Circular Procurement in the Building Sector

Aalborg University

Department of Planning

MSc. Environmental Management and Sustainability Science

Master Thesis

Project period: Spring semester 2019

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Number of pages: 71 pages

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Date of completion: 07/06/2019

Appendix: 8 pages

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Abstract

The project investigates the potential action for municipalities to facilitate the transition from the traditional way of conducting a public procurement to more circularity-based tenders. At the beginning project overviews the current situation and possible outcomes of the way how contemporary society is managing its consumption of the raw materials within the built environment. Furthermore, it introduces the circular economy concept and business models.

For the research, various experts in the circular economy and building industry were interviewed to obtain the newest information on the current trends and methods used. Furthermore, to get a national overview on circular economy and public procurement within the building industry survey has been sent out to 98 Danish municipalities.

For the project's conceptual framework, the multi-level perspective has been selected for distinguishing the scope of the project and data analysis.

To conclude the investigations in order, facilitate the transition to more circular public procurements. Municipalities should switch from a set of strict requirements to more ambition-based tenders, which means, using the circular economy models for setting the ambitions and motivating the market to be creative based on those ambitions.

Acknowledgements

I would like to thank all the persons who assisted throughout conducting this research. First, I would like to express gratitude to my supervisor ***Arne Remmen,*** for assisting and constant support, updates on the newest researches and events, and sharing his knowledge and network. Secondly, I would like to thank **CLEAN** for creating a fantastic working environment for conducting this research and constant assistance, mental support and the possibility to get the information from outside Denmark.

I would like to thank interviewees, who have assisted in making this research possible. **Cuno Van Geet –** Rejswaterstat**, Torben Gade –** Marina City (Kolding Municipality), **Emma Börjesson** – Malmö Municipality, **Kim Ankjær Nielsen-** Kolding Municipality, **Gitte Gylling H. Olesen –** Rambøll and **Veerle Labeeuw –** Vlaanderen Circulair.

Abbreviations

BR15 – Danish Building Code 2015

BR18 - Danish Building Code 2018

CE – Circular Economy

CSR - Corporate social responsibility

C2C – Cradle to Cradle

DGNB - Deutsche Gesellschaft fur Nachhaltiges Bauen

DK-GBC – Danish Green Building Council

EPD – Environmental Product Declaration

EU – European Union

GDP – Gross Domestic Product

LCA – Life Cycle Assessment

LCCA – Life Cycle Cost Assessment

PP – Public Procurement

SD – Sustainable Development

SDGs – Sustainable Development Goals

UN – United Nations

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Introduction

The purpose of creating this research took roots from general observation on the built environment and an interest in green building certification schemes. Likewise, because of the new project in cooperation with CLEAN cleantech, which is focusing on the circular economy within the building industry.

According to the European Commission, every year around 250 000 institutions in Europe spend around 1.9 trillion euros on the public purchase, it is equivalent to 14% to 18 % of their country's GDP. North Sea Region population is consuming around 960 million tons of the raw materials to produce the 360 million tons of waste. The built industry is responsible for a high amount of the total amount because of the traditional way of conducting public procurement.

"Why waste what can be used in a sensible manner?"

(EMF, SUN and McKinsey, 2015)

The literature review has shown that the current way of conducting a public tender has a higher focus on the price rather than acknowledging all three pillar of sustainability which the basis of the circular economy is.

This paper research analysed using the socio-technical conceptual framework. It researches the possible actions which supposed to assist municipalities and other institutions in stimulating transition towards a more circular society.

Growing Demand for Buildings and City Expansions

The exponential growth on the human population has become a risk to biodiversity on a global scale. By the United Nations (UN) predictions in 2050, the global population will be around 9.8 billion (United Nations, 2017), it will continue growth by 2.1 billion compared to present population which is 7.7 billion people (Worldometers, 2019). Population growth is accelerated by the improved health care in most of the world, together with life expectantly which have been increasing throughout the past decades.

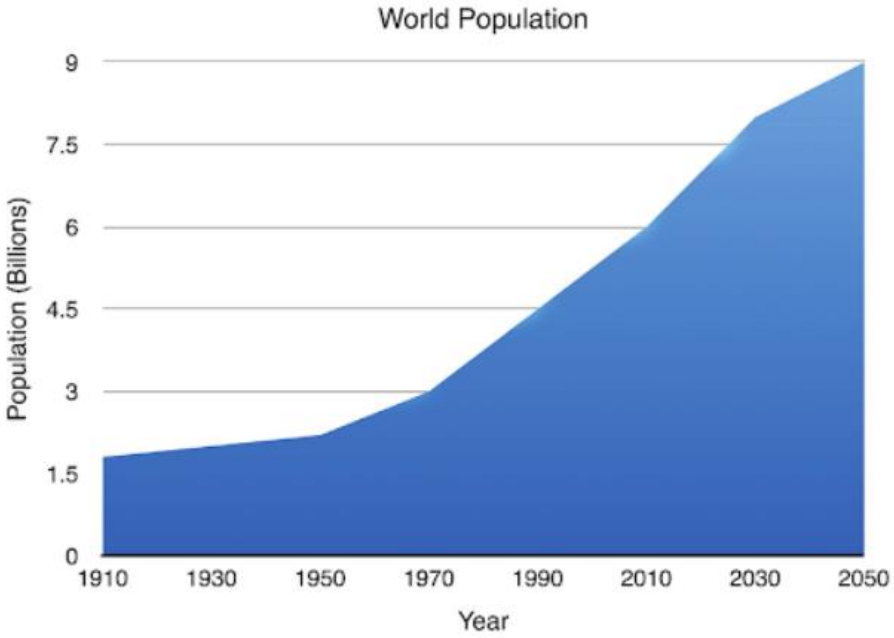

Figure 1-1 Expected world population growth by the year 2050 (Kibert, 2016)

Increased resource consumption, which differs in economically developed countries and economically developing countries. Whereas, developed countries have a much higher demand for natural resources compared to developing regions (García-Nieto *et al.*, 2018). The gap between the developing and developed countries in need of natural resources is understandable in the way how people perceive appropriate living conditions. Following with the urbanisation and the demand for the materials to provide enough accommodation, infrastructure, offices, businesses, end so forth. (Li and Lin, 2015)

Urbanisation and the impact on the environment

According to the UN, around 55% of the world's population is living in urban areas. In 2050 it is projected that the percentage of people living in the cities might reach 68% (United Nations, 2018a). In Europe, the rate of people moving from rural areas to the cities is higher

compared to other continents. The estimation for 2050 is 84% of Europe's population will be living in the towns (García-Nieto *et al.*, 2018).

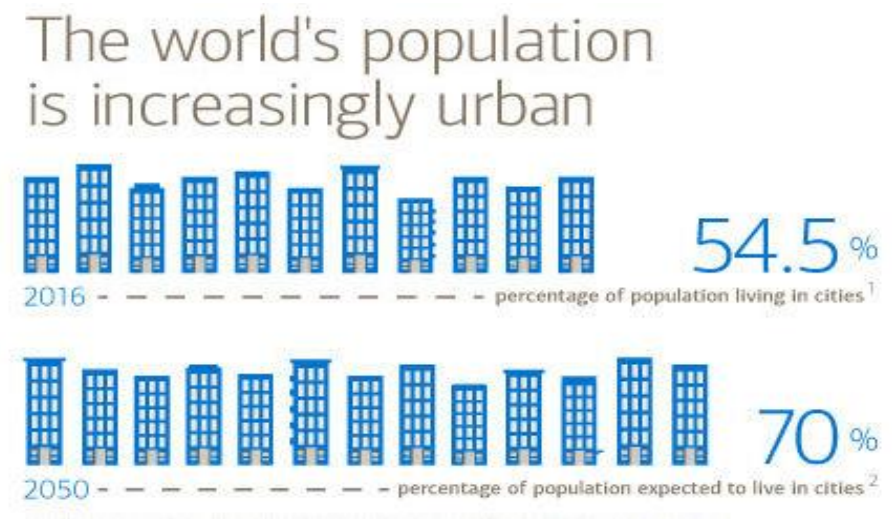

Figure 1-2 Percentage of the world's population living in cities and expected to live by 2050 (United Nations, 2018b)

Cities, as they are today, are responsible for the majority of production and emission of greenhouse gas (A. Allouhi *et al.*, 2015). Furthermore, cities are consuming around 80% energy production globally (Ellen MacArthur Foundation and ARUP, 2019). Whereas, according to the International Energy Agency (IEA) the buildings and buildings contractions are responsible around 36% of the global energy consumption and around 40% CO_2 emissions (International Energy Agency, 2018).

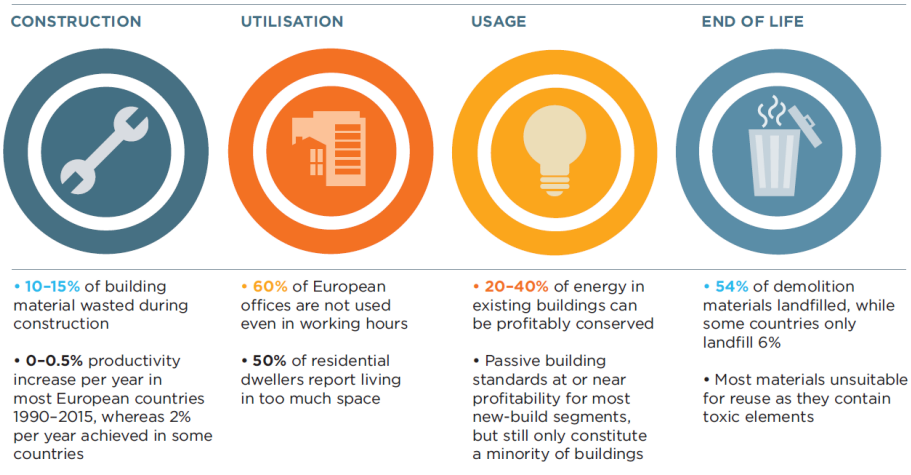

Figure 1-3 Structural waste in the built environment (EMF, SUN and McKinsey, 2015)

The building environment as it is today does not exploit the full potential in preventing waste and saving investments. Throughout the construction process, around 10-15% of built material is wasted.

Furthermore, the utilisation managed is the way it is not used in the highest capability, as around 60% of European offices are not used even in working hours.

Moreover, 20- 40% energy consumption in the buildings can be managed in the way it would be conserved. The aspect that the built environment is beginning to acknowledge as the significant problem is the end of life of the building. Materials gathered from the demolition works usually cannot be reused as it contains toxins, and because the way the building is design, it makes it more challenging to gather the materials in good condition. (EMF, SUN and McKinsey, 2015)

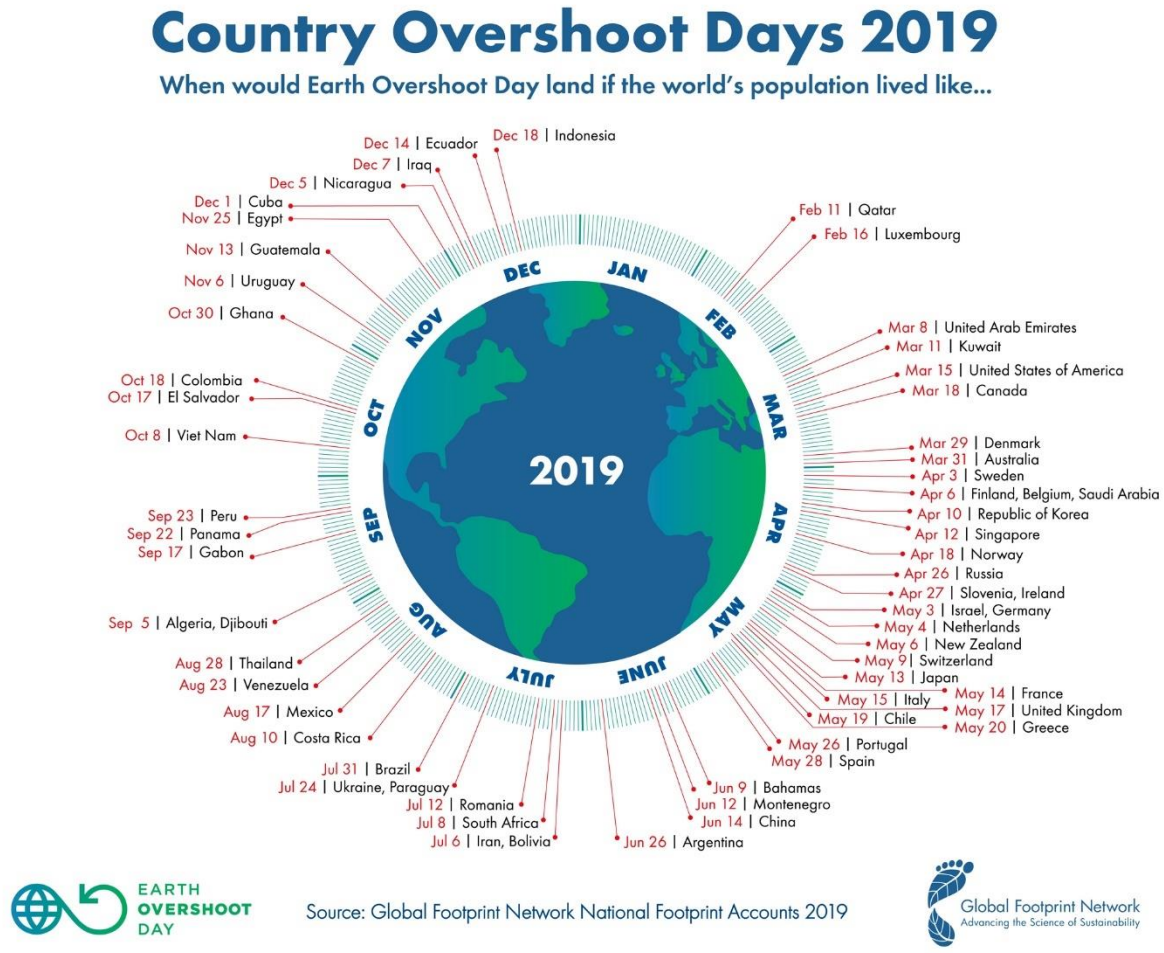

Figure 1-4 Country Overshoot Days 2019 by each country (Earth Overshoot Day, 2018)

The Overshoot Day calendar show date on which countries' resource consumption for the year exceeds Earth's capacity to regenerate those resources in the same year (Global Footprint Network, 2016). Calendar generated by four key factors representing the country's performance. Calculations made based on:

- How much countries do consume raw material;
- How efficiently products are made;
- The country's population;
- How much nature's ecosystems can produce the same year.

(Global Footprint Network, 2016)

On the first half of calendar majority of the countries listed are developed countries, whereas, in the second half of the calendar, most are developing countries. It indicates that developed countries have a higher demand for a resource to fulfil their comfortability.

The growing demand for the resources brings the pressure on the countries and business as the traditional business plan is based on the linear economy which can is described as Take – Use – Dispose, cannot fulfil the increasing need of resources. Besides the inefficiency, it also contributes to the global problem such as climate change, greenhouse gas, reduction of biodiversity. There is a need to switch towards the understanding of doing more with less is as an understanding of how sustainable consumption and production. The transition towards the use of services and products to fulfil a basic need while reducing the extraction and usage of natural resources and toxic materials. (Lukman *et al.*, 2016)

Sustainable Development Goals and Building Sector

At this time, the environmental issues are addressed more frequently in businesses, politics and national agendas. Sustainable development (SD) was discussed on the global agenda over three decades. During this period, there were continues action plans and frameworks which provides an approach towards solving global environmental problems. I.e. Climate change, greenhouse gas, depletion of natural resources, reduction of biodiversity. (Lomazzi, Borisch and Laaser, 2014)

While the Sustainable Development Goals (SDGs) are 17 goals that apply to all countries (see Figure 2) and 169 targets and 232 indicators. SDGs are made for the 15 years to accomplish determined goals. (UN News Centre, 2015)

Figure 1-5 Sustainable Development Goals (United Nations, 2015)

Responsible consumption and production (SDG no.12) have eleven targets, and 15 indicators on how to achieve it. One of the aims is to promote sustainable public procurements by national policies and priorities. Another objective that by the 2030 people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature. (United Nations Environment, 2017)

Construction has enormous social, economic and environmental impacts during the design and build process. The property sector is responsible for crucial decisions on how to operate, maintain and reconfigure buildings. Therefore, the green buildings can have a direct impact on the nine of seventeen SDGs. ‘

Figure 1-6 World Green Building Council and SDG's benefits (World Green Building Council, 2017)

1 Circular Business models

Circular economy (CE) based on a fundamental transformation of the economic system, reaching from different business models, different design and production models to radically change consumption patterns and culture. One of the descriptions on the circular economy which many other descriptions came out is from Ellen MacArthur Foundation:

„A circular economy is one that restorative and regenerative by design, and which aims to keep products, components and materials at their highest utility and value at all times, distinguishing between technical and biological cycles."

- (Ellen MacArthur Foundation, 2015)

Circular business models are one of the tools which aid the transition from the linear economy to a circular economy. In order of these model to work, they must be aligned with design strategies, governance and regulations. These models set up new ways to grow and manage business throughout the whole product life cycle. (Circularity City, 2018)

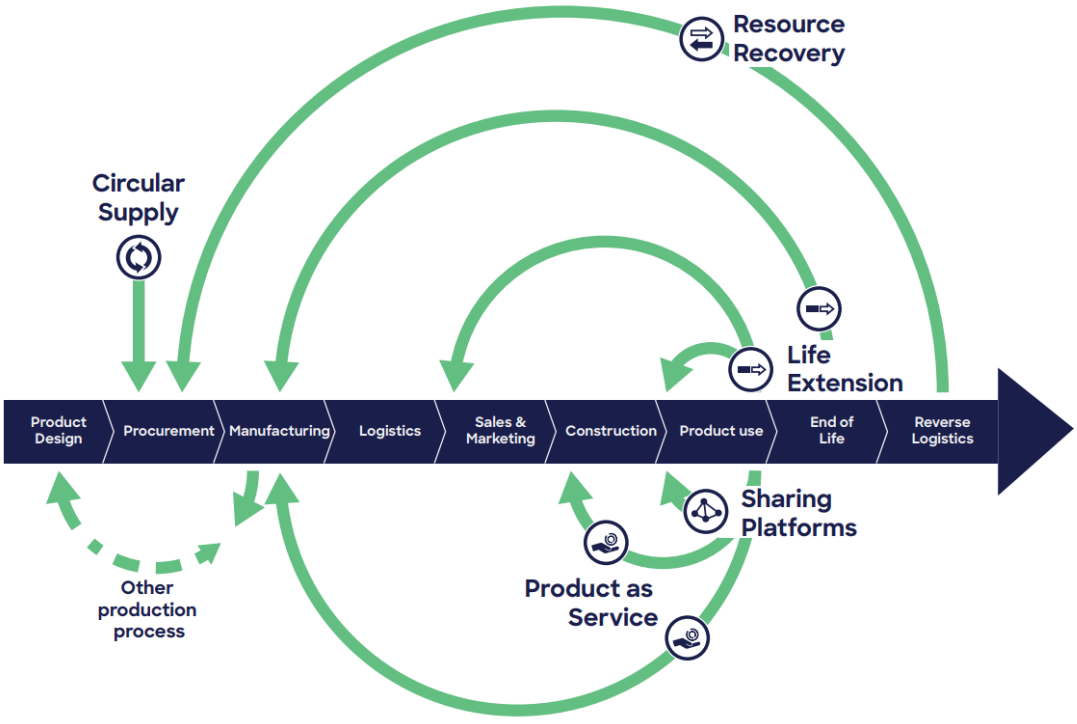

Figure 1-1 Circular economy business models (CircularityCity, 2018)

1.1 Circular Economy in the Building Sector

The way the buildings are designed today makes it challenging to recover materials and metals for reused as a high-value product at the end of the building's lifetime. Furthermore, most waste generated throughout the demolition process cannot be reused for practical purposes because of the design of the building. It is because of the materials, metals or other built products can damaged or contaminated. Thus, the demolition waste is usually downcycled, which means the materials processed throughout various procedures (e.g. heat, chemical reactions, or physical crushing). This type of recycling referred to as open-loop recycling. (Heinrich and Lang, 2019)

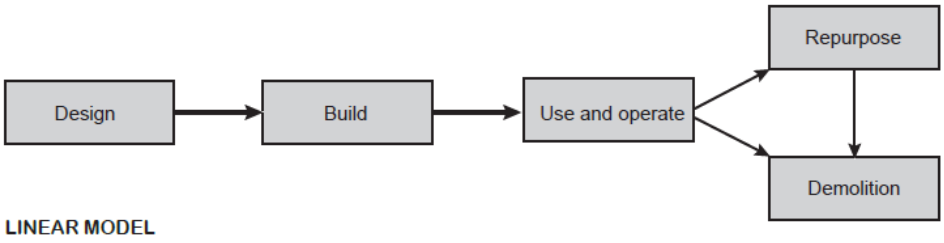

Figure 1-2 Linear model of the building lifespan (Heinrich and Lang, 2019)

Whereas, opposite than open-loop recycling is a closed loop where used products come back to the original manufacturer and components or materials are used again to produce new products of the same type. (reference)

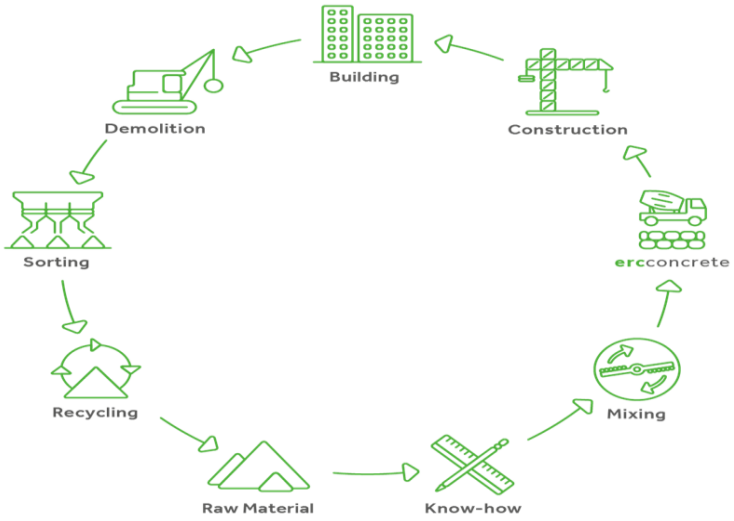

Figure 1-3 Circular model of building lifespan (Guldager Jensen and Sommer, 2019)

Circularity in means to facilitate current demand of materials in the way it is not compromising future needs by using resources in a way that they remain available for future use.

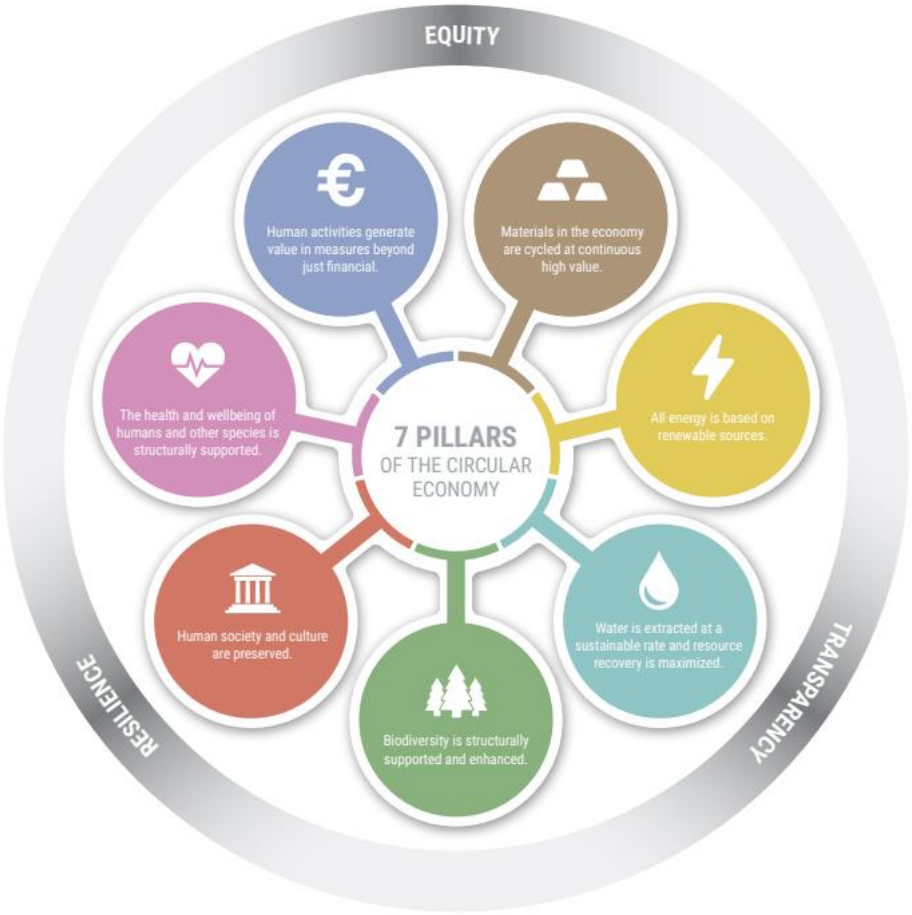

Figure 1-4 Seven pillars of a circular economy (Kubbinga *et al.*, 2018)

The principals of the circular economy within the building sectors classified into seven inter-linked pillars. The pillars mentioned below:

- Material Cycle
- Energy Cycle
- Water Cycle
- Biodiversity and Ecology
- Human Culture and Society
- Health and Wellbeing
- Multiple Forms of Values

This approach is focusing on reducing waste generation throughout the supply chain of the product. It addresses the importance that the economy needs to work effectively at all scales – for small and large businesses, organisations and individual, globally and locally. This is already known for more than four decades, unfortunately, at that time, the concept was not noticed by the major global companies or policymakers. (Wautelet, 2018)

The different sectors must adopt the circular concept in diverse strategies which would be suitable for the market. Therefore, this concept can be interpreted as a disruptive strategy within the building supply-chain. The idea of the circular construction chain based on buildings design and built the way that material's lifetime would be extended throughout reuse or repurposing and prevent the waste. (Circle Economy, 2016)

2 Public Procurement Directive

Public procurement (PP) is the acquisition of goods and services by governments or public sector organisations through a public contract. It includes education, construction, administration, transport, leisure, and social services (Lozano *et al.*, 2016). In Europe, the public procurements are around 14% of the country's GDP, wherein the developing countries, it can be up to 50% or more (World Bank Group, 2018). Furthermore, well prepared and described procurements have an essential role in the country's economic coherence and used as a tool to improve innovation and technology adoption in the private sector. Companies must continuously seek an innovative way to reduce their cost to be competitive in public bids. (Lozano *et al.*, 2016)

2.1 EU Public Procurement Directive

According to the EU Public Procurement Directive, procurement grants a contract to the tender/ supplier by evaluating which is economically advantageous compared to its competitors. The winner of the contract based on the lowest price; the lowest overall cost or most value for money, which based on the price-quality criteria ratio. (Lozano *et al.*, 2016)

2.2 Sustainable Public Procurement

Sustainable procurement is now being interpreted as a strategic level to hasten innovation and improve the sustainability practice of public and private sector organisations around the world. Recently, the Circular Economy (CE) concept has gained increased importance by focusing on transforming waste into resources while bridging production and consumption activities. Achieved by closing loops of different types and levels of recovery of valuable resources between parties in society. The circular bids usually are made on a small scale, and often it is the initiation of individual departments or agency within the government. However, sustainable public bids are getting more acceptable and spread all around the globe with new exciting and innovative examples. (United Nations Environment Programme, 2017)

2.3 Example of Sustainable and Circular Procurement

Circular procurement does not have on the single definition on what it is and how people are supposed to understanding and use it. The concept behind the wording is about the material's whole life span from the day it is designed to the end of lifespan and coming back to the production chain flow. (Jones, Kinch Sohn and Lysemose, 2017)

Kolding Municipality located in Denmark decided to be the first movers towards the transition to the circular economy concept. Therefore, they are working on the new district called Marina City, which meant to be as an example for other municipalities for the transformation towards a circular economy. (Turntoo, 2019)

The Marina city project has come up with several criteria for the way the new non-private buildings in the area must build. The preliminary requirements for upcoming public procurements are:

- Must be able to be certificated at least GOLD in DGNB certification scheme.
- Use of tree as a significant part of the construction
- Design for Disassembly
- Recycling of materials or building part now and subsequently
- Products as a Service (e.g. appliances, elevators, etc.)
- Energy-positive building
- Health indoor climate
- Flexibility
- Rainwater utilisation and/ or water use
- Common facilities that support the circular economy (e.g. workshop, guest house, car sharing, etc.)

(Kolding Municipality, 2019)

Project developers are aiming to address all business models of the circular economy. They applied two different approached on public procurement. The first one is as a checklist and framework of the different criteria for the product to be achieved. Whereas, the second approach is formulating the vision and set of ambitions and performance indicators, which allows the applicants to be more innovative and come up with their solutions. (Turntoo, 2019)

3 Going Towards Sustainability and Certifications

Achieving sustainability in the building industry is a difficult task. The monitoring of the urban areas began in the 1990s with the Local Agenda 21 when for the first time, the indicators for sustainability in the urban areas where introduced. (Ahvenniemi *et al.*, 2017) Throughout years various assessment tools have been developed, which are either sustainable city rankings or tools that allow cities to compare best solutions and find best practices. The sustainable development indicators are broadly used by public authorities as a tool to confirm cities' sustainable development strategies by enabling assessment and monitoring activities. (Ahvenniemi *et al.*, 2017)

Figure 4 Green Building Certifications and Eco-labelling (Guldager Jensen *et al.*, 2018)

Above listed most common building certifications and eco-labelling in the North Sea Region.

3.1 Building Regulations in Denmark

In Denmark the construction regulated by the Bygningsreglementet (BR) (transl. Building regulation) which has been updated to the new version from BR15 which released in 2015 July to BR18. (European Commission, 2018)

The building regulation is the set of rules for the constructions, which applies to private and commercial buildings. BR regulates and provides minimum requirements most of the constructions sectors except bridges, tunnels, roads, electricity supply. BR regulates in addition to administrative condition for buildings, access conditions, energy consumption, safety and health. The guide deals with the regulation of safety and health about common occurrences. (Trafik- og Byggestyrelsen, 2016)

3.2 Construction and Demolition in Denmark

By Denmark's country profile report released by the European Commission in 2018, Denmark's construction and demolitions sector are responsible for around 40% of the entire country's energy consumption. Furthermore, from data gathered in 2014, the activities in the construction and real estate sectors have accounted for 1,827,163 tonnes of greenhouse gases. (European Commission, 2018)

Moreover, the constructions and demolition sector generated a lot of construction waste; for example, Denmark in 2013 have generated over 2.89 million tonnes of construction waste. Denmark has a policy regarding the recycling of the C&D waste, the market for the reuse and recycled building materials are limited. Denmark's overall recycling performance rate is around 87%, yet a major role in the recycling C&D waste taken by the concrete, which used for road construction and renovation. (European Commission, 2018)

3.3 DGNB and Green Building Council Denmark

Denmark's Building Council have researched the green building certifications. To assesses, which of green building certification schemes are the most suitable for Denmark's market and indicates various solutions for sustainable development. Exploration made among these Green building certifications:

- BREEAM - Building Research Establishment Environmental Assessment Method
- DGNB - Deutsche Gesellschaft fur Nachhaltiges Bauen (German GBC)
- Green Star – Australian green building certification
- HQE - Haute Qualité Environmental (French GBC)
- LEED - Leadership in Environmental and Energy Design (US GBC)

As an outcome, the Danish Building Council have suggested DGNB as the most suitable for the Danish market. The German version of the DGNB had to updated to the Danish building code. Therefore, the Danish DGNB has the same key criteria, but the bar for achieving the requirements is raised accordantly to the Danish market. (Korhonen, Honkasalo and Seppala, 2017)

Talking about sustainability, Denmark is one the protagonist in a lot of the fields. Even though there are always place for improvements, especially in the building sector. Danish building Code (Bygningsreglementet), which updated in 2018 has set the strict requirement

for energy consumption as around 40% of Denmark's energy consumption comes from buildings.

Furthermore, the resource consumption is high, and buildings are responsible for around 30% of the total amount of waste in Denmark, and we are staying inside about 90% of the time. (Qvist and Raffbsøe, 2018) Therefore, to aim for more sustainability in the building sector is not enough to focus on energy consumption. There is a need to focus on other parts of the building. (Qvist and Raffbsøe, 2018)

Green building certification schemes guide designers and constructors of the building to from different angles. Since the previous green building certifications were focusing mainly on the building's energy efficiency. While some of the latest green building certification schemes are focusing on the circular economy and sustainability approach, for example, Danish DGNB. (Reith and Orova, 2015)

Deutsche Gesellschaft fur Nachhaltiges Bauen (DGNB) is a German Sustainable Building Council's systems of sustainable building certification. It consists of six major qualities in which develop into holistic framework assessing the overall sustainability of the building. DGNB addresses all three pillars of sustainability – Economical, Environmental and Social; each of the pillars weighted by 22.5% of the total score of the certificate system. Besides that, the technical quality weighted at the same rate as the three pillars of sustainability – 22.5%. The other criteria such as process quality represent 10 %, and the site quality assessed separately, you can see the evaluation criteria in **Figure 5** (Green Building Council Denmark, 2017b)

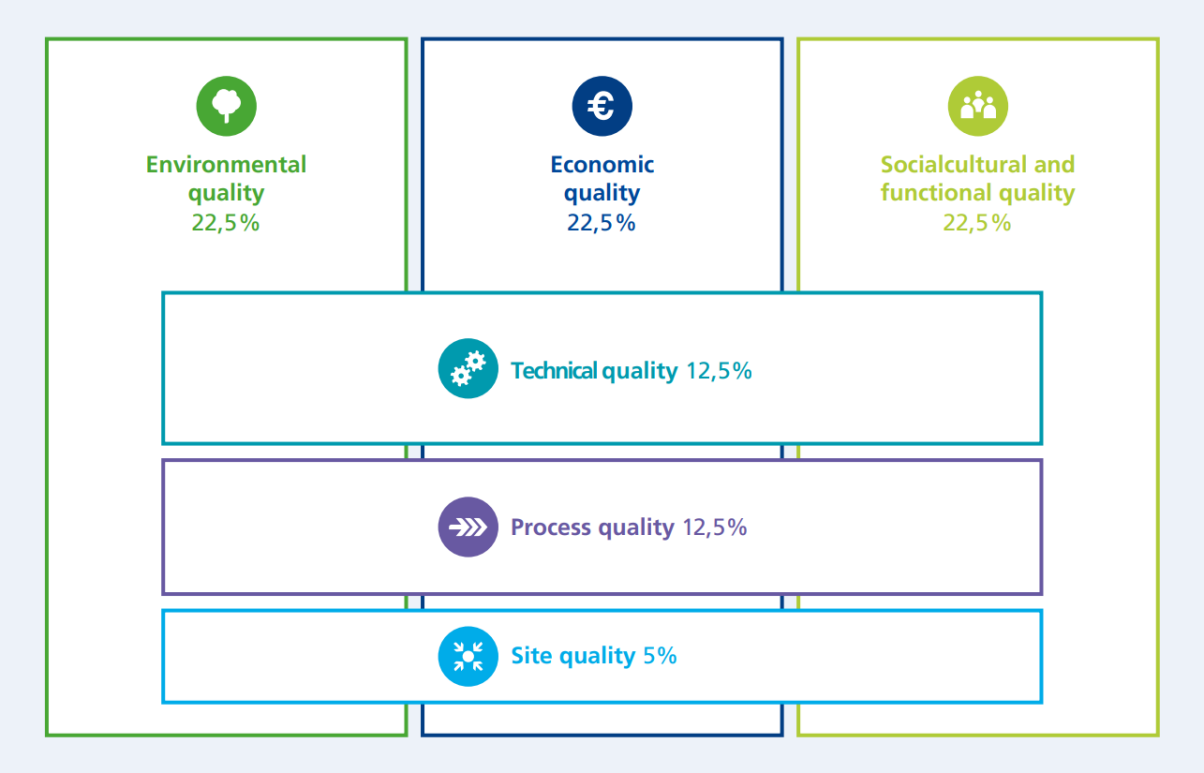

Figure 5 DGNB evaluation weighing (Green Building Council Denmark, 2017b)

In practice, the DGNB certification scheme is used more as a management tool or quality assurance purpose. The principle of DGNB is to involve all the actors and stakeholders from the early stage of the project throughout the whole project execution process. The criteria provided by the certification scheme guide architects, planners and building owners to build and renovate existing buildings in the way they would be more sustainable. Therefore, it assists as a communication tool among people with different specialities in the project group.

The DGNB certification has a reward system in which it reflects the completion of the criteria provided. Building gathers at least 35% of the overall performance, receives DGNB Bronze reward. For achieving higher awards, there are made minimum performance requirements from each category. Therefore, to get a silver reward building must obtain a minimum of 50 % in total performance and at least 35% in every group. These rewards calculations are scales up to DGNB Platinum reward, which requires a minimum 65% performance in each category and at least 80 % in total performance. (Green Building Council Denmark, 2017)

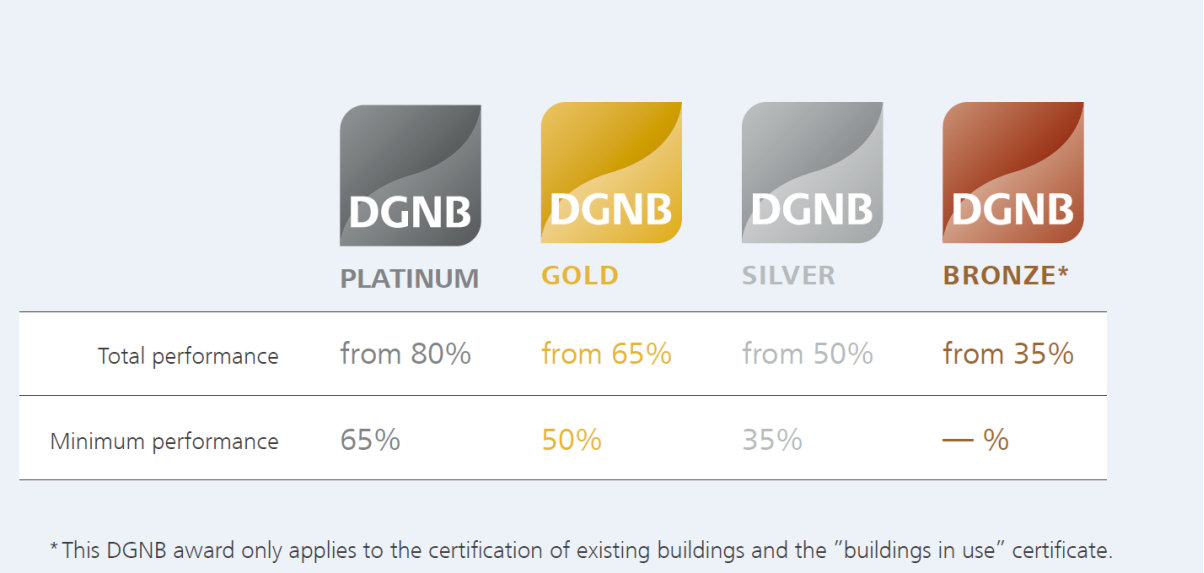

Figure 6 DGNB certification reward system (Green Building Council Denmark, 2017)

The certification categorised into 13 sustainable aspects showed in the Figure below (Guldager Jensen *et al.*, 2018). Each of the aspects addresses one of the three quality groups (Environmental, Economic, Social). There are three critical aspects out of 13, which have the highest attention. From the Environmental quality part, it is the **Resources** which contributes 15% of the entire assessment. Whereas, on the economic quality - **Life Cycle Costing** as 13% of the overall evaluation. In the last, social quality group, the highest attention is on **Health co**ntributes as 21% of the total assessment.

Figure 3-1 DGNB Certification Criteria(Guldager Jensen *et al.*, 2018)

In the environmental quality aspect – resources are evaluated by the Life Cycle Assessment (LCA) methodology (Green Building Council Denmark, 2017). It is one of the tools to calculate and assess the impacts on the environment of products, services, etc. This way, the DGNB certification scheme by using the LCA can compare different types of solutions and allow the decision makers to choose a more environmentally friendly solution. Additional to this, encourage to use product which has EPD (Environmental Product Declaration) which is a volunteering declaration based on LCA. Even though the EPD is independently verified and registered documentation of the product, it does not show that it is way better than the alternatives to the product (EPD International AB, 2017). Furthermore, regarding the resources as the criteria, the DGNB focuses on the thermal insulation and energy usage throughout the whole lifetime of the building. (Guldager Jensen *et al.*, 2018)

In the Economic quality aspect – LCC (Life Cycle Costing). LCC is a tool for assessing the overall cost of the alternatives (Sami, 2014). In the DGNB certification, The LCC contributes as a tool for decision making on the design of the building, cause it addresses subjects as cleaning and maintenance of the building products. (Guldager Jensen *et al.*, 2018)

The DGNB certification scheme also investigates the material origins and the substances it consists of. For the materials currently cannot be assessed by LCA, there is another assessment criterion for this type of materials. It will be rated by the quality levels which are qualifying minimal requirements, within each category, can be seen in **Figure 3-2** below.

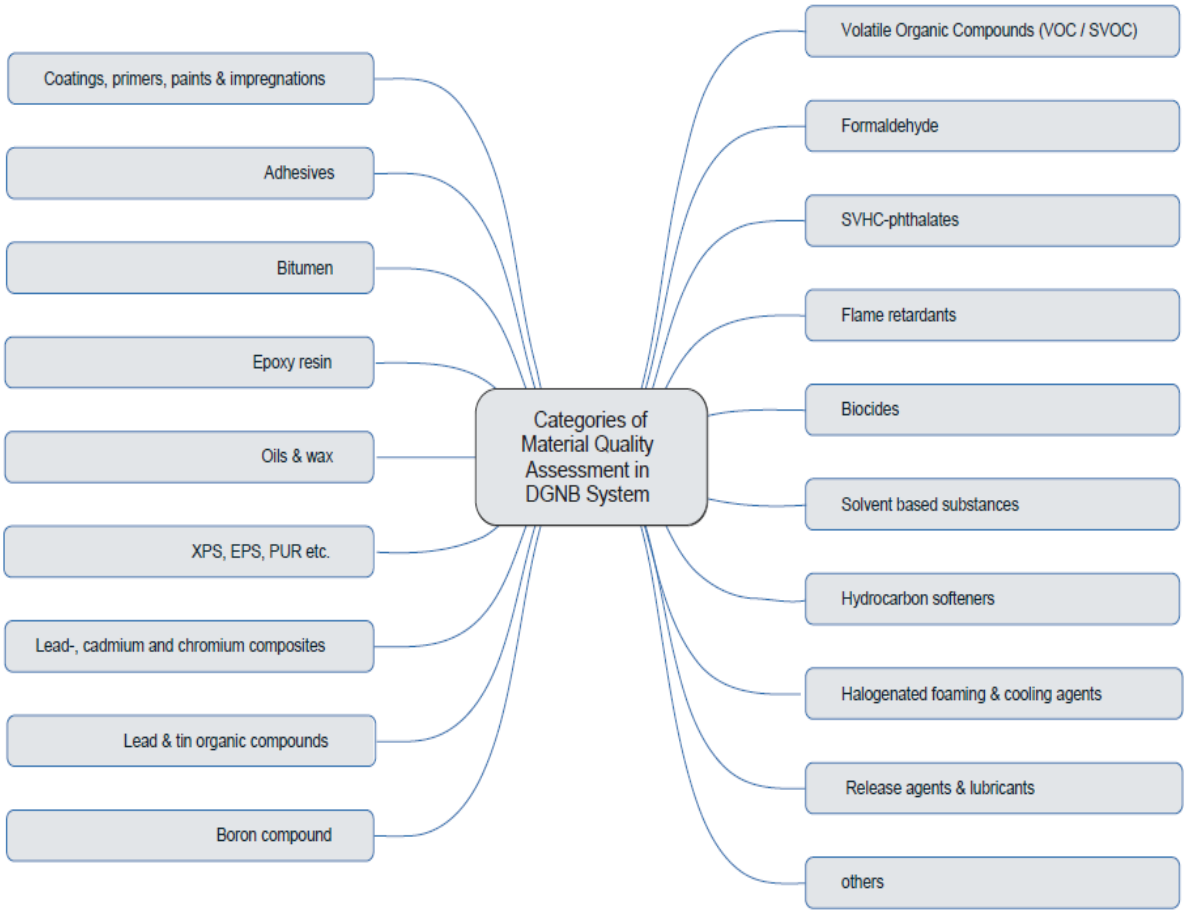

Figure 3-2 DGNB List of unwanted substances (Heinrich and Lang, 2019)

4 Eco-labelling

Eco-labelling can be associated with a tool for marketing purpose. On the other hand, it indicates the quality product. It assists to the end-users to identify products that are environmentally friendly and has socially desirable characteristics. The products which are supposedly labelled by eco-label is associated with the production along its entire life cycle for being environmentally and socially responsible. (Cai, Xie and Aguilar, 2017)

4.1 EU Ecolabel

The EU eco-label is environmental excellence reward that is given to the products and services which match-high environmental standards throughout their lifecycle (raw material extraction- production – distribution and disposal.)

Furthermore, this eco-label promotes circular economy concept by encouraging the producers to generate less waste lower their CO_2 footprint during the manufacturing processes. Also, the EU eco-label inspire companies to develop a new design of the products that it would have features as long durability; simple disassembling and would be recyclable. (Euopean Eco-Label, 2017)

4.2 The Nordic Swan Ecolabel

The Nordic Swan Ecolabel (NSE) is a certification scheme which promotes sustainable development and circular economy concepts. Ecolabel used as a tool to assess sustainability throughout the entire life cycle of the product – raw materials, production, consumption and waste recycling.

It addresses the circularity in the way the products documented in the building and providing the quality stamp as the products without the toxic materials which can be brought back to the biological cycle. (Guldager Jensen *et al.*, 2018)

The Nordic Swan Ecolabel has 60 different product groups which can be certified. In each of the product groups, there are a set of criteria and the description of materials types which included or excluded from the product group.

Whereas, NSE in the building sector focuses on the building's energy use, indoor environmental, chemical product together with building products or goods. Furthermore, it consists

of requirements for quality management and construction process until the handover of the building to the residents. (Nordic Swan Ecolabelling, 2016)

4.3 Cradle to Cradle

Cradle to Cradle (C2C) certification focus on the three pillars of sustainability addressing the Economic, Environmental and Social issues of human design, use of product and services. The main objective of C2C is to improve and change the way people make, use and reuse different products.

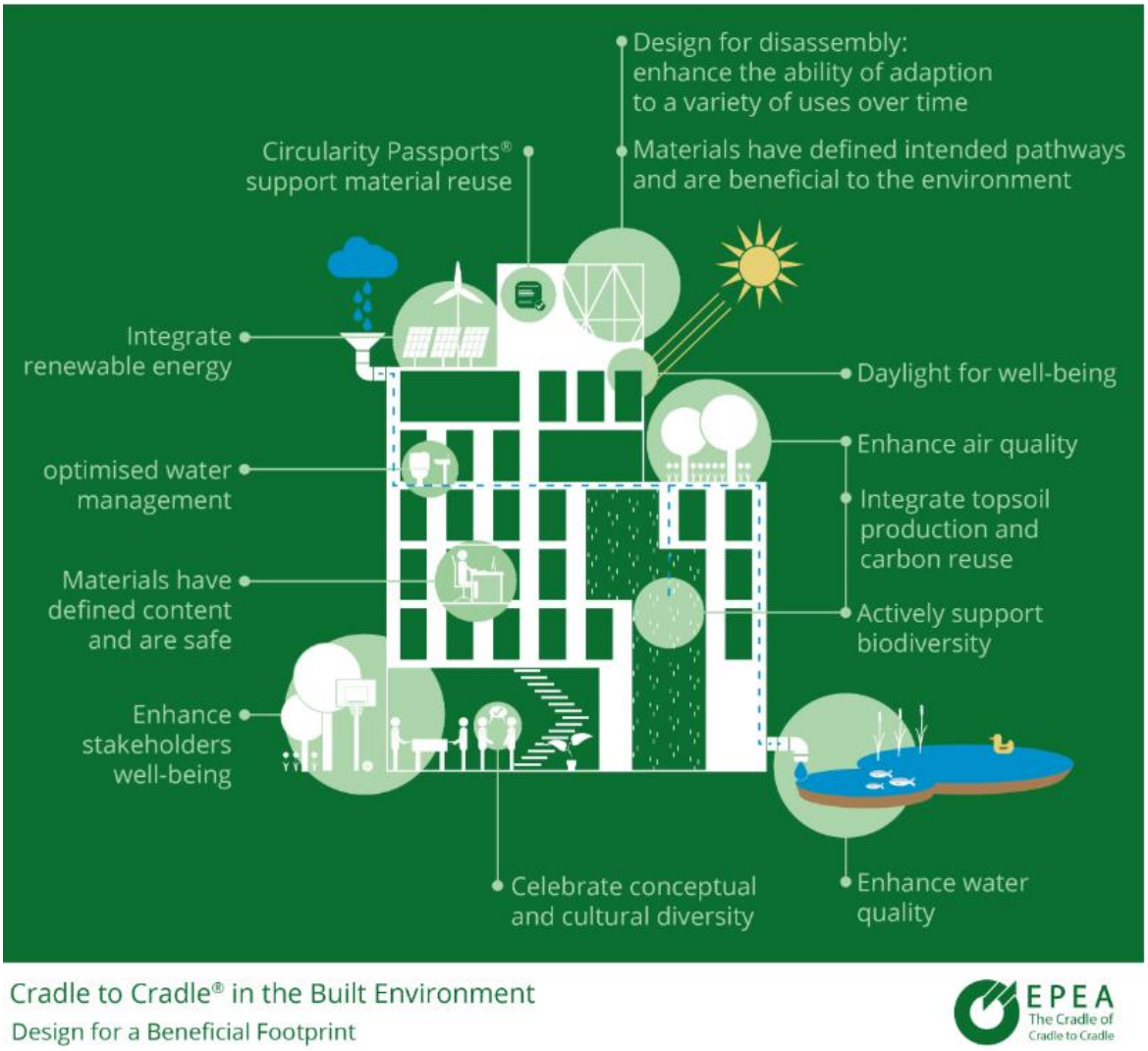

Figure 4-1 Cradle to Cradle in the built environment (EPEA - Internationale Umweltforschung mbH, 2019)

The Cradle to Cradle certification promotes the circular economy models. The certification aims to biological and technical circles. In the built environment, it does promote the design for disassembly, the materials which are used supposed to be environmentally friendly, and it requires circularity passports. (EPEA - Internationale Umweltforschung mbH, 2019)

4.4 *Energy labelling*

Energy performance of buildings directive was established to boost energy performance within the buildings in the EU. This labelling aims to promote energy savings by visualising the building energy efficiency and the potential improvement it might reach. (Danish Energy Agency, 2019)

The energy performance certification informs the user on the energy preliminary energy consumption level of the building. Below there is an example of the Energy labelling.

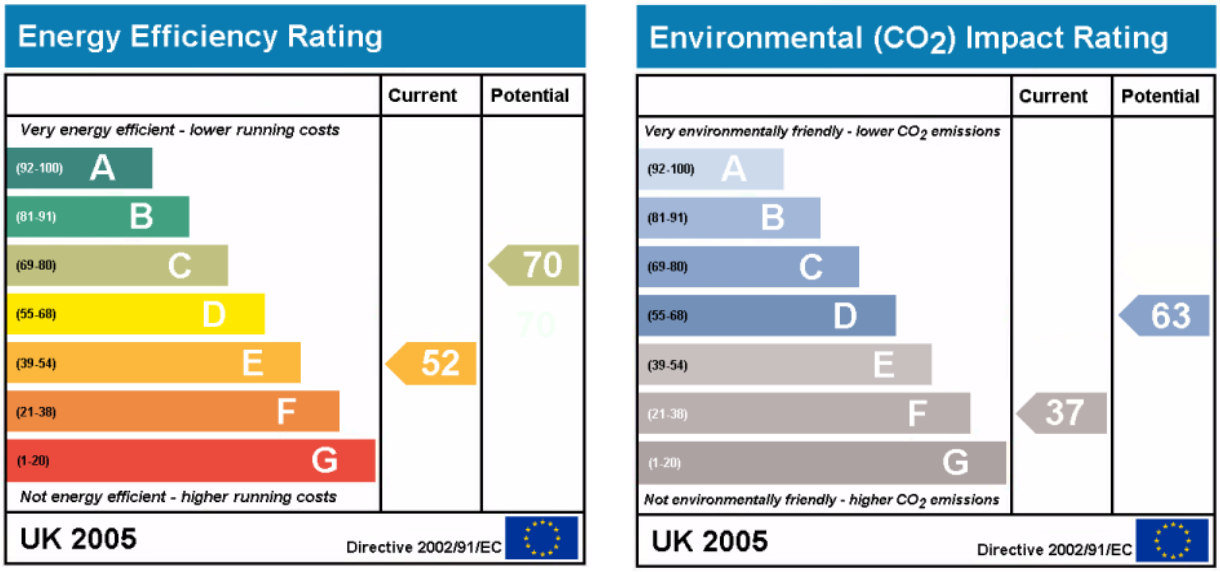

Figure 4-2 Energy efficiency rating with Environmental impact rating (UK Home Performance Rating, 2005)

The Figure above indicates the building energy efficiency whereas A is the highest and G is the lowest assessment – meaning building evaluated by the grade G will have a higher running cost compared to for example building which is evaluated by grade D.

5 Design for Disassembling

Design for Disassembling is one of the solutions for transition from a linear economy towards circularity in the building industry. The building would be design in the way they could be transformed or dismantling its systems, elements without damaging materials. This type of design supposed to guarantee high reuse potential and reduce maintenance cost as the material can be replaced, removed. To achieve transparent reuse of the materials and the quality standards, the tool as material passport should provide the necessary information about the product.

Furthermore, Design for Disassembling can be interpreted not only a way how to recover the materials but also as a possible way how to manage build space. (Eberhardt, Birgisdóttir and Birkved, 2019)

5.1 Material Passport

To achieve circularity within buildings, there is a need an information gathering and storing system which can be used throughout the whole value chain of the building's materials lifespan. The detailed information on the products usually is not publicly available because of the protection of intellectual property rights. The one way of storing this type of information is the material passport. (Heinrich and Lang, 2019)

This type of passport is a digital set of data which defines the characteristics and components of the material in products and systems that give them value for immediate use, recovery and reuse.

Furthermore, a Material passport is a tool which provides more detailed information about the product. In theory, this tool supposed to assist in analysing the material value for recovery and as the management tool for material fate after building demolition. (Heinrich and Lang, 2019)

Problem Statement

The North Sea Region countries spend around 14% of their GDP on the public procurements, which are approximately 1.9 billion euros annually (Semester and Factsheet, 2017). The population of the NSR consumes 960 million tons of raw material and produce 360 million tons of waste and 21 million tons of CO_2 emissions. Primary investigation revealed various interlinked problems within the Public procurements and the way they conducted today. The urbanisation, rising human population and consumption and production have a consequence on the environment.

Furthermore, the need for the alternative way to form the public procurements. The alternative supposed to conserve the natural resources, while fulfilling the rising demand for raw materials, moreover, as a solution which would contribute to the three pillars of sustainability.

Therefore, from the initial investigations, the following research questions were constructed.

Problem Statement:

How can municipalities facilitate the transition from traditional public procurements into more circular procurements within the Danish building sector?

Sub-Questions:

- What tools/methods have been applied earlier and today? Including what is the role of the building code and DGNB?
- How can municipalities encourage businesses to aim for sustainability and circularity?
- What should be the minimum requirements from the municipalities for the circular building projects in public procurements?

Delimitations

This project utilises qualitative interviews for investigation, which will be elaborated on further in the report. The cases will be taken all around the North Sea region, especially from Denmark. The examples selected to address the problem statement.

Different scientific articles and paper have been studied as the primary desk-research to understand different approaches to the sustainability and circular economy within the building industry. It has also done to analyse the current situation of the public procurements and how they are conducting today.

Interviews were done with the experts and the project managers who are working with sustainability and circular economy and public procurements within the building industry. These interviews give a better understanding of what are the current problems for applying the circular economy concept in PP. The experts have been selected because of their backgrounds and expertise in the circular economy. Furthermore, to find out the problems, there are facing in their municipalities and countries and finding out what tools are they use for solving the issues.

The target group of this research is municipalities and institutions responsible for conducting the public procurements within the building industry.

6 Methodology

Data Collection

6.1 Literature review

To answer the research question and the sub-questions data collected through different activities. For setting the basis for the project, desk research has been done. This type of research helped with setting the research questions and delimitations. For the desk, research information has been used from different scientific articles, publications, annual reports, reports on the successful examples within the circular economy. Furthermore, desk research provides an overview of the current situation and the tools for addressing the circularity and sustaina

6.2 Semi-structured interviews

The purpose of semi-structured interviews is to allow to collect the data in a manner that prevents the tendency for an interviewee to lead a conversation. It also encourages conversations to be conducted into areas of interest that the interviewer may not have considered, and this additional knowledge could prove essential and necessary to the research. Semi-structured interview utilises open-ended questions to let the interviewees broaden up their answers. (Uwe Flick, 2004)

The open-ended questions are the qualitative technique. It can be accomplished by minimising the influence on the interviewee and avoid limiting the respondent in his answers. Furthermore, the open-ended questions allow the interviewer to go in-depth with the answers together with the interviewee if needed. It can result in obtaining rich data with disclosed and profound information. (Uwe Flick, 2004)

The following types of questions used in the interview guides:

- **Preliminary Questions**: Offers the opportunity to discuss the subject relevant to the research area
- **Supplementing Questions** Are used to continue the conversation and offer the chance to elaboration on relevant details
- **Structured Questions** Used to stay on topic, these questions bring the conversation back around if they have gotten off track
- **Direct Questions**: Used to gain clarity if the intent of a statement is unclear

- **Explanatory Questions**: Used to engage a particular conversation topic further

(Uwe Flick, 2004)

The interviews were conducted in English and as telephone interviews or in-person interviews. Interview guides were made in order to structure the interview in the way it would be possible to obtain the needed data see Appendix. The resumes were also sent to interviewees and approved when and where requested. These telephone interviews were approximately 35 minutes to one hour long.

For the qualitative research, the experts and actors such as representatives from municipalities interviewed. The experts selected on both national and transnational level, who have a close work partnership with Denmark and involved in projects regarding the circular economy and sustainability. Interviews have been conducted with persons whose expertise in the building industry.

Table 4 shows the persons who have interviewed, persons current occupation, interview time and date, and the duration of the interview.

Figure 6-1 Interviewees

6.3 Events and Workshops

For the additional information and findings on the current market in the building sector. I have been attending the annual two days conference (05.04 – 06.04) - Building Green Aarhus 2019. During this conference, I was able to meet different representatives and experts within green buildings and sustainable solutions for the building sector. Nonetheless, it was an opportunity to find out upcoming trends, niches and success stories and hear the critical discussions on different aspects within the built environment.

Furthermore, I have been invited to participate in the workshop in Amsterdam in The Netherlands; it was a three days' workshop from 07.05.2019 to 09.05.2019. It was held by the Rejswaterstat the Ministry of Infrastructure and Environment. The workshop was done for the new project ProCirc, which is funded by Interreg North Sea Region. Shortly, this project is focusing on helping the municipalities and procurers to conduct the public procurements more circularly. Furthermore, the project group is making the Pilots on the three sectors such as Building sector, infrastructure and furniture.

During this workshop, the issues and potentials of the circular economy in public procurements. Most importantly, one of the main discussions were on the tools on how to assess the circularity and different approaches to it.

6.4 Survey

For the additional information and to get an overview of the tools and knowledge regarding the circular economy in the building sector. The survey sent to 98 Danish Municipalities. People for the survey have been chosen by their nature of work. The criteria for selected people was that they supposed to work within the building sector. Therefore, the people from the Teknik of Miljø department was selected. When it was possible individual people contacted for the survey and in other cases, it was sent to the general email with a request to send the survey to the right person.

6.5 Conceptual framework

Multilevel perspective

The Multilevel perspective explains that the transition from the innovation to the mainstream usage happens throughout three different levels – ***the niche, the regime and the landscape***. Whereas, ***the niche*** referred to unique change which it develops from the idea, invention or innovation to the applicable market. The regime represents the systems which exist and

functionals currently throughout the cognitive, regulative and normative institutions. The Landscape represents the global or nationally significant events which can affect or disrupt the current regime and influence the adaptation for the niche to take a major place in the regime level, i.e. it could come as climate change, war, environmental disaster, etc. (Sovacool and Hess, 2017)

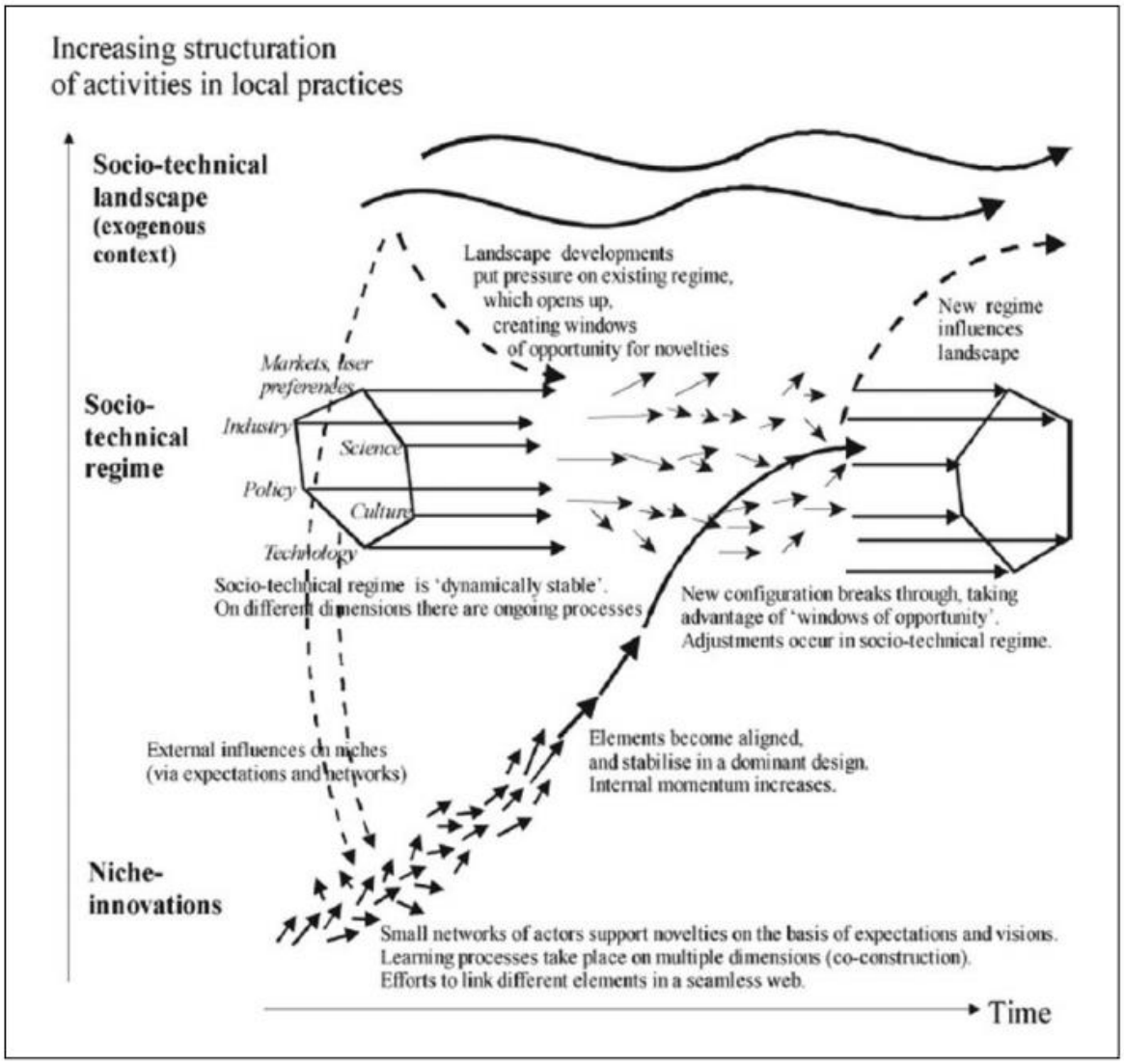

Figure 6-1 Multi-Level Perspective - the niche, the regime and the landscape (Sovacool and Hess, 2017)

The Multi-level perspective can be understood as a disruptive innovation changing the settle regime within the Socio-technical regime. Which have been influencing or accelerated by the landscape.

Institutionalisation

Institutionalization is a part of the MLP (Multi-Level Perspective) it consists of three stages: habitualization, objectification and sedimentation. The first stage of the institutionalization is the habitualization in represent the small group of individuals using the specific innovation, where there is no general agreement on the usefulness of the innovation as there is no theory or knowledge about the innovation. The second stage of institutionalization is the objectification. In which the general agreement become to appear among the decision makers who are responsible for creating the infrastructure for the innovation and develop a structure. The last stage of institutionalisation is sedimentation. In this stage, the innovation has been used long enough as it becomes normative, which have the historical continuity of structure. (Fuenfschilling and Truffer, 2014)

7 Data Analysis of Empirical Findings

This chapter presents the analysis of the interviews and several methods and guidelines of the circular economy. With the use of the conceptual framework, the investigation addresses the main research question and the sub-questions. Results of the analysis will be divided into different parts. Each part will be answering the questions mentioned in the problem statement.

7.1 Survey

The first part of the investigation is the survey which has sent to 67, and 18% of the experts have filled up the questionnaire. The correspondents have been asked to answer 17 questions.

How well are you familiar with the circular economy model?

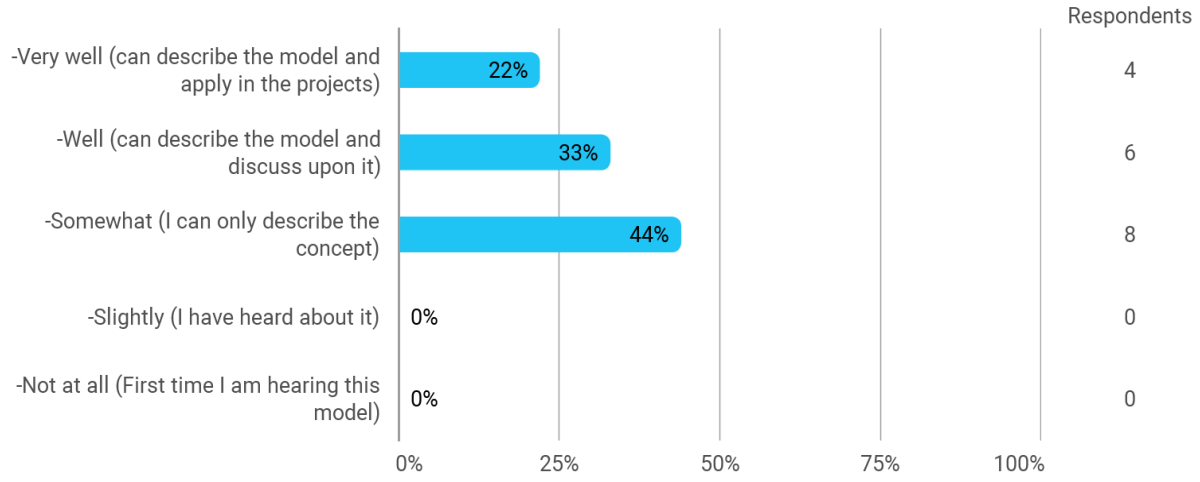

Figure 7-1 How well municipalities are familiar with the circular economy

On the question regarding how familiar they are with the circular economy, the majority, 44% have answered that they are somewhat familiar with it. It means that they can describe the concept of the circular economy but do not know how to apply it on the projects. Whereas, 33% of answers saying that they know the concept well and can discuss it and not only describe it. Moreover, 22% have answered that they know the concept of the Circular economy very well, and they know how to apply to the projects.

It shows that the concept of the circular economy is spreading widely, but there is a lack the knowledge on how successfully implement the concept in building industry's daily basis activities. It shows the positive pathing of the circular economy within the building industry.

The second question has shown the current understanding of today's building industry.

Do you agree that building sectors model is made on the linear economy?

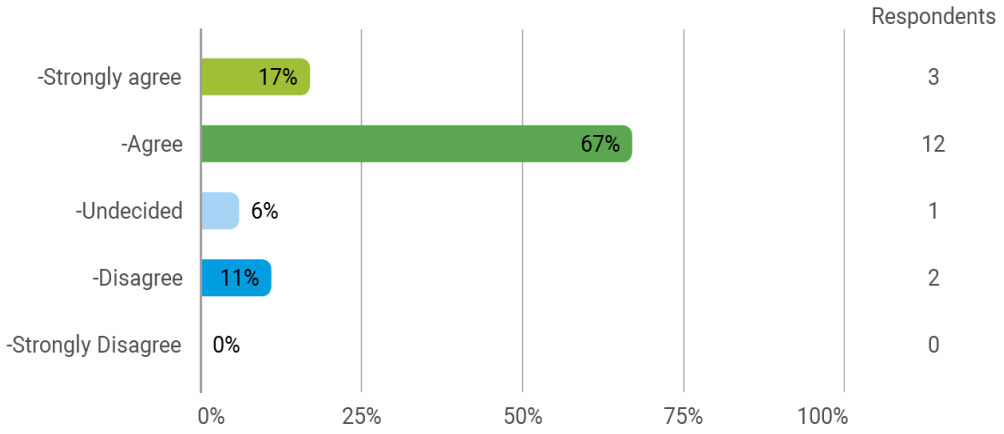

Figure 7-2 Is building sector model based on a linear economy

The most replicants 67% have answered that they do agree that the building sector made on the circular economy model, and 17% strongly agree with this statement. Whereas, 11% disagree with it, and the last 6% states that they are undecided on this statement.

It indicates the current status of the building sector on the way its design.

How important is circularity in your ordinary projects?

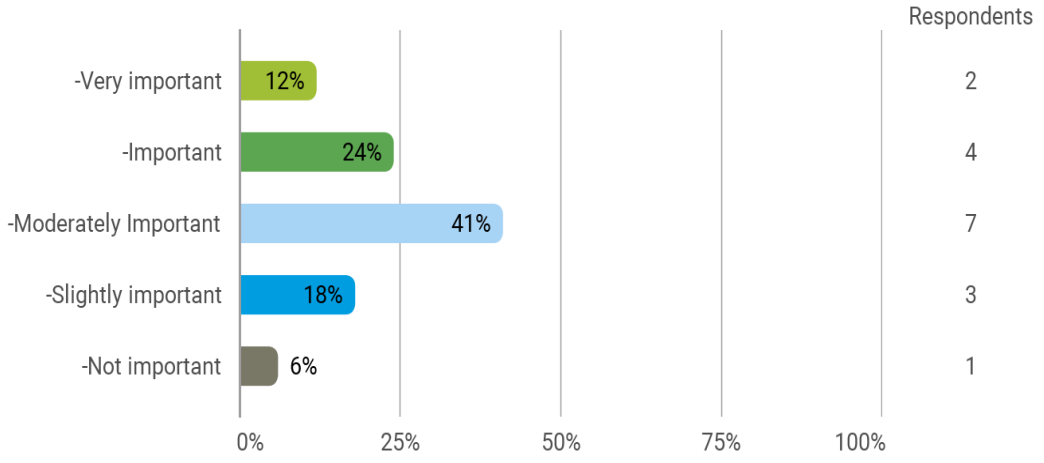

Figure 7-3 How important is Circularity in ordinary project

The importance of circularity within ordinary projects shows the different distributions among the respondents. 12% of the respondent has answered that circularity is very important within their regular projects. 24 % responded that it is important. The highest percentage

(41%) of respondents have answered that is moderately important, 18% have indicated that it is slightly important, and 6% of the respondents answered that it is not important at all.

It shows that depending on the project; the circularity addressed on different levels. The answers show that importance does differ; it might happen on the complexity of the project, stakeholders, how procurement is made, etc.

Do you have/know tools for assessing the circularity in projects?

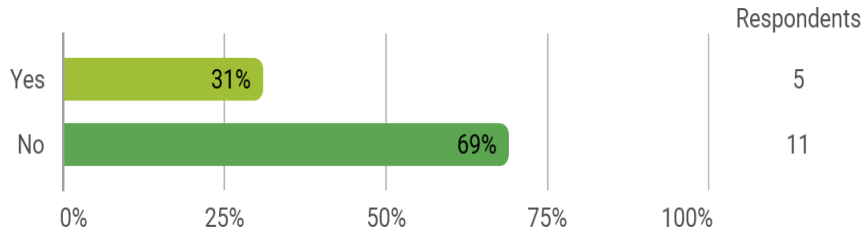

Figure 7-4 Tools assessing circularity

To the question, if they have or know tools for assessing the circularity have shown that 69% of the answers say that they do not have or know any tools and 31% of responded that they do or have tools for assessing the circularity.

The results of this question show that even though the circularity is essential in their ordinary projects, they have no tools to set and follow up on the requirements of circularity.

What is the name of the tools?

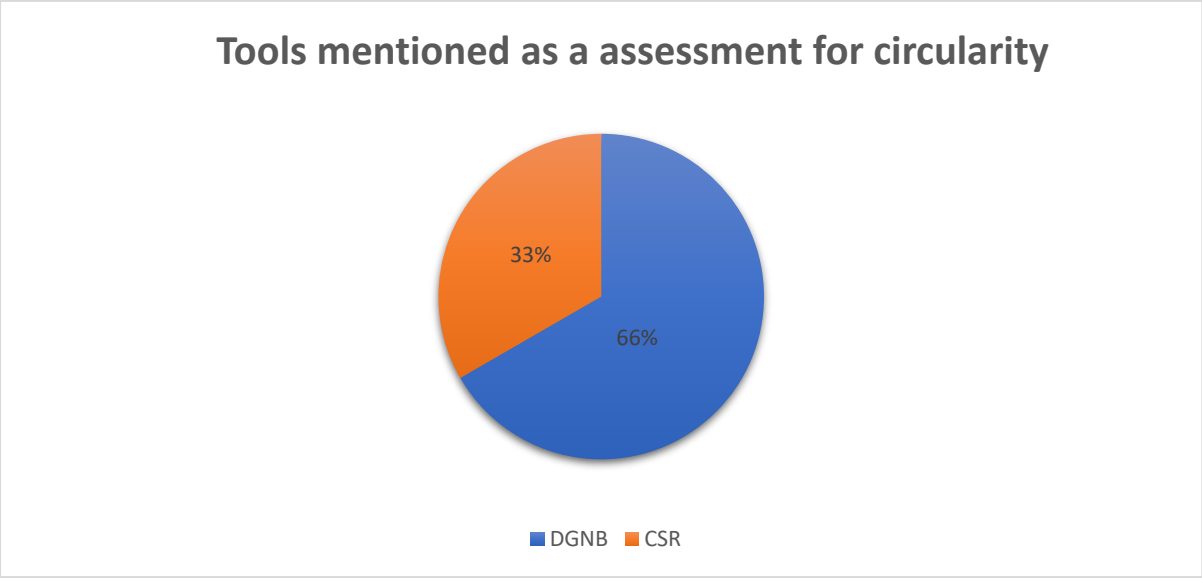

Figure 7-5 Indicated circularity tools

The respondents who answered „Yes “to the previous question have been asked to identify the tools that they have or know to assess the circularity. DGNB Green Building certification

scheme acknowledged the most as the tool for evaluating the circularity within the building industry. Respondents indicated in their opinion that CSR (Corporate Social Responsibility) as a tool.

The DGNB mentioned as the Green Building Council assessed different certification schemes, and the decided DGNB is the best for the Danish building market. It is described in chapter **DGNB and Green Building Council.**

How important circularity is in conducting Public procurement within the Building sector?

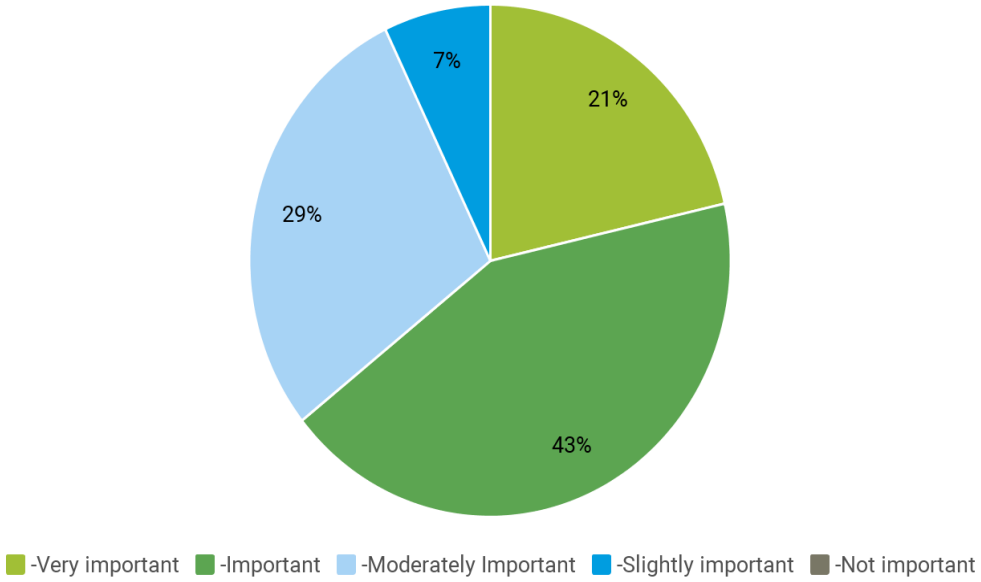

Figure 7-6 Importance of circularity in public procurements

The answer's distribution on importance of circularity in the public procurement shows that 43% of the respondent answered it is important, 21% indicates the circularity as a very important part in conducting public procurement in the building sector. The other part of respondents, 29% states that circularity is moderately important, and 7% of replicant states it is slightly important. The results indicate that either way, the circularity is an important requirement in public procurement. There was no one stating that circularity would be not important. The following questions are addressing another part of the circularity and the design of the building.

How important is Design for Disassembling to achieve circularity within buildings?

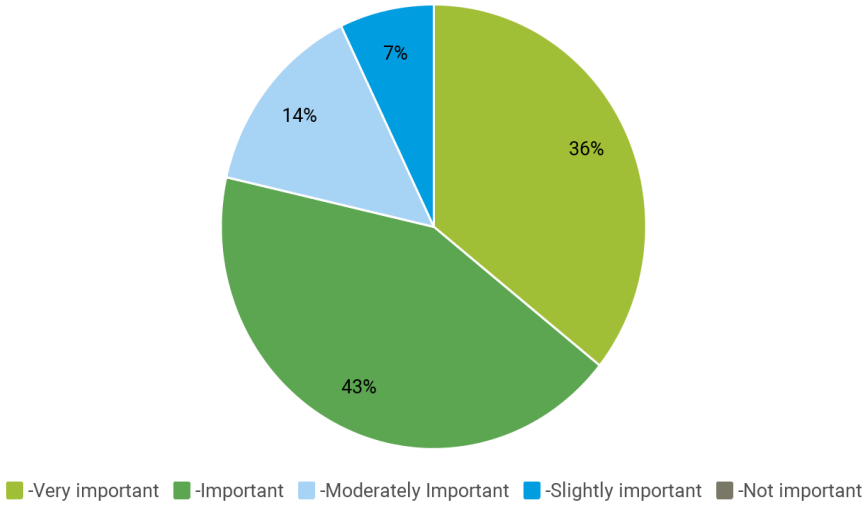

Figure 7-7 Importance of Design for Disassembling

Respondents acknowledge that design for disassembling is an important aspect of attaining the circularity within the buildings. Most of the respondents (43%) have answered that it is important, whereas 36% have stated it is a very important part. While 14% have said, it is slight moderate important and 7% that is slightly important.

It shows that the design of the building has a significant role in achieving the circularity. Respondents have been asked to name eliminations of Design for Disassembling in their opinion. The respondents have indicated five main limitations.

What are the main limitations of Design for Disassembling, in your opinion?

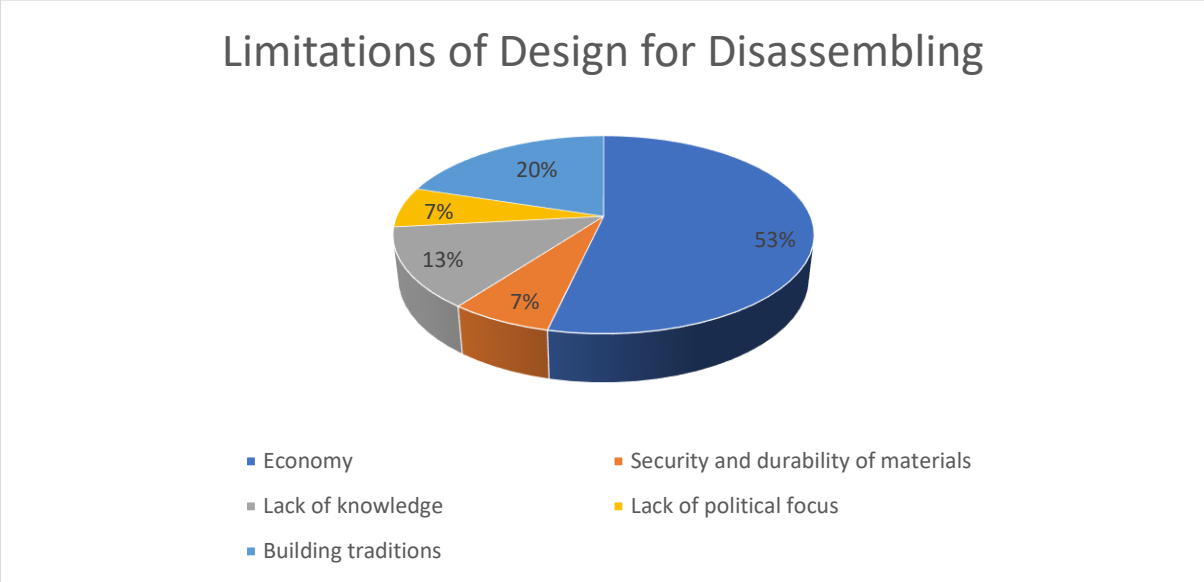

Figure 7-8 Limitation of Design for Disassembling

The economy was mentioned by 53% of respondents as one of the main limitations from their perspective is the economy, which means the cost of designing the building the way it would be able to disassemble. The second commonly mentioned: built traditions, it was stated by 20% of the respondents. 13% per cent of respondents have indicated the lack of knowledge on the concept of the design for disassembling. The last two limitations – lack of political focus and Security and durability of materials have got the same amount of responses – 7%.

The primary limitations remain economy as the moment the short-term investments in the Sustainable building. Furthermore, other barriers such as lack of knowledge and building traditions indicate the need for spreading information regarding the technical explanation on what is the design for disassembling to change the mainstream way of the built environment. This statement influences the following questions regarding the green building certification scheme which have been approved by Green Building Council Denmark.

How well are you familiar with DGNB (Deutsche Gesellschaft für Nachhaltiges Bauen) green building certification scheme?

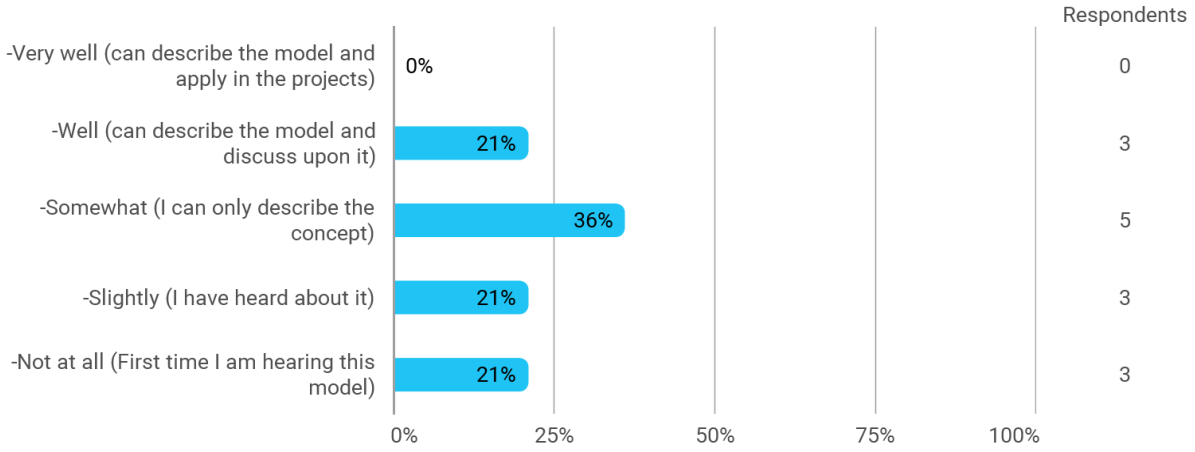

Figure 7-9 How well municipalities are familiar with DGNB

It shows that the knowledge about the DGNB green building certification knowledge distributed on different levels. The 21% of the respondents know the DGNB model well enough level in which they can describe and discuss upon it. Whereas 36% describe that they can describe the concept of this certification. Another 21% of the respondents have heard about this certification, yet they would not be able to describe the concept. The last 21% have never heard about DGNB.

Furthermore, the respondent who has heard or can describe the concept have asked about the role of the DGNB in assessing the circularity.

Do you agree that DGNB can be used as an assessment tool of circularity?

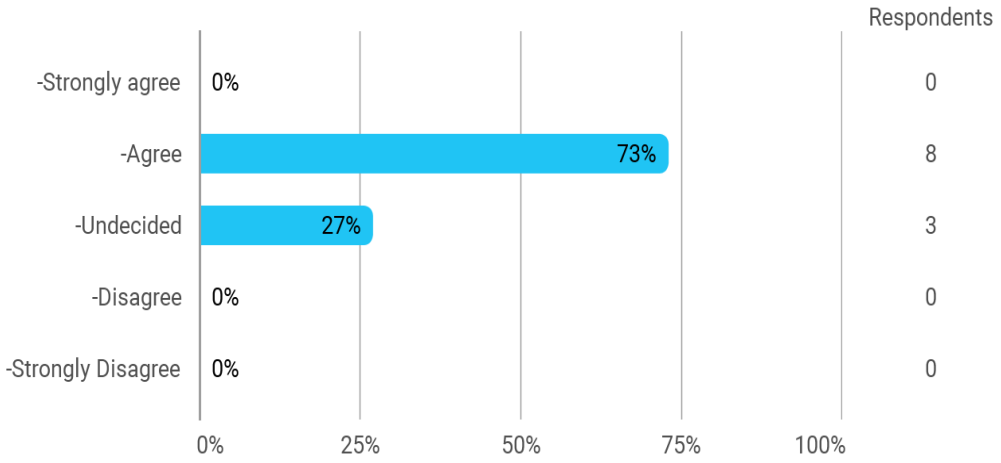

Figure 7-10 Can DGNB be as an assessment tool of circularity

Majority of the answered respondents (73%) indicates that DGNB can use as an assessment tool for circularity. While 27% are undecided. The results are interlinked with the previous questions. People who think DGNB can use as a tool for assessing circularity have a knowledge level on the concept of DGNB that they can describe it. Moreover, the respondents have indicated the DGNB as the tool for evaluating the circularity in the questions on their knowledge of tools.

Next question was mean to find out the knowledge on the material passport, as it is as a tool to show what components have been used to create a material and other information.

How well are you familiar with a Material passport?

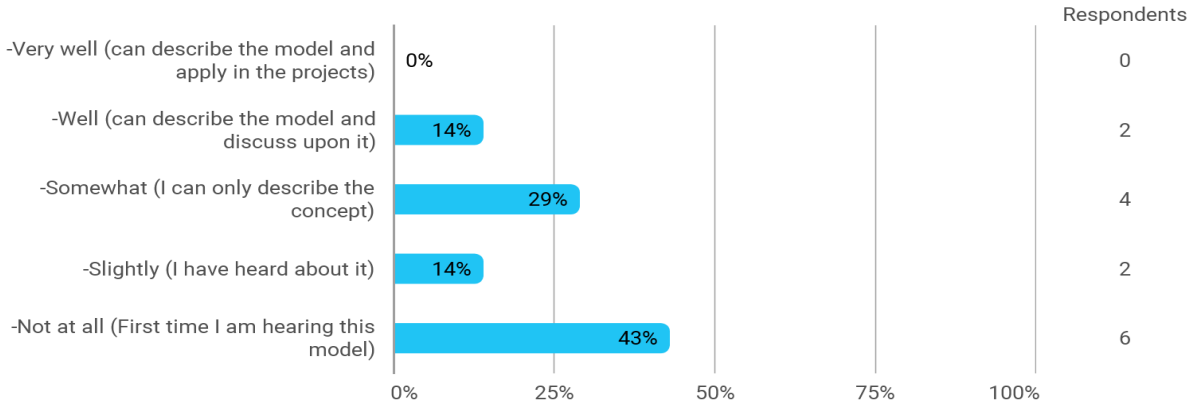

Figure 7-11 How well material passport is known

Most respondents, 43%, have answered that they are not familiar at all with the material passport. While 14% have heard about it and 29% can describe the concept. Moreover, 14% knows enough that they can describe and discuss the concept of material passport.

Furthermore, they have been asked to indicate the names of material passport. The names that have mentioned not all of them are the material passports.

- *InnoBYG*
- *FSC*
- *Madaster*
- *EPD*

None of the respondents has tried to use a material passport in their projects. As from the respondents, all of them have answered that they have never used the material passport on their projects.

Have you been using a Material passport in any of your projects?

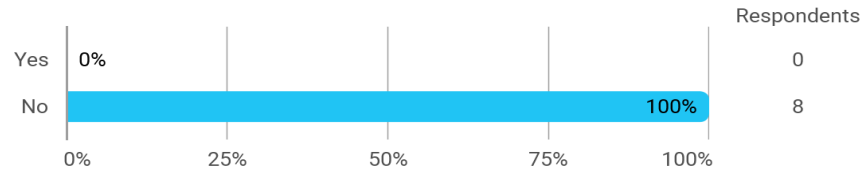

Figure 7-12 Have material passport been used in municipal projects?

They have been asked about their Municipalities strategy on the circularity. The half has answered that they do not have the plan to work with a circular economy, yet they do consider to create one in the future. Whereas, 14 % of the answers have stated that they do have the strategy on the circular economy within their municipality. 21% have indicated that it is on their Agenda and they are working on it. 7% of respondents have answered that they do not have a strategy, and they do not need one.

Does your municipality have a strategy regarding Circular Economy?

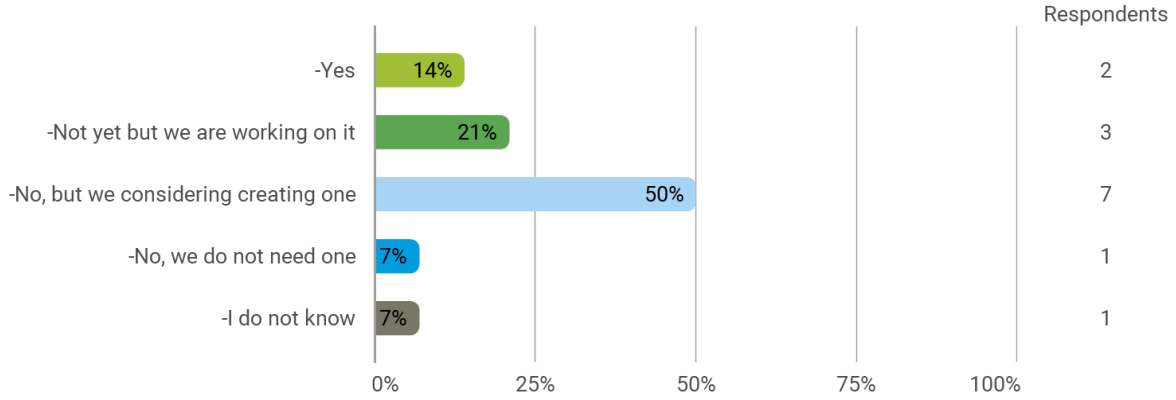

Figure 7-13 Does municipality have strategies on the circular economy?

Moreover, they have been asked to indicate how they could promote the circular economy. Respondents named these aspects of how they can encourage them.

- *There must be some solutions that are well tested*
- *lifetime economy*
- *By demanding a circular solution in the procurement decisions*
- *It is part of the City Council's official policy; we work with it in, e.g. waste solutions and new buildings*
- *I do not know*
- *By demand*
- *We could facilitate*
- *Cocreation*
- *By networking*
- *By defining the application of circular requirements in the tender phase*

The outcome of conducting the survey was to analyse the municipalities knowledge on circular procurement in building industry nationally. The main outcomes of the survey are:

- Need more good examples of circular procurements which are well tested and analysed.
- DGNB certification is recognisable as possible to evaluate if the building is circular.
- Municipalities can promote circular economy throughout setting the demand in their public procurement processes, networking
- The material passport have not been used in municipal projects within the building sector

7.2 Circular Economy Experts

This chapter will analyse data gathered from interviews with different stakeholders and experts within the circular economy. This analysis supposes to answer the main research question and sub-questions. The interviewees have been asked to answer questions about the circular economy and public procurement; interview guidelines can be found in the appendix.

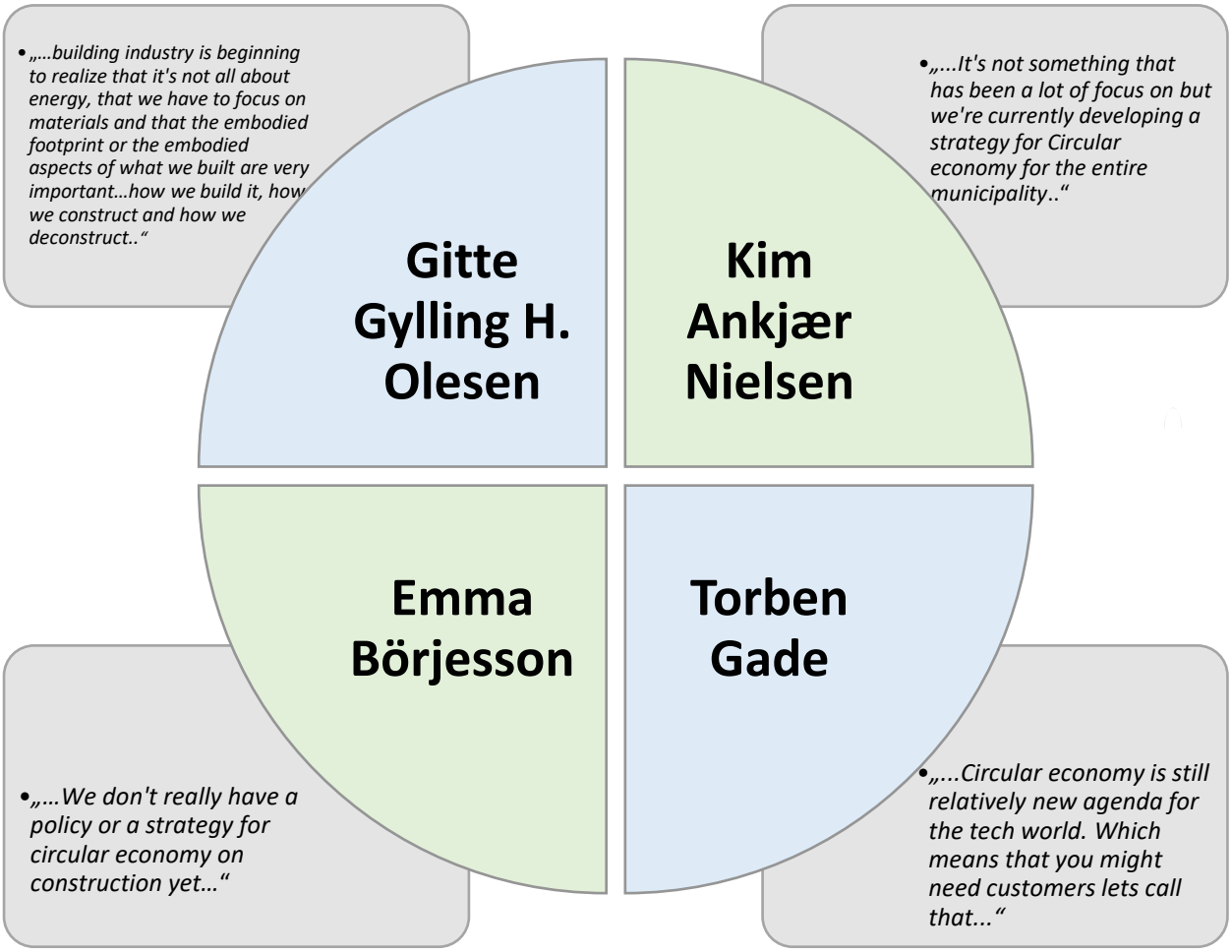

Figure 7-14 Circular Economy in the current market

Circular economy beginning to get a higher recognition within the building industry. The interviews show that a circular economy is starting to be one of the essential aspects when it comes to the building environment. Even though, steps are still slow as the building industry and procurements are the conservative places.

“...Public procurement is one of the most conservative areas you can find that it is very difficult to find new solutions in there is actually fit in all the procedures to public procurement is one of the higher-level conditions of change.” - Cuno Van Geet Rijkswaterstaat

Everyone has agreed on public procurement being approach in a linear way. Conducting a tender, procurers are focusing on minimising energy consumption. In other types, circularity understood as recycling. Furthermore, interviewees have been asked to name the tools which can be used for assessing the circularity at this moment.

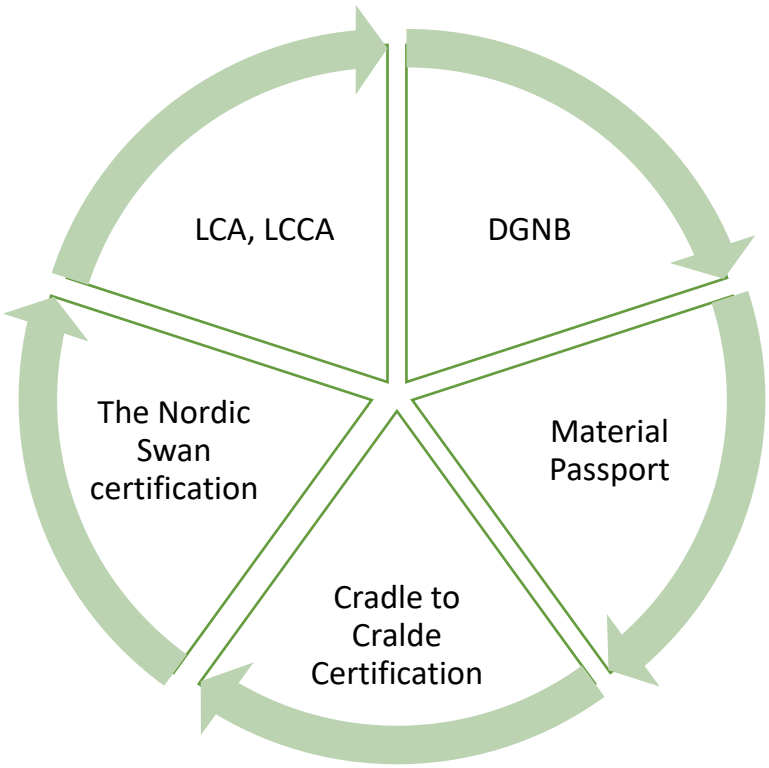

Figure 7-15 Tools for possible circularity evaluation

Tools for assessing the circularity in interviewer's opinion are stated in the diagram above. The focus is on the product's characteristics and what it consists of and how environmentally friendly it is. From named methods, the DGNB is the most suitable for assessing buildings as it initially created for buildings. Moreover, DGNB and the other certification schemes are as voluntary standard as an addition to the building code, which supposed to bring transparency to the project, but also work as a common language between different background expertise.

> *„It is a framework for how we can work with different aspects of sustainability. That is not only deducted "what is in the building" regulations... This is much wider because it unfolds sustainability and range of aspects to a much more holistic extent than a technical focus or our building regulation is able to."*
>
> - Gitte Gylling H. Olesen

The experts did not state one precise method which would work for everyone in the building industry. In their opinions, the main barriers for changing the more circular procurements. The main barriers are seen as the lack of documentation on the materials and infrastructure on how to deal with the materials after their lifespan, replacement, demolition of the building. It was mentioned three major point of concerns – ensuring the quality of the material after the use phase, the quantities of the material, where to store the materials and who supposed to be responsible?

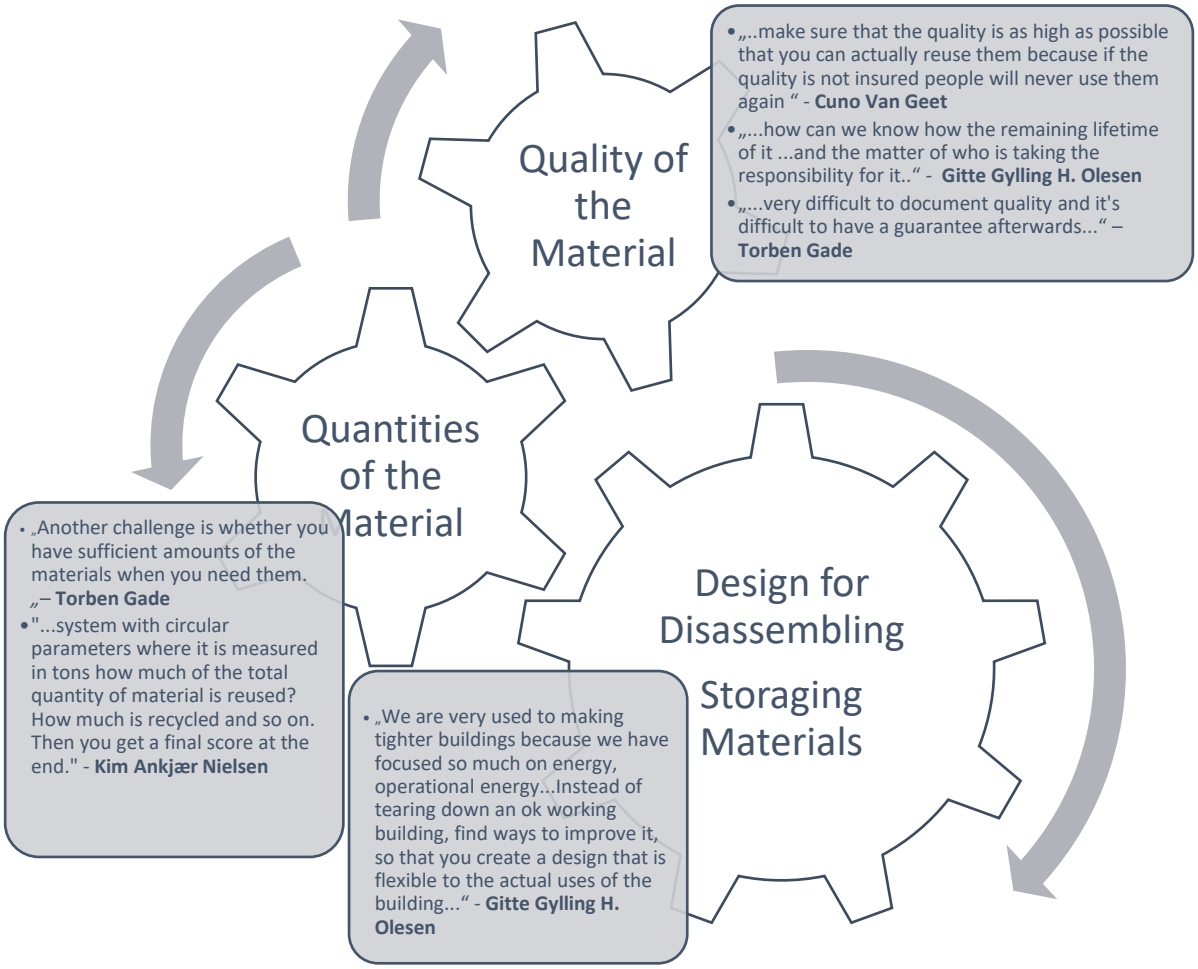

Figure 7-16 Barriers for the transition to a more circular market

One of the solutions is requesting more documentation from the manufacturer and follow through its value chain and end of life.

Every expert has agreed that the material passport is a great way to document what building consists of. This type of documentation of the materials will hand to hand with design to dis-assembling as it would assist working with maintenance and repair works, and concept such as building as a material bank and design for disassembling.

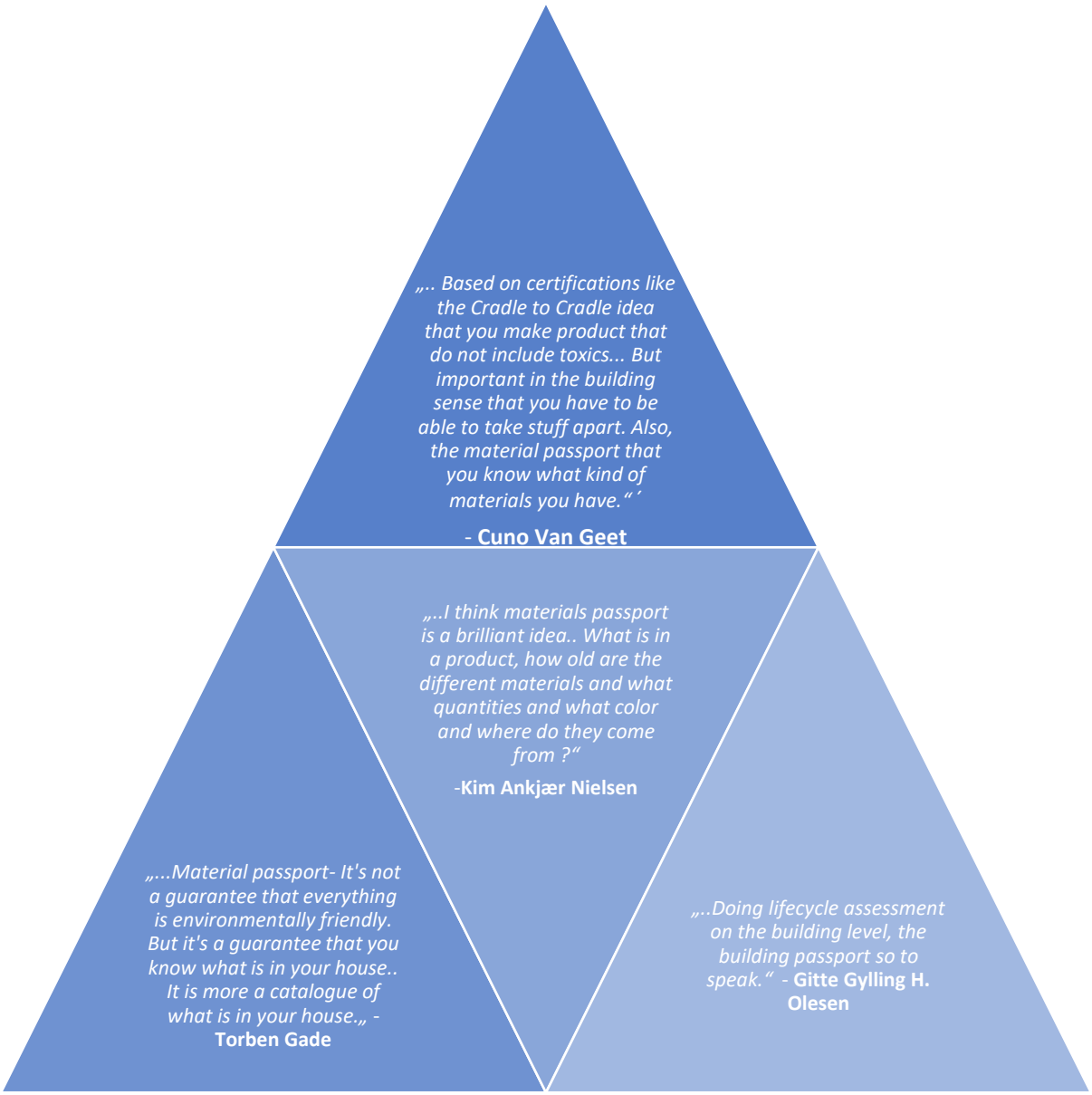

Figure 7-17 Material passport by the experts

Some interviewers acknowledge different certification schemes which criteria's design on geographical aspects too.. It is hard to exclude or indicate which one better than others. Every certification has its strengths and weaknesses, and it dependable on the project.

How can municipalities facilitate the transition to more circular procurement?

In the Figure below it is shown the main aspect what did the interviewees stated as the significant way how to facilitate the transition to more circular procurement.

Figure 7-18 Five aspects on how municipalities can facilitate the transition

Interviewees mentioned good examples of the pilots/project/procurements conducted in a circular manner which attracted and aware people on the significant issues and the possible solutions to it. Moreover, good examples would be as one way how to raise the level of knowledge about the circular economy in general.

Municipalities can put criteria in their public tenders on specific material sorting process which it has to be done on the construction site. By putting pressure on the company's management, which is responsible for construction, it would work as the top-down application for sorting. Moreover, there is a need for the structural change where the whole infrastructure and market would be capable of dealing with different material types, documentation, storing and transporting materials. The key word was „ ambition ", in the context that there a need to set the ambition for the project.

7.3 *From Ambitions to Solutions*

A different way of creating a circular way by setting a level of ambitions on the products which are used, bought or sold. The way how the procurers can push the market for innovations and sustainable and circular product design is to set clear project ambition. It is complicated to set strict requirements on the project when there is a lack of expertise in the field.

> "…We want the market to do this thinking for us… they are actually the built environmental experts, so we have the mindset of letting the market come up with a solution."
>
> – **Kim Ankjær Nielsen Kolding Municipality**

Nederland's hub – Circular Flanders is developing a method to assist procurers in assigning their ambitions. Circular Flanders is a partnership of government, companies, civil society and the knowledge community. (Circulair Flanders, 2019)

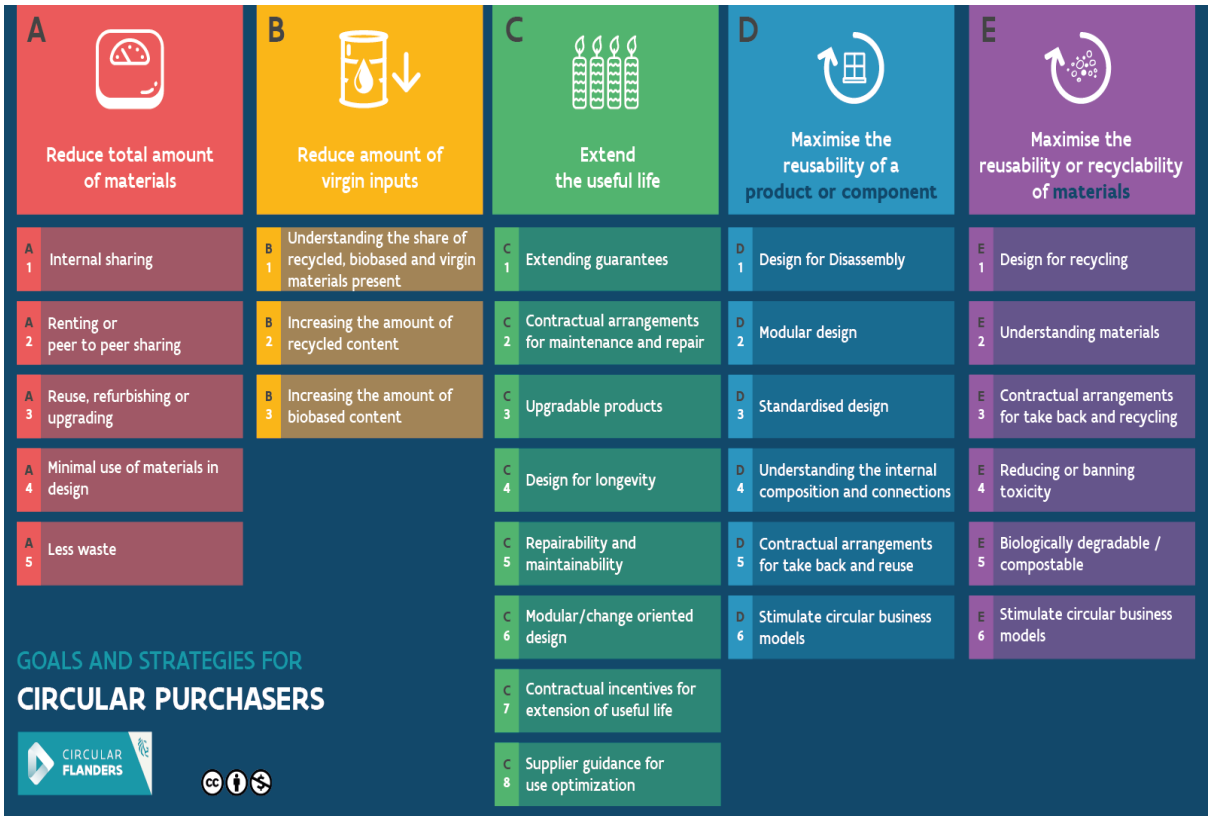

Figure 7-19 Circular goals and strategies made by Circular Flanders (Vlaanderen Circulair, 2019)

The method is based on five different circular strategies and goals:

- Reduce the total amount of materials;
- Reduce the amount of virgin inputs;
- Extend the useful life;

- Maximise the reusability of product or component;
- Maximise the reusability or recyclability of materials;

Procurer decided on which strategies are they aiming. Institutions can aim for all of them at once or go for individual goals. To assist the institution in choosing the correct strategy, they are developing a questionnaire for which will address each of the strategies or decide if there is a need to buy a new product.

"The real thing that is necessary to serve is that you need and then in your job description of your procurement, you must focus on that ambition."

- **Veerle Labeeuw Vlaanderen Circulair**

Furthermore, this method based on Meet the Buyer concept. These events help to analyse the market and potential product providers. Where the providers must indicate which strategies they tackle, how are they addressing them and provide documentation on it? The figure below shows the example which has been made in the Meet the Buyer event in The Netherlands.

Figure 7-20 Example of Meet the Buyer concept application (Vlaanderen Circulair, 2019)

The provider indicates they are addressing three of five circular strategies and provides a sum-mary. The method supposed to be used together with an independent assessment tool for the documentation as proof for materials characteristics.

Discussion

Limitation for data collection:

The literature review was conducted in a too broad perspective and would have worked better if it would concentrate on biological circular economy cycle or technical. Furthermore, there language barriers while analysing documentation in Danish and Dutch.

Conducting this research included the time restriction across to stakeholders and the acquisition of answers to interviews questions due to the possibility of interviewees willingness to participate and respond to the query.

Furthermore, the survey which has been sent to 98 Danish municipalities might not represent the correct situation due to the lack of answers received from municipalities.

The challenges conducting the interviews were that some questions which were prepared beforehand were phrased unclear and rather, therefore, it was sometimes difficult to control the interview. Secondly, lack of follow up interviews regarding new information and more in-depth understanding with some of the interviewees.

Further investigation

The circular economy within the public procurements can be recognised as a new field because of the lack of knowledge of how to conduct one and what should be requirements, etc. On the other, in the past years, different tools have been developed. These types of tools should be analysed in practice to find out do they assist the municipalities and other institutions, or does it make more complicated for businesses to achieve set ambitions. Furthermore, analyse the strengths and limitations of this type of tools. It can be done by creating a workshop, analysing the pilots or by similar methods.

Conclusions - recommendations

The report investigates the circular economy's role in the public procurement within the Danish building industry which leads to the inquiry into what are the ways for municipalities to facilitate the transition from traditional public procurement to more circular?

To answer this question, current certification schemes were addressed and investigated. Furthermore, in order to analyse the current situation within the Danish municipalities, the surveys have been sent to 98 municipalities. Moreover, interviews with experts within the circular economy, built environment, policymakers, procurers and green building certification experts were conducted.

The overall findings will be summarised and presented in the way it will answer problem statement and sub-questions.

Problem Statement

How can municipalities facilitate the transition from traditional public procurements into more circular procurements within the Danish building sector?

Municipalities should facilitate the Meet the Buyer events, where municipalities and other stakeholders can meet the suppliers and analyse the potential market possibilities. Furthermore, municipalities should state clear vision and ambition of the projects that they are making.

Furthermore, municipalities should provide information on their performance and achievements on the circular economy as it is crucial for spreading awareness and knowledge internally and externally. Furthermore, municipalities should exchange their findings and good examples with other institutions.

Sub Questions

What tools/methods have been applied earlier and today? Including what is the role of the building code and DGNB?

The findings show that the most acknowledged way to evaluate the circularity within the building industry is by using the DGNB certification scheme and Life Cycle Assessment. DGNB provides additional criteria on sustainability within the building industry and focuses on aspects typical for the circular economy as design for disassembly. Moreover, what is the material characteristics and DGNB has as a criteria to conduct an LCA on the building.

Whereas, to achieve the highest evaluation building must use reused materials. The Danish building code is mostly focusing on the building's energy efficiency, and there is almost no additional focus on building's environmental part.

How can municipalities encourage businesses to aim for sustainability and circularity?

The representatives from the municipalities have indicated that demand in the public procurements for the circular products should encourage the business to provide additional services which are more circular.

What should be the minimum requirements from the municipalities for the circular building projects in public procurements?

Requirements depend on the type of the project and ambitions of the institution which conducts a procurement. Instead of creating a minimum requirement, for example, saving 20% of raw material, the project should focus on circular strategies which depend on the type and application of the building together with additional documentation on the materials used and the types of commitments for the suppliers.

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8 Appendix

8.1 Questionnaire guidelines for Danish Municipalities

Nr.	Question	Answers
1.	Which municipality do you represent?	
2.	How well are you familiar with the circular economy model?	- Very well (can describe the model and apply in the projects) - Well (can describe the model and discuss upon it) - Somewhat (I can only describe the concept) - Slightly (I have heard about it) - Not at all (First time I am hearing this model)
3.	Do you agree that building sectors model is made on the linear economy?	- Strongly agree - Agree - Undecided - Disagree - Strongly Disagree
4.	How important is circularity in your ordinary projects?	- Very important - Important - Moderately Important - Slightly important - Not important
5.	Do you have tools for assessing the circularity in your projects?	- Yes - No
6.	(If, yes) What tools are you using?	----------

7.	How is important circularity in conducting Public procurement within the Building sector?	- Very important - Important - Moderately Important - Slightly important - Not important
8.	How important is Design for Dissembling in order to achieve circularity within buildings?	- Very important - Important - Moderately Important - Slightly important - Not important
9.	What are the main limitations of Design for Dissembling, in your opinion?	----------
10.	How well are you familiar with DGNB (Deutsche Gesellschaft für Nachhaltiges Bauen) green building certification scheme?	- Very well - Well - Somewhat (I can only describe - Slightly - Not at all
11.	Do you agree that DGNB can be used as an assessment tool for circularity?	- Strongly agree - Agree - Undecided - Disagree - Strongly Disagree
12.	How well are you familiar with a Material passport?	- Very well - Well - Somewhat (I can only describe - Slightly - Not at all
13.	(Expect who answered Not at all) What is the name of the Material passport?	- ----------
14.	(Expect who answered Not at all) Have you been using a Material passport in any of your projects?	- Yes - No
15.	(if yes) What were/are cons and pros of material passport in the practise?	_____

16.	Does your municipality have a strategy regarding Circular economy?	- Yes - Not yet but we are working on it - No, but we consider creating one - No, we do not need one - I do not know
17.	How municipalities could promote Circular Economy within business?	_____
18.	What of the mentioned things are the biggest barrier for the transition to a circular economy?	- Lack of knowledge - It is too expensive - Culture (are used to the traditional way of doing things) - The market is not ready - Legislations - All of the above - Other
19.	(If other) other:	----------
20.	What is the main reason for the municipality to transfer to circularity?	- Reducing the expenses - Branding - Participate in SDG - Reduce the CO2 footprint - All of the above - Other
21.	Other.	----------

8.2 Interview guideline*: Gitte Gylling H. Olesen Rambøll*

No.	Question
1.	Can we record the interview for the educational purpose?
2.	Can you introduce yourself? What is your position and background?
3.	How would you describe current trends in the building sector?
4.	What is the role of the DGNB in the BR18?
5.	What is the role of circular economy in today's building sector?
6.	How significant role has Circular economy in DGNB certification? In what way?
7.	If not, what kind of tools can be used to address the circularity in the building?
8.	What is your opinion on building as a material bank? (Where to store material? What if there are not enough materials for the project?)
9.	What is your opinion on the Design of disassembling? What are the cons and pros?
10.	During the maintenance of the reuse materials, are there any issues regarding the life-time of materials?
11.	How to ensure the durability of the materials after the building's demolition/ disassembling?
12.	What is your opinion about a material passport? What are the cons and pros of it?
13.	Have you been a part of the Public procurement where circularity addressed?
14.	How was circularity approached? What were the minimum requirements?
15.	Could DGNB be used as an evaluation tool for building circularity?
16.	Can renovated buildings become circular buildings (because of the way they designed)?
17.	What could be a solution for the municipality to push forward the circular economy within the business?

8.3 Interview guideline*: Cuno Van Geet – Rejswaterstat*

No.	Questions
1.	Can we record the interview for the educational purpose?
2.	Can you introduce yourself? What is your position and the background?
3.	How would you describe the situation of public procurements in NSR from a sustainability perspective?
4.	What were the main barriers you have encountered during the Green Deal projects within the circular procurements?
5.	Which pilot was most successful and the least successful/unsuccessful and why? - What kind of type was the project? (Building, infrastructure, etc.)
6.	Have you made a Post-Occupancy Evaluation on the projects? **If yes** – What were the main results? **If not** – Are you considering on making POE on your pilot projects?
7.	Which criteria was/is the most essential in making the circular procurement? **E.g. in Circular building procurement**
8.	On the International level, what were/are the main difficulties for conducting a CP?
9.	Comparing **Linear procurements** and **circular procurement** were there a difference in numbers of participants/applicants?
10.	What is your opinion about a material passport? What are the cons and pros of it?
11	What is your opinion on building as a material bank? (Where to store material? What if there are not enough materials for the project?)
12.	What could be a solution for the municipality to push forward the circular economy within the business?

8.4 Interview guideline*: Kim Ankjær Nielsen- Kolding Municipality*

No.	Questions
1.	Can we record the interview for the educational purpose?
2.	Can you introduce yourself? What is your position and background?
3.	How would you describe current trends in the building sector?
4.	What is the role of circular economy in today's building sector?
5.	What kind of tools can be used to address the circularity in the building?
6.	What is your opinion on building as a material bank? (Where to store material? What if there are not enough materials for the project?)
7.	What is your opinion on the Design of disassembling? What are the cons and pros?
8.	During the maintenance of the reuse materials, are there any issues regarding the life-time of materials?
9.	How to ensure the durability of the materials after the building's demolition/ disassembling?
10.	What is your opinion about a material passport? What are the cons and pros of it?
11.	Have you been a part of the Public procurement where circularity addressed?
12.	How was circularity approached? What were the minimum requirements?
13.	Could DGNB be used as an evaluation tool for building circularity?
14.	Can renovated buildings become circular buildings (because of the way they designed)?
15.	What could be a solution for the municipality to push forward the circular economy within the business?

8.5 Interview guideline*: Emma Börjesson – Malmö Municipality*

No.	Questions
1.	Can we record the interview for the educational purpose?
2.	Can you introduce yourself? What is your position and background?
3.	How would you describe current trends in the building sector?
4.	What is the role of circular economy in today's building sector?
5.	Have your municipality considered tools for the evaluation of Circular economy? - What kind of tools are you planning to use?
6.	What is your opinion on building as a material bank? (Where to store material? What if there are not enough materials for the project?)
7.	What is your opinion on the Design of disassembling? What are the cons and pros?
8.	During the maintenance of the reuse materials, are there any issues regarding the life-time of materials?
9.	How to ensure the durability of the materials after the building's demolition/ disassembling?
10.	What is your opinion about a material passport? What are the cons and pros of it?
11.	Have you been a part of the Public procurement where circularity addressed?
12.	How was circularity approached? What were the minimum requirements?
13.	Can renovated buildings become circular buildings (because of the way they designed)?
14.	What could be a solution for the municipality to push forward the circular economy within the business?

8.6 Interview guideline*: Torben Gade – Marina City (Kolding Municipality*

No.	Questions
1.	Can we record the interview for the educational purpose?
2.	Can you introduce yourself? What is your position and background?
3.	How would you describe current trends in the building sector?
4.	What is the role of circular economy in today's building sector?
5.	Have your municipality considered tools for the evaluation of Circular economy? - What kind of tools are you planning to use?
6.	What is your opinion on building as a material bank? (Where to store material? What if there are not enough materials for the project?)
7.	What is your opinion on the Design of disassembling? What are the cons and pros?
8.	During the maintenance of the reuse materials, are there any issues regarding the lifetime of materials?
9.	How to ensure the durability of the materials after the building's demolition/ disassembling?
10.	What is your opinion about a material passport? What are the cons and pros of it?
11.	Have you been a part of the Public procurement where circularity addressed?
12.	How was circularity approached? What were the minimum requirements?
13.	Could DGNB be used as an evaluation tool for building circularity?
14.	Can renovated buildings become circular buildings (because of the way they designed)?
15.	What could be a solution for the municipality to push forward the circular economy within the business?

8.7 Interview guideline*: Veerle Labeeuw – Vlaanderen Circulair.*

No.	Questions
1.	Can we record the interview for the educational purpose?
2.	Can you introduce yourself? What is your position and background?
3.	How would you describe current trends in the building sector?
4.	What is the role of circular economy in today's building sector?
5.	Have your municipality considered tools for the evaluation of Circular economy? - What kind of tools are you planning to use?
6.	What is your opinion on building as a material bank? (Where to store material? What if there are not enough materials for the project?)
7.	What is your opinion on the Design of disassembling? What are the cons and pros?
8.	During the maintenance of the reuse materials, are there any issues regarding the life-time of materials?
9.	How to ensure the durability of the materials after the building's demolition/ disassembling?
10.	What is your opinion about a material passport? What are the cons and pros of it?
11.	Have you been a part of the Public procurement where circularity addressed?
12.	How was circularity approached? What were the minimum requirements?
13.	Could DGNB be used as an evaluation tool for building circularity?
14.	Can renovated buildings become circular buildings (because of the way they designed)?
15.	What could be a solution for the municipality to push forward the circular economy within the business?