company’s products, but even the participants who did not have prior experience with the case company’s products had a good image of their product quality and product sustainability.

Table 36. What Data Would You Value and Wish for Suppliers to Add to Building Materials?

More information on packages, how recyclable the are
Water usage and CO2 usage / a ton of the product
There should be continues development of the products to offer to us

Improve transparency
Open communication
Inform us what is coming up in easily understandable way
More information on recycled materials
Energy and recycled material percentages
More LEED BREEAM and RTS certifications related info
Accurate data
We need the calculations
If there is any chemical that needs to be considered in the building or even demolition phase
Would be really good if we get details of what materials are used
Cutting waste should be made easier
Availability of the information should be made easier
Information about the environmental performance of the product
Cost over time matters
"this might be stupid" but if possible, data from suppliers to us on what products have they delivered
They should lead the CO2 emission war
Cooperate with ministry of environment and update all the materials from generic so designers can get reliable and current information. "Designer"
Information on indoor air and how does material work with water and vapor "Designer"
The more technical information the better "Designer"
Data on chemicals and smells of the materials.
M1 classification
Material passports are hot topic. All details of materials can be found from a database and we can check out data on what they include and if later on found toxic we could know where exactly it is and remove it
Concentrate on relevant things, a lot of information on EPDs are useless and hopefully we get rid of them
Promote more and remind us of your good work
Short but right to the point data "at the moment it's too complicated"
How much waste is produced and how much can be recycled
More information that is easier to compare like how much emissions a cubic meter of the product creates
How far is the production
Designers need more info about the whole LCA, what kind of preparation and maintenance work is needed during whole life cycle and how many times is it needed to be replaced during whole LCA of the building
Life cycle information
Disassembling information
We should think different levels in circular economy so more recyclability information
New parameters if recyclability is added

The questions above were related so they were combined as the interviews continued. The most demanded information from suppliers was related to the circular economy. Other interesting

topics that emerged from the question was product specifications related water usage, water vapor related and if product included harmful or poisonous materials. Builders wanted information in a simpler form and easy to understand in order to be able to find the necessary information quickly and effortlessly. Designers wanted more technical up-to-date information and requested Saint-Gobain to cooperate with the Ministry of Environment to update all the information on materials from generic so designers could get reliable and current information.

Table 37. Would You Be Interested to Cooperate with Building Material Supplier?

Maybe
Why not
The development is going towards new buildings models
One way to step forward is some kind of cooperation, even if we have to accept that it comes at a cost
Cooperation could benefit both parties
Cooperation is the only way the industry could go forward
We are in this mess together so why not
We already cooperate with material suppliers
We have common action in Rakennusteollisuus where we meet
We are looking into it; we need to collaborate more with suppliers
We are already cooperating
Yes, we would be interested
We are in contact with them already
We want to collaborate and make effort to achieve carbon neutrality "Building owner"
As public procurer we should provide open environment so cannot cooperate with only one supplier
In some sorts maybe yes

Almost all participants showed interest in cooperation with material suppliers. Some believed the only way the sector could ever be emissions free is cooperation between builders and material suppliers. Some companies said they were cooperating already through common organizations while others had started looking into it and actively pursuing how to deepen their cooperation with material suppliers. Essentially, everyone was willing to cooperate if both parties could benefit from collaboration.

Table 38. How Could the Flow of Information Be Strengthened Between X and the Building Material Providers?

Provide more clear information, not just EU information that is hard to understand
We might develop somethings together in the future like report of climate emissions
We want to hear about opportunities, but construction companies are a better partner "Building owner"
Weekly meetings
As long as the information can be found easily, we are good
We could start with a meeting; I already know their sustainability manager
More collaboration between material providers and designers "Designer"
We have to look into it together, what kind of stuff they can offer so we can both win
We do notice some similarities; this is some kind of research project that we could do together "Building owner"
We already have annual events

The information flow between the members of the Finnish construction value chain has to be improved. Good start would be to meet more often, collaborate and develop projects together. Designers requested more cooperation between designers and material providers since they design buildings and choose materials in the first place.

Table 39. What New Forms of Collaboration Can Be Built Over the Value Chain in Construction Industry to Minimize CO2 Emissions and Add Circular Economy?

There has to be a need, only laws, requirements, regulations
Everything might look different in the future
We might buy services but not products
Collaborating with research institutes and universities
It is already formed
We can talk about everything in green building council
Increase knowledge in whole value chain
Everything starts from the design
Suppliers should convey information to designers and not only sustainability related information
Designers have limited knowledge
Someone always starts something
More communication, more collaboration
Involvement of all parties
Educating all parties early enough
Joint ventures of building companies with materials suppliers
The key is a dialogue between construction companies and people who plan cities. We can do a lot more
Calculation method should be set "how to calculate should be standardised"
Legislations

There is a tremendous potential in collaboration of all members of value chain where not only members of the value chain can benefit but also environment will benefit greatly from the cooperation of all members. The members of the value chain are already cooperating in some shape or form, meeting in common events and organizations but many thought there is a need for a deeper collaboration, and it can be formed by educating all involved parties and increasing knowledge in the whole value chain.

6. Discussion

Construction industry affects the environment and climate change through land use changes, resource materials extraction and production. The industry creates a substantial amount of greenhouse gas emissions. According to the research there is a growing urgency for construction industry to become more environmentally and ecologically sustainable and as a result environmental issues are becoming increasingly important and vital for a company's strategy. People expect more environmental and social responsibilities from the businesses as society evolves.

Finnish National Governments' goal is to be carbon neutral by 2035 and become one of the leading countries in circular economy (Valtioneuvosto, 2019). This study's purpose was to find questions related to these goals, to find how ambitiously companies are taking actions to reach these goals set by the government and furthermore, what else could the whole value chain of Finnish construction industry do to accelerate this transformation towards carbon neutrality.

In this chapter the results of the study are discussed, and research findings related conventions that emerged in the discussions with the experts and specialists of the industry regarding low carbon construction, circular economy, sustainability related regulations and practicalities that needs to be updated in the industry. Firstly, the research questions and sub research questions will be discussed separately, then new points of view that emerged will be discussed and then the final results of the research will be concluded in the next chapter.

The first main research question was:

What are Finnish construction companies' sustainable development goals, criteria and low-carbon road map?

The results of the research suggest that low-carbon construction is the top or among the top priorities of large and medium sized Finnish construction companies. All of the companies that were included in the research are actively taking actions to minimize their carbon footprint and

become more efficient. Companies are cutting waste, enhancing their recycling processes and planning energy efficient buildings that use renewable energy sources.

Some companies want to be pioneers (“WaveRiders”), take the next step before others, pave the way towards carbon neutrality of the industry, give a more sustainable image, become more visible to investors and get a competitive advantage. There is an incentive for forerunners. On the other hand, some companies prioritize social sustainability or have other goals.

Borrowing comments from the interview “What is good for the environment is also good for us” and “When everyone sees that sustainability can save money, they will rethink”. The International Finance Corporation (IFC), World Bank and the EU are trying to create market for green buildings and according the IFC estimations, the investment in green building will at least be 3.4 trillion dollars comparing to 2015 388 billion dollars. In conversation with Matti Kuittinen he mentioned: “according to the estimates of the world bank, the investments to green construction within the next 10 years are expected to increase to the level of 25 trillion dollars.”

He added “that is an immense amount of money and I think we should re-evaluate from the perspective of what is the worldwide demand for this sort of new accountable on green construction and if there is a huge pot of money waiting there, if you tell the people who are saying that we cannot do this because of this or that, to think about the business potential then it is easier for them to forget all those traditional excuses that they make. And surely all the shareholders of construction companies and construction product manufacturers are of course interested in increasing their shareholder revenue.” Borrowing comment from an interviewee “not investing in green building is like shooting yourself in the leg before running a marathon”. Certainly, companies who are more prepared will get bigger share of the that pie and have more success in the long run.

The first sub research question related to question was:

How does Finnish national carbon neutrality and circular economy related goals will affect the industry?

Finland's national government has set goals for the construction industry regarding carbon neutrality and circular economy. Finnish construction industry has to be carbon neutral by 2035 and among leaders in circular economy. Furthermore, the Finnish Ministry of Environment has started the LCA pilot, where many of the participant companies are taking part in calculating the emissions of some of their projects. These goals will affect the construction industry even more when in 2025 LCA calculations will be compulsory and will be used as a license to build.

Undoubtedly this makes it hard for all companies, but while some participants talked about the complications, others concentrated on solutions and how they will effectively cut down carbon footprint of their operations and projects. This could also be observed from the goals that companies have set. One participant believed they will build the first emission free building in Finland and one company is aiming to have their self-developed emission free projects by 2030. On the other extreme some companies have goals that are later than the national goals. However, most of the companies are aiming to follow the national and city guidelines and most of them update their sustainability strategy regularly, so changes to their current strategies are expected.

EPDs certifications can be a handy tool to reach carbon neutrality. In conversation with Matti Kuittinen we discussed that there will be difficulties on the way of carbon neutrality and circular economy. He mentioned "EPDs represents the highest quality of data that is available. From regulation viewpoint that is a handy tool for calculating buildings performance on a building level and then seeing if you can really achieve the low carbon goals that will be set. For that purposes EPDs will be necessary. Alternatively, generic data can be used and as you may know we are preparing a generic database that will be more conservative in its values. So, if you want to achieve a low carbon footprint for your building for regulatory purposes or just because of market demand, then using EPDs for the calculations would be a way towards that goal."

The situation of circular economy is more ambiguous than carbon neutrality. Company representors mentioned "There could be plenty of opportunity to use recycled material that might not be approved by the city because of legislations and so on" and "It is hard to get

permission to use recycled materials and hard to sell. We need three parties to agree before we can use recycled materials. City and officials to give permissions. Find manufacturers for the recycled material and depending on what quality they can get out of the recycled materials and property owners that are willing to buy”.

Discussing comments above with Matti Kuittinen, he mentioned “It is our very sincere wish that the use of recycled materials in construction would grow and we recently decided to start another rail of thinking about what sort of intervention we could do to public procurements to boost this. There are a few viewpoints that are somehow sometimes making it a bit complicated. I understand the problems of public procurer from the viewpoint that they don’t want to make the procurement process too complicated by adding too much qualitative criteria into the procurement and they are also hesitant of setting criteria that would expose them for lawsuits. So, for those reasons they pretty much want to proceed with the existing patterns that have proved to be working and don’t want to change them. There are quite many things that intertwined in this problem, but it is a must that we make the transition to that world.

This is something that should be incorporated in the attitudes and in the culture so it would be desired to have stuff that has recycled contents and it would be less desired to have stuff that is 100% virgin. There should be some sort of shift in the mindset and attitudes, but how do you do that without setting any norms? We have had this sort of voluntarily criteria that for instance 10% of the weight of the public building should be made from recycled materials but since it is a voluntary criterion I don’t know if anyone has really taken that into their effective use. Now we are thinking what the steps are between the voluntary and a criterion, how could we be more affective about this because the current methods are not working.”

The second main research question was:

What kind of collaborations can be built between members of the value chain to maximize environmental sustainability and cut down emissions?

There were many inconsistencies in the value chain. For example, the boundary of what emissions belongs to who is blurry, there is not exact practice and there are differences in scopes of carbon calculation of the builders. If same project was done by different companies with the same outcome there would be difference on the final amount of carbon emissions for building the same project.

Construction projects are planned by designers and they admit that they would choose EPD certified products and if product properties are similar and the only difference is emission, they would rather choose the product with lowest possible amount of emissions for the project. While some building companies might stay with the original materials that were chosen, based on questionnaire some subcontractors get to choose materials, even subcontractors have to take care of their own image in the market and make sustainable choices. Comments like “concrete is concrete” when asked where they find emission details of products and “when calculating yes, when building no” when asked are EPDs priority when comparing similar products, makes it clear that the amount of emissions might differ from planning phase versus as built. Especially for the companies with criteria different from their subcontractor or is not communicated well enough.

The biggest obscurity that emerged here, was that building owners set targets for the buildings and construction companies. The construction companies will only aim to achieve targets that the owners has set and paid for, and borrowing a comment from the interviews “building owners have strict criteria and select partners carefully and keep them accountable to make sure they keep their end of bargain and audit if needed” so the construction companies has to fulfil the targets set by building owners. Construction companies can only become more sustainable on their own expense to a certain level or they will not be economically profitable. As a result even if there are more sustainable options available in the market, they are not used because the profitability of the whole value chain would suffer. It all comes back to the final users of the building. When they are able to pay more to building owners, they will set more sustainable targets for buildings.

From the context of the study I would state that even though companies are transparent and already have common ground like the Green Building Council and RTS, there is a need for deeper cooperation between all the members of the value chain. It seems like there are no clear boundaries to some of the operations yet. The reasons for this can be that we are still in learning phase. Sharing knowledge is essential to the whole value chain so the importance of sustainability related actions would become more visible and the border between the members of supply chain could be clear and everyone would know what emission belongs to who in order to avoid counting doubles and leaving emissions out of calculations.

Cooperation between the members is essential to make those boundaries clearer. Many believed that the only way to reach carbon neutrality is to cooperate. Designers directly asked manufacturers to share knowledge and cooperate with policy makers so they can stay up to date. Building owners want to be educated and they believe sustainability brings them more value directly through energy savings and in the long run and the value of the future-proofed building will not decrease as drastically compared to a building that is not future-proofed. Builders are ready to cooperate as long as all parties' benefit from cooperating.

Based on the interviews, the case company Saint-Gobain has a good image among all parties. When asked about Saint-Gobain there was not a single comment that was negative with the exception of one interviewee who said that they are not familiar with the case company at all. Some of the comments from the research were, "They are ambitious, good products with circular economy, they are the key player in research and product development, they are putting a lot of effort on sustainability" and when asked about their products participants commented: "premium quality, they provided detailed information about emissions and recycled material components, product performance is clearly stated". Furthermore, they provided this topic and help me throughout the research.

There is a clear interest from all parties and hopefully this research will be followed up by cooperation between the most ambitious WaveRiders to pave the way for everyone to become more sustainable and the national goals to be achieved. In addition to improvements and cost savings, there are other benefits that the cooperation can bring. A building owner commented:

“Everyone is looking for their own LCA phase and methods, if all work together and invest in common R&D to research features like energy efficiency and heat production, everyone could overall be more sustainable”.

Maybe in learning phase it is still better that everyone learns from their own processes and build their own custom regimes. if there was a platform where they could share their learning and authorities could make regulations based on the best practices, everyone would have to adapt. The one thing that is non-negotiable and cannot be overlooked are the regulations. Be it owners, designers or builders they all have to comply with the laws and regulations.

The second sub research question related to second question was:

What are the requirements of Finnish construction companies from construction material providers regarding EPDs and sustainable development of the industry?

Environmental product declarations (EPDs) represent the highest quality of data that is available, and they are considered trustworthy in the industry because they are third party certified. Many of the participants compared them to CE markings. They believed that EPDs will be business-as-usual, meaning they will be used commonly making lifecycle assessment and calculation of the emission of the buildings simple and easier in the future.

Designers wanted more technical information related to emission calculations and product specifications, they needed to know more about the consistency of the product and how would the product react with water vapor. Furthermore, they asked Saint-Gobain to cooperate with the Finnish Ministry of Environment and update all the materials from generic so designers can get relatable and current information. In addition they wanted more information directly from manufacturers.

Most of the builders found EPDs complicated. They commented that they find it hard to read and understand, the information they need is bothersome to find and the format is complicated

to understand. Some said it makes it harder and more expensive for them to choose EPD certified materials and some mentioned that there are a lot of irrelevant information that should be removed. Many of the builders requested simplified version of the document and commented that “we need more clear information and not just EU information that is hard to understand, some guidelines how to approach them, a short summary with most useful information and EPD information could be excelled so it would be easy to pick up” with the exception of a few who were well acquainted with EPDs.

Building owners said they do not have to do anything with directly with EPDs, they were more interested in products environmental performance, lifecycle costs related information but they are still interested to learn more because they are interested in building ratings like LEED and BREEAM and EPDs have major role in building rating.

Building owners, builders and designers however requested more information related to recycling and circular economy and believed circular economy will be a bigger component of Finnish construction industry in near future. They commented “we should think different levels in circular economy, more details on recycled materials and components, how recyclable are material packages, recycled material percentages and wanted to know how much waste is produced during manufacturing of the product and how well they are recycled”.

7. Conclusions

The purpose of the study was to get an insight into Finnish construction industry's environmental sustainability goals and find out how ready they are for the challenges and how likely they will achieve the national goals set by the national government. National goals are to be carbon neutral by 2035 and become one of the leading countries in circular economy. Furthermore, the study aimed find out the gaps and inconsistencies that exist and the possible solutions to these and additionally raise awareness towards the national goals.

Research results shows that there are still some inconsistencies, missing gaps and a slight negligence in the industry. There already exist solutions that would affect the end result, cutting carbon and waste while adding to the circularity of the economy that are not used. Based on the interviews, I could argue that most of companies could cut down a lot of their emissions with the solutions that are available right now, but they cannot cut down alone at their own cost. However if the whole value chain cooperated more intensely than they are doing right now and shared the cost of sustainability it would be possible to cut down carbon with the smaller investments from everyone and we would achieve carbon neutrality faster.

Fortunately, The World Bank Group is creating market for the green buildings that is estimated to be 25 trillion dollars in the next 10 years. To conclude the research results, I argue that at this point of time, even though in short term investing in sustainability will cost more and lower the short term profitability of a company, concentrating on low carbon building and competing in sustainability not only benefits the environment and gets us closer to the ultimate goal of carbon neutrality, but it also brings benefits to all the members of the value chain financially, in long term.

Based on the interviews and comments like “We are all in the same boat. Hiding and greenwashing does not help. Acknowledging the problem is half of the solution, cooperation is the only way the industry could go forward even if it comes at a cost, we are in this mess together so why not” there are very ambitious parties who are willing to learn, to change, to invest and make effort in every way possible to make this better for everyone and for the most

conservative companies that are not willing to change, to make efforts or consider carbon neutrality impossible, there are laws and regulations that cannot be negotiated.

When builders were asked about the role of building owners, they said they pay the bill and they decide what they want, we have to provide them anything they ask, and they do deliver everything builders ask for. Now that legislation is becoming tighter, they will have to do the same and deliver because that is their only option. Ultimately, I would like to state that what we can do right now is for the good of the environment, By not doing it the environment is the party that is paying for it continuously. The environment does not ask but we have to listen. If we do not listen and do not stop degrading social and ecological systems upon which we depend, it will face irreversible changes.

7.1 Theoretical Contribution

The study analyses the concepts related to climate change environmental sustainability and the transition of Finnish construction industry to low carbon building and circular economy. The Low carbon building is examined through life cycle assessments, sustainable procurements and transparent data acquisition to what EPD certifications contribute tremendously. Circular economy on the other hand can be examined through capturing value that would be lost and becoming more efficient.

To better understand how they are connected, the model below demonstrates the relationship between the findings and the theories. The interviews did not directly focus on this model, but this was created from the whole context and the knowledge that was gained from this research.

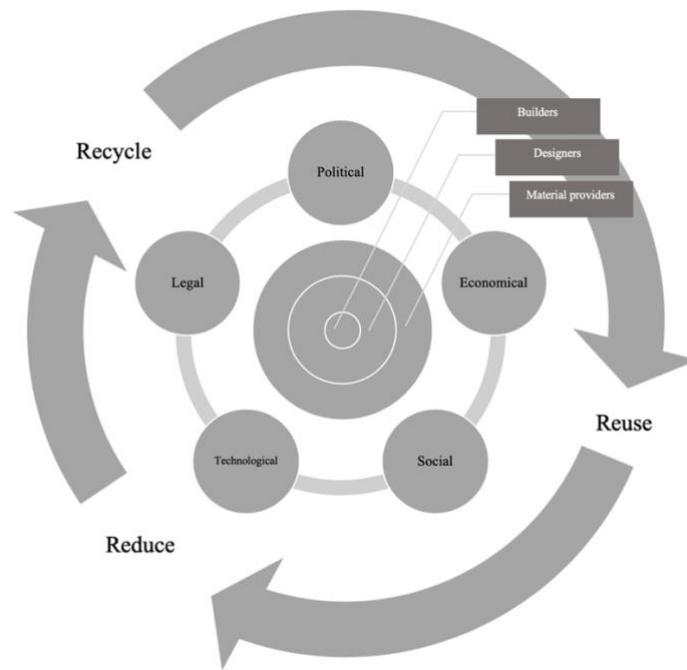


Figure 19. Climate Change and The Transition to Low Carbon Building in Finnish Construction Industry

The research model above brings together relevant theories and discloses how they are related. The model creates a framework for the research. Figure 19. was created based on the literature review and theory. It includes the dimensions that are relevant to the research in terms of low carbon building of the Finnish construction industry. The model includes all the forces that affect the industry continuously and the members of the value chain upon whom the forces are concentrated. Additionally there the planetary boundaries that are pushing the industry towards carbon neutrality and a circular economy.

The first theory that is connected to the model above is Porters Five Forces that is not only used to gain competitive advantage against other builders and make it hard for the new entrants (Porter, M. E. 1998), but it is also used to gain advantage and visibility while solving the problems that the industry is facing (Murphy, 2018). The reason why builders are in the middle of all this, is that they deliver the final product. All the other parties that are around the builders are not just to put pressure on them but to help them achieve the common goal and that is why the information should not only travel from authorities to suppliers to builders but the other way around as well for the whole industry to become more efficient.

We have already transgressed some of the planetary boundaries and becoming more efficient will help us at the least keep our reserves longer till we come up with better solutions (Rockström et al., 2009). So the second theory that is contributes to the research topic is DPSIR framework that will help drive circular economy to the industry. DPSIR is based on the 3R principles “Reduce, Reuse, Recycle” (Sandoval, 2016). The theory behind it is to capture value that would end up in landfill and use if for higher objectives. Exploiting more value from the existing structures or reusing the potential parts of them will help us not only sustain longer, but also it can also make virgin materials less desirable.

7.2 Implication

The results of the study show that companies are cooperating to some degree and do have common grounds where they interact continuously, but it is not enough. There is a plenty of room for improvements. On this topic Matti Kuittinen said “I think that leading companies are on the very right track. We wish for the transparency and we wish that companies should take environmental accountability into their core values just like Saint-Gobain has done.”

We would like to see companies taking lead and trying to find out clever ways of being more accountable, solve the resource crises and make good profit at the same time. So, for us it will be best if the companies would actually be the forerunners of exploring different alternative paths towards the goals. In my opinion the law maker should in set the vision, for instance carbon neutrality of Finland or the EU. Then the companies would figure out the smartest and the most profitable way of getting there, but at the moment it has not happened on its own so therefore we are forced to step in and intervene with the legislations so there will be mandatory requirements.

Plausible suggestions for solution to these issues that came from the research were: to research projects together, to meet directly and to co-develop projects, give open feedbacks, have two-way conversation top-down and bottom-up. A comment that best sums up this all was: “We educate subcontractors, and some educate us on information we did not know we needed”. As

an example all the companies that have participated in the carbon foot printing pilot of the Ministry of Environment could share their experiences and find out the best possible solution so it could be regulated by the officials. There would be one right way to do it until it can be further improved. In order for something to be regulated it needs to be specific. All the companies can benefit from everyone's knowledge and learnings and so would the environment. Some companies will probably find it hard or even impossible and fall of the wagon, but it would be the same case and same price for those companies if they will not adapt to changes and make effort.

7.3 Limitations and Further Research

The research included 21 participants from three different groups who work in Finnish construction industry - the building owners, designers and builders. Inside these groups there were still different profiles. For example, builders who were interviewed were head of sustainability, head of procurement, development manager, quality manger from different companies. Better research results would have been possible if head of sustainability, head of procurement, development manager and quality manager of every company were interviewed.

Not all the companies contacted had time for the interview and not all the large and medium-large companies were included. No subcontractors or smaller building companies were included in the research. Other significant issue that could have affected the result of the research was the timing of the interviews. The interviews happened from 6th of April to 7th of May when the virus pandemic Covid-19 contagion was at its peak and it was mentioned in many interviews. That had an effect on mentality of the participants.

This paper identified new gaps in understanding that could be researched. One topic that was mentioned in the interviews that even if we cut carbon and other greenhouse gas emissions more aggressively than what it is done at the moment, global warming at best will continue at least 1.5 degree Celsius yearly. All buildings that are built now will face global warming in future. Even though we are talking actively about global warming and cutting carbon, there are not many active conversations about how future ready these buildings are, what else should we take into consideration going forward.

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Appendices

Appendix 1. Semi Structured interview questionnaire

Interviewee information:

Position in the company X:

How long have you been working for X?

Company:

Does company X have a sustainability strategy?

What are the sustainability objectives / criteria for Company X?

- How do you see these criteria changing in the future?
 - In 3 years
 - In 5 years
 - In 10 years

How transparent are X:s activities and goals?

- How are goals communicated to the stakeholders?

GHG & CO2 emissions:

What is the roadmap of X for low carbon construction?

- Do you have a target for low carbon building? For example, CO2/ X building unit

Do you calculate the LCA for building?

Do you know which building parts create most of the emissions?

How accurately do you calculate CO2 emissions of a construction?

- How many times do you count the footprint and when?
- How much of a divergence is there on average between the calculations? (planning phase vs. as built)

What tools and methods do you use for counting carbon footprint of buildings?

- Do you count the footprint of the buildings yourself or do you use third-party consultants for counting footprints?
- Where do you get product's CO2 emission details?

How do you keep your project's CO2 goals consistent from start to finish, between your sub-contractors and the whole value chain?

- Does X determine what materials are used, or can contractors decide on their own?
- Do X's criteria match those of their subcontractors?

Sustainable procurement:

What are your criteria for sustainable procurement?

How do you guide your criteria through procurement?

How do you compare products product's carbon emissions?

Where do you search information from?

- Do you always find the information you need?
- How do you make sure the information is reliable?

How much impact does the product's CO2 emissions / cost have on purchasing?

EPD:

Is EPD a criteria, when comparing similar materials?

How do you see the progression of EPDs in building material industry?

Saint-Gobain:

What do you think of Saint-Gobain's environmental sustainability?

- How sustainable do you see Saint-Gobain's construction materials (Isover glasswool, Gyproc gypsum boards, Weber industrial mortars, Leca expanded clay, Ecophon acoustic ceilings...)
- Did you know that Saint-Gobain have the most EPD certified building materials in the world?

What do you expect/demand from Saint-Gobain and other suppliers regarding construction materials LCA / CO2 data?

How much value would it bring to you, if Saint-Gobain provide you more elaborated data e.g. system level CO2-data in LCA-calculation tools or system / structure level EPDs?

- Where could this cooperation lead?

What data would you value and wish for suppliers to add to building materials?

- recycled or renewable raw material data, recyclability etc.

Would you be interested to cooperate with building material supplier?

- How could the flow of information be strengthened between X and the building material providers?

Interviewee's assessment:

What is the role of the building owner in a construction project?

- How involved are the building owners in steering the low carbon construction?
- What are their interests?

What new forms of collaboration can be built over the value chain in construction industry to minimize CO2 emissions and add circular economy?

Appendix 2. Gioia first order concepts

Codes from the interviews
Does company X have a sustainability strategy?
Sustainable strategy not yet published
Sustainable strategy Yes (10)
Sustainable strategy No (2)
Not yet, but in the future part of overall sustainability
Recently had a kickoff to start
Not a written strategy
Follow the city guidelines
What are the sustainability objectives / criteria for Company X?
Material use efficiency
Reducing waste
We build ecolabelled/certified houses
Recycle
Balanced overall sustainability
Engage customers project sustainability
Take climate and emissions into consideration
Social sustainability "workers' health", employee wellbeing,

Overall economic portfolio
Compliance with law
Energy efficiency
Renewable energy
LEED and BREEAM certifications
Social: happy neighbourhoods & affordability
Protecting the planet
Zero harm (health and safety)
Not only environmental but complete sustainability including health, safety and quality
Not only build sustainably but also can be used sustainably
Energy efficiency, the first 0 energy building will be built by us
Real estate sustainability and risk management
Net zero carbon as goal
We do not try new things often
We build easy to maintain structures
We have a CSR program that includes sustainability
Circular economy
Space efficiency and co-using of space
New more ambitious targets
Cut emissions 50% by 2030 vs 2019
Carbon neutral by 2030 with own compensations "building and using phase"
We want to be seen as an idea leader and promote sustainable development
Sustainability is one of our four corner stone of success that is becoming more important
Concentrate and take action on social development goals 8, 11, 12, 13 and 16
Want to be pioneer in sustainability (3)
Criteria of building owners:
We don't have criteria for LCA and energy efficiency, but our criteria do include less cost of LCA
More criteria mean more price form us
Energy performance
Science based target "NCC as the only company with science-based targets"
Non hazardous materials
Half of production Joutsenmerkki certified
Re-evaluate strategy every 3 years, some every 5 years
Criteria changes in future in general "added section"
The EU sets goals, Nordics and national goals will be changing constantly not only regarding carbon
Knowledge about carbon neutrality is important and in rise
More recycled materials in the future
Biodiversity is going to gain interest
Increase usage of certifications
Biodiversity is decreasing that might be important in the future
We should talk more than just waste
Social sustainability to rise
Criteria changes in 3 years

Cities will procure low carbon and green buildings more
Legislation changes
Companies need to provide solutions
Geothermal energy on rise "Building owners"
Criteria changes in 5 years
Laws change the environmental ministry will make the CO2 footprint obligatory
Changes in customer demand
There will be more limitations and LCA calculations will be mandatory
It will not be enough to just own a green property anymore "Building owner"
Criteria changes in 10 years
Maturity of people "what is good for the environment is also good for us will increase"
Biodiversity goals on rise
Goals regarding water use, treat and use rainwater
We can hope it's not the investors who pay and do not get return on investment. When everyone sees that sustainability can save money, they will rethink.
We might not be afraid of trying something new or be scared that trying new things will come back to "bite us in the ass in 5 years" this goes to the officials as well who are making the decisions and regulations
circular economy will become important and a bigger component
How transparent are X:s activities and goals?
Transparent (14)
We are working on it (1) "Designer"
How are goals communicated to the stakeholders?
Social media
Cooperation with Nordic ecolabels
Seminars
Print media
Newsletter
Companies that are in stock exchange has to be transparent
Stuff that are under development are not reported yet
Direct marketing to customers
Inside report everything, outside everything that law and stakeholders require
Prevent grey economy
Press releases
Information packages for investors
Construction sight information for people who pass by
Direct info to stakeholders
Environmental reports
GRI reporting
Through green building council and other organizations
Blog posts
We work tightly with city owned stakeholder
We develop with cities together and write instructions together
Monthly consumption reports

4 times a year meeting
Capital market day event
What is the roadmap of X for low carbon construction?
Use mainly wood to be efficient
Max 5% waste
Transferrable buildings to cut down rebuilding
Moving the buildings cut emissions in half vs demolishing and building new
Taking part in pilot carbon footprint counting of the LCA
LCA will be important and we have started working on it
Already counted LCA for some buildings, but on learning phase to build the roadmap
2045 zero carbon and 2018 as baseline and 2030 to be half 50%
We try to find design solutions "Designer"
Make our own actions efficient "in worksite, in logistics and so on"
We try to affect property owners
Take smarter action
Minimise energy and water waste
We try new design solutions, new ways to build and new energy solutions "Designer"
We are working with consultants to make a roadmap for low carbon construction
We will cut down half of the carbon by 2030 and carbon free by 2045 baseline 2015
Our Finnish subsidiary aims to be carbon neutral by 2035, the whole group by 2040
50% from 2015-2030 and carbon free by 2045
It is our job to cut emissions "Designer"
Building sector need to be carbon neutral, it's not a question of like to do anymore "Designer"
City guidelines "carbon neutral by 2035"
National goals
Become carbon neutral
We provide designers and engineer; we help our customers reach their roadmaps and targets
Self-developed projects emissions cut by 50% by 2030, baseline is 2019
Do you have a target for low carbon building? For example, CO2/ X building unit
No (8)
Internal classified projects have guidelines
We do have measurements library. The tool can rank the buildings
Not yet
We are starting to have baseline level of emissions.
Do you calculate the LCA for building?
Yes, some buildings (6)
We calculate LCA for all new construction projects
Not yet constantly
LCA calculation will be part of building permit in the future
Calculate footprint for 50 years
All buildings and we also comparison footprint of the solutions "design institute"
Not at all

How accurately do you calculate CO2 emissions of a construction?
Building phase
Building phase and transportation
We calculate the footprint created on sight
To minimize carbon we should calculate and optimize materials in planning phase "building owner"
Whole LCA
Depends on rating of the building like BREAAAM, LEED
From raw material to ready building to demolition
Use generic values "design institute"
Follow city guideline
Follow the national guidelines set by the ministry of environment
Everything
Depends on customer needs
First and second scope fully and partially 3rd scope
How many times do you count the footprint and when?
Once (3)
Twice (1)
Depends on project and customer demand
Twice or more and we use 2 methods. The old one and the new standard of the ministry of environment.
First estimations then as build, if anything is changed, we re-evaluate (currently only once)
It is done to get building permit
Early draft, and an accurate as build calculation
When is CF counted?
Planning phase (4)
As built (1)
Planning phase and as built
To minimize carbon we should calculate and optimize materials in planning phase "building owner"
Early design phase
Rough calculation in the beginning and detailed as build calculation
Early calculations, during design phase and as built calculations
Method set by ministry of environment
How much of a divergence is there on average between the calculations? (planning phase vs. as built)
Depends on how project develops. If we can stick to our original plan the footprint stays the same
Depends on project, but usually quite low
In my opinion it should be done at least 3 times to get a good picture of the carbon divergence
It varies but we consider energy efficiency more important
If materials are change it can affect the end result
What tools and methods do you use for counting carbon footprint of buildings?

Oneclick LCA "Everyone"
Arkicad
BIM model excel
Calculation tool by ministry of environment
All available methods
LEED and BREEAM have their own guidelines
Carbon designer tool "Designer"
Rekla
WWF ilmastulaskuri
Based on EN standards
Own optimization tool
Do you count the footprint of the buildings yourself or do you use third-party consultants for counting footprints?
Count CF in the company (6)
Outsource CF calculation (2) "Building owners"
Outsource CF calculation only in some cases (2)
Depends on customer needs
Partially us, partially outsourced
Person in charge inside the company
Outsourced, in the future probably in-house calculation
Where do you get product's CO2 emission details?
Emission details from Bionova Oneclick LCA (3)
From suppliers directly (2)
From EPDs
Search engines
Suppliers webpages
International material databases
From builders "building owners"
Generic values by Bionova or other Officials
We calculate ourselves
Dig from the internet
Consultants do it
Data bases
Gabi database
How do you keep your project's CO2 goals consistent from start to finish, between your sub-contractors and the whole value chain?
Subcontractors only work, material stream by company X
Train subcontractors 1-2 times a year to be more sustainable
Depends on project
Long term contracts
We are on the track of finding the best practices at the moment
Value chain approach to emissions
Construction sector is highly regulated, and contract binds everything to work as agreed

Design documentation ja manufacturers are our source of information, because we know where materials come from
We choose materials early enough and not change suppliers
We don't have a method
We use consultants "Building owner"
Workshops with different parties where we discuss goals like energy consultants and structural engineer on how it will affect them and another workshop before the project starts
It is hard to supervise the actions of the subcontractors. We have a limit of how long chain we can have
Does X determine what materials are used, or can contractors decide on their own?
Company x negotiate everything but only in special cases contractors can choose
Projects can vary
We decide the materials and we have to stick to the plan
In cases there are no specific requirements, subcontractors can choose the materials used
We have criteria for usability and durability "Building owners"
Mainly we decide
Depends on building and property owners
Subcontractors always need to negotiate with us and building owner on their suggested materials
The system is made so the specifications of the project goes through process and the situation is such that we order some ourselves and some by the sub-contractors.
We can suggest, but the builders decide it ultimately "Designer"
Contractors decide on their own, we chose contractors, meet regularly and check
We design if wood or concrete, contractors can choose what concrete they actually use and that can vary between manufacturers
There are some attitude problems and no they do not match "construction is a conservative field"
We chose, but contractors can suggest
They are specified by the designers based on their performance; contractors chose the final product
Typically contractors
Depends, but they need approval for the most important orders
They mostly do the right thing as long as you give info and not leave them alone with decisions
Do X's criteria match those of their subcontractors?
We make sure criteria matches
We have not done that type of follow up
Contract requirements regarding safety and sustainability
Inform sub-contractors of our criteria that they need to answer
We educate sub-contractors, and some educate us on info we did not know we needed
Any respected builders wont chose something with high maintenance. They understand where to put their money
It's on designers to check the materials
We don't have control over subcontractors
Criteria should be set before hand
We do not have to match; we make reasonable demands

What are your criteria for sustainable procurement?
Buy only certified wood
Use paints with Nordic ecolabels
Buy materials from Finland or close by
Buy energy efficient products
Swan labelled materials
Works according to our sustainability strategy overall
Comply with applicable laws and regulations "building owners"
Our partners have a responsibility to combat and prevent grey economy "building owners"
Partners are responsible for the commitment of their own subcontractors "building owners"
Raw materials providers have to answer to our requirements "for example report us how do they treat waste"
We do auditing
We look for ISO certifications
We look for EPD certifications
We work with big material providers and do auditing
Most important is optimal cost for the building like several calculations, total cost, future anticipations and maintenance cost "Designer"
We have supplier's code of conduct
Green guidelines for procurement
In every step we have 3rd party consultants for auditing
Common criteria and ethical rules
Distance of the source
Emission performance
We don't have those
Non-toxic materials
Purchase from local Finnish suppliers
We go by the law; Finnish laws are OK "building owner"
How do you guide your criteria through procurement?
Selects a partner according to its own criteria / compatibility of them to us "Building owner"
Construction projects are procured as total contracts, the contractor is responsible for procurement "Building owner"
We work together and they have to answer to our appendices
Negotiations and contracts
We ask questions and require answers before we consider them as partners
Depends what are the main criteria for the companies
Through agreements that we do with contractors
It's a part of our contract package
We audit risky ones
Maintainability and flexibility of the place "building owner"
How do you compare products product's carbon emissions?
By EPDs if possible (7)
In case of energy we go for non-emission products

We compare buildings, not just products used "Optimization on their money and targets that they have to get the best one for themselves. "
We don't compare product vs. produce. We look at the big picture
We compare design solutions "some insulations work better with less amount, but might create more emissions in long run or some that create more emissions might save energy better"
Consultants do it
Where do you search information from?
Suppliers
www pages
EPDs
Oneclick LCA
From materials-based declarations that are found in CE marked products. We don't suggest using products without CE marking
Consultants who are helping us
RTS has EPD portal about certified products
Generic information
If there is no product specific data, we use generic data or some other products data
Do you always find the information you need?
No, not always, hopefully it will get better
We find at least rough estimations
Usually find something
We always find something "concrete is concrete"
Not always but suppliers who won't provide are off the list
Not always find information needed (2)
How do you make sure the information is reliable?
20 years of experience and gut feeling
Too good to be true is not reliable.
We trust on information from EPDs
We calculate the footprint ourselves and, in some cases, we use 3rd party for verification
We look for public certifications
We hope for the best
Only way to make sure is 3rd party certifications
We believe that people are honest
If you see the information you can immediately spot wrong information
We don't recommend using products that's information can't be found
It has to have European label and approval, otherwise it cannot be used.
We just count on what information we get
We assume or ask the designers
If we use consultants, we use the ones with good references
Compare 2 different sources if they make sense and rely on your instincts
We need reliable information on products emissions
How much impact does the product's CO2 emissions / cost have on purchasing?
We follow customer demands

We have purchased more expensive product which creates less emissions
Hopefully owners care more and pay more for sustainability in the future, generally gut feeling and budget
In cases of price war we have to be cost efficient
It depends on how much load the material can carry
If we have certain goal in project, it can cost more but we need to take that into consideration.
LCA cost is more important
If otherwise similar we chose lower emissions "Designer"
Discuss with customer and we think at some point carbon might be taxed
We would not accept anything that is not as good as designed
We buy the whole building "Building owner"
Is EPD a criteria, when comparing similar materials?
Not yet but more in the future
Not commonly yet today
We are in the process of learning EPDs
Compare the price of materials not EPDs
Not yet
It is a good way to compare, but there are not enough products with EPD certifications yet in the market
Yes (4)
In some cases yes (2)
The designers decide that
No
Buildings rate better in BREEAMs if they have more EPD certified materials "building owner"
When calculating yes, when building no
How do you see the progression of EPDs in building material industry?
Customer demands will affect on increase of EPDs
If no customers want them, they won't exist
Still to become a document used in daily bases.
Cannot compare to CE markings yet
Compared to CE markings "they took long till they become usual"
It will take a while for procurement to understand what the document says
Pioneering companies develop criteria and use them to gain a competitive advantage "building owners"
There is a need for standardize methods in the industry so we can read and compare easily
EPDs are complicated and expensive
It will take a long time till EPDs can be business as usual "can be compared to CE marking"
They can be used for marketing
I would like to see more, since there is not enough at the moment
For some ratings there is supposed to be used at least for example 5 EPD certified material
If material providers want to be in the game, they have to have more EPD certified materials
They will become business as usual
They are useful but we need more information "building owner"

They are not reliable
They make it worse for us
They will be more relevant in the future because we have to calculate LCA of all buildings in near future
Certification schemes require more EPDs and the need for transparent information will be rising as well
What do you think of Saint-Gobain's environmental sustainability?
They are ambitious
Easily approachable
Good products with circular economy
They have good reputation
They have good understanding
Good communication
Good environmental processes
Have been looking at these issues for longer
They have a good program going on, but I think all European manufacturers have good programs
They are quite high in that aspect
They have engaged in sustainability early
Good image brand
Leading manufacturer in sustainability
They are different
They are going forward
Not familiar with S-G
They seem active
They are putting a lot of efforts in sustainability
They should come out and tell more about their operations publicly
They are doing a great job
I see them as a key player in research and product development
What data would you value and wish for suppliers to add to building materials?
More information on packages, how recyclable the are
Water usage and CO2 usage / a ton of the product
There should be continues development of the products to offer to us
Improve transparency
Open communication
Inform us what is coming up in easily understandable way
More information on recycled materials
Energy and recycled material percentages
More LEED BREEAM and RTS certifications related info
Accurate data
We need the calculations
If there is any chemical that needs to be considers in the building or even demolition phase
Would be really good if we get details of what materials are used
Cutting waste should be made easier
Availability of the information should be made easier
Information about the environmental performance of the product

Cost over time matters
"this might be stupid" but if possible, data from suppliers to us on what products have they delivered
They should lead the CO2 emission war
Cooperate with ministry of environment and update all the materials from generic so designers can get relatable and current information. "Designer"
Information on indoor air and how does material work with water and vapor "Designer"
The more technical information the better "Designer"
Data on chemicals and smells of the materials.
M1 classification
Material passports are hot topic. All details of materials can be found from a database and we can checkout data on what they include and if later on found toxic we could know where exactly it is and remove it
Concentrate on relevant things, a lot of information on EPDs are useless and hopefully we get rid of them
Promote more and remind us of your good work
Short but right to the point data "at the moment it's too complicated"
How much waste is produced and how much can be recycled
More information that is easier to compare like how much emissions a cubic meter of the product creates
How far is the production
Designers needs is more info about the whole LCA, what kind of preparation and maintenance work is needed during whole life cycle and how many times is it need to be replaced during whole LCA of the building
Life cycle information
Disassembling information
We should think different levels in circular economy so more recyclability information
New parameters if recyclability is added
Would you be interested to cooperate with building material supplier?
Maybe
Why not
The development is going towards new buildings models
One way to step forward is some kind of cooperation, even if we have to accept that it comes at a cost
Cooperation could benefit both parties
Cooperation is the only way the industry could go forward
We are in this mess together so why not
We already cooperate with material suppliers
We have common action in Rakennusteollisuus where we meet
We are looking into it; we need to collaborate more with suppliers
We are already cooperating
Yes, we would be interested
We are in contact with them already
We want to collaborate and make effort to achieve carbon neutrality "Building owner"
As public procurer we should provide open environment so cannot cooperate with only one supplier
In some sorts maybe yes

How could the flow of information be strengthened between X and the building material providers?

Provide more clear information, not just EU information that is hard to understand

We might develop somethings together in the future like report of climate emissions

We want to hear about opportunities, but construction companies are a better partner
"Building owner"

Weekly meetings

As long as the information can be found easily, we are good

We could start with a meeting; I already know their sustainability manager

More collaboration between material providers and designers "Designer"

We have to look into it together, what kind of stuff they can offer so we can both win

We do notice some similarities; this is some kind of research project that we could do together "Building owner"

We already have annual events

What is the role of the building owner in a construction project?

Important

They set criteria

If they don't set low carbon criteria nobody will deliver lower emissions

They have to ask, otherwise no one will deliver

Some are active some are not at all towards sustainability

Price is more important to them

They are getting more and more interested towards sustainability

Housing companies has the most important role in LCA, sustainability and energy efficiency

Huge! They make all the decisions on costs and what to invest in and we would not exist without them

They pay the bill, so it's crucial

Anything they require we have to give them, like LCA, LEED or use EPDs, I mean ANYTHING

If they set any target except the money, then we go where the fence is low

The owner should make the goals for the building

Owners are more interested in life cycle costs

More problems if they don't own the building long term

If they are not planning to have the building long term, LEED and BREEAM helps in this situation. Ratings means more value then

Owners want to be educated

Discussing with clients makes it more realistic and can educate the owner

The government is making them cut carbon.

They decide everything

We select the players, decide the targets, we need to cooperate with cities, it is important that there are partners who work with us long term" Building owner"

Long term owners are more interested in sustainability and maintaining

Depends "active owner owns the building for its whole life cycle, investment company only for 10 years"

They decide everything and if costs are high, they won't invest

We aim to have high sustainability on our own self developed projects "Building company"

We do not have anything with EPDs "building owners"

How involved are the building owners in steering the low carbon construction?

Some are involved
Some have not heard about it
When they realize building environmentally friendly building can save money, they get more interested
Some are ambitious
Requirements are pending for procurement criteria "building owner"
Their awareness is rising, they are eager, and they see it as marketing value
There are a lot of variations among them
They are finally interested in sustainability
They have realised that we have to do it and we are running out of time
Younger owners are more involved, people over 50 are not that interested
Institutional people have longevity and think in long term it will pay off
They are interested, but no one is willing to pay for it
States have higher level of sustainability
Handful of cities and real estate companies have signed a zero-carbon building commitment

What are building owners' their interests?

Indoor air quality
Costs and price are their biggest interest
Sustainability
Megatrends
Climate change and low carbon
Some are interested in renewable energy solutions
Collaboration at the beginning of the project is crucial to be on the same page
Make sure buildings are future proved for resells down the line
Make sure they get value for their money
Cost cost cost
Profit that they get from the buildings
Location
Return on investments
How the value of the building can stand in the future
Low maintenance
As much value as possible
Green certifications, low energy consumption and other ratings can bring them more value
Energy savings
Cities are more interested and putting more effort in sustainability
Investors will be more interested in sustainability
Energy saving makes a case for saving money
They want to have materials that are maintainable and long-life buildings.
Materials have to be in sync with other materials and structures
Economy of the building
Income of the building long term
Big owners like x and cities do care
Provide good service to make money
Private owners more ambitious, cities and government not up to date and focus more on price

Location of the building and how close to public transportation is it and what kind of spare time activities are available close by
Costs are always important
Solutions that save costs
What new forms of collaboration can be built over the value chain in construction industry to minimize CO2 emissions and add circular economy?
There has to be a need, only laws, requirements, regulations
Everything might look different in the future
We might buy services but not products
Collaborating with research institutes and universities
It is already formed
We can talk about everything in green building council
Increase knowledge in whole value chain
Everything starts from the design
Suppliers should convey information to designers and not only sustainability related information
Designers have limited knowledge
Someone always starts something
More communication, more collaboration
Involvement of all parties
Educating all parties early enough
Joint ventures of building companies with materials suppliers
The key is a dialogue between construction companies and people who plan cities. We can do a lot more
Calculation method should be set "how to calculate should be standardised"
Legislations
Open feedbacks between material providers and builders
Other interesting comments:
Everyone is looking for their own LCA phase and methods, if all work together and invest in common R&D to research features like energy efficiency and heat production, everyone could overall be more sustainable "building owner"
Property owners makes all the decisions related to climate change
The needs of property owners and managers affects us. If their environmental needs changes, we have to adapt
Constructions is never going to be carbon free unless there is some compensation is involved
Investors do not pay for sustainability yet, but hopefully soon they will
The government is trying to make us use wood more
There has to be a need to make greener buildings
They should follow the development and absorb the changes.
Use phase is way more important
I think building owners should be taken into consideration or included in every step of the value chain
Competition is good for the environment
In demolition, time is money, only expensive waste is separated while there could be more materials that could be vitalized that are not separated

Designers play a huge role and lead architect has the most impact if they have good awareness
Planning phase is important
Construction is a conservative field
How to move buildings can cut at least half of the carbon. Country sides are getting empty, how to move those buildings to cities or vitalize them better
Multifunctional buildings can be good for the environment
Now government calls the cards
Customers don't know what to ask, they need help
There is a lot of inconsistency in between that is ignored and read wrong between the lines
It is important to have two- way conversations, from construction companies to material developers and back
We are not mature enough to use EPDs
Big part in solving climate issues and understanding the CO2, how much do we create
Building takes more and more roles in CO2 of the whole LCA. Building materials importance is increasing
Early communication is better and keeps the builders happy
The whole industry is quite early with this. It will take more time and it will be more and more important in the future
EPDs info should be integrated into CE mark
Speak more on adaptation of climate change because we know it will change whatever we do. How can we adapt to climate change? The buildings will see the climate change in future.
Climate change is not discussed only stopping it is discussed. We should now think of future and be climate proof.
We are all in the same boat. Hiding and greenwashing does not help. Acknowledging the problem is half of the solution
Zero carbon buildings are a long road
Certification method for a building or low carbon building certification and low carbon in use phase certifications that is important. "criteria should be very strict so not every building can claim that they are energy efficient"
The reality of reaching those are challenging. I would be suspicious if a company sets a goal like that, I would like really information how they do it
Trying to prevent the terms form used every day. A building to be zero carbon, you would need to get every factors to the maximum "zero emission green energy use" materials still need emissions so then compensation should be regulated on how it's done and how long till it has compensated everything. "example compared to Sweden"
Either build for long time or if the inside is adaptable. Or design very recyclable from the start with short life cycle. To be sustainable.
We are not including the energy use because that does not belong to us.
Learning curve step by step to be more accurate
If you don't concentrate on sustainability, you're shooting yourself on the leg because it will be trillions in the future
There could be plenty of opportunity to use recycled material that might not be approved by the city because of legislations and so on.
Customers comments on EPDs: There is a need for simplification or a separated manual how to read EPDs or a table where to find data that is needed:

If I think about myself, I would need documents to be easily understandable, EPDs are complex, I would need a simplified version or a table where are all the most essential information needed from the document

If EPD information could be excelled so easily pick up

There are only few people who know how to read them.

Some guidelines can make it easily approachable.

Yes please

This will bring us a lot of value

They are made by engineer, so they are very complicated, they are deep into it, but we won't understand

EPDs should have a short summary

I never read EPDs because they are complicated. I use the information the suppliers provide me

We need a manual to be able to read EPDs