UPPSALA
UNIVERSITET

SAMINT-MILI-23031
Master's Thesis 30 credits
June 2023

Marking tags within the construction industry

A qualitative case study of the Swedish construction industry regarding implementing technical standardizations to promote circularity

Markus Eriksson
Casper Norberg

Master's Programme in Industrial Management and Innovation

Mastersprogram i industriell ledning och innovation

UPPSALA
UNIVERSITET

Faculty of Technology

Visiting address:
Ångströmlaboratoriet
Lägerhyddsvägen 1

Postal address:
Box 536
751 21 Uppsala

Telephone:
+46 (0)18 – 471 30 03

Telefax:
+46 (0)18 – 471 30 00

Web page:
http://www.teknik.uu.se/education/

Abstract

Marking tags within the construction industry

A qualitative case study of the Swedish construction industry

Casper Norberg & Markus Eriksson

The construction industry is vital in meeting humanity's infrastructure and essential building needs. However, its current practices contribute significantly to environmental challenges such as global warming, deforestation, and biodiversity loss. The current study points out the need for a more sustainable approach in the construction sector.

The reason this study focuses on RFID-tags is both because of the academic gap regarding implementation of new standardizations and the project Lumi that this study has as its case study of the thesis.

The goal of this thesis is to analyze the Swedish construction industry's attitude toward the implementation of RFID-tags as a standardization and fill the academic gap that has been identified in the literature review. The goal is to determine the attitude of each stakeholder type within the industry through the lens of socio-technical transition theory, to determine specific barriers and drivers for the concept. Furthermore, the aim is to determine if RFID-tags can be implemented to promote circularity and enhance sustainable development.

The research methods incorporate a literature review and a case study with semi-structured interviews conducted with eight participants. The sample consisted of actors within the construction industry, such as customers, distribution companies, entrepreneurs, manufacturers, service companies, and workers.

The thesis identified the conservative nature of the industry as an obstacle, along with the fear of failure within the construction industry. The attitude towards the standardization of RFID-tags is positive, where beneficial factors were identified, such as saving time, reducing environmental impact, and improving the structure for recycling.

Key words: Sustainability, Construction industry, Radio frequency identification, Circularity, Attitude, Environment, Socio-technical transition theory, multi-level perspective.

Supervisor: Patrik Belin

Subject reader: Inez Khadri

Examiner: Michal Zawadzki

SAMINT-MILI-23031

Printed by: Uppsala Universitet

Popular science summary

The construction industry is crucial in meeting our infrastructure and building needs. However, its current practices contribute significantly to environmental challenges, including global warming, deforestation, and biodiversity loss. To address these issues, there is an urgent need for a more sustainable approach in the construction sector.

This research thesis focuses on analysing the stakeholders of the Swedish construction industry's attitude toward implementing RFID (Radio Frequency Identification) tags as a standardization measure to promote circularity. The primary goal is to understand the perspectives of different stakeholders within the industry and identify specific barriers and drivers for adopting RFID tags. Additionally, the aim is to determine if these tags can be used to promote circularity and enhance sustainable development.

The research methods employed in this thesis include a comprehensive review of existing literature and a case study featuring semi-structured interviews with eight participants. The sample consists of various stakeholders within the construction industry, such as customers, distribution companies, entrepreneurs, manufacturers, service providers, and workers.

The thesis findings shed light on some significant obstacles faced by the conservative construction industry and the fear of failure associated with adopting new technologies. However, the overall attitude towards standardizing RFID tags is positive. Furthermore, the study identifies several beneficial factors associated with this technology, including time savings, reduced environmental impact, and improved structures for recycling.

The results of this research have important implications for the future of sustainable construction in Sweden. By embracing RFID tags as a standardization measure, the industry can make significant strides toward achieving its sustainability goals. The time-saving aspect of RFID technology allows for more efficient construction processes, reducing both costs and environmental impact. Moreover, the enhanced structure for recycling materials can contribute to the circular economy, reducing waste and conserving resources.

In conclusion, this research highlights the urgent need for a more sustainable approach in the construction industry. By analysing the attitudes of different actors within the Swedish construction sector towards implementing RFID tags, the thesis identifies both barriers and drivers for adopting this technology. The positive outlook toward standardization of RFID tags suggests they can promote circularity and enhance sustainable development. Embracing RFID technology in construction practices can bring significant positive changes, including time savings, reduced environmental impact, and improved recycling structures.

Table of content

Popular science summary II
Acknowledgements VI
List of figures VII
List of tables VIII
Abbreviations IX
1 Introduction ..... - 1 -
1.1 Background ..... - 1 -
1.2 Problematisation of the area ..... - 2 -
1.3 Research purpose and question ..... - 4 -
1.4 Limitations ..... - 5 -
1.5 Empirical context ..... - 5 -
2 Literature review ..... - 6 -
2.1 Circular economy ..... - 6 -
2.1.1 Circular approach within the construction industry ..... - 8 -
2.2 Social-technical transition theory ..... - 10 -
2.3 Socio-technical transition through standardisation ..... - 13 -
2.4 Socio-technical transition through lean manufacturing ..... - 14 -
2.5 Digitalization and socio-technical transition ..... - 15 -
2.6 Radio-frequency identification (RFID) and socio-technical transition ..... - 16 -
2.7 Conclusion of Literature Review ..... - 18 -
3 Methodology ..... - 19 -
3.1 Research design and Purpose ..... - 19 -
3.3 Case Study ..... - 20 -
3.4 Sampling ..... - 21 -
3.5 Interviews ..... - 21 -
3.6 Analysis approach ..... - 23 -
3.7 Trustworthiness ..... - 25 -
3.8 Limitations ..... - 26 -

3.9 Ethical considerations ..... - 26 -
4 Results ..... - 28 -
4.1 Thematic Analysis ..... - 28 -
4.2 Data Structure and story ..... - 34 -
5 Analysis ..... - 36 -
5.1 Theme one: Market needs ..... - 36 -
5.2 Theme two: Barriers for the concept ..... - 40 -
5.3 Theme three: Benefits of the concept ..... - 44 -
5.4 Comparison analysis of the themes through socio-technical transition theory ..... - 50 -
6 Discussion ..... - 52 -
6.1 The prerequisite ..... - 52 -
6.2 The attitudes ..... - 53 -
6.3 Theoretical implications ..... - 54 -
6.4 Ethical and social considerations ..... - 55 -
7 Concluding remarks ..... - 57 -
7.1 Limitations of the study ..... - 57 -
7.2 Further research ..... - 58 -
8 References ..... - 60 -
Appendices ..... - 65 -

Acknowledgements

We want to extend our utmost gratitude to our supervisor, Patrik B., and other esteemed individuals associated with the Lumi project and the company WSP for their guidance and support throughout our thesis.

Furthermore, we wish to express our sincere appreciation to the interviewees who graciously dedicated their valuable time to participate in the interviews, providing us with invaluable feedback and insightful perspectives that significantly contributed to the overall outcome of our thesis.

We are also profoundly grateful to our peers for their efforts in reading our thesis and providing constructive feedback during seminars and oppositions. Their input has been instrumental in refining our work and enhancing its quality.

Lastly, we would like to convey our thanks to our subject reader, Ines Khadri at Uppsala University, for her continuous support, feedback, and guidance throughout the various challenges we encountered during our thesis journey. Ines Khadri, you have been invaluable during meetings, seminars, offering your expertise whenever we were in need. We sincerely appreciate you for your indispensable contribution to our work.

Thank you!

List of figures

Figure 1: Transition from a linear to a circular economy (European Environmental Agency , 2015) ..... - 7 -
Figure 2 : Multiple-level perspective from W. Geels (2002) ..... - 12 -
Figure 3 : Schematic of the RFID tags system (OMRON, 2023) ..... - 17 -
Figure 4 : Illustration of a "naked" reader and the tag (Sparkfun, 2017) ..... - 17 -
Figure 5 : Illustration of a thematic analysis approach (VOXCO, 2021) ..... - 25 -

List of tables

Table 1: Overview of the respondents (Eriksson & Norberg, 2023) ..... - 23 -
Table 2: Thematic analysis (Eriksson & Norberg, 2023) ..... - 29 -
Table 3: Data analysis (Eriksson & Norberg, 2023)..... - 35 -

Abbreviations

AEC	Architecture, Engineering, and Construction
BIM	Building Information Modelling
BMT	Behaviour Management Theory
CAGR	Compound Annual Growth Rate
EU	European Union
R&D	Research and Development
RFID	Radio Frequency Identification
UNEP	United Nations Environment Programme
WSP	Williams Sale Partnership (consultant company)

1 Introduction

This chapter and the following sub-headings aim to describe the background of the thesis by presenting the impact on the planet that the construction industry is creating. It also present's the research question followed by the problematisation of the research area, including limitations that have been done.

1.1 Background

The world faces several difficulties related to sustainable development and reducing the strain on the earth and environment. A sustainable approach is crucial for the environmental problems that we face today. Several environmental problems can be mentioned, but some of the major ones are global warming from fossil fuels, food waste, air pollution, melting ice caps and sea level rise, agriculture, biodiversity waste, plastic pollution, and deforestation (Robinson, 2023). According to Robinson (2023), the global temperature has risen by 1,15 degrees Celsius since pre-industrial levels. Robinson also writes that "the population sizes of mammals, fish, birds, reptiles and amphibians have experienced a decline of an average of 68% between 1970 and 2016". Moreover, the rapid deforestation that the world has today will reduce the rainforest by 90% by 2030 (Robinson, 2023).

The construction industry is a major actor when it comes to the burden of the environment through the use of resources and emissions. According to data from the United Nations Environment Programme (UNEP), the building and construction industry accounts for 4% of global energy consumption, 30% of energy-related greenhouse gas emissions, 12% of water use, and close to 40% of waste production (Linderoth & Isaksson, 2018).

In sustainable development, the construction industry can reduce its burdens on the earth and the environment by applying more reusing methods. The industry is essential for humanity's survival because it supplies the community with hospitals, houses, schools, infrastructure, and many more essential constructions/buildings. However, the construction industry does not need to burden the environment to the extent it does today to supply humanity with different constructions. The industry's revenue annually increases with a CAGR of 10-11 %, which results in an estimated increase from 13,6 trillion dollars (2021) to 39.4 trillion dollars (2031). This can indicate an increasing strain on the environment due to increasing demand for materials, natural resources, and transportation (The Business Research Company, 2022). On account of the increasing strain on the earth, there have been several strains from the authorial to establish more sustainable construction for the future.

Improvement, development, and digitalization occur in all industries today. However, the construction industry needs to catch up compared to other industries when it comes to these parameters. According to (Agarwal, et al., 2016) the construction industry does only beat the agriculture industry in a comparison table regarding digitalization. This can be related to the social aspect that the construction industry is conservative and struggle to create changes based on long-term perspectives where issues are solved with short-term solutions today (Rietdijk, 2009). The industry struggle to implement new standardisations and technology as a result from the price-oriented industry and the occurring conservatism which is a social aspect hindering development (Larsson, et al., 2013).

1.2 Problematisation of the area

According to Mohammed et al. (2017), a significant challenge regarding circular economy practice in the construction industry is connected to the fact that the companies believe that the customers are more concerned with the price and performance rather than the environment. Therefore, there are challenges in making the price of their product (Mohammed, et al., 2017). In addition, the authors indicate concerns related to the social aspect of management, the acceptance and belief of managing toward sustainable development and a circular economy approach (Mohammed, et al., 2017). Several aspects can be problematized regarding implementing a new standard in the construction industry. Implementing a new standard can be equated to a disruptive innovation, meaning that a new service within an industry is implemented and performs better and generally at a lower price than existing services (Christensen , et al., 2013).

The implementation of new standards is beneficial to ensure that goods or services produced in a specific industry come with consistent quality and are equivalent to other comparable products or services in the same industry (CFI, 2022). These beneficial outcomes that derives from standardization can be applied on the RFID tag system. In order to implement RFID tags as a standard within the construction industry, several of social aspects needs to be taken into considerations. The socio-technical transition theory is a theory that can analyze the relationships between social aspects and the technical aspects (W. Geels, 2018). The implementation of a new standardisation regarding a marking tag system is analysed through the socio-technical transition theory. The socio-technical transition theory enables the analysis of the industry's attitude, including barriers, drivers, and needs (Binder, et al., 2017).

When it comes to the challenges connected to implementation of RFID tags an article by Daan et al. (2019), reveals and describes some of them. According to Daan et al. (2019), the article reveal that the challenges associated with implementing a Circular Economy within supply chains can be attributed to two fundamental factors: the diffusion of responsibility and disparities in perceptions. The primary factors contributing to these phenomena are as follows: firstly, a deficiency of incentives compelling supply chain actors to adopt circular practices;

secondly, a lack of shared interests among these actors; thirdly, pervasive uncertainties and risks; and finally, conflicting perceptions prevalent across all levels of supply chains.

Both these statements from Mohammed (2017) and Daan et al. (2019) concern the social aspect of socio-technical transition theory. They emphasize the resistance towards transition due to the need for more interest and the company's concerns.

Additional, the author Riedjik (2009) highlights the conservativeness within in the construction industry and how it generates challenges connected towards changes. According to Rietdijk (2009), there are challenges in changing the current working methods within the construction industry. The conservative approach and attitude that the industry possesses results from short-sighted solutions for solving problems, such as reducing the strain on the environment by complementing with specialized technical knowledge. As a result of the short-sighted solutions applied within the construction industry, the long-term vision and developments that derived from it were lost. These characteristics aggravate an innovative approach that makes changes and adoption difficult (Rietdijk, 2009). Additionally, the institutional processes have formed the industry into focussing more on short term rather than long term as a result of the business structure being fostered around the lowest tender policy amongst customers. (Isaksson & Linderoth, 2018)

Moreover, the difficulties towards changes within the construction industry can be connected to the social aspect of finding consensus among all stakeholders regarding the changes that need to be performed. According to Hossein et al. (2020), the problematisation of the area is connected to challenges and difficulties connected to consensual attitudes among customers, entrepreneurs, and stakeholders. Additionally, the traceability of materials, objects, and installations within the construction industry is challenging (Hossein , et al., 2020). In context to what Hossein et al. (2020) writes, the social barrier is directly associated to the consensus among actors which affects the technical transition regarding difficulties of objects and material.

A significant obstacle to achieving sustainable development goals is the construction industry's declining investment rate in green buildings. The lack of demand from society and businesses for sustainable buildings is one of these factors, as is poor communication and a lack of shared interests and understanding among designers, contractors, and project stakeholders (Dalirazar & Sabzi, 2022). Other factors include resistance to switching from conventional to sustainable buildings. Effective communication management, information sharing, BIM use for improved collaboration, government support, incentives, environmental policies, education, awareness, and stakeholder engagement at early project stages are all necessary to overcome these social barriers. The development of the construction industry toward sustainability might be hampered if these social issues are not addressed (Dalirazar & Sabzi, 2022).

The existing literature extensively analyzes the challenges that impede the adoption of circular economy practices in the construction industry to lower the use of new resources and reduce the strain of the environment. These challenges include socio-cultural resistance, differing perceptions, lack of incentives, high uncertainties, and risks, as well as technical difficulties in tracing materials and objects. However, there is a noticeable gap in understanding the attitudes of the construction industry towards new technologies and more standardized processes, which has resulted in stagnation in the transition towards a circular economy. Additionally, the literature emphasizes the roles of customers, companies, and supply chain actors in this transition, but there is limited discussion on the influence and responsibility of stakeholders in facilitating or hindering this transition. Therefore, this study aims to capture the industry's attitude toward technical transitions and new standardizations, in this specific case, the implementation of RFID tags.

1.3 Research purpose and question

This study aims to address the identified gaps regarding implementations of new standardized processes in the Swedish construction industry within in the existing academic literature by employing the socio-technical transition theory. By applying this theory, we seek to gain insights into the social attitudes in the construction industry towards new technologies and standardized processes and to understand the influence and responsibility of stakeholders in facilitating or hindering the transition towards a circular economy. Through this approach, we aim to contribute to a more comprehensive understanding of the barriers and facilitators in achieving sustainable practices throughout standardized solutions in the construction industry. Through this, the goal is to determine the attitude within the industry towards implementing a new standardization of a tag marking system in the Swedish construction industry. The standardization of implementing RFID tags can enable a more sustainable approach, emphasize circularity, be more time efficient, reduce the strain on the earth, reduce cost from a long-sighted perspective, and provide more precise data documentation.

The research question the thesis aims to answer is as follows:

- How do stakeholders in the Swedish construction industry perceive the adoption of a standardized marking tag system using Radio Frequency Identification (RFID) technology, and how do their social attitudes toward the concept affect the promotion of circularity?

The thesis is a qualitative case study were the market's attitude to the concept of implementing a new standardization within the construction industry is analysed. The attitude of the interviewed stakeholders will generate an indicator for the construction industry’s maturity towards implementations of new standardizations and provide this study with barriers and drivers towards implementations of new standardizations along with the market needs.

To answer the research question a semi-structed interview study was conducted with respondents representing each stakeholder within the construction industry such as customers, distributions, entrepreneurs, manufacturers and service companies. The interviews will be transcribed and analysed through the socio-technical transition theory with help of a thematic analysis.

1.4 Limitations

The thesis aims to evaluate the market's attitude towards the concept of RFID tags as a standardization. However, investigating the technical parts of the concept lies outside the scope of the thesis and thereby, is limited. The study only investigates the chosen concept of RFID tags to promote circular approach, not other concepts that could theoretically be standardized within the industry.

The study is limited to the Swedish construction industry, including foreign companies that are active within the Swedish market. Therefore, the study has geographical limitations and cannot automatically be implemented in other international markets, but the findings can be used for knowledge and understanding the market structures of the construction industry.

1.5 Empirical context

This thesis is carried out and supervised by the company, Williams Sale Partnership (WSP). The empirical perspective of the thesis was written in cooperation with WSP as an external partner and the construction project called Lumi in Uppsala. The construction company Vasakronan is currently carrying out the production phase on the project in Uppsala. Lumi is a rather complex project where Vasakronan is restoring a building; the restoration consists of adding three levels and changing the facade without increasing the total weight of the building. Byggstyrning together with WSP implies that the system of using RFID tags would enable precise information regarding their deliveries and logistics which can contribute to circularity and sustainable development along with tackling the conservatism within the industry.

2 Literature review

This chapter reviews existing literature and studies of the construction industry's need for sustainable development in a recycling aspect through socio-technical transition theory and sub-hierarchical theory. The core focus was to find literature that focuses on the social-technical transition theory and the enabling concepts, which are regarding recycling, LEAN, circular production, marking tags (RFID), innovation, and digitalization within the construction industry. The literature review aims to generate a deeper understanding and to provide the base of the field research for this study. The concept of social-technical transition theory was chosen to help describe the case and the relation between the technical and the social aspects. The other enabling concepts/theories have been selected and applied to enable a deeper understanding. This is to understand the multi-level perspective that creates a new standardization in the construction industry.

2.1 Circular economy

The literature regarding the circular economy concept is presented in the research report "The Potential for Substituting Manpower for Energy" (1976), which was sent to the European Commission in Brussels and later published as a book in 1982 called "Jobs for Tomorrow, the Potential for Substituting Manpower for Energy". The report presented a sketch of an economy in a loop (or circular economy). In the report, the circular economy concept is presented to have an impact on waste prevention, economy, job creation, and resource savings (Walter & Geneviève , 1981).

The circular economy approach aims to conserve the environment by reducing the use of raw materials by recycling/reusing existing materials. On WSP's webpage from 2021, they explain that the circular approach is a transition from the traditional linear approach. The linear approach builds on the intake of raw material transforming into desired components, and after it has been used, the components are classed as waste and get disposed of. According to WSP, the circular approach aims to be more structured throughout the whole phase and, in the end, aims to recycle as much as possible in a sustainable manner (WSP, 2021).

The circular approach can be broken down into six levels sorted from most preferable to least preferable. These six levels are avoidance and reduction, reuse, reprocessing, recycling, energy recovery, and disposal. Through the circular approach, the construction industry can reduce the strain on the environment, create jobs by reprocessing products existing products, lower the total cost of the project, and increase the building value by achieving different certifications such as BREEAM, LEED, and Greenbuilding (WSP, 2021). These certifications are coveted by banks, owners, tenants, and buyers due to that certification generates a higher value certification is an indicator that the building is sustainable.

The transition from the linear approach to the circular approach can be problematized, the benefits from the transition will not be evenly distributed: businesses and industries that producing low-quality goods or jobs in industries that producing virgin materials can potential be lost as a result of circular economy (European Environmental Agency , 2015). Additional, the report emphasizes that the benefits depends on importance of quickly adequate skills and education need to adapted to promote circular economy (European Environmental Agency , 2015).

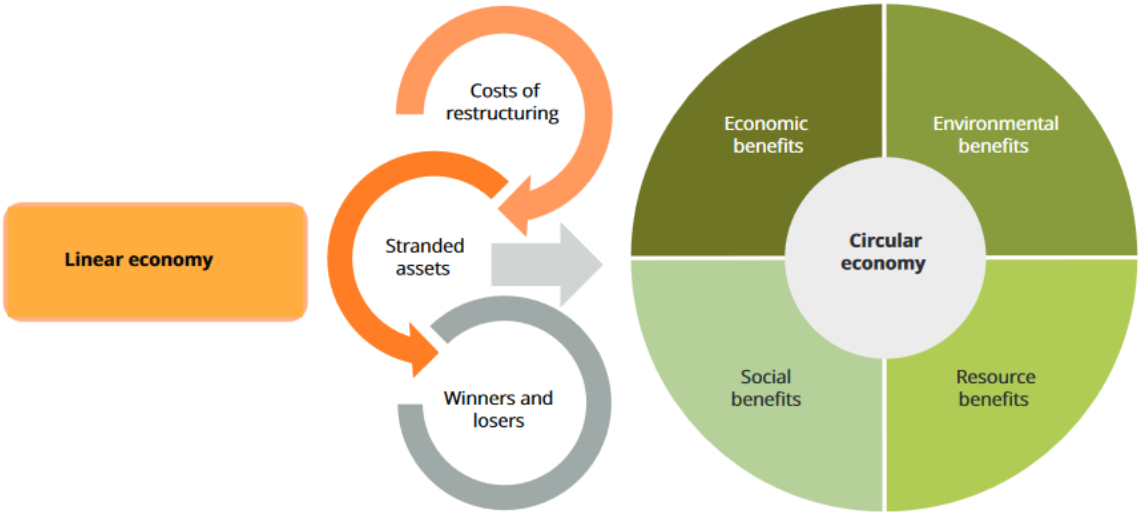

Figure 1: Transition from a linear to a circular economy (European Environmental Agency , 2015)

The transition from a linear economy to a circular economy will affect the socio-economic issues within the world, there will be frictions in the society that will affect people. The prevailing economic system has developed and matured over many years and been adapted to the linear approach, the transition to circular economy will generate frictions between the prevailing and the new economic approach (European Environmental Agency , 2015). Resistance to the transition may occur due to socio-aspects which perceive the transition as threatening to their existing well-being and current economic situation (European Environmental Agency , 2015). Additional to the prevailing well-being, the issues of disturbing the current well-being and life standard that arise when aim to perceiving the environment and economy affects the transition towards a circular economy. The report from (The European Environmental Agency , 2015, p.33), writes in one sentece that they emphesize the risk of human healt and well-being in relation to circular economy, “The assessment and governance of risks to human health and well-being cut across all dimensions of the green economy, and may deal with anything from exposure to air, soil and water pollution to loss of ecosystem services and impacts of climate change”.

The circular economy aims to promote benefits within social, economic, environmental, and resource aspects without affecting the current social situation negative. The problematization

with the process to promote a circular economy within the construction industry are related to the social aspects within the transition. According to Daan et al (2019) and Mohammed et al (2017), the aspects that hindering the transition towards a circular economy within the construction industry is the social focus on price and performance along with the diffusion of responsibility and disparities in perceptions. Furthermore, this is relatable to the socio-technical transition theory that emphasizes the social drivers and barriers for technical transitions, such as those that Daan et al (2019) and Mohammed et al (2017) mentioned in previous sentence which is along with Binder et al (2017) and their description of socio-technical transition theory as an analyzing tool for social barriers, drivers and needs.

2.1.1 Circular approach within the construction industry

Industries are constantly finding ways to become more sustainable and environmentally friendly; recently, these phenomena have risen within the Swedish construction industry. Reusing materials and objects from constructions to be restored or demolished and using them in new projects or restoration projects are increasing a lot but quite a new method on an industrial scale. The reason for using this method is to reduce the impact on the environment and, at the same time, chase lower numbers on the environmental impact for each project by using materials that have already been used in previous projects (Williams, 2021).

The production of concrete alone accounts for 4% of Sweden's annual total carbon dioxide emissions, where lower impact is being targeted by using recycling to reduce the strain (Fosilfrittsverige, 2022). Natural graves are included in making concrete, making up the ingredient called aggregate. In contrast, the use of natural graves in Sweden can be reduced using recycled torn concrete as aggregate, a method used within the industry (Lidelöw, et al., 2017). Torn concrete can also be used as filling materials within construction instead of using natural gravels when for instance, setting the foundation for roads or facilities (Lidelöw, et al., 2017).

The term reusing and recycling materials have different meanings in the construction industry and can be described using the waste hierarchy, a tool conducted and directed by the EU stipulated in the Swedish Environmental Code (Milios & Dalhammar, 2020). The waste hierarchy is a mandatory guideline for handling materials for all countries within the EU, to reduce the impact of the construction industry on the environment (Milios & Dalhammar, 2020). The waste hierarchy consists of five steps where they are ranked in order where the first is best for the environment, and the last is least good (Zhang, et al., 2021). The steps are equal to the steps that describe the circular economy cycle.

1. Prevention

Minimize the creation of waste, through lower consumption and producing with more efficient methods lowering the strain on earth.

2. Reuse and preparation for reuse

Use existing materials without the need of reprocessing it, either strait of or through an easier restoration, provided that the material holds high enough quality for usage.

3. Recycle

Use the material to produce other products or materials, usually through a reprocessing stage that requires energy.

4. Recovery

Use the material as combustion fuel on a power plant converting it as an energy source.

5. Disposal

The last stage is the disposal stage, where the material is sorted and then thrown into a dump. This is common for materials used previously for construction that is illegal to use today such as the material asbestos which is banned to use in Sweden (Järvholm & Burdorf, 2015).

There are barriers to recycling within the construction industry, such as assessing what materials are to be recycled, where the trouble lies in the dimensions, quality of the materials, the cost, and the possibility of recycling the materials. The process of reusing materials usually includes the separation of materials in order to access the wanted material; this stage requires methods that might damage the material reducing its quality, endurance, and functionality. Along with that, it might not be economically sustainable (Cai & Waldmann, 2019). Another barrier is the design of the constructions who are not commonly constructed for future separation which leads to a more complicated procedure when separating materials resulting in that not all materials can be recycled and thereby moved for either recovery or disposal (Park & Tucker, 2016).

Planning in the production phase and overviewing what materials are being used with their specifications, the structure, and the combining of materials can be executed to reduce the complex process of reusing and recycling different materials in the construction. This stage in the construction process is essential to take into consideration to facilitate more efficient re-usage and recycling for the future of the industry (Bertino, et al., 2016).

Along with reducing the complexity, it is essential to have the input of knowledge and experience of recycling and reusing within the industry in the early stage of project planning to facilitate recycling and reusing (Sobotka & Sagan, 2015) Reusing materials that require

minimal separation, such as doors, windows, or even furniture, however, holds lesser barriers, where the main ones are the requirements on quality and assessing the material's properties (Cai & Waldmann, 2019).

The term reusage within the Swedish construction industry is a well-known concept connected to sustainability. However, the implementation of reusage in construction projects is not as present. According to an investigation by Rörborn & Baena (2020), it implies that only around 20% of real estate owners in Sweden are working with reusage on a larger scale (Rörborn & Baena, 2022). Environmental goals say that the amount of reusage will increase drastically within upcoming years, the will is there, and the need to build greener is clear. The three most common answers from sustainability managers to why reusage is used to the current extent is because laws and regulations, economy, and insurance matters are restricting the growth of the concept (Rörborn & Baena, 2022).

Reviewing more significant real estate owners in Sweden, practical information with concrete numbers within project reusage is restricted. Vasakronan, the third largest real estate company in Sweden, used 5% reused and 15% recycled materials during their construction projects in 2022. Their long-term environmental goals are to use 100% circular material use by the year 2030 (Vasakronan, 2022). Fabege who is the seventh largest real estate owner company in Sweden built the “Hagahuset” which was construction through using 70% reused materials (Fabege, 2022).

2.2 Social-technical transition theory

The problematisation chapter emphasizes the challenges that arise from implementing new technical standardisations aimed at environmental circularity within the construction industry on account of the conservatism and the focus on price and performance rather than the environment. However, earlier studies mentioned in the problematization has investigated the issue with in the construction industry through a framework foccused on competiveness such as price and performance-oriented solutions rather than the social aspects (Mohammed, et al., 2017). Presently, the economic potential only constitutes a part of the challenge for innovation.

Earlier studies usual provides findings based on green supply chain management, circular economy, and life cycle assessment, which do not apply to the social aspect of the implementations of technical standardisations in the extent as the socio-technical transition theory (Mohammed, et al., 2017). A challenge for innovation currently also rests on the societal changes induced by innovation. The development of a broader problem framing demands a framework that considers broader analytical perspectives (Grin, et al., 2010).

Previous literature provides the findings based on green supply chain management, circular economy, and life cycle assessment, which do not apply to the social aspect of the

implementations of technical standardisations in the extent as the socio-technical transition theory (Mohammed, et al., 2017).

Rietdjik (2009) used behavioural management theory (BMT) to apply a social perspective to analyse the conservatism within the construction industry. The BMT focuses on social aspects and can therefore be compared to social-technical transition theory even though BMT concerns management and focuses on productivity in an organisation. However, the focus in a BMT differs from the socio-technical transition theory in such way that it does not implicitly concern the technical transition as this implementation of RFID tags (Rietdijk, 2009), which is the aim of this paper.

Socio-technical transition theory emphasizes that organizational systems and performances only can be understood and managed if both technical and social aspects are united and managed as interconnected parts within a complex system (Baxter & Sommerville, 2011).

The concept of social-technical transition is a standard theory and has been researched for over two decades. The research in the field of innovation studies was originally tested and refined through several historical case studies of transitions in several different areas, such as heating, power, music, and mobility. Throughout the years, it has subsequently been widely used for future sustainability transitions analysis, including renewable electricity, biomass district heating, and electric vehicle (W Geels, 2019).

The core concept of socio-technical transition is described as “Socio-technical transitions are technological changes that alter the way society functions such as transportation and communication are realized” (Mohammad, et al., 2022). According to Mohammed, the socio-technical transition theory has limited scientometric studies regarding “such as mobility, heating, energy, food, water, health, and music sectors, and then future sustainable trends like renewable electricity, biomass regional heating, electric vehicles, agricultural environment and urban mobility” (Mohammad, et al., 2022).

The socio -technical transition theory can be applied in several sectors. In an article regarding the transition of the current energy sector does Binder et al. (2017) explain the socio-technical transition process through these sentences, “The system has to remain resilient to external and internal shocks and unplanned disruptions throughout the transition process. For this to be achieved, both the technical properties of the systems in transition as well as the connection to the social sphere have to be considered along the different phases of the transition pathway”. While social actors are important to drive the transition, a faultless functioning of the technical energy production and distribution systems is important both from an economic and political point of view to ensure public support and prevent unwanted disruptions of the transition process “ (Binder, et al., 2017). This explanation by Binder et al. (2017) highlights the connection between the technical properties and the social actors, which can be explained as a

multi-level perspective (MLP) framework. The social-technical transition approach is complex, interconnected, and includes multi-level perspectives (MLP). From a sustainability perspective, the issues that socio-technical transition theory strives for calls for a system-based approach to policies and research, but equally important with this approach is that focus on facilitating "mutual learning rather than making blueprints" must be established (Graugaard , u.d.).

In addition to the concept of socio-technical transition theory, the MLP is related due to the number of actors included in a socio-technical transition. The MLP is structured in such a way that it can be broken down into three main parameters, these are landscape developments, the socio-technical regime, and the technological niches (Figure 2 2: Multiple-level perspective from W. Geels (2002)).

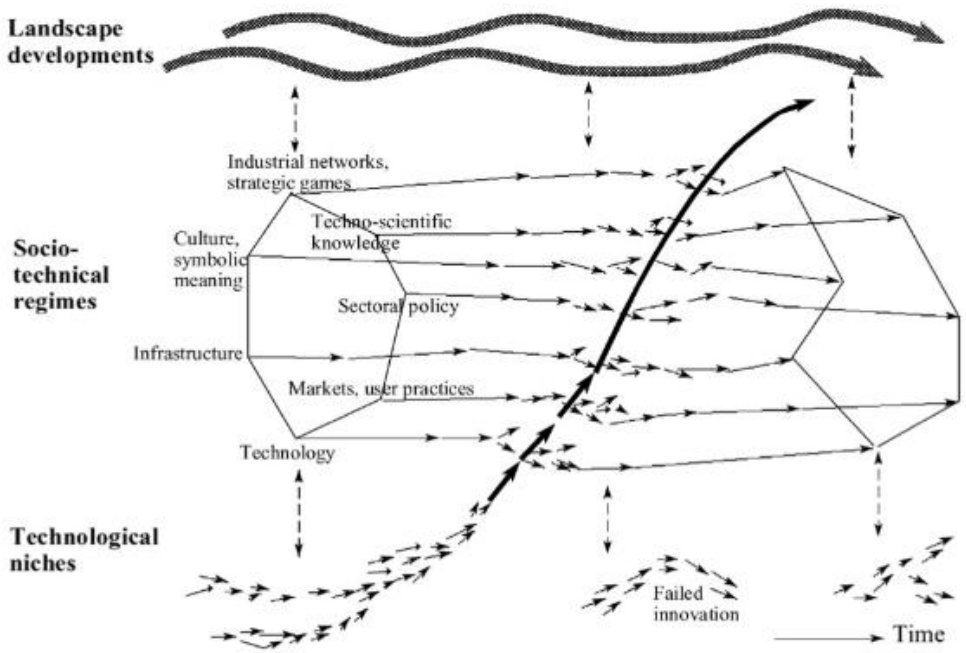

Figure 2 2: Multiple-level perspective from W. Geels (2002)

The concept of MLP is illustrated through this model (Figure 2 2: Multiple-level perspective from W. Geels (2002)) by Graugaa, he implicate *that "The three analytical levels of niche, regime and landscape form the theoretical basis of the multilevel perspective (MLP), a model which describes these entities as sitting, and interacting, within a nested hierarchy"* (Graugaard , u.d., p. 7). He continues explaining the concept of MLP through following sentence, *"The long-term patterns of the three levels are seen as an effect of social (inter)actions within semi-coherent rule structures that are recursively reproduced and incrementally adjusted by interpretive actors"* (Graugaard , u.d., p. 7).

The multi-level perspective as an analyzing tool is commonly used within the field of sustainable development and can be applied to micro (individual), meso (organizational/institutional), and macro (societal) levels. The MLP simplifies and analyze the dynamics in transitions by categorizing the transition process in three categorized (Figure 2 2: Multiple-level perspective from W. Geels (2002)), this is relatable and suitable for the concept regarding the implementation of new standardizations regarding RFID tags within the construction industry (W Geels, 2019).

However, while the MLP focuses on technical transitions and take numerous parameters in consideration to analyze, the cultural and social aspects tendence to be overlooked in relation to economic and technological parameters (Spaargaren, et al., 2000). In addition to what Spaargaren, et al 2019 writes, MLP is a framework which, if it focused right, can simultaneously contribute to the socio-technical transition theory and focus on the social parameters within a technological transition and enable an analysis that contributes to the social and cultural aspects within the implementation a new technical solution that this concept of RFID tags emphasizes (Smith & Raven, 2012). According to Smith & Raven (2012), the MLP as an analyzing tool can recognize that different actors at disparate levels holds contrasting levels of power and influence towards the technical transition within the socio-technical transition theory. The application of MLP can offer insightful understandings into how social factors can both help and hinder a technical transition. The analysis based on the socio-technical transition theory is therefore considered to be supported by and authenticated by MLP, which is regarded as an appropriate analytical tool (Smith & Raven, 2012).

2.3 Socio-technical transition through standardisation

Standardisation is a concept that is a common in all industries. According to Corporate Finance Institute (CFI) a standardisation can be defined by following sentences, “Standardization is the process of creating protocols to guide the creation of a good or service based on the consensus of all the relevant parties in the industry. The standards ensure that goods or services produced in a specific industry come with consistent quality and are equivalent to other comparable products or services in the same industry” (CFI, 2022). This definition by CFI explains that standardization is a working method that includes the relevant parties and aims to ensure that the production will be executed with quality that can be compared to comparable companies. Standardization does also include safety parameters which is an essential aspect in the construction industry on account of an unsafe working environment, which leads to the number of injuries that occur in the construction industry.

The construction industry is an industry that basically has a new project site at each new project; this obstructs the implementation of more efficient working methods such as automation and line production. There are several barriers in the construction industry when it comes to implementing a new standardization. According to Liu et al. (2015), the architecture,

engineering, and construction (AEC) industry had several barriers, such as lack of national standards, high cost of application, lack of skilled personnel, organizational issues, and legal issues (Liu, et al., 2015).

The socio-technical transition theory and mainstream standards are commonly related to each other; when new niches appear and enter the existing regimes consisting of multi-dimensional parameters, there are challenges for the new niches to enter the market and disrupt the existing standards. These challenges are connected to the socio aspect of the theory, such as social acceptance, political adjustments in regulations, and economic competitions (W. Geels, 2018).

2.4 Socio-technical transition through lean manufacturing

The concept of Lean production was first introduced to the world by the company Toyota in Japan. Lean production aims to reduce the production of unnecessary waste. Waste is defined in such a way that if the moment or object in the production does not add value to the end-product, it is waste (Gupta & Jain, 2013).

The market has become more volatile, and lean production is more adjustable compared to traditional production; by understanding the market dynamics, lean production can reduce unnecessary waste. Lean production agrees that the customer pays for value and does not take mistakes in production into consideration (Rawabdeh, 2005).

The construction industry includes several unnecessary moments and objects that can be categorized as waste from a lean production perspective. According to Maraqa et al. (2021), the construction industry is one of the most polluting industries in the world.

Maraqa et al. (2021) state several moments in the construction industry that is categorized as waste by the concept of lean production. These moments are transportation, inventory, waiting, over-production, over-processing, and defects (Maraqa, et al., 2021).

Lean manufacturing and its approach to strive for optimal production by excluding unnecessary stages that doesn't add value to the production and the customer. The flexible approach that Rawabdeh (2015) indicates that lean manufacturing consist of enables technical transitions. According to Yadav et al. (2017), the socio-technical transition theory plays a critical role in the lean manufacturing approach. According to Yadav et al. (2017), *"technological changes result in changes in values, cognitive structures, lifestyles, habitats, and communications that significantly affect a society and its potential of growth and survival. An optimal socio-technical system based on fundamental lean principles facilitates the lean transformation of the organization to provide sustained growth and a competitive edge"* (Yadav, et al., 2017). In relation to what Yadav et al. (2017) implies, the socio-transition theory is commonly applied in lean manufacturing and creates value to the concept and technical transitions.

2.5 Digitalization and socio-technical transition

Digital development emerged drastically last century, resulting in a new industrial revolution called the fourth industrial revolution or Industry 4.0. The fourth industrial revolution is a further development of the digital revolution where the main focus and drastic change is the integration between the physical, digital, and biological. It has some leading technologies that set the base for it, such as artificial intelligence, big data, the Internet of Things, and cloud services (Westman, 2019).

Artificial intelligence is a term within computer science that has been mentioned for many years; the term is a definition of a computer that can handle thinking like a human brain and solve complex problems (Westman, 2019). AI is based on huge amounts of data-setting algorithms, allowing it to filter and select relevant facts for solving tasks. There is primary and advanced AI, which are used frequently today; basic AI is designed to perform basic tasks such as telling your phone to call someone. Advanced AI is, in theory, something that can have the same intelligence as a human, meaning it can understand feelings, learn new things, solve complex problems, and even produce futuristic data (Popkova, et al., 2019).

Big data describes the technology that enables us to collect and analyze large amounts of data in structured and unstructured form. This is used frequently by industries to identify patterns and trends and thereby adapt their strategies to be more efficient, whether it is about reaching out more targeted audience or developing their products and services to suit the users better. Structured data is what is seen as filtered and has a clear message, such as one person in a geographical area buying a particular product. This links together as data companies can use to target these areas with certain products. Unstructured data is what is most flowing in the cloud, consisting of all kinds of data, such as pictures, sound files, movies, emails, documents, and other data that are not organized (Popkova, et al., 2019).

The Internet of Things describes the connection between using items and the internet, such as monitoring a security camera that is accessible via the internet or collecting data from customer usage of specific products connected to the internet (Westman, 2019). This technology enables data to be collected, analyzed, and exchanged, which can help with developing and optimizing specific systems or products. With this technology, data from GPS can be gathered from cars to identify traffic stops, for instance, which can reroute other drivers or provide data that can help reprogram traffic lights to enable more efficient traffic. The Internet of Things is being applied to devices that generally would not be connected to the internet nor equipped with sensors and intelligence that can communicate via the internet and provide data (Popkova, et al., 2019).

Cloud services have emerged drastically last few years, meaning that storage and data services are provided from large data centers, which puts fewer storing requirements on the device that

everyday users are devoting. Along with that, the need for its servers is eliminated. This opens up opportunities to run apps directly through the internet via the service providers without any need for specific programs by the users. Using this technology eliminates the need of using IT staff by the customers since they are not using their own servers for the services (Popkova, et al., 2019).

The digitalization enables technical developments, improving the technical properties of present innovations along with the enablement of new radical innovations. Digitalization can be viewed from a socio-technical transition theory perspective through its continued presence in daily life (Govers & van Amelsvoort, 2019). Digitalization plays a significant role in all types of product development along with the systems we are using today (Govers & van Amelsvoort, 2019). Digitalization takes place both in the niches part of the theory as well as in the regime as a result of its presence. Ramirez (2020) says *"transformative processes are driven both by the emergence of new industrial sectors as well as the direct and indirect effects new technologies have on existing industries"* implying the digitalization's extensive presence (Ramirez, 2020, p. 1). New industrial sectors refer to de continuous development of the current industry (social drivers), which creates technical transitions within digitalization.

2.6 Radio-frequency identification (RFID) and socio-technical transition

RFID is a standardized technology within society and can be found worldwide; the technology can be found in several applications such as access tags, ticketing, payment, passport, car keys, etcetera (Durac, 2018).

According to Yvan Duroc, "the concept of passive RFID communication is based on the retro-modulation or so-called backscatter principle: an emitter (reader in emission mode) radiates an electromagnetic wave with given frequency and constant amplitude; this wave is both the energy source for the target (the tag) and the retro-modulated wave support in order to send the ID target; the receiver (reader in reception mode) demodulates the information message, then sends it to the database. Therefore, any RFID system is composed of three main elements: the tag that embeds specific information of the item on which it is attached, the reader that empowers the tag and reads the information stored within it and a data base that processes the information and performs the global RFID application" (Durac, 2018). This technology is well established but has several application areas left to explore, including the construction industry. RFID technology can also be found in the construction industry but with limited accessibility. However, RFID holds the potential to enable a more extensive circular economy through automated tracking components in a dynamic and uncontrolled environment (Akinci & Ergen, 2007). Thus, with the introduction of RFID tags in the construction industry, there are significant opportunities where RFID tags can provide value. The implementation of Information & Communication Technologies (ICT), as RFID tags are categorized, to promote a circular economy is an unexplored territory within the construction industry (Yu, et al., 2022).

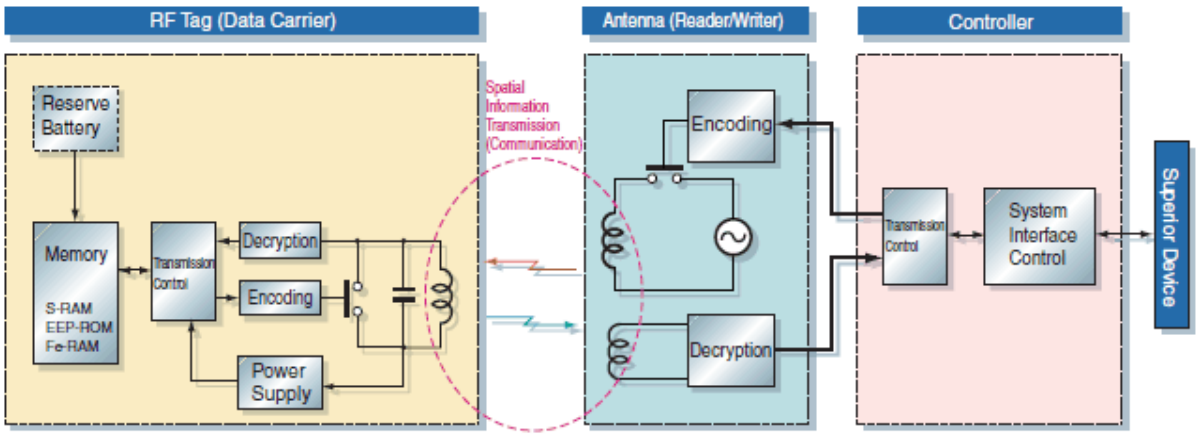

Figure 3 3: Schematic of the RFID tags system (OMRON, 2023)

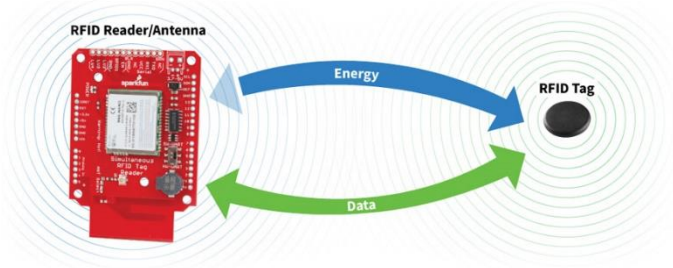

Figure 4 4: Illustration of a "naked" reader and the tag (Sparkfun, 2017)

The first figure above (Figure 3 3: Schematic of the RFID tags system shows illustration of the schematic that the RFID tag system consists of, including the data carrier, the transition of information, the receiver, and the controller. The second figure above (Figure 4 4: Illustration of a "naked" reader and the tag shows an illustration of the physical reader/receiver and the RFID tag and how they exchange information wirelessly.

The RFID tags and their niche are relatable to the technical transition aspect of the socio-technical transition theory. According to Geary et al. (2022), RFID tags interact between people and technology in systems. Geary et al. (2022) state in their result, *"The CUBE disclosed significant areas of new learning in relation to the social dimensions, and culture within the system"* (Geary, et al., 2022, p. 9). This sentence implies that with help of the social-technical transition theory and the framework called CUBE (including these four parameters, the system, the culture, the action, and the sense-making), have they discovered the relation between the technical transition regarding RFID tags within the *"transport of precious laboratory samples in a large acute teaching hospital"* and the social dimensions.

2.7 Conclusion of Literature Review

To conclude the literature review, the central theory including a framework is presented and followed by several other relevant concepts to improve the understanding of existing literature that concern the implementation of RFID tags as a new standardization within the construction industry. The most significant extracts from the literature review are briefly presented here and these lays the foundation for this thesis.

The central theory underlying this study is the socio-technical transition theory. This theory emphasizes the importance to manage and integrate both technical and social aspects as interconnected components of a complex system. It acknowledges that when these two factors are taken into account collectively, organizational systems and performances can only be understood and managed effectively (Baxter & Sommerville, 2011). Additionally, the socio-technical theory is a suitable theory to analyze the empirics for this study and to generate a conclusion that will increase the understanding and provide filling gaps regarding social attitudes towards the implementation of new technical standardizations within the construction industry and knowledge within the academic gaps.

The MLP framework can be found in the socio-technical transition theory and is a framework that analyze the technical transition in three level which are the niches, regimes, and landscape. The application of MLP can offer insightful understandings into how social factors can both help and hinder a technical transition (Smith & Raven, 2012).

The study focuses on investigating the social attitude regarding the circularity-promoting concept of RFID tags. The model of circular economy is crucial in this context for supporting the study's goals and the use of socio-technical transition theory. By promoting the recycling and reuse of existing materials, the circular economy model emphasizes the importance of minimizing the consumption of new resources. (WSP, 2021).

Additional, literature regarding other concepts that affects the implementation of RFID tags as a standardization within the construction industry has been reviewed to enhance knowledge regarding the implementation of FRID tags. These are literature regarding standardization, RFID, lean manufacturing, and digitalization.

To summarize the literature review, the purpose of the thesis is to investigate how the practices from the literature review can be applied to the concept regarding the implementing of RFID tags within the construction industry as a new standardization. Additionally, the core theory for this study is the socio-technical theory because it is a suitable theory based on the RQ and the academic gap presented in the chapter *1.3 Research purpose and question.* The entire literature review has been performed through the lens of socio-technical transition theory to suit this study.

3 Methodology

The following chapter describes and explains the methodological choices that occur within the study. Then, present the research design and purpose of the thesis, data sampling, and analysis methods used, discuss validity and reliability, and lastly, consider ethical aspects.

The study was initiated through a literature study to get a broader understanding of the field of work and to enlighten the current state of the concept of RFID tags within the construction industry today. Followed by the literature study, interviews were conducted with relevant people active in the industry to understand the stakeholder's social attitude towards implementation of RFID tags as a standardization.

3.1 Research design and Purpose

This thesis was conducted through an ontological constructionist viewpoint and an epistemological interpretivist stance are both adopted in this qualitative interview-based case study (Bell, et al., 2022). These philosophical perspectives hold that social interactions shape reality. The interviews and related questions centered on the interviewees' perceptions and interpretations of reality under the direction of this ontological and epistemological framework. As it enables a nuanced understanding of context-specific influences, the chosen philosophical stance is in line with the case study methodology. Semi-structured interviews were conducted in order to address the qualitative and interpretive nature of the research question and gain insight into these contextual influences (Bell, et al., 2022).

The case study aims the Swedish construction industry with the perspective originating from the theory of socio-technical transition theory, which is a theory that refers to the bond of social and technical developments within organisational systems (W Geels, 2019). With a focus on a socio-technical transition perspective, the industry's attitude is analysed focusing on the technical implementation of a new standardisation concerning marking tags. Several articles are written regarding digitalization and recycling in the construction industry, but limited information regarding the implementation of RFID technology in objects to streamline the recycling process. Therefore, a research gap can be identified regarding this implementation. To enable using this theory, it is essential to understand the social aspects of the industry to achieve technical development. This was achieved through a qualitative approach using semi-structured interviews to investigate the social aspect of this transition towards technical development of the existing circular approach within the construction industry.

The qualitative approach provided an in-depth understanding of the social parameters of the case study. The study does not provide any experimental results, such as prototypes or laboratory tests, because the aim is to evaluate actors' attitudes to the concept of implementation RFID tags as a standardization. The focus lies on collecting data from the actors to evaluate the fundamental aspect of the case. The fundamental aspects imply identifying where the

attitude derives from and how them affects this case. The study aims to be based on primary data, which are first-hand sources collected by the researchers through interviews with the different actors within the industry, this type of source is more relevant and authentic compared to secondary data, which are data collected by others than the researchers in this thesis (Bell, et al., 2019).

The purpose of the thesis was to provide an extensive report investigating how the stakeholders of the Swedish construction industry stands toward implementing a tagging system using RFID technology. To understand the industry's attitude toward this implementation, extensive market research was done where different actors in the industry were interviewed, analysed, and later connected to results. To get a broader understanding of the industry's challenges, several theories were investigated, analysed, and iteratively with the empirical case of the thesis.

The thesis was written using an iterative approach. The iterative approach is when each part of the thesis is reviewed and revised multiple times during the thesis (Bell, et al., 2019). Initially, the literature was identified and analysed to get a broad understanding of the area's problems, along with finding relevant theories and frameworks used to analyse to the empirical case and phenomena that form the foundation of the thesis. During this phase, the research gap was identified within the academic literature which is the gap in understanding the attitudes of the construction industry towards new technologies and more standardized processes, which has resulted in a stagnation in the transition towards a circular economy. Following this phase, the interview guide was written along with the selection of whom to be interviewed; this process was revised continuously along with the progress of the thesis. The researchers contacted potential respondents and got direct help from WSP to find relevant respondents. After the interviews, a thematic analysis was performed to analyse the data.

3.3 Case Study

The thesis was written in cooperation with WSP, where the empirical problem was identified. A case study design was chosen in order to analyse the problematization initially based on WSP's perspective; using a case study design allows the researcher "to follow a single organisation, location, person, or event to relevant data and study the complexity and particular nature of the case" (Bell, et al., 2019). The boundaries of the case study also include stakeholders other than WSP since the whole market of the Swedish construction industry is investigated in the study, meaning that the case study is centred around project Lumi but explores other external stakeholders. The project LUMI where the researchers were based, was a starting point and part of the foundation for the thesis, supporting the researchers during the progress of the thesis, but did not constitute any limitations for the thesis.

3.4 Sampling

The sampling method for this qualitative study is a purposive sampling method, which is a non-probability sampling method (Bell, et al., 2019). The respondents for this study were selected through the method based on their company affiliation and respective positions within the industry. This selection aimed to ensure a comprehensive representation of various actors within the industry, enabling a detailed examination of the overall market's attitudes towards the standardization of RFID tags. With a purposive approach, the risk of biased answers increases, but the validity and reliability increase as well (Bell, et al., 2019). This is due to respondents being well-educated and having experience and knowledge of the industry.

To ensure covering the whole construction industry and all actors within it with the interview study, the industry was categorized into customers, distributions, entrepreneurs, manufacturers, and service companies. The customers are the prominent actors of the industry who initiate the orders to construct the buildings, also called developers, and in this sample consisting of Akademiska Hus and Uppsala Kommun. Distribution companies work with deliveries of goods and deposit waste, intermediate storage, and logistics circling construction. In this sample, this category consists of Wiklunds Åkeri AB. The entrepreneurs within the construction industry are the actors that perform services or work on the projects in this study consisting of Byggstyrning. The manufacturers are the firms who produce the objects used in the construction projects, in this study consisting of Jeld-Wen and Signify. The last actor is the service section; they provide services within the industry such as technical programs; in this study, the sample consists of BuildID, who is working with a similar concept as the one in this study.

3.5 Interviews

The data was collected from eight respondents with extensive experience from the construction industry. All respondents except two come from different companies, and the purpose of that is to reach most parts of the industry. The companies that have been interviewed are chosen by their influence in the market (larger companies), their willingness to contribute, and based on geographical parameters such as if they are located or operating in Sweden. The choice of companies is made with purpose of answering the RQ. These actors are important enablers for the standardisation because they are all actors in the market and their attitude matters toward developing and implementing a new standard regarding RFID tags. The number of respondents was a relatively small sample size but a consequence of lack of interest and availability from potential respondents along with time constraints.

A semi-structured interview is a method that combines determined questions along with follow-up questions meaning it’s a mixture of both structured and unstructured (Bell, et al., 2019). The reason for choosing semi-structured interviews was to encourage discussions and

follow-up questions that provide a deeper understanding of the topic. The interviews were conducted with an interview guide consisting of closed, open-ended questions followed by additional questions if necessary. The interview guide consent is in two different parts: firstly, the individual part where the respondent's position, company and stakeholder type are presented. Secondly, this part aims to answer the research question with the relevant question of the actor's attitude toward the implementation of marking tags to provide a comprehensive perspective from all the actors in the construction industry. The interviews started with the consent of recording, followed by an introduction of the subject and standard questions to understand the respondents' backgrounds and to ensure their relevance in the study. Under the appendices, the interview guide can be seen; it does not include the follow-up questions. The interviews were performed both face-to-face in person and online on Zoom. The reason for choosing in-person interviews was to simulate a more genuine interview with a higher quality and less chance of misunderstandings with those respondents that had to option to meet in person (Bell et al, 2019). The choice of doing some interviews on Zoom was conducted since it was seen to be the best alternative for those respondents who did not have the opportunity to meet in person.

The following table presents the number of respondents and the specifics for each respondent. The specifics present their experience in the branch and which role and business area they have within the company. All respondents are chosen by the impact their company has on the industry. Well-established actors within the branch were contacted, and through mail conversation with the company’s support division, the right person at each company was addressed and interviewed to establish representative information from the actor.

Table 1: Overview of the respondents (Eriksson & Norberg, 2023)

Respondent	1	2	3	4
Company	Akademiska hus	Uppsala Kommun	Wiklunds åkeri AB	Byggstyrning
Stakeholder type	Customer	Customer	Distribution	Entrepreneur
Position	Sustainable strategic specialist	Project manager	Concept responsible waste	Digital project manager
Interview Date	2023-04-19	2023-03-29	2023-04-12	2023-04-17

Respondent	5	6	7	8
Company	JELD-WEN	Signify	Buildid	Byggstyrning
Stakeholder type	Manufacturing	Manufacturing	Service	Worker
Position	R&D Manager	CEO Northern region	Board member	Production manager
Interview Date	2023-04-14	2023-04-19	2023-03-29	2023-04-21

3.6 Analysis approach

Analysing the results acquired from the interviews is a crucial stage in finding the relevant information to answer the research question and ensure the relevance of the study. The method used for analysing the data was thematic analysis, which is a method used to break down the data, identifying patterns through dividing it in themes and codes (Braun & Clarke, 2006). The data were analysed by firstly transcribing the interviews and then coded using the six steps of the thematic analysis presented below according to Braun & Clarke (2006).

- The six steps start with getting familiar with the data, listening to the recorded interviews, and reading the transcripts; in this stage, the researchers also put notes on parts initially identified as of interest before moving on to the next step.

- The second step is generating initial codes that provide a structure and reduce the amount of non-usable data by selecting what is viewed as of potential interest to answer the research questions. Sentences of relevance were marked and connected to describing words or short sentences that constitute the codes. Codes seen as having uncertain relevance but still not irrelevant were coded initially and later revised since it is easier to discard codes rather than review the unfiltered data all over again if pieces are missing. Codes were generated one at a time along with reviewing the data from start to finish, taking the data from each interview separately to prevent any inaccuracies.
- The third step is searching for themes within the codes where connections between codes are identified. The theme "captures something important about the data in relation to the research question and represents some level of patterned response or meaning within the data set" (Braun & Clarke, 2006, p. 82). The codes were reviewed, and the research identified topics from each code that held similarities. The generated themes were reviewed to ensure that they could provide a representable overview of the interview study that holds relevance toss the research question. Suitable potential names for the themes were noted before moving on to the next stage.
- The fourth step is to review the themes generated in the previous stage and begin a selection process where the themes are compared to the collected data to ensure that it holds a correct relation. Codes and themes can be relocated or reviewed in this stage if necessary to ensure relevance. The researchers reviewed the collected data one more time before moving on to step five to ensure that the themes captured the most critical and relevant data connected to the research questions.
- The fifth step is to define and name the themes. At this stage, the goal is to have defined themes with clear focus, scope, and purpose related to the goal of the whole thesis, along with some sort of relation between themes. Naming the themes is the other part of this stage where the importance lies in naming each theme with an informative, concise, and catchy name. The researchers reviewed the names noted in stage four and changed some of the names while some remained the same.
- The sixth and last step is writing the analysis resulting in a complete thematic analysis usable for reports or journals. The order of the themes is essential, so they connect naturally and ideologically build upon each other to facilitate the coherence of the analysis.

A deductive approached was used in the analysis, it is used when a researcher wants to find more specific information connected to previous research or theoretical perspectives, to understand more details connected to this (Braun & Clarke, 2006). This method was used to get a clear structure of the results enabling a deeper understanding and correlation between the

interviews and the research question along with the academic gap to provide relevant data for achieving the aim of the study (Braun & Clarke, 2006).

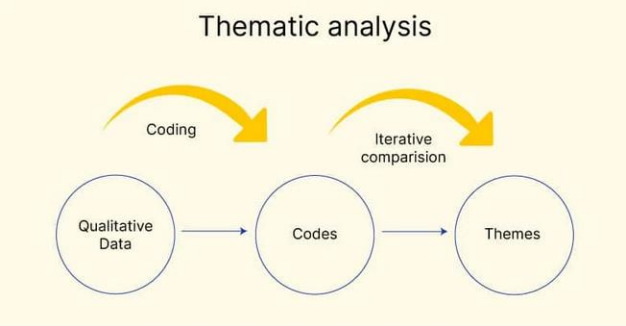

Figure 5 5: Illustration of a thematic analysis approach (VOXCO, 2021)

3.7 Trustworthiness

The concept of trustworthiness is essential for the research to be seen as relevant. Within quantitative research, the concept can be referred to as validity and reliability, but since this thesis was done as qualitative research, validity, and reliability are not as relevant concepts for this case (Bell, et al., 2019). Trustworthiness in qualitative research can be defined with four keywords which are credible, transferable, confirmable, and dependable (Bell, et al., 2019).

For the interviews, respondent validation was performed to lower the chances of data misinterpretation through recording the interviews and listening through them multiple times to ensure the results are correct; this to enhance the credibility aspect of the study (Bell, et al., 2019). Since this was a case study investigating the market's attitude towards a new standardization, it would not be easy to transfer this study to other industries other than the construction industry since this standardization has specific properties adapted for the construction industry. However, the study's structure and base could be transferred to studies investigating other industries, but with a specific research question and goal narrowed to the construction industry, as in this study, the transferability stays low. Confirmability describes whether or not the results are neutral or objective. The interview results were coded using thematic analysis to ensure objective results based on data and not on own preferences or thoughts. Dependability in qualitative research can be achieved through different methods and is usually described with the word consistency. During the period for the thesis, regular meetings and discussions were performed between the researchers and supervisor to discuss the results and eventual flaws to be corrected, enhancing the dependability of the study (Bell, et al., 2019).

3.8 Limitations

This section focuses on the possible limitations of this study. The limitations impact on the study and possible outcomes are discussed for future research improvements.

One core limitation of the study concerns the limited schedule to perform the study. The tight schedule impacts the number of actors that the study reaches out to. The number of actors that the study reaches out to is a core factor for analyzing the attitude of the industry. Because the number of actors in the industry is extensive and to analyze the attitudes of a whole market, all actors might need to be included.

Moreover, one limitation concerns the geographical aspect; some of the manufactories in the Swedish market are owned by foreign companies. This aggravates the analysis to focus on the Swedish market because the respondents are based in other countries and might not be representative of the Swedish construction industry as a pure Swedish company. Additional to the purposive sampling method, the level of cooperation from the selected actors varied. All companies were not cooperative due to a lack of time and interest. The reduced number of respondents impacts the reliability of this study because more respondents are necessary to fully represent the entire industry and provide a representative conclusion.

3.9 Ethical considerations

According to Arifin (2018), the ethical consideration in a qualitative study is important specially when including vulnerable groups as participants. It is important for the researcher to protect the participants by enabling freedom to choose to participant and promote clear and honest results without deceiving the reader (Arifin, 2018).

The research was carried out at the project called Project Lumi, with the collaboration of WSP as its core foundation. The researchers visited the project Lumi's site office on a weekly basis, and those who worked there were aware of why we were there, as the supervisor for this thesis had informed every one of our presence and purpose which is in line with the ethical considerations for a qualitative study (Arifin, 2018). It should be noted, however, that not all workers at the site office were personally informed about the study and its purpose.

We obtained permission from all respondents before interviewing and recording them to ensure that the study did not violate any ethical guidelines which is in line with the ethical consideration for a qualitative study (Arifin, 2018). We also asked them how they wanted to be referred to in the study and informed them that the information gleaned from the interviews would support the thesis's empirical content. However, because the empirical data collected

included information such as the respondent's company and position, complete anonymity could not be guaranteed.

4 Results

This chapter presents the result of the interview study in shape of a thematic analysis regarding the industry's attitude toward implementing a new RFID marking tag system. The empirical data is later used in following chapters to be analysed, discussed and to draw conclusions from. The semi-structured interviews were performed based on an interview guide attached in the appendix. The focus of the study is on the attitude of stakeholders in the construction industry towards the implementation of a new standardization, and not how the concept should be executed in detail, therefore this aspect is not considered.

4.1 Thematic Analysis

The thematic analysis is presented and structured to illustrate the main themes generated, backed up by codes and further on by quotations extracted from the interview study shown in Table 2. The thematic analysis serves as a crucial tool in this study, providing a structured and comprehensive presentation of the main themes that emerged from the interview data. By employing codes to categorize and organize the data, the analysis aims to uncover the participants' perspectives and shed light on their thoughts, feelings, and opinions regarding the implementation of standardized RFID tags.

The quotations presented were picked to gain knowledge of the market's attitude toward implementing standardized RFID tags intending to understand the problematization, help fill the academic gap and answer the research question. These codes capture significant participants' thoughts, feelings, and opinions, enabling to comprehend their perspectives on the prospective advantages, difficulties, and general acceptance of implementing RFID technology for standardized tagging, which stands as an academic gap in the literature.

Overall, this thematic analysis, with its structured presentation of main themes, codes, and supporting quotations, serves as a robust methodological approach to comprehensively explore and address the research question, filling an important gap in the existing academic literature regarding the market's attitude towards standardized RFID tagging.

Table 2: Thematic analysis (Eriksson & Norberg, 2023)

Quotes	Codes	Themes
"I think the concept is great. It is something we are working on. We need to get to a circular world where we reuse materials. Because today we consume 1.6 times the world's annual growth of resources and therefore, we need to start reusing materials more." **-Respondent 6**	Need to promote circular approach, must lower strain on earth	Market needs
"In my experience, things either start with very proactive businesses that sees an opportunity, when it's a standard, when customer pull demands it or when a legislation insists that businesses must act. And the majority obviously act when they're told to act, and a few companies take a proactive approach." **-Respondent 5**	Need of customer pull or legislation could promote the concept	
" Circulation needs a huge transport network to facilitate the process of circularity within the industry. Today they transport only to send raw materials back and forth." **-Respondent 6**	Need to improve the transport network	
5.4 5.4 "Everyone talks about it, but it doesn't happen much, that's my opinion. We have the foundation and technical conditions to perform it. It's about the decision-makers having the courage to take the step, I think." **-Respondent 3**	The decision makers need to dare	
"In order to reduce the need for transporting materials between countries and continents, it is essential to establish local recycling stations that can handle the process of separating materials found in various products. This is particularly important because production plants are not present in every country. By having recycling stations in each country, the specific data gathered can be utilized to sell the materials to both local and international production facilities." **-Respondent 6**	Need more and accurate local recycling stations, to reduce transports and enable reusage	
"To increase volume capacity and efficiency, this initiative must become the norm across the EU rather than being restricted to Sweden alone. Although it might start in Sweden and	Need a standard from EU, not just in Sweden	

pave the way for the industry, there is a chance that if the concept stays in Sweden, used goods could end up being shipped to third-party nations and eventually disappear.” **-Respondent 6**		
” Everyone is probably positive if we can just decide how we want this standard, but getting the different wills to come to an end I think is difficult. The industry is in need of a standard to follow” **-Respondent 7** & “There are many people who want a lot in this area, I think some form of standardization is needed to promote this transition.” **-Respondent 3**	Industry needs a unified solution	
“With any big company the red tape and getting sign off on approval, I think it would have to be done on a full scale. You either do it or you don't do it, so it needs that strategy. Aligning at the top level of the business. I'm not saying it's impossible, but that's the only real challenge we probably have, just getting the sign off and then the resource is allocated to a project too.” **-Respondent 5**	Needs to be done on a full scale to be successful	
“It is likely that the market is still a bit immature for such a transition considering the conservatism of the industry. Now we are still talking about what is added to a new product today that can be dismantled later in the future with more knowledge regarding the dismantled object.” **-Respondent 1**	Market immaturity	Barriers for the concept
“As we know the construction industry is conservative which poses challenges and obstacles when a new solution is introduced within the industry.” **-Respondent 6**	Conservative industry	
“One disadvantage is that the idea of such things are sensitive, the RFID chip, can it break in some way, and then you must replace it and that there must be a structure for those procedures. There might be actors who don’t want to implement this due to technical problems like that and with systems that handle data around it.” **-Respondent 4**	Concerns of technical failure	

But I don’t think all suppliers will agree on this implementation and think the same way and I think that's a lot because they don't understand the bigger picture of it and their benefits of circularity.” **- Respondent 4**	Concerned of supplier’s willingness of implementation	
“The industry needs a gathering point for the technical innovations within this area, there are actors out there who have concepts similar to this, but it’s to scattered.” **-Respondent 3** & “If these goods are documented in this way, it can be very difficult to keep track of them if there are many different types of documentation. So, it is important that there is a common thread so that it actually becomes really simple. There must not be different tagging systems on different products.” **-Respondent 2**	Finding a unified solution	
“So, what complexity and labelling will the concept have? Because there are quite a few varying standards today, which of the competing options should be chosen as the overall standard? There can be both economic and political reasons why certain actors support certain views. It might take time to reconcile them.” **-Respondent 7**	The complexity of the concept	
“The problem will probably be getting the actors to work together since they have their own ideas and solutions, so getting them to agree on this is probably the hardest part.” **-Respondent 8**	Unifying the actors	
“It takes time to convince the customers to transfer more towards minimizing the waste rather than the traditional waste management along with the economic barrier, that it might not be as profitable initially.” **-Respondent 3** & “I think there will be an associated Cost element to the concept. It doesn't come for free. The cost I guess will be determined by how much data will be included on the tag or on the cloud system. That's probably what would be expensive and seen as a limitation for the concept.” **-Respondent 5**	Cost	

“I think the big results would be easy to keep track of the inventory in the buildings, what you have and what warranty periods for maintenance, you can get a structure on it and have better access to data which would reduce time and costs.”. **-Respondent 4** & “As of today, we struggle with some recycling projects since we have to do time consuming inventorial processes, I think this concept could reduce the time spent on these stages which would be really beneficial.” **-Respondent 2** & “More information early in order to potentially reduce the inventory time or in any case that this should be able to provide something at an earlier stage in order to be able, for example, to make a rough inventory of what is available in a building”. **-Respondent 1**	Reduced inventory time (better structure and data access)	Benefits of the concept
“A good advantage would be that you can keep track of what's there, and it could improve the inventory process. As we have experienced, the biggest problem is that it's difficult to find objects with the scanner when we have tried. It needs to be a little better in my opinion.” **-Respondent 8**	Improved traceability of objects	
“It might not risk losing the documentation in the same way if you compared to today when you might still have a lot on paper or in some folder on someone's computer or something like that it seems to be more accessible to everyone somehow. Be able to track regardless of whether people change jobs and thus over time.” **-Respondent 2**	More accessible documents and materials	
“With the accessible data it can provide, it becomes a basis for the next decision on whether to take it further into the next reusage in a later stage in the next project, so you shorten the decision paths there.” **-Respondent 4**	Shorter decision paths for projects	
“Installed objects needs to be maintained, if this can add to the RFID tag digitally instead of having manually recorded papers it would facilitate to	More accessible knowledge of object service and maintenance history	

keep track of what's been done in terms of service and maintenance." **-Respondent 5**		
"Using this concept, we could recycle more materials from used objects and use the materials with longer lifespan than the object itself holds, which would reduce the use of new materials. It can also be possible to provide extended warrantee on restored objects if us manufacturers perform these restorations, which is a concern amongst entrepreneurs since they want warrantee on products which is lacking today when using recycled products" **– Respondent 5**	Reduced environmental impact and use of new resources	
A lot of the implementation is trying to show the benefits with the value it creates. The operation and maintenance costs a lot, if you look at 50 to 75 years of operation and maintenance as well as the management phase itself. Can you make the actors realize that you can save money by keeping track of what is in the building and therefore reduce working hours for example, maintenance, projecting for future projects and more, then I believe they will take on the concept". **- Respondent 4**	Lower operating and maintenance costs	
"I think it is good step towards circular industry, just finding materials and being right in time to find materials and match the pace of the project. It is very important that you can see what and where the objects are in the market in real time." **- Respondent 3** & In the United Kingdom today, there are platforms where RFID tags can be added to doors with a particular focus on fire doors and it's more for the fire door compliance than the circular economy. But you can very easily see how it links back or can be utilized. From a circular point of view as well. So, I think the concept is very good and I think without it, it's quite difficult actually to understand the products journey and then how to capture the	Promotion of the circular industry	

product at the end of its life". - **Respondent 5**		
"I think it should be easy to implement this concept, there is not much that needs to be added". **-Respondent 4** & "I think this could be implemented without many complications. We have all the parts in place, we have transport, technical tools, storage, inventory tools and stores to sell it, it's about just deciding to do it". **Respondent 3**	Easy implementation	
"I think it will be a great thing for our management in projects that will make it easier as we will know more clearly what it is there and how it should be maintained, as well as the flexibility in handing over the management to other actors". **-Respondent 4**	Facilitated handover of projects to other actors	

4.2 Data Structure and story

The generated codes led to the identification of three central themes: market needs, barriers to the concept, and benefits of the concept. These themes are directly linked to the research question and form an essential component in achieving the thesis's objectives. Table 3 presents a visual overview of the data analysis, showcasing the identified themes and codes.

The empirical findings highlight a social factor concerning the apprehension surrounding the unsuccessful implementation of a new standardization related to RFID tags for promoting circularity. These findings are pertinent to the study as the research question explores attitudes and their impact on the promotion of circularity within the Swedish construction industry. The analysis has resulted in three derived themes: market needs, barriers to the concept, and benefits of the concept.

As stated in the introduction of this thesis, the global community must initiate changes to alleviate environmental burdens. One approach to address this issue is by promoting circularity. The thesis incorporates the research question by structuring the thematic analysis in table 3, which applies the lens of socio-technical transition theory. The respondents also recognize the conservative nature of the construction industry but emphasize the necessity and need for changes to foster long-term circularity (Theme: Market needs).

One prominent issue identified in the empirical research is the transient nature of construction industry projects, resulting in efficiency challenges due to the temporary nature of all site offices. Additionally, the study revealed concerns about competitiveness and increased costs among companies in the construction industry (Theme: Barrier for the concept).

Furthermore, the empirical findings indicate that there is a market demand for the concept, and the respondents recognize significant potential in terms of maintenance, structure, efficiency, and circularity (Theme: Benefits of the concept).

Lastly, this study contributes to the existing academic literature by addressing gaps previously identified. By applying socio-technical transition theory to analyze the findings, the study provides a comprehensive understanding of attitudes and how circularity can be promoted.

Table 3: Data analysis (Eriksson & Norberg, 2023)

Themes	Market needs	Barriers for the concept	Benefits of the concept
Codes	Need to promote circular approach, must lower strain on earth	Market immaturity	Reduced inventory time (better structure and data access)
	Need of customer pull or legislation could promote the concept	Conservative industry	Improved traceability of objects
	Need to improve the transport network	Concerns of technical failure	Improved traceability of objects More accessible knowledge of object service and maintenance history
	The decision makers need to dare	Market immaturity	More accessible documents and materials
	Need more and accurate local recycling stations, to reduce transports and enable reusage	Finding a unified solution	Shorter decision paths for projects
	Need a standard from EU, not just in Sweden	The complexity of the concept	Reduced environmental impact and use of new resources
	Industry needs a unified solution	Cost	Lower operating and maintenance costs
	Needs to be done on a full scale to be successful		Promotion of the circular industry
			Easy implementation
			Facilitated handover of projects to other actors

5 Analysis

This chapter analyses the data collected from the semi-structured interviews. The structure divides the analysis in three sub-chapters consisting of the three generated themes market needs, barriers for the concept and benefits of the concept along with the codes within each theme. The literature and problematization previously found are presented within each sub-chapter connected to the themes and data from the interviews. The themes are analysed through the lens of socio-technical transition theory with the MLP framework. This approach to analyse was chosen with the aim to add empirical context and fill the academic gap of the study.

5.1 Theme one: Market needs

Previous research has highlighted the strain on the world caused by various environmental problems, including global warming resulting from the use of fossil fuels, food waste, air pollution, melting ice caps, rising sea levels, agriculture-related issues, biodiversity waste, plastic pollution, and deforestation (Robinson, 2023). Supporting this notion, data provided by the United Nations Environment Programme (UNEP) reveals that the building and construction industry is responsible for 4% of global energy consumption, 30% of energy-related greenhouse gas emissions, 12% of water usage, and nearly 40% of waste production (Linderoth & Isaksson, 2018). The authors highlight the impact that the construction industry is responsible for and that the current situation regarding the environment needs to be changed to reduce the strain on the environment and to promote a sustainable development.

Moreover, the implementation of a circular economy poses several challenges, as highlighted by Daan et al. (2017). One significant challenge involves the necessity for a unified interest among all stakeholders. The authors emphasize that if the transition to a circular economy shall be successful the need for a solution that is suitable to all and with a unified interest and among all the actor's is of value. Furthermore, Daan et al (2017) reveal that the challenges associated with implementing a circular economy can be attributed to two fundamental factors: the diffusion of responsibility and disparities in perception. Moreover, different interpretations and understandings of the same event or scenario can lead to disparities in perception. People's perceptions can vary depending on their personal histories, prejudices, cultural backgrounds, and societal training. As a result, people may view and interpret reality differently.

There are similarities and patterns in the codes within the theme, market needs, presented previously that can be analyzed using the socio-technical transition theory. How the market has needs/demands that create forces for the technical transitions, societal behaviors, and technological developments will alter over time as user preferences, institutional norms, and legal requirements interact with technological improvements. From this perspective, market demands may be a significant transitional driver since they reflect the shifting consumer and

corporate wishes and preferences. The aspect of environmental conservation acts as a parameter that could be related to the market's need within the socio-technical transition theory. Through the socio-technical transition theory the theme named “Market needs” has derived and the belonging codes that is categorized as market needs are decomposed and specified to highlight the parameters that are connected to market needs.

Codes within the theme: Market Needs

Code: Need to promote circular approach, must lower strain on earth

The urgent need to promote a circular approach stems from the alarming strain we are putting on our planet. As the interviewee acknowledged, the concept of a circular economy has potential. When we consider that our current consumption exceeds the world's annual resource growth by 1.6 times, it is clear that a fundamental shift is required. Adopting a circular model, forces us to prioritize reusing materials, lowering our reliance on virgin resources. This need is heightened by the market, where sustainability is emerging as a critical success factor.

“I think the concept is great. It is something we are working on. We need to get to a circular world where we reuse materials. Because today we consume 1.6 times the world's annual growth of resources and therefore, we need to start reusing materials more.” **-Respondent 6**

Code: Need of customer pull or legislation could promote the concept

The need for customer pulls or legislation to promote a concept arises from the market's demand for change. Proactive businesses identify opportunities and align their strategies accordingly. However, most businesses will only act if they are forced to. Customer pull, which is driven by consumer preferences and demands, is critical in encouraging businesses to adopt new concepts. When customers express a desire for a specific product or service, businesses feel compelled to meet those demands in order to remain competitive. Furthermore, legislation acts as a driver, compelling businesses to act by imposing regulations and standards. Businesses can adapt and thrive in an ever-changing market landscape by recognizing the importance of customer pull and legislation.

“In my experience, things either start with very proactive businesses that sees an opportunity, when it's a standard, when customer pull demands it or when a legislation insists that businesses must act. And the majority obviously act when they're told to act, and a few companies take a proactive approach.” **-Respondent 5**

Code: Need to improve the transport network

The quest for circularity in modern industry necessitates a robust transportation network to enable seamless circulation. Currently, transportation is only used to transport raw materials back and forth. This approach, however, falls short of meeting the market's requirements. We must improve transportation infrastructure to achieve true circularity. Transportation systems that are efficient would allow for the movement of not only raw materials, but also finished goods, recycled materials, and waste. We can reduce resource waste, improve supply chain agility, and promote sustainable practices by optimizing the transportation network. A comprehensive transportation framework would meet market demands for increased efficiency, lower environmental impact, and the successful implementation of a circular economy.

" Circulation needs a huge transport network to facilitate the process of circularity within the industry. Today they transport only to send raw materials back and forth."
-Respondent 6

Code: The decision makers need to dare

In today's rapidly evolving market landscape, the need for daring decision-makers is more crucial than ever. The quote emphasizes the prevalent gap between discussing daring actions and carrying them out. Despite a strong foundation and the required technological resources, meaningful progress remains difficult in the absence of daring individuals at the leadership. The market requires decision-makers who are prepared to challenge themselves, challenge the status of things, and take calculated risks. These leaders may unleash opportunities and achieve dramatic change by daring to take the journey into unfamiliar territory. Organizations can adapt to altering market dynamics, capture competitive advantages, and ultimately thrive in an era marked by disruptive innovation because of their audacity.

"Everyone talks about it, but it doesn't happen much, that's my opinion. We have the foundation and technical conditions to perform it. It's about the decision-makers having the courage to take the step, I think." **-Respondent 3**

Code: Need more and accurate local recycling stations, to reduce transports and enable reusage

To meet the growing demand for sustainable practices, decision-makers must be willing to take risky initiatives. The requirement for more and more accurate local recycling stations is one pressing issue that needs their creative approach. These stations are critical in decreasing material transportation across countries and continents. By building such stations, the process

of segregating materials from various products can be carried out efficiently within each community.

Due to the restricted presence of manufacturing factories in each country, the market requires a paradigm change toward localized recycling solutions. The presence of recycling facilities in each country not only decreases the environmental impact of long-distance transportation but also allows for the collection of useful data. This information can be used to sell the separated resources to both local and foreign manufacturing facilities, promoting a circular economy and reducing waste generation. Decision makers can make a substantial contribution to sustainability and resource conservation by taking the risk of investing in local recycling infrastructure.

"In order to reduce the need for transporting materials between countries and continents, it is essential to establish local recycling stations that can handle the process of separating materials found in various products. This is particularly important because production plants are not present in every country. By having recycling stations in each country, the specific data gathered can be utilized to sell the materials to both local and international production facilities." **-Respondent 6**

Code: Need a standard from EU, not just in Sweden

To fulfil the changing demands of a market, decision-makers must be willing to take risky steps. This necessitates expanding activities beyond national borders and developing a unified approach across the European Union. The market itself drives the demand for a unified standard, as customers want greater volume capacity and efficiency in their transactions. While Sweden may have pioneered an innovative notion, restricting it to a single country may have unintended consequences. Without EU-wide adoption, there is a real risk of utilized goods being transferred to third-party countries and then disappearing. Decision makers can secure the long-term viability of this initiative and answer current market needs in a comprehensive way by daring to expand and unite it.

"To increase volume capacity and efficiency, this initiative must become the norm across the EU rather than being restricted to Sweden alone. Although it might start in Sweden and pave the way for the industry, there is a chance that if the concept stays in Sweden, used goods could end up being shipped to third-party nations and eventually disappear." **-Respondent 6**

Code: Industry needs a unified solution

In today's rapidly shifting industry scene, a unified solution is more important than ever. Decision-makers must reconcile divergent viewpoints and bridge gaps between numerous parties. As implied by the first quote, there is a common desire to set a standard that may guide and streamline procedures. Without a unified framework, the sector suffers from fragmentation and inconsistency, inhibiting advancement and innovation. The second quote underlines the

necessity of standardization in making the shift easier. Businesses may manage the complex dynamics of the market, foster teamwork, and drive success by taking a united strategy. A unified standard would not only improve operational efficiency but will also create confidence among stakeholders, resulting in a healthy and sustainable sector.

" Everyone is probably positive if we can just decide how we want this standard, but getting the different wills to come to an end I think is difficult. The industry is in need of a standard to follow" **-Respondent 7**

&

"There are many people who want a lot in this area, I think some form of standardization is needed to promote this transition." **-Respondent 3**

Code: Needs to be done on a full scale to be successful

To be successful in making a big shift inside a firm, it is critical to do it on a large scale. The socio-technical transition theory highlights the importance of a complete strategy that is aligned with the top-level company objectives. The major issue, however, is overcoming bureaucratic red tape and securing consent from decision-makers. The required resources can be allocated to the project by gaining support from the highest levels of the company. This is especially important when considering the market's need for change. As a result, in order to successfully satisfy market demands, it is critical to overcome approval bottlenecks and assure full-scale transition execution.

"With any big company the red tape and getting sign off on approval, I think it would have to be done on a full scale. You either do it or you don't do it, so it needs that strategy. Aligning at the top level of the business. I'm not saying it's impossible, but that's the only real challenge we probably have, just getting the sign off and then the resource is allocated to a project too." **-Respondent 5**

5.2 Theme two: Barriers for the concept

Previous research by Daan et al. (2019) implies how the implementation of circular economy within industries holds two main challenges, the disparities in perception that result in a lack of consensus amongst actors and the diffusion of responsibility that leads to decreased sense of accountability and low probability in taking initiative within the industry (Daan, et al., 2019). According to Hossein et al. (2020) one challenge is to find consensus amongst the stakeholders when facing technical transitions that requires changes. From the interviews it was retrieved that one of the major concerns regarding implementing the RFID tag within the construction industry is the process of unifying the actors and coming to an agreement. It was also mentioned about the critic view towards the stakeholder's willingness to take responsibility and implement this.

Furthermore, Riedjik (2009) and Larsson et al. (2013) describes how the conservatism within the construction industry is hindering technical developments and changes in the working methods. This barrier is mention by several respondents whom describes how the conservatism within the industry is making the market immature and resilient towards technical transitions. Coherent to the resilient industry, Lie et al. (2015) explains one of the main barriers for technical developments and standardization as the lack of national standards within the industry, indicating the need of a unified solution. The need for a unified solution is continuously mentioned from the interviews as it explained how the current solutions are scattered and need a consensual gathering point so successfully be implemented.

The construction industry being fostered around the lowest tender policy amongst customers is according to Isaksson & Linderoth (2018) hindering the development of long-term solutions as the main focus within the industry lies in the costs. Being that the transformation towards circularity might not be profitable is seen as a hindering factor towards applying circularity (Cai & Waldmann, 2019). The concerns regarding costs were brought up by respondents explaining how it can take time to convince the actors to transfer towards circularity instead of traditional methods to minimize waste. The change towards circularity might result in extended costs er not being profitable initially, which from the data is seen as a limitation for the concept.

Within socio-technical transition theory, concept barriers can result from social and technical limitations. Social limitations can be regulations legislated by the state and cultural norms hindering changes in the industry, meaning that society does not want specific innovation. Technical limitations hinder innovation development because the technology required does not exist, does not have the financial funding, or takes too long to innovate. These barriers are essential to understand and overcome to successfully implement a new innovation in an environment where barriers circulate.

Codes within the theme: Barriers for the concept

Code: Market immaturity

The code market immaturity refers to the sceptic attitude towards weather or not the market is mature enough to adapt such technical transition. The idea of market immaturity implies that there might be difficulties and obstacles that must be overcome before the suggested transition can be successfully implemented on a larger scale. This suggests that the infrastructure, systems, and support required for the transition might not be entirely in place or widely distributed. The respondent speculates that the market may not be fully aware of, understanding, or accepting of the new strategy.

‘

"It is likely that the market is still a bit immature for such a transition considering the conservatism of the industry. Now we are still talking about what is added to a new product today that can be dismantled later in the future with more knowledge regarding the dismantled object." **-Respondent 1**

Code: Conservative industry

When it comes to introducing new solutions, the construction industry's conservatism creates significant difficulties and obstacles. As we all know, the industry has a tendency to stick with conventional techniques and established practices, making change challenging. The adoption and application of innovative solutions within this sector may be hampered by this inherent conservatism. The industry's resistance to risk and preference for conventional methods frequently pose obstacles to the successful adoption of unconventional ideas, innovations, or procedures. When introducing and promoting new innovations in the construction industry, it is crucial to carefully navigate and address these conservative tendencies.

"As we know the construction industry is conservative which poses challenges and obstacles when a new solution is introduced within the industry." **-Respondent 6**

Code: Concerns of technical failure

The sensitivity and potential for breakage of RFID chips, which would require replacement and the establishment of proper procedures, is a possible limitation of implementing them. Additionally, some actors might be reluctant to use this technology because they are worried about technical issues and the management of data systems related to the implementation of RFID. These factors highlight significant difficulties and potential obstacles to the widespread use of RFID chips in various contexts.

"One disadvantage is that the idea of such things is sensitive, the RFID chip, can it break in some way, and then you must replace it and that there must be a structure for those procedures. There might be actors who don't want to implement this due to technical problems like that and with systems that handle data around it". **-Respondent 4**

Code: Concerns of supplier's willingness of implementation

It is essential to keep in mind that not all suppliers may automatically agree to the implementation of this concept. Suppliers may have different viewpoints as a result of their varying levels of understanding of the wider implications and advantages of circularity. Before fully embracing and supporting circular practices, some suppliers might need more information and awareness about their benefits resultant of implementing the concept of RFID tags.

"*But I don't think all suppliers will agree on this implementation and think the same way and I think that's a lot because they don't understand the bigger picture of it and their benefits of circularity.*" **- Respondent 4**

Code: Finding a unified solution

The industry needs to establish a unified solution for technological advancements in this area. Although some actors share concepts with one another, the current landscape lacks unity and seems scattered. It becomes difficult to effectively track and manage these goods if their documentation is done using multiple and unconnected systems. To ensure simplicity and coherence in the process, it is crucial to establish a common thread. To simplify processes and encourage effective documentation practices, it is crucial to prevent the existence of various tagging systems across various products.

"The industry needs a gathering point for the technical innovations within this area, there are actors out there who have concepts similar to this, but it's to scattered." **-Respondent 3**

Code: The complexity of the concept

Relevant concerns are raised by the concept's complexity and labelling features. Due to the industry's spread of competing standards, a critical choice must be made regarding which one will serve as the fundamental standard. Political and economic considerations may be made during the selection process considering various actors may have vested interests and support different points of view. Because of the complexity, it might take some time to reconcile these conflicting interests and reach an agreement.

"So, what complexity and labelling will the concept have? Because there are quite a few varying standards today, which of the competing options should be chosen as the overall standard? There can be both economic and political reasons why certain actors support certain views. It might take time to reconcile them." **-Respondent 7**

Code: Unifying the actors

Establishing collaboration among the various actors involved is a major obstacle in implementing the concept into practice. Each actor within the industry contributes their own thoughts, options, and perhaps conflicting interests to the discussion. Therefore, reaching consensus and getting them to agree on a single strategy is probably the most challenging part of the process. The different viewpoints and personal agendas may make it challenging to coordinate their efforts in order to achieve a common objective. To overcome this obstacle, effective communication, compromise, and the creation of common goals are required. To successfully navigate the implementation process' complexity and produce the desired results, the actors must work together effectively.

"The problem will probably be getting the actors to work together since they have their own ideas and solutions, so getting them to agree on this is probably the hardest part."
-Respondent 8

Code: Cost

It takes time and effort to gradually encourage customers to switch from traditional waste management to waste minimization. Additionally, since the idea might not be as immediately profitable, there might be financial obstacles to overcome. The associated costs of using this strategy must be taken into account. The cost implications of the concept will probably depend on how much data is stored in the cloud system or included on the tags. The concept is not free. This aspect of the idea might be seen as expensive and put a cap on how widely it is adopted. In order to navigate the difficulties and find solutions to make the idea economically viable in the long run, it will be essential to comprehend and address the cost component.

"It takes time to convince the customers to transfer more towards minimizing the waste rather than the traditional waste management along with the economic barrier, that it might not be as profitable initially." **-Respondent 3**

&

"I think there will be an associated Cost element to the concept. It doesn't come for free. The cost I guess will be determined by how much data will be included on the tag or on the cloud system. That's probably what would be expensive and seen as a limitation for the concept."
-Respondent 5

5.3 Theme three: Benefits of the concept

Reduced inventory time (better structure and data access), Improved traceability of objects, more accessible documents and materials, Shorter decision paths for projects, More accessible knowledge of object service and maintenance history, Reduced environmental impact and use of new resources, Lower operating and maintenance costs, Promotion of the circular industry, Easy implementation, Facilitated handover of projects to other actors

According to existing literature by Hossein et al. (2020), challenges in the construction industry lies in the traceability of materials, objects, and installations. Addressing these challenges, interviewees indicates that the RFID tags can tackle these difficulties by enhancing the ability to track and identify materials and objects in a more effective and uncomplicated approach. This aligns with the authors Akinci & Ergen (2007) who explains that the implementation of RFID tags within the construction industry can be used to track items in various environments, even ones that are unpredictable or constantly changing. This technology can be particularly beneficial in the construction industry, offering valuable opportunities for improved tracking and management of materials and components (Akinci & Ergen, 2007).

The reason for adopting a more circular approach according to William (20221), to reduce the environmental strain and usage of new materials by reusing and recycling current materials instead. The concept of RFID tags is described from the interviews as a concept that promotes recycling materials from used objects, reducing the need for new materials along with enabling to utilize materials with longer lifespan than from the original objects, which could expand lifespans and extend warrantees.

The construction industry's emphasis on cost, driven by the lowest tender policy, hinders the development of long-term solutions and poses a challenge to the adoption of circularity due to concerns about profitability according to (Isaksson & Linderoth, 2018; Cai & Waldmann, 2019). However, retrieved from the interviews, the implementing of RFID tags offers significant benefits that streamlines the tracking of materials and inventory management, resulting in reducing time and costs. By leveraging RFID technology, the industry can overcome cost and time-related challenges, optimize resource utilization, and promote a more sustainable approach to construction.

Within socio-technical transition theory, concept benefits show the accuracy of how well the technical aspect of a concept meets the social requirements. If a product satisfies the needs of the social demands, it will have identifiable benefits. Another factor in measuring the benefits of a concept within the theory is how it performs against current concepts; if it is better than the current concept, it will have benefits.

Codes within the theme: Benefits of the concept

Code: Reduced inventory time (better structure and data access)

The idea of shorter inventories times has several advantages for the market when socio-technical transition theory is used. Businesses may efficiently monitor inventory inside buildings by enhancing structure and data access, guaranteeing clear visibility of available stock and warranty terms for maintenance. Companies may optimize operations, save wasteful expenses, and streamline procedures thanks to this methodical approach. Improved data accessibility also enables more rapid decision-making and well-informed tactics, which boosts effectiveness and customer satisfaction. Overall, the idea gives firms more authority over their inventory, cuts down on time-consuming procedures, and eventually increases their ability to compete in the market.

"I think the big results would be easy to keep track of the inventory in the buildings, what you have and what warranty periods for maintenance, you can get a structure on it and have better access to data which would reduce time and costs." **-Respondent 4**

Code: Improved traceability of objects

Increased item traceability has several advantages in the marketplace. Businesses may improve their inventory procedures and ensure effective stock management by precisely tracking the whereabouts and condition of their inventory products. The capacity to quickly find items cuts down on time spent looking, improving productivity, and lowering operating expenses. Improved traceability also makes it possible to take preventative action against theft or loss, protecting priceless assets. Businesses may efficiently fulfill consumer expectations by minimizing stockouts, optimizing supply chain processes, and tracking inventory levels and movements in real-time. Organizations may boost their competitiveness, raise customer happiness, and improve overall company performance with improved traceability.

"A good advantage would be that you can keep track of what's there, and it could improve the inventory process. As we have experienced, the biggest problem is that it's difficult to find objects with the scanner when we have tried. It needs to be a little better in my opinion."
-Respondent 8

Code: More accessible documents and materials

The idea of making documents and resources more available has a lot of advantages for the market. Organizations can improve productivity and cooperation by switching from paper-based or fragmented digital documentation to a centralized and accessible platform. This move reduces the possibility of losing crucial information and makes it possible to trace documents easily even when people change employment. Employees are empowered by such accessibility to quickly access relevant information, which promotes quicker decision-making and more efficient processes. The increasing accessibility of information also encourages knowledge exchange and ongoing learning within the company. Businesses may use their collective intellect, uncover hidden talent, and foster innovation by increasing accessibility. In the end, this change gives businesses the ability to adjust to changing market needs, cut operating expenses, and gain a competitive edge in a world that is becoming more and more digital.

"It might not risk losing the documentation in the same way if you compared to today when you might still have a lot on paper or in some folder on someone's computer or something like that it seems to be more accessible to everyone somehow. Be able to track regardless of whether people change jobs and thus over time." **-Respondent 2**

Code: Shorter decision paths for projects

The socio-technical transition theory, which emphasizes the integration of easily accessible information into decision-making processes, can be used to shorten decision processes for projects. Organizations may make more intelligent and effective decisions on the continuation or changing of projects by applying the concept of RFID tags. Shorter decision paths provide two advantages. First of all, it enables swift adaptation of organizations to shift consumer needs by enabling flexible reactions to market dynamics. In addition, it reduces resource waste by rapidly recognizing projects with low potential, freeing up important time and funds for initiatives with more potential. By encouraging a proactive and adaptive strategy and ensuring that businesses stay sensitive to client requirements and take advantage of new possibilities, this idea boosts market competitiveness.

"With the accessible data it can provide, it becomes a basis for the next decision on whether to take it further into the next reusage in a later stage in the next project, so you shorten the decision paths there." **-Respondent 4**

Code: More accessible knowledge of object service and maintenance history

Significant commercial gains might result from making item service and maintenance histories easier to access. RFID tags may digitally include maintenance records, streamlining and streamlining the process. This switch from manual paper records to digital tracking enables a thorough analysis of the servicing and maintenance carried out on installed objects. Businesses can assure timely and proper maintenance, minimizing time and boosting production, with simple access to this information. Additionally, the digital format makes it possible to analyse data effectively, finding patterns and trends that might improve resource allocation and maintenance plans. In the end, this idea enables businesses to make wise choices, increase operational effectiveness, and provide better customer satisfaction, giving them a competitive edge in the market.

"Installed objects needs to be maintained, if this can add to the RFID tag digitally instead of having manually recorded papers it would facilitate to keep track of what's been done in terms of service and maintenance." **-Respondent 5**

Code: Reduced environmental impact and use of new resources

The socio-technical transition theory can encourage the utilization of new resources and lessen the impact on the environment. Adopting policies that favor recycling and the use of materials with extended lifespans is possible if we accept this theory. By minimizing the demand for additional resources, this strategy eases the burden on the environment. We may also provide

longer warranties on these restored devices by pushing manufacturers to do restorations on old items. This answers the questions of business owners who, even when using recycled products, value warranty coverage. As a result, the idea helps the market by developing resource-efficient manufacturing and consumption habits, reducing waste, and building a circular economy that emphasizes environmental preservation and resource efficiency.

"Using this concept, we could recycle more materials from used objects and use the materials with longer lifespan than the object itself holds, which would reduce the use of new materials. It can also be possible to provide extended warrantee on restored objects if us manufacturers perform these restorations, which is a concern amongst entrepreneurs since they want warrantee on products which is lacking today when using recycled products"
–Respondent 5

Code: Lower operating and maintenance costs

The concept presented emphasizes the potential benefits of lower operating and maintenance costs, highlighting its value creation. Organizations that use the socio-technical transition hypothesis can see considerable long-term cost reductions. Streamlining operations and lowering the need for intensive maintenance work are both made possible by effectively managing buildings and their assets. Businesses may pinpoint areas that need attention, optimize maintenance schedules, and decreased related work hours by using effective tracking and monitoring technologies. This strategy improves project planning and makes it possible to make precise estimates for next projects. The idea encourages players to embrace it by displaying these benefits since they understand the potential for significant savings in operations and maintenance costs, which will increase their bottom line and overall market competitiveness.

"A lot of the implementation is trying to show the benefits with the value it creates. The operation and maintenance costs a lot, if you look at 50 to 75 years of operation and maintenance as well as the management phase itself. Can you make the actors realize that you can save money by keeping track of what is in the building and therefore reduce working hours for example, maintenance, projecting for future projects and more, then I believe they will take on the concept". **- Respondent 4**

Code: Promotion of the circular industry

The concept of promoting the circular industry aligns perfectly with the quote's emphasis on finding materials and matching the pace of projects in real time. Businesses can see substantial revenue gains by adopting the ideas of a circular economy. First, encouraging circularity encourages resource efficiency and lowers waste production, which lowers the cost of

acquiring raw materials. Additionally, it promotes innovative business models like product-as-a-service, resulting in new income streams and increased client loyalty. The circular economy also encourages collaboration and openness throughout supply chains, improving market response and providing greater visibility of commodities that are accessible. By adopting the circular economy idea, businesses may take advantage of new market possibilities while reducing their negative environmental effects, promoting sustainability, and maintaining their competitiveness in a market that is continually changing.

"I think it is good step towards circular industry, just finding materials and being right in time to find materials and match the pace of the project. It is very important that you can see what and where the objects are in the market in real time." **- Respondent 3**

Code: Easy implementation

In view of the socio-technical transition theory, the idea under discussion has potential for convenient implementation. Transportation, technical equipment, storage facilities, inventory management programs, and established sales channels are all already in place. Utilizing these already-present components will enable the concept to enter the market without too many major difficulties. The market gains a lot from this simplified implementation procedure. The ability to adjust rapidly enables firms to seize new possibilities quickly. Second, the cost-effectiveness of the approach is due to the decreased complexity, which saves time and resources. The simple implementation also promotes smooth operations and customer satisfaction by guaranteeing a seamless transition and increasing market efficiency. Overall, this idea offers a simple market integration with significant benefits for all parties involved.

"I think it should be easy to implement this concept, there is not much that needs to be added". **-Respondent 4**

&

"I think this could be implemented without many complications. We have all the parts in place, we have transport, technical tools, storage, inventory tools and stores to sell it, it's about just deciding to do it"- **Respondent 3**

Code: Facilitated handover of projects to other actors

The idea of eased project handover to other actors has several advantages for the market. Organizations may improve the efficiency of project management and maintenance by using this strategy. By highlighting the significance of clear understanding and knowledge transfer within project management, the Socio-Technical Transition Theory promotes this. There is

more openness about project needs and maintenance requirements when projects are transferred to other actors. Future activities become more efficient as a result, and improved planning and resource management are also made possible. Additionally, the adaptability offered by assisted handover enables more seamless transitions between project phases and guarantees operational continuity, minimizing interruptions and enhancing project outcomes overall. In the end, this strategy encourages cooperation, creativity, and adaptation, making it a significant asset in the competitive market climate of today.

"I think it will be a great thing for our management in projects that will make it easier as we will know more clearly what it is there and how it should be maintained, as well as the flexibility in handing over the management to other actors". **-Respondent 4**

5.4 Comparison analysis of the themes through socio-technical transition theory

When examining the three themes in this study through the lens of socio-technical transition theory, interesting insights and potentials emerge regarding the adoption of RFID tags in the construction industry.

The socio-technical transition theory's focus on how social demands and technology development interact in the construction sector is consistent with the central idea of market needs. The market's need for sustainable solutions, which is driven by environmental concerns and a reduction in the consumption of new resources, is what drives technological transitions (Robinson, 2023; Linderoth & Isaksson, 2018). This demonstrates that the use of RFID tags, which may decrease environmental stress and enhance resource management, responds to market requirements in the context of socio-technical transformations.

The adoption of RFID tags is limited by the difficulties in reaching consensus among stakeholders, diffused responsibility, industry conservatism, and cost considerations (Daan et al., 2019; Riedjik, 2009; Larsson et al., 2013; Isaksson & Linderoth, 2018; Cai & Waldmann, 2019), according to the theme of barriers for the concept. The socio-technical transition theory can be utilized to define these obstacles as social and technological barriers that prevent innovation. Cultural norms, laws, and stakeholders' willingness to accept responsibility are all examples of social limitations (Daan et al., 2019; Isaksson & Linderoth, 2018). Technical constraints include a lack of funding, a protracted development process, or outdated technology (Larsson, et al., 2013)For RFID tags to be successfully implemented as an innovation and a new standard to promote circularity, these obstacles must be removed along with any technical ones.

The benefits of the concept are emphasizing the potential benefits of implementing RFID tags in the construction industry, including improved traceability, decreased costs, and the promotion of circular practices (Hossein et al., 2020; Akinci & Ergen, 2007; Williams, 2021).

These advantages line up with how the socio-technical transition theory assesses how well a concept performs in comparison to current practices. In the context of socio-technical transitions, RFID tags can be seen as offering advantages in promoting circularity if they provide greater functionality, efficiency, and sustainability compared to existing methods.

The interactions between these themes also emphasize how dynamic socio-technical transitions are. Innovative solutions are in request because of market demands, but their implementation is difficult due to barriers. The advantages of the concept offer potential incentives and rewards for removing these obstacles and easing the switch to more environmentally friendly and productive practices in the construction sector.

As concluding remarks, analysing the three themes through the lens of socio technical transition theory provides an understanding of what market needs, barrier and benefits there are towards the implementation of RFID tags. By addressing the socially structured demands and obstacles along with promoting the benefits, the transition towards a more efficient and circular industry is doable.

6 Discussion

The main goal of this chapter is to thoroughly explore and elucidate the research question asked in the study through detailed analysis of the overarching dimensions drawn from the codes and using the socio-technical transition theory as a lens. This discussion aims to fill the academic gap discovered in the literature study presented earlier in this report.

The research question for this study aims to investigate and present is the social attitude connected to implementing a new standardization. In this specific case, the implementation of RFID tags within objects and installations to enable a more sustainable approach.

The RQ is as following:

RQ- How do stakeholders in the Swedish construction industry perceive the adoption of a standardized marking tag system using Radio Frequency Identification (RFID) technology, and how do their social attitudes toward the concept affect the promotion of circularity*?*

6.1 The prerequisite

The answer to the RQ is related to the construction industry, including all actors. The RQ is a multidimensional question relating to both social and technical parameters with several actors included. Firstly, the construction industry is conservative and struggles to change its trends regarding short-sighted solutions (Rietdijk, 2009). The construction industry needs to aim for more long-term solutions (Rietdijk, 2009). Additional to what Reitdjik (2009) indicates, one could argue that the short-sighted solutions that the construction industry has had, leads to difficulties in maintaining and promoting the conservation of the earth. This can be connected to what Mohammed et al. (2017) says regarding the priority within the construction industry. Mohammed et al. (2017) implicit that competitiveness within the construction industry results in a higher focus on price and profitability than the environmental aspects which can related to why the construction industry accounts for 4% of global energy consumption, 30% of energy-related greenhouse gas emissions, 12% of water use, and close to 40% of waste production (Linderoth & Isaksson, 2018).

Furthermore, the competitiveness and high focus on profit can be associated with the construction's struggle to implement new standardizations on account of the lacking national standards, high cost of application, lack of skilled personnel, organization issues, and legal issues (Liu, et al., 2015). This can be connected to what Reitdjik (2009), and Isaksson & Linderoth (2018) indicates that the industry is conservative and solves its problems with a short-sighted approach; it creates difficulties when striving for challenges and development (Rietdijk, 2009). This correlates to what Hossein et al. (2017) says regarding the barrier of

unifying the actors and creating a consensus, hindering the process of development and standardisation.

However, this could be related to the social driving force within the socio-technical transition theory. The construction industry consists of several stakeholders, all providing different types of forces within the industry. To implement a technical transition with a solution that has a long-term perspective, the stakeholders need to create the driving force to enable changes. This driving force must promote the long-term perspective of preserving the earth to be sustainable. This relates to what respondent six indicated during the interview and relates both to Rietdijk (2009) and Linderoth & Isaksson (2018) who writes about the long-term perspectives that needs to be met and the impact that the construction industry has on the environment. Respondent Six highlighted the overconsumption of the earth and indicated that the world, today, consumes 1.6 times the annual growth of resources.

6.2 The attitudes

The research question aims to answer how the social aspect in form of how attitudes, stands towards the technical transition in form of the implementation of RFID tags within the construction industry. Additionally, the RQ aims to contribute to the academic literature by fill the identified gap regarding implementations of new technical solutions in form of RFID tags as a standardization.

The empirical founds are through the socio-technical transition theory identifying patterns in specific parameters, these are barriers, drivers, and needs. These patterns are straight related to the attitude (social aspect) connected to the implementation of new technical solutions within the construction industry.

The general positive social attitude of all stakeholders contributes to the understanding to the literature regarding conservatism by explaining the specific parameters that leads to the conservatism. This contributes to what Rietdjik (2009) indicates regarding the conservatism within the industry. Even though the construction industry is conservative and struggles to implement new standardizations, the industry clearly shows willingness, striving, and need to improve and develop. The analysis shows patterns of positivity and willingness to implement the concept of RFID tags within objects. Several respondents did not show any signs of the conservative approach that both Rietdijk (2009) and Liu et al. (2015) implicate that the industry consists of. Instead, they showed enthusiasm and strive for improvement. These respondents expressed that they are already investigating this kind of concept.

However, these respondents acknowledge the conservatism within the industry and see difficulties in aligning all actors' different wills and needs, a problem coherent to what Hossein et al. (2017) says. Additionally, the intuition of the overall industry's attitude is positive and that it is necessary. Empirical findings show that factors hindering the development and

standardising processes is the social fear for failure and as mentioned the alignment amongst actors.

Additionally, one could argue that respondents five and seven are somehow biased because respondent seven's company is currently working with RFID solutions. It would be contradictory to indicate anything else that the service actor is positive. Because this whole company's ambition and strive originates from this concept. Moreover, the manufactory actor in this study expresses enthusiasm and positivity for the concept, but one could argue that if the market determines how they want the concept to be designed, the manufactories can add a step in their production phase, and then they are ready for this concept to be initiated. There is an extra step, but they can charge for the RFID tags, and in the end, the product will perhaps return to their facility, either to be served or as material for new products. This can be seen as a win-win solution for manufactories, enabling a service business by getting old items back to the manufactory to be served and shipped back and contributing to a circular approach within the construction industry by reducing the consumption of raw by reproducing their objects of recycled material. The reproducing aspect is aligned with WSP's description of a circular approach; one could argue that this can be used as a social driver for the technical transition from a linear approach that WSP states is the traditional working method used within the construction industry (WSP, 2021).

Furthermore, the stakeholder represented by the Entrepreneurs can provide an interpretation of how the industry, in this study highlights the technical parameters as the significant barriers for this implementation. Through the socio-technical transition theory perspective, the entrepreneurs act as social barrier for this technical transition. The Entrepreneurs indicate that the concern for the technical implementation, specified as the physical implementation of the RFID tag within the object. I addition to the technical implementation, the Entrepreneurs indicate that the actor named Manufacturers are the key holder for this technical implementation. The entrepreneurs indicate if the manufacturers enable this physical implementation of RFID tags within objects the most significant barrier for this technical transition will disappear.

6.3 Theoretical implications

The concept of RFID tags and the circular approach has received more attention in the latest decades. The circular approach is commonly used and discussed within the construction industry and other disciplines. This can be correlated to the overconsumption of raw materials, the decreasing population of mammals, deforestation and more consequences (Robinson, 2023) & (Linderoth & Isaksson, 2018).

However, this study aims to contribute to and increase the understanding of how the construction's attitude is toward change in a sustainable path. There has been shown in the

literature that the industry is conservative, and that the industry struggles to change (Rietdijk, 2009). This study's specific area concerns the attitude toward implementing RFID tags as a new standardization within the construction industry to promote the sustainable approach at an accelerating momentum. This study's empirical findings indicate an alternative perspective of the conservatism that the literature indicates; the empirical findings contribute to the literature by explaining the positivity and willingness to develop. It also shows where the barriers attached to developments arrive; it concerns the fear of unsuccessfully introducing new innovations and working methods, which can be costly and time-consuming. As a contribution to conservatism, one underlying parameter of conservatism is connected to fear of failure and the subsequent negatives.

The use of RFID tags in construction has important societal repercussions. The use of this technology promotes more accountability and openness during the construction process. RFID tags provide the ability to track and trace supplies, tools, and parts, assuring their right use and reducing waste. The ability to quickly identify and handle possible dangers thanks to this degree of visibility helps to increase worker safety. Using RFID tags can also improve the construction industry by enabling stakeholders to monitor and control the movement of materials, resulting in improved logistics and lessening the environmental impact.

The use of RFID tags in construction is politically compatible with initiatives by the government to promote sustainability and lower carbon emissions. The adoption of RFID technology may be encouraged by governments through laws, rules, and financial assistance. This support can result in widespread industry acceptance and standardization, advancing the objectives of sustainable construction methods. Political implications, however, may include possible difficulties and obstructions. As was previously indicated, resistance to change might develop out of concern over poor implementation. To ensure a technical transition, the construction sector may need legislators' aid in funding and instructional programs to counteract the institutional processes that have formed the conservative industry. Data security and privacy concerns must also be resolved to ensure RFID technology's proper and moral use.

6.4 Ethical and social considerations

The implementation of RFID tags in the construction industry can come with both social and ethical dilemmas. The results chapter presents concerns regarding technical failure, costs, and unity amongst the actors. The fear of failure is something familiar within the construction industry and one of the reasons it is behind other industries; this is shown in this study where some of the actors express their fear of the concept's technical properties and user compatibility. Furthermore, adding a stage in the manufacturing stage could drive up the costs for this concept, which is an expressed worry from the actors that might lead to it not successfully entering the whole market. Finally, a social worry concluded from the study is if the actors will

be unified with this concept since it is a factor considered crucial for the concept to be successfully implemented in the industry.

7 Concluding remarks

This chapter aims to highlight and specify what has been identified throughout the study. This chapter provides the attitude of the market, the barriers, and facilitators for implementing a new standardisation within the construction industry. Additionally, potential further research is presented to contribute to the academic gap, the comprehensive analysis of the case study, and its potential to contribute to a more circular approach within the construction industry.

According to the existing literature, the construction industry is characterized as conservative due to its tendency to favor short-sighted solutions and prioritize profit-driven approaches, as well as its frequent relocation of work sites. This conservatism challenges adopting change, development, technical implementations, and improvement within the industry.

The study highlights concern regarding the implementation and specifics of the data included in the study. However, it also identifies a recurring obstacle known as "social breakers," which refers to the fear of failure in creating a unified solution that all industry actors can simultaneously embrace and implement. The study reveals numerous driving factors behind transitioning to a new standardization of marking tags with Radio Frequency Identification to promote circularity. The industry's stakeholders recognize the potential for saving time and costs, reducing environmental strain, improving overall structure, minimizing documentation losses, enhancing maintenance, and reducing raw material consumption.

In conclusion, in response to the research question regarding the attitude of stakeholders in the Swedish construction industry toward the technical transition to a new standardization of marking tags with RFID to promote circularity, the overall attitude toward the concept is positive. All industry stakeholders indicate a genuine need for this transition and believe it would benefit the sector as a whole. Further research and improvements are recomhymended to ensure successful implementation and the creation of an easily adaptable and value-adding standard for the entire market to promote circularity.

7.1 Limitations of the study

One limitation is that the technical product of this concept does not yet exist on a unified, standardized scale, meaning that how it would work in practical matters is unclear, meaning the integration of materials, compatibility with computer systems, and economic impact. This fact leads to the result of this study might be a bit towards the speculation part of the practical implementation of the concept, leading to some incorrect thoughts by respondents. If the respondents knew precisely how the concept would work, the answers might have differed. However, bearing in mind that this is a study of a market research to fill the academic gaps within the literature regarding the implementation of RFID as a standardization to promote circularity within the construction industry, not research of a complete product/concept.

Furthermore, the geographical limitation presented earlier in this paper limits this study to genuinely finding the whole market's attitude regarding implementing RFID tags as a standard to promote circularity within the construction industry. The limitation was added to enable this paper to fit the allotted time and the 30 credits this thesis should represent.

Lastly, the number of respondents were unevenly distributed at each stakeholder because the number of respondents were relatively small compared to the number of stakeholders. This was due to the selection of respondents were carefully selected to create higher credibility. As a result, the number of respondents willing to contribute to this research decreased. One could argue that if this study were performed by a large company with influence in the sector, the willingness to contribute and credibility would increase.

7.2 Further research

The prospects for future research are to address the potential outcomes of the concept, and the technical parameters for the concept should be shaped and included. These are the parameters that this study excluded because of the limitations presented earlier.

Throughout the result and the analysis, there is a pattern regarding the specific data the RFID tags should include and how the platform for the actual second-hand market should be executed.

Based on this study's limitations and the patterns in the result, this recommendation is divided into two categories. Firstly, research the capacity of the RFID tags and the specific type of data that is necessary for the tags to consist of. In addition, research the best approach to minimize the risk of lost data. Secondly, research the capacity and performance of a trading platform for these objects, including aspects such as coding, design, security, and payment solutions.

- Which approach is best to preserve the specific data in the RFID tag and what should be included to promote sustainable development and to generate an efficient working tool?
- How should the trading platform be designed and executed to be efficient and secure?

Both these suggestions are questions the repeatedly have occurred in this study, the actors fear for failure and prefer to know more about these aspects of the concept.

Furthermore, investigating the efficiency parameters of the concept to enable the transition of this technical transition. In addition to what Rietdijk (2009) indicated, the construction industry's conservatism is related to the current working methods and needs to change. By presenting precise data on the outcomes regarding cost and time, the changes can be executed. Additionally, research the effect RFID tags have on reducing the strain on the environment.

- Will RFID tags increase the efficiency of inventory and logistics within the construction industry and reduce the strain on the environment and promote circularity.

8 References

Agarwal, r., chandrasekaran, s. & sridhar, m., 2016. Imagining construction's digital future. *Mckinsey & company*, 24 june.

Akinci, B. & Ergen, E., 2007. *An Overview of Approaches for Utilizing RFID in Construction Industry,* USA: IEEE.

Arifin, S. R. M., 2018. Ethical Considerations in Qualitative Study. *International journal of care scholars* , 1(2), p. 32.

Bahr, W. & Price, B. J., 2016. *Radio frequency identification and time-driven activity based costing:RFID-TDABC application in warehousing,* United Kingdom : Aston University.

Bell, E., Bryman, A. & Harley, B., 2019. *Business research methods.* 2 ed. s.l.:Oxford University Press.

Bell, E., Harley, B. & Bryman, A., 2022. *Business Research Methods.* 6 ed. s.l.:Oxford University Press.

Bertino, G. et al., 2016. Fundamentals of Building Deconstruction as a Circular Economy Strategy for the Reuse of Construction Materials. *Applied Sciences.*

Binder, C., Mühlemeier, . S. & Wyss, . R., 2017. An Indicator-Based Approach for Analyzing theresilience of transitions for energy regions. part 1: Theoretical and conceptual considerations.. *Energies*, 10(36).

Braun, V. & Clarke, V., 2006. *Using thematic analysis in psychology.* [Online]
Available at:
https://www.researchgate.net/publication/235356393_Using_thematic_analysis_in_psychology
[Accessed 2 March 2023].

Cai, G. & Waldmann, D., 2019. A material and component bank to facilitate material recycling and component reuse for a sustainable construction: concept and preliminary study. *Springer Link.*

CFI, t., 2022. [Online]
Available at: https://corporatefinanceinstitute.com/resources/economics/standardization/
[Accessed 06 02 2023].

Christensen , c., raynor, m. & mcdonald, r., 2013. *What Is Disruptive?,* Boston: Harvard Buisness Review.

Daan, S., Uroš, B., Francesco, D. M. & Marcel, H., 2019. Circular transition: Changes and responsibilities in the Dutch stony material supply. *Resources, Conservation and Recycling,*, Volume 150.

Dalirazar, S. & Sabzi, Z., 2022. Barriers to sustainable development: Critical social factors influencing the sustainable building development based on Swedish experts' perspectives. *Wiley Online Library*, 30(6), pp. 1963-1974.

Durac, Y., 2018. *RFID: A key technology for Humanity,* Villeurbanne, France: ScienceDirect.

European Environmental Agency , 2015. *Circular economy in Europe: Developing the knowledge base,* s.l.: European Environmental Agency .

European Union, 2021. *Circular Economy Action Plan.* [Online]
Available at: https://www.europarl.europa.eu/committees/sv/circular-economy-action-plan-/product-details/20201106CDT04441
[Accessed 11 05 2023].

Fabege, 2022. *Fabege.* [Online]
Available at: https://www.fabege.se/siteassets/rapporter-och-kvartalspresenationer/fabege_ars-och-hallbarhetsredovisning_2022.v2.pdf

Fosilfrittsverige, 2022. *Fosilfritt Sverige.* [Online]
Available at: https://fossilfrittsverige.se/roadmap/cementbranschen/
[Accessed 26 Februari 2023].

Geary, U. et al., 2022. *A socio-technical systems analysis of the application of RFID-enabled technology to the transport of precious laboratory samples in a large acute teaching hospital,* Ireland: Applied Ergonomics.

Govers, M. & van Amelsvoort, P., 2019. A Socio-Technical Perspective on the Digital Era: The Lowlands view. *EUROPEAN JOURNAL OF WORKPLACE INNOVATION*, 4(2), p. 18.

Graugaard , j., n.d. *patternwhichconnects.* [Online]
Available at: http://patternwhichconnects.com/phd/academic_writing.html
[Accessed 24 februari 2023].

Gupta, S. & Jain, S. K., 2013. A literature review of lean manufacturing. 8(4), pp. 241-249.

Hossein , U., Ben, A., S. Thomas, N. & Prince, A.-A., 2020. Circular economy and the construction industry: Existing trends, challenges and prospective framework for sustainable construction. *Renewable and Sustainable Energy Reviews,* September, Volume 130, pp. 1-3.

Isaksson, A. & Linderoth, H., 2018. Environmental considerations in the Swedish building and construction industry: the role of costs, institutional setting, and information. *Springer, Journal of Housing and the Built Environment,* p. 18.

Järvholm, B. & Burdorf, A., 2015. Emerging evidence that the ban on asbestos use is reducing the occurrence of pleural mesothelioma in Sweden. *Scandinavian Journal of Public Health,* p. 7.

Larsson, J., Eriksson, P. E., Olofsson, T. & Simonsson, P., 2013. Industrialized construction in the Swedishinfrastructure sector: core elements and barriers. *Taylor & Francis Online,* Volume 32, p. 14.

Lidelöw, S., Macsik, J., Carabante, I. & Kumpiene, J., 2017. Leaching behaviour of copper slag, construction and demolition waste. *Journal of Environmental Management,* p. 9.

Linderoth, H. & Isaksson, A., 2018. Environmental considerations in the Swedish building and construction industry: the role of costs, institutional setting, and information. *Journal of Housing and the Built Environment,* Volume 33, pp. 615-632.

Liu, S., Tivendal, L., Xie, B. & Liu, C., 2015. *Critical Barriers to BIM Implementation in the AEC Industry,* Geelong, Australia: Canadian Center of Science and Eduscations.

Maraqa, M., T, F., R, S. & S, S., 2021. *Reducing construction and demolition waste through lean production: Observations from,* Isreal, Herzliya, Region: School of Sustainability, IDC Herzliya,.

Milios, L. & Dalhammar, C., 2020. ASCENDING THE WASTE HIERARCHY: RE-USE POTENTIAL IN SWEDISH RECYCLING CENTRES. *Detritus Journal,* p. 11.

Mohammad, . N., Mohammad , N., Soroush , G. & Manoochehr , M., 2022. The evolution of socio-technical transition studies: A scientometric analysis,. *Technology in Society,* 8 December.68(1).

Mohammed, H. A. N. et al., 2017. Comparing linear and circular supply chains: A case study from the construction industry. *International Journal of Production Economics,* 183(2), pp. 443-457.

Naturskyddsföreningen, 2021. *Naturskyddsföreningen.* [Online]
Available at: https://www.naturskyddsforeningen.se/faktablad/avfallstrappan/
[Accessed 01 03 2023].

OMRON, 2023. *RFID Systems.* [Online]
Available at: https://www.ia.omron.com/support/guide/47/introduction.html
[Accessed 9 05 2023].

Park, J. & Tucker, R., 2016. Overcoming barriers to the reuse of construction waste material in Australia: a review of the literature. *International Journal of Construction Management.*

Popkova, E., Ragulina, Y. & Bogooviz, A., 2019. *Industry 4.0: Industrial Revolution of the 21st Century.* s.l.:Springer.

Ramirez, P., 2020. Technological revolutions, socio-technical transitions and the. *RSA.*

Rawabdeh, I. A., 2005. A model for the assessment of waste in job shop environments. *International Journal of Operations & Production Management,* Volume 25, pp. 800-822.

Rietdijk, M., 2009. *Organisaties Conditioneren. De invloed van beloning en straf op werkprestaties,* Amsterdam : RsearchGte.

Robinson, D., 2023. *EARTH ORG.* [Online]
Available at: https://earth.org/the-biggest-environmental-problems-of-our-lifetime/
[Accessed 01 03 2023].

Rörborn, C. & Baena, E., 2022. *Hög tid att prioritera återbruk inom,* s.l.: Tyrens Sverige AB.

Smith, A. & Raven, R., 2012. What is protective space? Reconsidering niches in transitions to sustainability,. *sciencedirect,* 41(6), pp. 1025-1036.

Sobotka, A. & Sagan, J., 2015. Analysis of the Factors Stimulating and Conditioning Application of Reverse Logistics in Construction. *Procedia Engineering.*

Spaargaren, G., Mol, A. & Buttel, F., 2000. *Environment and Global Modernity.* London: Sage.

Sparkfun, 2017. *Using RFID Tags and Readers.* [Online]
Available at: https://www.sparkfun.com/rfid
[Accessed 11 05 2023].

Svenskbetong, 2022. *Svensk Betong.* [Online]
Available at: https://www.svenskbetong.se/bygga-med-betong/bygga-med-platsgjutet/hallbart-byggande/bestandighet-och-livslangd-2
[Accessed 26 Februari 2023].

The Business Research Company, 2022. *Construction Global Market Opportunities And Strategies To 2031: COVID-19 Impact And Recovery,* s.l.: The Business Research Company.

Vasakronan, 2022. *Vasakronan.* [Online]
Available at: https://wwwvasakronanse.cdn.triggerfish.cloud/uploads/2023/04/vasakronan-arsredovisning-2022-3.pdf

VOXCO, 2021. *Thematic Analysis: Definition, Methods & Examples.* [Online]
Available at: https://www.voxco.com/blog/thematic-analysis-definition-methods-examples/
[Accessed 11 05 2023].

W Geels, F., 2019. Socio-technical transitions to sustainability: a review of criticisms and elaborations of the Multi-Level Perspective,. *Current Opinion in Environmental Sustainability,* Volume 39, pp. 187-201.

W. Geels, F., 2018. Disruption and low-carbon system transformation: Progress and new challenges in socio-technical transitions research and the Multi-Level Perspective224-231. *Energy Research & Social Science,* Volume 37, pp. 224-2231.

Walter , R. S. & Geneviève , R.-M., 1981. *Jobs for Tomorrow: The Potential for Substituting Manpower for Energy.* California : Vantage Press.

Westman, D., 2019. *Den fjärde industriella revolutionen - en immaterialrättslig introduktion,* Stockholm: DiVA portal.

Williams, J., 2021. Circular Cities: What Are the Benefits of Circular Development?. *MDPI,* p. 27.

WSP, 2021. *Building A Circular Economy.* [Online]
Available at: https://www.wsp.com/en-se/insights/2021-building-a-circular-economy
[Accessed 07 02 2023].

WSP, 2022. *Our Story.* [Online]
Available at: https://www.wsp.com/en-se/who-we-are/our-story
[Accessed 24 01 2023].

Yadav, P., Nepal, B. P., Rahaman, M. M. & Lal, V., 2017. Lean Implementation and Organizational Transformation: A Literature Review. *Engineering Management Journal,* 29(1), pp. 2-16.

Yu, Y., Yazan, D., Junjan, V. & Iacob, M.-E., 2022. Circular economy in the construction industry: A review of decision support tools based on Information & Communication Technologies. *Journal of Cleaner Production,* 349(1).

Zhang, C. et al., 2021. An overview of the waste hierarchy framework for analyzing the circularity in construction and demolition waste management in Europe. *Science of the Total Environment* , p. 13.

Appendices

Appendix A

Questions for the interviews:

Introductive questions

1. Do we have your consent to record this interview?
2. Name, company, and position within the company?
3. Are you aware of the main purpose of the study?

Investigating questions.

4. What is your first impression of the concept?
5. Which outcomes do you see with this concept?
6. What would be the greatest benefit from this concept?
7. What would be the greatest disadvantages or problem with this concept?
8. Which barriers do you see for this concept?
9. How easy do you think this standardisation could be implemented?
10. How do you think your company would react and be affected by the implementation of this concept?
11. How do you think the overall Swedish construction industry would respond to this concept including all actors?
12. Do you feel that there is something concrete that needs to be added to the concept to create a successful introduction in the construction industry?
13. Do have any other thoughts that you think may be of interest for this study and concept?