UNIVERSITY OF TURKU

ABSTRACT

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Abstract

The study aims to investigate how does global firm utilise system change perspective to closed loop thinking for creating circular economy strategy in the energy industry. The study adopted 4 circular economy implementation strategies and 4 circular economy principles from relevant circular economy literature. The theoretical framework is empirically tested utilizing a qualitative single case study research methodology. The primary data was obtained by a purposive sampling technique. 3 semi-structured interviews and 2 webinars were utilised to obtain both primary and secondary data for the empirical analysis. The semi-structured interviews were obtained during the winter of 2022 from Project Manager, Technology Development Manager, and Senior Business Development Manager of the Power to X Project of Wärtsilä Energy Business unit.

The overall empirical findings suggest that Wärtsilä recognises the Power to X project as an important reflection to its strategic vision for a carbon neutral smarter society. The empirical data analysis has identified that all the four implementation strategies and principles have been utilised in the Power to X project and especially cleaner production using renewable materials, and zero waste policy have been found to be most effective strategies. Whereas recycling and reduction principles found to be most prominent guiding circular economy principles. Based on the data analysis it is possible to argue that the Power to X project could be a catalyst of system change. The empirical analysis also reveals that Wärtsilä's Power to X project has ensured implementation of different circular economy strategies by utilising certain measures. Furthermore, beyond the scope of the identified literature, this study contributes to the existing system change perspective literature by adding value co-creation and industry alliances as a new but effective circular economy implementation strategy. However, it is an unexpected empirical finding that recovery principle has no influence for the Power to X project.

Based on the comprehensive literature review and empirical findings, the study proposes that system change perspective implementation strategies can assist global firms to achieve a certain principle of circular economy, such as Eco-design as a system change perspective strategy can help a global firm to achieve the circular economy principle of Reduction in its operations, and so forth.

Keywords	Circular economy, system change perspective, closed loop thinking.

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CIRCULAR ECONOMY IN GLOBAL FIRM: A SYSTEM CHANGE PERSPECTIVE TO CLOSED LOOP THINKING

Master's Thesis
in International Business

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1 INTRODUCTION

This chapter introduces the background of the research and research gap. Secondly, it represents the research questions of the study. Lastly, the structure of the thesis is discussed.

1.1 Research background and research gap

Global firms are at the forefront of present-day worldwide economic prosperity and development. Manyika et al. (2021, 2-4) report that in 2018, global firms have contributed 72% values in Gross Domestic Product (GDP) with $40 trillion in revenue and $17 trillion in gross value added for major Organization for Economic Co-operation and Development (OECD) economies. However, this vast fortune produced by the global firms has also contributed to a social problem, popularly known as climate change and carbon dioxide (CO2) gas emission in the natural environment from industrial processing and supply value chain activities (Griffin 2017, 5). According to Griffin (2017, 8) in recent times, investor-owned global firms in the fossil fuel industry (over 100 active fossil fuel producers) alone have yielded over 635 Giga tones of CO2 gas from operational and production facilities into the atmosphere. Griffin (2017, 8) further maintained that 25 global corporations i.e., ExxonMobil, Shell, BP, Chevron, China National Coal Group, etc. and a few states i.e., OECD, China, Russia, etc. producing entities account for 51% of global industrial greenhouse gas emissions in 2015.

As such adoption of circular economy concepts, specifically evaluating and utilizing raw materials within a systematic closed loop thinking is gaining much research interest (Winans et al. 2017, 825). Winans et al. (2017, 825) argued that a system change perspective to closed loop thinking allows the usage of natural resources while reducing pollution (CO2 emission) and sustaining economic growth. Extant literature suggests that in recent times many influential governmental and non-governmental organizations have taken actions to promote circular economy concepts in businesses (Ghisellini et al., 2016, 2; Kirchherr, 2017, 221; Winans et al. 2017, 825; Korhonen et al. 2018, 37). For instance, to respond to the United Nations Framework Convention on Climate Change, all the 196 participating countries agreed to create strategies for low-carbon development in industrial production and commercial activities (Winans et al. 2017, 825). Furthermore, many international organizations such as The European Union, and influential countries such as China, Japan, The UK, France, Canada, The Netherlands, Sweden, and Finland are heavily conscripting to the idea of circular economy concepts as a rescuing measure to fight against global climate change (Korhonen et al. 2018, 37).

Circular economy concepts in business have received much scholarly attention in recent times including more than 100 publications on the topic in peer-reviewed journals that appeared alone in 2016 (Kirchherr 2017, 221). Extant literature argues that circular economy concepts in business can be viewed as an important phenomenon for research as it can be considered as an effective tool to implement overwhelmingly discussed sustainable business development (Ghisellini et al., 2016, 2; Kirchherr, 2017, 221). Other streams of research suggest that circular economy concepts can help organizations and nations to generate more economic output while combating environmental pollution and global climate change (SITRA & Mckinsey 2015, 3; SITRA 2016, 2; Winans et al. 2017, 826; Korhonen et al. 2018, 37).

Recent studies that estimate the commercial and economic benefits of subscribing to the circular economy concepts suggest huge commercial benefits for the businesses operating within the premise of circular economy (SITRA & Mckinsey 2015, 3; SITRA 2016, 2; Korhonen et al. 2018, 37). For example, The European Commission submits that utilizing circular economy-type economic transitions in the EU manufacturing sector can alone create 600 billion euros annual economic gains (Korhonen et al. 2018, 37). Whereas SITRA & Mckinsey (2015, 3) estimated that Finland alone had gained 2.5 billion euros annual gains from the national economy through utilizing circular economy concepts. Furthermore, an estimated 1000 billion US dollars annually can be secured globally if circular economy concepts are to be subscribed predominantly in the global economies (SITRA & Mckinsey 2015, 3; Korhonen et al. 2018, 37). Thus, all corporations regardless of their sizes, industries, global orientations, customer bases, etc. have enormous roles to play to utilize and get benefits from the circular economy concepts.

In recent times, circular economy concepts are being mostly practiced by the national governments and their associated agencies in infrastructure development and institutional policy practices (Winans et al. 2017, 826). For instance, in the late 1990s, Germany introduced the circular economy concept to deal with the environmental policy regarding the management of efficient raw material and natural resource usage for sustained economic growth (Geng & Doberstein 2008, 232). Whereas the UK, Denmark, Switzerland, and Portugal applied circular economy concepts for waste management, and material recycling and reuse concepts (Costa et al. 2010, 11-13). To increase consumers' responsibility for material use and waste management some circular economy-related initiatives are evident in France, South Korea, and Japan (OECD 2015, 12).

Concurrently, many global firms such as Unilever are applying circular economy concepts to enhance reduce, reuse, and recycling programs, and conducting product-level life cycle studies in North America and Europe (Unilever 2015; Winans et al. 2017, 826). On the other hand, current research has strongly demonstrated positive firm performance indicators of utilizing circular economy concepts in businesses in terms of improved sustainable business practices, marketing efficiencies, sales generations, collaboration, value creation, superior firm performance, etc. (OECD 2015, 10-18; Prendeville et al., 2015, 7-10; Unilever 2015; Winans et al. 2017, 826-830; Korhonen et al. 2018, 40).

In this stream of research, the contributions that global firms are putting towards applying successful circular economy concepts utilizing a system change perspective to closed loop thinking are less represented (Rashid et al. 2013, 168; Prendeville et al., 2015, 12). There is a significant paucity of research available that explains how global firms utilize a system change perspective to closed loop thinking for creating circular economy strategy in different industries for instance in the energy and manufacturing industry (Rashid et al., 2013, 167). On the other hand, energy and manufacturing industries are on a constant lookout for resources and are expected to invest in sustainable business practices either to enhance profitability or to ensure the promotion of marketing strategies for a "green image" (Rashid et al. 2013, 173). A system change perspective to closed loop thinking can help those global energy and manufacturing industries to ensure adoption of circular economy principles (Rashid et al. 2013, 173) and to reduce vulnerability to resource scarcity, supply risks, price change shocks and increase social and environmental wellbeing (Preston 2012, 2; Ellen MacArthur Foundation 2013, 8-11; and van Buren et al. 2016, 3).

However, van Buren et al. (2016, 2) argued that this system change is complex and requires simultaneous changes in various subsystems on the regional, national, and global scale. Furthermore, the idea of system change perspective to closed loop thinking lacks common understanding in terms of its definition and key considerations across different industries and thus impeding the successful adoption of this concept in practice (Rashid et al. 2013, 167).

1.2 Research question and structure of the thesis

To address the identified research gap and the mentioned importance to research the concept of system change perspective, this study aims to answer the following research question.

RQ: How does global firm utilise system change perspective to closed loop thinking for creating circular economy strategy?

To better answer the main research question and reveal the importance of the concept as a research agenda, the study introduces the following three sub research questions.

SQ1: What is the system change perspective to closed loop thinking?

SQ2: How does the system change perspective implement to develop a circular economy strategy?

SQ3: What is the role of the system change perspective to achieve circular economy principles?

Answering the main research question will offer a critical understanding of how global firms in the energy industry, for instance, utilize the approach for creating a circular economy strategy. Thus, it will contribute to the existing literature of system change perspective as a circular economy creation strategy. The first sub-question aims to provide a critical understanding of the system change perspective as a circular economy creation strategy. The second sub-question discusses how the system change perspective is implemented to develop a circular economy strategy in a global firm. Lastly, the third sub-question aims to discuss what role it plays to achieve circular economy principles.

However, this thesis is organised into six chapters. The first chapter has introduced the research background, relevant research gap, and the research questions for this study. The second chapter discusses a range of literature review elements and introduces the preliminary framework of the study. The third chapter outlines the discussion and rationale against adopting a particular research approach, methodology, case selection criteria, data collection technique, data analysis method, etc. The chapter also provides justifications regarding the validity, reliability, and trustworthiness of the study. The fourth chapter provides a detailed analysis of the collected data and reports important findings of the study. In particular, this chapter aims to answer all of the three identified sub-research questions of the study.

Consecutively, the fifth chapter provides a generalisable research conclusion considering the theoretical contribiútions and the managerial implications of the study. Limitations of the study and scope for future research are also discussed in this chapter. The last chapter outlines the whole research summary as the main takeaways of the study. Finally, the thesis ends with outlining the cited references and utilised appendices such as the Interview guide.

However, the following chapter introduces the literature review analysis relevant to the research topic.

2 GLOBAL FIRM, CIRCULAR ECONOMY, AND THE SYSTEM CHANGE PERSPECTIVE

This chapter discusses literature relevant to the research topic. The chapter emphasises conceptualizing global firms, circular economy, characteristics, and principles of the circular economy. The chapter also emphasises the available theoretical background of the novel approach of system change perspective to closed loop thinking as a circular economy creation strategy. Lastly, the chapter introduces a preliminary theoretical framework of the research based on a synthesis analysis of the system change perspective relevant to the global firm and circular economy.

2.1 Global firm and Circular economy

2.1.1 Conceptualization of global firm

The present-day increased globalization of economies has given global firms an exciting opportunity to rise and go beyond their national territories with a global thinking and local acting attitude (Ali & Kaynak 2000, 107). In recent times, global firms represent tremendous business activities and revenues in global trade accounting for $40 trillion in revenue, nearly 27 per cent of average employment, and $17 trillion in gross value added only in the OECD countries in 2018 (Manyika et al. 2021, 3-8).

Although the concept of the global firm is a well-researched phenomenon, there is confusion on the definitions and characteristics that constitute a global firm from practitioners' and scholars' perspectives (Ali & Kaynak 2000, 115). According to common practitioners' viewpoints, global firms are considered a means to capitalize on the concept of globalization which denotes among other things the ability to introduce products in each market catering to the specific needs of that market or customers (Ali & Kaynak 2000, 109). In this instance, the common perception of practitioners relating to global firms denotes a strong commitment towards global economic integration and the welfare of the communities wherever they operate their businesses (Ali & Kaynak 2000, 110).

On the other hand, scholars who research global firms interchangeably refer to the term as global corporations, multinational companies (MNCs), transnational companies, etc. (Ali & Kaynak 2000, 111). Ali & Kaynak (2000, 111) further argued the extant literature of global firms based on organization theory suggests a global firm can be categorised in terms of its geocentric world orientation, global strategy, and centralized hub organizational structure. In this regard, a geocentric world orientation helps global firms to view the world as their unit of analysis. The global strategy enables efficient utilization of worldwide supply chain, production, and market capabilities to compete against existing competitors. Whereas a centralized hub structure enables the headquarters to make key strategic decisions to implement the devised global strategy (Ali & Kaynak 2000, 111).

However, to truly become a global firm, a company must at first try to be considered to its customers as a world citizen and thus must not represent its tie with any specific culture or even it's home country. The company must produce its own culture that is inspiring, and its allegiances and orientations must target improving the quality of lives of its customers and environments where it will operate its business activities. (Ali & Kaynak (2000, 111.) As such, Ali & Kaynak (2000, 111) argued global firms have three major characteristics notably inner security, inner direction, and inner coherence. The inner security provides global firms with the confidence to shape, compete, expand, recruit global talents, and conduct research and innovation experiments.

On the other hand, the inner direction provides global firms with clarity in its vision, and mission which also enables engagement and networking on a global scale aiming at strengthening mergers, acquisitions, and strategic alliances. Lastly, inner coherence helps global firms to establish a strong sense of purpose aiming at strengthening their role as local players in their operating environments. (Ali & Kaynak 2000, 114.)

Considering the above-mentioned characteristics of global firms, this study corroborates with the following definition of the global firm offered by Ali & Kaynak (2000, 118). The definition reads,

> *‘‘Global firms are those that internalize globalization’s challenges. These firms have a culture that profoundly articulates their mission and orientations, de-emphasizes boundaries in their conduct and view the world, rather than any country, as their market. Therefore, in their orientations and conduct, they do not exhibit an obsession with a national culture or politics. More importantly, commitment to the quality of the lives of their customers in every part of the world*

is considered a source of competitive advantage. Global firms seek to translate 'thinking and acting globally' into a reality.''

However, the following sub-section introduces the conceptualization of circular economy.

2.1.2 Conceptualization of circular economy

Extant literature suggests that the concept of circular economy has its root originated from the sustainability concept, a widely discussed research phenomenon of the previous decades (van Buren et al. 2016, 2). Many studies dedicated to sustainability research stream revealed that a linear economic model focused on driving out the short-term profits by adopting a raw materials-production-use-residual-waste philosophy, have long ignored, undervalued, and harmed the societal and environmental interests (van Buren et al. 2016, 3). As such the emergence of circular economy research under the sustainability research stream has quickly gained widespread interest among various scholars and practitioners in recent years (Ghisellini et al. 2015, 2; van Buren et al. 2016, 3; Geissdoerfer et al. 2017, 760; Kirchherr et al. 2017, 221).

Geng and Doberstein (2008, 238); Ghisellini et al. (2015, 2) argued circular economy as a new business model to lead to a more harmonious society through sustainable development. Ellen Mac Arthur Foundation (2013, 10) viewed the circular economy as a greener economy that promotes and implements a more appropriate and environmentally sound use of resources to create innovative employment opportunities. On a similar notion, Ellen MacArthur Foundation (2013, 22) and Sitra & Mckinsey (2015, 2) submits circular economy as a restorative and regenerative economic model where innovative designs ensure products, materials and associated components always aim to yield superior performance and utility to users, thus reducing the need for recycling, reuse, and waste management for those products.

On the other hand, Kirchherr et al. (2017, 127) report the findings from Fang et al. (2007), Sakr et al. (2011); and Jackson et al. (2014) who advocate circular economy from a system perspective and argue that a transition from business-as-usual (often considered as a raw materials-production-use-residual-waste philosophy by van Buren et al. 2016, 2) to a circular economy requires fundamental changes at least at three levels of the circular economy system: the macro, the meso and the micro-system. In this instance, the macro-system represents the entire structure of the national or regional economy and calls for fundamental changes in the industrial consumption of a given economy. Whereas the meso level system calls for fundamental changes in consumption at an industry level such as in different industrial parks, export processing zones, etc. Lastly, the micro-level system targeted individual organizations, products, and customers to address the need to recognize what measures ought to be taken to increase their circularity in an economy. (Kirchherr et al. 2017, 127.)

Although extant literature published different streams of research to define the concept yet there is no succinct definition of a circular economy that has received a universal agreement among the various school of thought (Lieder and Rashid 2016, 37). However, Mac Arthur Foundation's definition can be considered as the most representative (Lieder and Rashid 2016, 37; Kirchherr et al. 2017, 221). According to Mac Arthur Foundation's (2013, 22), the circular economy definition is,

> *"Circular economy refers to an industrial economy that is restorative by intention; aims to rely on renewable energy; minimises, tracks, and eliminates the use of toxic chemicals; and eradicates waste through careful design."*

Lieder and Rashid (2016, 37) considered a circular economy as a solution to drive out economic growth and environmental protection. Lieder and Rashid (2016, 37) further added by the implementation of circular economy it is possible to avoid and minimize environmental impacts of the business, reduce resource scarcity issues by motivating regenerative use of resources, and produce economic benefits as increase profitability and sustainability in businesses.

In a similar line of research incorporating circular economy aims, van Buren et al. (2016, 3) considered circular economy as an eco-design, product lifecycle prolonging process and argued that it can create important values for the economy, society, and environment. The circular economy definition of van Buren et al. (2016, 3) reads,

> *"…the focus point in a circular economy is to not unnecessarily destroy resources. It is the process of reducing the consumption of raw materials, designing products in such a manner that they can easily be taken apart and reused after use (eco-design), prolonging the lifespan of products through*

> *maintenance and repair, and the use of recyclables in products and recovering raw materials from waste flows."*

However, Kirchherr et al. (2017, 127) in their comprehensive review of 114 definitions of circular economy argued that circular economy ought to be viewed as a sustainable means to create systematic change towards achieving certain principles, environmental quality, economic prosperity, and social equity which will ultimately benefit the current and future generations in each society.

This study has a similar view as Kirchherr et al. (2017, 127) and it attempts to explore the context of global firms' implemented system change perspective strategies towards achieving circular economy principles. Thus, the adopted circular economy definition for this study from Kirchherr et al. (2017) reads,

> *"A circular economy describes an economic system that is based on business models which replace the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes, thus operating at the micro-level (products, companies, consumers), meso-level (eco-industrial parks) and macro-level (city, region, nation and beyond), to accomplish sustainable development, which implies creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations."*

However, the following sub-chapter introduces the characteristics and principles of circular economy and its creation strategies.

2.2 The context of circular economy

2.2.1 Circular economy characteristics

A circular economy can help businesses and the economics of the world to address increasing resource-related challenges, and it can generate economic growth, jobs, and reduce environmental impacts such as reducing carbon emissions from business models (Ellen MacArthur Foundation 2015, 3). To pursue such ambitions circular economy aims at implementing sustainable development concepts in business operations (Ghisellini et al. 2015, 2; Ellen MacArthur Foundation 2013, 22). Kirchherr et al. (2017, 224) furthermore argued that such notion of sustainable development must encompass three aims that must be accomplished concurrently such as environmental quality, economic prosperity, and social equity.

To highlight how a circular economy can bring positive outcomes through sustainable development practices, Andrews (2015, 305) compared the circular economy with the opposing view i.e., the linear economy which aims at the take-make-use-dispose model where products become waste at the end of their lifecycles. Concurrently, to oppose the view of the linear economy several authors represent their findings on the enormous benefits of circular resource management such as the cradle-to-cradle concept, closed spiral loop economy concept, etc. (van Buren et al. 2016, 2; Lieder and Rashid 2016, 37).

The cradle-to-cradle concept is characterised by an effective design philosophy that considers all technical and biological materials involved in industrial and commercial processes to be nutrients. This concept equally emphasises the energy and water consumptions in the industrial processing systems and posits ‘Waste equals food’; ‘Use current solar income, and ‘Celebrate diversity as the three main principles of this philosophy. (Ellen MacArthur Foundation 2013, 27.) Whereas Lieder and Rashid (2016, 37) argued a closed spiral loop economy concept as a philosophy that focuses on minimizing matters (technical or biological), energy-flow and environmental corrosion without imposing any significant limits to bring out economic growth, social and technical progress in our societies.

To incorporate a holistic view of the concept, Ellen MacArthur Foundation (2015, 7-8) outlines the following characteristics of the circular economy. These are described in table 1.

Table 1. Characteristics of the circular economy. *(Source: Ellen MacArthur Foundation 2015, 7-8).*

Circular economy		
#	*Characteristics*	*Definition*
1	Waste is "designed out"	The circular economy is designed to eliminate possible waste from the production processes and product lifecycles. A careful design of the production processes ensures all the non-toxic biological materials will be decomposed to return to the soil as nutrients. Whereas all the technical materials (i.e., plastics, polymers, alloys, etc.) are designed to be upgraded to capture more values and result in less energy and water consumption, and recoverable for refresh usability.
2	Diversity builds strength	The diversity of various businesses (large to medium scale) in an economy is a core value of a circular economy. It recognises that the presence of larger corporations and small-scale industries in an economy can build long term economic strength and resilience, particularly against volatile economic adversity.
3	Renewable energy sources power the economy	A circular economy appreciates renewable energy sources to wheel the motion of production processes that ultimately targets reduced resource dependency for a nation. Alternative renewable energy sources such as wind power, solar power, geothermal energy, etc. help industries to gain considerable flexibility in energy procurement for sustainable development.

4	Think in systems	System or design thinking works as a building block in the circular economy to improve, improvise and upgrade products or services. In circular economy people, plants, businesses, partners, stakeholders, collaborators, etc. are always considered holistically as interrelated elements of the complex economic system. For instance, in a feedback loop system collaboration with a landfill or garbage treatment company can assist a manufacturer to know about the effectiveness of its materials for reusability and recyclability.
5	Prices or other feedback mechanisms should reflect real costs	In the circular economy, the total costs of implementing circularity closed loop strategies, functions, investments, marketing expenditures, etc. must be transparent and recorded to share with the community.

The following sub-section discusses the principles of the circular economy.

2.2.2 Circular economy principles

Extant literature presents several principles that underpin the concept of circular economy (Ellen MacArthur Foundation 2015, 5-7; Ghisellini et al. 2015, 3; Sihvonen and Ritola 2015, 640-642; Lieder and Rashid 2016, 37; Kirchherr et al. 2017, 127). Considering a system change perspective, Ellen MacArthur Foundation (2015, 5-7) proposed three main principles of the circular economy such as *a) preserving and enhancing natural capital through utilizing renewable resource flows, b) ensuring that materials for production always remain utility (values) in both technical and biological cycles, and c) driving out negative externalities from production and consumption processes by adopting a systematic design thinking.*

However, as the study aims to investigate Finland *(Finland being one of the member states of EU)* based global firm's circular economy initiatives from an empirical perspective, thus the study adopts the EU 2008 Waste Framework Directive for Circular Economy principles as the context of this study. It is noteworthy that in this framework, reduce is regarded as the highest (i.e., first) priority principle followed by reuse, recycle, and recovery (European Commission 2008, 10).

The following sub-section provides a detailed account of these principles.

2.2.2.1 Reduce

The reduction principle focuses on implementing eco-efficient production and consumption processes where the input of raw materials, primary energy, and waste consumption will be minimised (Ghisellini et al. 2015, 5). This less consumption of raw materials, primary energy, and waste is possible due to the utilization of smart technologies, lightweight and advanced product features, promotion of simpler lifestyle choices and manufacturing of more energy-efficient household appliances, etc. (Ghisellini et al. 2015, 5).

Furthermore, Figge et al. (2014, 26) pointed out that by adopting a Zero Emission Strategy, companies can utilise the reduction principle as the means to pursue a higher level of value creation for goods so that the goods will yield zero (or decreased) environmental impacts during or after the consumption process.

2.2.2.2 Reuse

European Commission (2008, 10) defines reuse as "any operation by which products or components that are not waste are used again for the same purpose for which they were conceived". Kirchherr et al. (2017, 127) argue reuse as the measure to closing the loop, cycling, repairing and/or refurbishing resources. Castellani et al. (2015, 374) and Ghisellini et al. (2015, 5) submit there are numerous environmental benefits of the reuse principle such as it can help to consume fewer resources, energy, and labour as opposed to the manufacturing of the new products from virgin materials.

To further promote the reuse principle, Castellani et al. (2015, 376) suggest that reusing of resources can prevent the emission of contaminant pollutants from textile, furniture, glass products, and so on thus it can reduce air, water, and soil pollution. Conversely, to highlight the economic benefits of the principle, Su et al. (2013, 216) asserted that the used items and wastes coming out of one industry can be considered as the direct input resources for other firms or industries.

2.2.2.3 Recycle

European Commission (2008, 10) defines recycling as "any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes. It includes the reprocessing of organic material but does not include energy recovery and the reprocessing into materials that are to be used as fuels or for backfilling operations". Su et al. (2013, 219) argued recycling is the means of creating new products through less raw material consumption owing to utilizing waste materials as input resources. Hu et al. (2011, 225) further added recycling makes it possible to utilize waste materials as input resources because of comprehensive collection, classification, sorting of the waste materials. Kirchherr et al. (2017, 127) argue recycling is the dialogue about remanufacturing, closing the loop, cycling, recycling, and/or reuse of wastes.

In principle, recycling can offer numerous economic and environmental benefits (Ghisellini et al. 2015, 6) although it has few limitations (Prendeville et al. 2014, 11; Ghisellini et al. 2015, 6). Recycling of still useable and retrievable values or utilities from the wastes ensure fewer wastes will end up going to the waste treatment plants thereby it can help to reduce associated labour and transportation costs to deal with landfilling or decomposing processes for those waste products. As a result, recycling can not only offer important raw materials for future use but also can prevent any associated environmental impacts of the wastes that are going into the ecological process such as wastes that are utilised for landfilling or decomposing for fertilizers. (Ghisellini et al. 2015, 11.)

2.2.2.4 Recover

Recover as the fourth principle of circular economy is less represented in the extant literature as opposed to the previously mentioned other three principles (Sihvonen and Ritola 2015, 642; Kirchherr et al. 2017, 127). van Buren et al. (2016, 3) and Kirchherr et al. (2017, 127) argue recovery as the incineration of materials with an aim to energy recovery as generating heat for cities as an example. Sihvonen and Ritola (2015, 642) argued recovery as a principle has two objectives such as added value and material recovery. While, added-value recovery refers to repairing and remanufacturing of products, material recovery targets to retrieve valuable or hazardous materials during the post-use phase of the products (Sihvonen and Ritola 2015, 642). Whereas material recovery means incineration of materials to energy recovery as heat, emissions, and ashes (van Buren et al. 2016, 3; Kirchherr et al. 2017, 127).

On the other hand, concerning the circular economy application in waste management, Ghisellini et al. (2015, 9) argue recovery as a principal can have significant economic benefits and positive environmental impacts. Ghisellini et al. (2015, 9) pointed out that the recent recovery of resources in the waste management sector has yielded with the emergence of new typologies of business operators and processes namely "scavengers" and "decomposers" who have expert innovative recovery technologies to extract resources out of wastes. In this regard, both scavengers and decomposers collect recyclable materials from the disposal supply chains to redistribute them to companies that can reuse, recycle, and decompose wastes to turn into raw materials for future production processes. (Ghisellini et al. 2015, 9.)

2.3 Circular economy creation strategies

Extant literature suggests various circular economy creation strategies. For instance, Preston (2012, 8), Ellen Mac Arthur Foundation (2015, 5), Ghisellini et al. (2015, 16), van Buren et al. (2016, 7), and Kirchherr et al. (2017, 127) posited a transition to a circular economy requires a systematic change perspective to closed loop thinking from current take-make-dispose practice. Whereas Ellen Mac Arthur Foundation (2015, 7), Ghisellini et al. (2015, 2) and Lieder and Rashid (2016, 44) suggested a regenerative design approach that is regenerative and restorative.

Furthermore, Lieder and Rashid (2016, 44) argued social entrepreneurship is a mechanism to create a circular economy. Lieder and Rashid (2016, 45) additionally proposed resource conservative manufacturing to create a circular economy. Finally, Ellen Mac Arthur Foundation (2015, 16) argued reverse cycle is one of the building blocks to creating a circular economy in recent times.

The following paragraphs describe these circular economy creation strategies in detail.

2.3.1 A system change perspective to closed loop thinking

Transition to a circular economy requires a fundamental paradigm shift (Ellen Mac Arthur Foundation 2015, 5; Ghisellini et al. 2015, 16; van Buren et al. 2016, 7; Kirchherr et al. 2017, 127) and rethinking on the role and function of resources in the economy (Preston 2012, 2). Preston (2012, 2) argued the move towards circular economy notions industrial organizations would fundamentally rethink and allow sustainability and closed loop thinking at the heart of their business models.

This closed loop thinking perspective has important implications in creating a circular economy as Womack et al. (1990, 9) once speculated *'how we make things dictates not only how we work but what we buy, how we think, and the way we live'.* This system change perspective to closed loop thinking has several advantages. For instance, Preston (2012, 2), Ellen MacArthur Foundation (2015, 5), and van Buren et al. (2016, 7) argued among other things transition to circular economy shift can enable developed countries to reduce vulnerability to resource scarcity, supply risks, price change shocks and increase social and environmental wellbeing.

2.3.2 Regenerative design

A circular perspective in value creation can be achieved through regenerative design which aims to ensure the highest utility and value of products, components, and materials always (Ellen Mac Arthur Foundation 2015, 7). Lyle (1996, 37) submitted strategies for regenerative design were adopted to support the sustainable development concepts. Allwood et al., (2011, 372), Ellen Mac Arthur Foundation (2015, 7) and Lieder and Rashid (2016, 44) argue regenerative design approach ought to start at the product design stage aiming to improve material efficiency for producing longer-lasting products, component re-use and remanufacturing, and designing products with fewer materials.

Whereas Ghisellini et al. (2015, 2) posit regenerative design as a broader and more comprehensive approach to design radically alternative solutions in their entire lifecycles aiming not only material or energy recovery but also to improve the wellbeing of the entire living and economic model as opposed to contemporary business-as-usual economy and resource management.

2.3.3 The blue economy and social entrepreneurship

The blue economy is a model of action that stimulates innovations and social entrepreneurship (Pauli 2011, 14; Lieder and Rashid 2016, 44). The blue economy is premised on scientific analysis to identify the best solutions to manufacturing products through innovative processes that generate social entrepreneurship (Iustin-Emanuel and Alexandru 2014, 197).

Blue economy considers the learning from the natural world as a source of innovation such as biomimicry, the exploitation of gravity to harvest energy, utilizing solar energy as an alternative fuel to fossil fuels or the cascading of nutrients systems which generate cash-flows based on transforming waste from one process to the resources for another operation (Pauli 2011, 15; Lieder and Rashid 2016, 44). Additionally, Costa et al. (2019, 59) argue the blue economy is the concept of industrial process redesigning to search for viable biological solutions inspired by the natural world in reducing contamination yielded from industrial manufacturing.

Extant literature proposes several advantages of conscription to blue economy principles in creating a circular economy model and encouraging social entrepreneurship (Pauli 2011, 15; Lieder and Rashid 2016, 44). Pauli (2011, 16) and Lieder and Rashid (2016, 44) argue blue economy can offer a series of innovations to create an ecosystem-like business function that can provide numerous economic, social, and environmental benefits. Whereas Iustin-Emanuel and Alexandru (2014, 199) proposed blue economy can guide social entrepreneurs to build national capital through local job creation and promoting the health and welfare of human beings and the environment.

2.3.4 Resource conservative manufacturing

Resource conservative manufacturing is a novel state-of-the-art concept of sustainable manufacturing aiming to implement closed loop thinking in product design, development, and manufacturing (Asif 2011, 37; Rashid et al., 2013, 173; Lieder and Rashid 2016, 45). Resource conservative manufacturing starts at the early stage of the product development with rigorous analysis to determine the entire lifecycle numbers of the products and components if they can ensure maximum resource conversion considering manufacturing costs, resource consumption, value recovery, and environmental protection (Asif 2011, 7; Rashid et al., 2013, 170).

Thus, at the heart of this approach during the entire life cycle of products it aims to transform the waste management phenomenon into value management (Rashid et al., 2013, 170). Conversely, Asif (2011, 25) argues resource conservative manufacturing aims to converse three important resources such as material, energy and value-added.

However, Asif (2011, 8) and Rashid et al., (2013, 170) argue that resource conservative manufacturing can be considered as a holistic approach integrated at the product design and development strategy to improve product value management from a multiple product lifecycles perspective where the primal focus is to conserve energy, material and value-added to prevent waste generation and to protect the environment.

2.3.5 Reverse cycle

A value preserving mechanism is a core requirement to transit to a circular economy. To pursue value preservation and creation from products and materials after their use or end-of-life ought to be brought back to the original manufacturers. (Ellen Mac Arthur Foundation 2015, 16.) In this instance, the reverse cycle also popularly known as reverse supply chain, reverse logistics is a mechanism that helps industries to treat, reuse, remanufacture and re-market those products in the markets (Ellen Mac Arthur Foundation 2015, 16).

Contrary to the forward supply chain logic in the reverse cycle, products are returned after their end-of-life usage to the original equipment manufacturers requires comprehensive sorting, evaluation, warehousing, risk management, decomposing, etc. to determine what components of the products can be reused, recycled, remanufactured, and re-market to the customers (Asif 2011, 56; Rashid et al., 2013, 172; Ellen Mac Arthur Foundation 2015, 16). There are endless economic benefits that the reverse cycle can offer to enable circular economy thinking to the manufacturing industries such as mobile technologies and automotive industry Ellen Mac Arthur Foundation 2015, 13).

Ellen Mac Arthur Foundation (2015, 13) submit the remanufacturing costs of mobile phones could be reduced by 50% per device if the mobile phone manufacturers can make it easier to take the product components apart, offer incentives to return the damaged phones and improve their reverse cycle to collect the damaged phones from the end customers.

2.4 The system change perspective in Circular economy

2.4.1 The approach of system change perspective

Economies around the world still appears to be locked into the favour of liner system of production and consumption in terms of regulations to mindset to production economies to consumption behaviour (Ellen Mac Arthur Foundation 2013, 18; 2015, 80). However, some degree of change towards a more sustainable system is already visible in many industries as to respond to the stricter environmental regulations and incremental resource scarcity (Ellen Mac Arthur Foundation 2015, 80). As such, the adoption of the circular economy concepts and a shift towards systematic change is already making inroad to liner systems and proving to be a wining concept for greater societal, environmental, and economic benefits (Ellen Mac Arthur Foundation 2015, 80).

However, moving towards the circular economy needs a paradigm shift placing sustainability and closed loop thinking at the heart of business models in industrial organizations (Preston 2012, 2). Whereas van Buren et al. (2016, 2) argued a circular economy suggests a structural systematic transition of society that is complex and requires changes in various subsystems such as energy, logistics and finance. The circular economy that triggers a systematic change shift is often not presented although it is mostly characterised as a medium of reducing, reusing, and recycling activities (Kirchherr et al. 2017, 229). Whereas Preston (2012, 5) argued a system change perspective requires redesigning industrial systems, cradle-to-cradle production, attitude towards collaborative consumption, measuring progress, and international cooperation as means to implement circular economy concepts. Further, Rashid et al. (2013, 168) concluded the closed loop system thinking requires developments in sustainable product design, supply chain design, business model design and innovative manufacturing technologies.

To define a system change perspective in the circular economy, Ellen Mac Arthur Foundation (2013, 25) expressed *''a systematic change refers to the non-linear systems or most popularly referred to a feedback-rich systems where the combination of imprecise starting conditions plus feedback leads to multiple, often surprising consequences and to outcomes that are not necessarily proportional to the input.''*

Ellen Mac Arthur Foundation (2013, 25) further argued *''systems thinking emphasises on flow and connection over time and has the potential to encompass* *regenerative conditions rather than needing to limit its focus to one or more parts and the short term.''*

A system change perspective in the circular economy can create immense opportunities for industrial renewal, regeneration, and innovation through the application of the ReSOLVE framework which is a set of six actions that businesses and governments can utilise to transit to a circular economy, i.e., Regenerate, Share, Optimise, Loop, Virtualise, and Exchange (Ellen Mac Arthur Foundation 2015, 9). On the other hand, it could also assist developing countries to industrialize their manufacturing without increasing unsustainable burden on natural finite resource consumption and preventing to breaching environmental limits (Preston 2012, 2). Furthermore, to highlight the enormous economic benefits of shifting towards CE, Ellen MacArthur Foundation (2013, 66) estimated that *"CE represents a net material cost-saving opportunity of USD 340 to 380 billion p.a. at The EU level for a 'transition scenario' and USD 520 to 630 billion p.a. for an 'advanced scenario' by 2025."*

However, van Buren et al. (2016, 2) argued that this system change is complex and requires simultaneous changes in various subsystems on the regional, national, and global scale. In the similar research stream Ghisellini et al. (2015, 10) argued circular economy as a systematic change implies the adoption of an eco-industrial design, cleaner production patterns, increased producers' and consumers' awareness and responsibility, usage of renewable technologies and materials, and clear policies as tools at different levels i.e., micro, meso, and macro-level. Furthermore, Lieder and Rashid (2016, 48) suggested practical implementation of circular economy and system change perspective requires a top-down approach and a bottom-up approach. On the other hand, Ellen MacArthur Foundation (2015, 17) suggested that there are also a few risks to consider before investing significant commitment to the system change perspective such as the need to allow appropriate time and investments for the incumbent industries to align and adapt their business models towards moving to a systematic circular economy strategy which could create a redistributive effect in the economy. As such time, costs, knowledge, and commitment would be crucial to consider before realising the factual benefits that circular economy might bring to the consumers, businesses, and governments (Ellen MacArthur Foundation 2015, 17). However, the following table 2 represents a summary of the previous research results on circular economy and system change perspective.

Table 2. Summary of the previous research results on circular economy and system change perspective.

Study	Context	Data and methods	Findings
Preston (2012)	Exploring the possibility of system change perspective in the circular economy as a model for an industrial organization that will increase wellbeing, environmental protection, and reduce vulnerability to resource, and price shocks.	Qualitative case study research based on Industrial ecosystem in Tianjin, China.	- Moving towards the circular economy needs a paradigm shift placing sustainability and closed loop thinking at the heart of business models in industrial organizations. - A system change perspective requires redesigning industrial systems, cradle-to-cradle production, attitude towards collaborative consumption, measuring progress, and international cooperation as means to implement circular economy concepts.
Rashid et al. (2013)	Exploring the necessity for a radical shift in closed loop system perspective and laying out foundations for the development of closed loop manufacturing systems.	Literature review analysis on closed loop manufacturing.	- Closed loop manufacturing can be considered as a solution to the problem of resource scarcity and maximum product returns to ensure reduction, recycling, reuse, and recovery principles from an industrial perspective. - The closed loop system thinking requires developments in sustainable product design, supply chain design, business model design and innovative manufacturing technologies.
Ellen Mac Arthur Foundation (2015)	Outlining the economic and business rationales for an accelerated transition towards a circular economy model based on systems thinking.	Qualitative case study research and expert interviews in Europe.	- Adoption of circular economy principles i.e., a shift towards system thinking can benefit Europe to induce a technology revolution and create a net benefit of €1.8 trillion by 2030. - A system change perspective in the circular economy can create immense opportunities for industrial renewal, regeneration, and innovation through the application of the ReSOLVE framework which is a set of six actions that businesses and governments can utilise to transit to a circular economy, i.e., *Regenerate, Share, Optimise, Loop, Virtualise, and Exchange.*
Ghisellini et al. (2015)	Reviewing circular economy literature from the last two decades	Literature review analysis on circular	- The circular economy can be considered to decouple economic growth from resource consumption.

	to critically discuss the main features and a system change perspectives of circular economy concept at the different levels i.e., micro, meso and macro-level in the global context.	economy, system change perspective and implementation perspectives in different levels.	- Circular economy as a systematic change implies the adoption of an eco-industrial design, cleaner production patterns, increased producers’ and consumers’ awareness and responsibility, usage of renewable technologies and materials, and clear policies as tools at different levels i.e., micro, meso, and macro-level. - Circular economy concept can optimize efficient natural resource use by implementing closed loop cycles of materials and energy usage processes.
Lieder and Rashid (2016)	Critically analysing how circular economy and system change perspective concepts can reduce resources scarcity, waste generation, and promote economic advantages.	A systematic literature review analysis on circular economy and system change perspective.	Practical implementation of circular economy and system change perspective requires a top-down approach *(i.e., presence of favourable legislation and policy, Support infrastructure, and social awareness)*, and a bottom-up approach *(i.e., Establishing collaborative business models, Product design, Supply chain, and Information and communication technology)*.
van Buren et al. (2016)	Analysing how the logistics industry can overcome different barriers to implement circular economy and system change perspective and what help policymakers can offer.	Qualitative case study research on the Dutch Logistics Industry.	- Developing a circular economy requires a consistent change in business practices, consumer behaviour, and governmental policies. - A circular economy suggests a structural systematic transition of society that is complex and requires changes in various subsystems such as energy, logistics and finance.
Kirchherr et al. (2017)	Creating transparency on the current conceptions of the circular economy theory.	A systematic literature review analysis on 114 circular economy definitions.	- The circular economy that triggers a systematic change shift is often not presented although it is mostly characterised as a medium of reducing, reusing, and recycling activities. - Available definitions ignore linkages of the circular economy to sustainable development and its effect on social equity and future generations are scarcely stated.

The following sub-chapter discusses various implementation strategies of the system change perspective relevant to the circular economy.

2.4.2 Implementation strategies of the system change perspective

Extant literature suggests various implementation strategies of the system change perspective in circular economy (Ghisellini et al. 2015, 15). A few of those implementation strategies as suggested by Preston (2012, 10), Ghisellini et al. (2015, 15), Korhonen et al. (2018, 9) and others are discussed below.

2.4.2.1 Eco-design

Eco-design as an implementation strategy of the system change perspective in circular economy is well recognized in the extant literature (Preston 2012, 10; Ghisellini et al. 2015, 15; Korhonen et al. 2018, 9). Ghisellini et al. (2015, 15) and Kirchherr et al. (2017, 229) compared eco-design as a strategic measure to establish eco-industrial parks to support the meso-level circular economy initiative often adopted by the regional governments. Whereas Van Berkel et al., (1997, 53), Ramani et al., (2010, 3), and Wrinkler (2011, 244) argued eco-design as green design or design for environment which aims to enhance the environmental performance of the product throughout its life cycles and from product design to decomposing.

According to Van Berkel et al., (1997, 53) and Ghisellini et al. (2015, 15) eco-design considers sustainability and environmental aspects into the early stages of product design and development to ensure the durability and optimal performance throughout the product life cycle to match with environmental aspirations. On the other hand, Ramani et al., (2010, 3), highlighted that to achieve the environmental aspects from a product priority ought to be invested on its early design stage as the choices made on the product design stage will determine what components will be utilised and based on the compositions of the raw materials the principle of reduction, reuse, recycle or recovery will see actual sustainability or environmental performance.

However, there are also some degree of institutional arrangements to make awareness on the necessity of eco-design in many industries, particularly to the energy industry, such as the European Union’s Eco-design directive 2005 that provides a consistent and unified framework for mandatory eco-design minimum requirements applicable to energy using products (Ghisellini et al. 2015, 8).

Extant literature reports various tools and methods for eco-design such which can largely vary depending on the data presentation and design process implementation requirements (Ramani et al., 2010, 3). Ramani et al., (2010, 3) reported that various tools and methods can be classified into three categories based on checklists, life cycle assessment, and quality function deployment. However, eco-design as a systematic change strategy offers numinous advantages such as design for environment philosophy (i.e., eco-design as a strategy) can transform environmental considerations as business opportunities and thereby enhances product branding to capitalise superior market competition position (Ramani et al., 2010, 2). Eco-design strategy can also enhance industry collaboration and alliances such as the most scientifically referred case the eco-industrial park in Kalundborg, Denmark characterizes a model system of industrial symbiosis where eco-deign principle has assisted the natural physical linkages of material flow exchange among industries within the region to ensure maximum waste recovery, reduction, recycle and reuse (Winans & Deng 2017, 826).

On the other hand, (Ghisellini et al. 2015, 16) argued eco-design can help companies to reduce all kinds of environmental impacts through the product life cycle, prevent loss of valuable materials, allow to save on costs as careful product design phase out possible wasteful and unnecessary materials or production stages, enhances waste management performance, and create job opportunities for societies, etc. On a similar research stream, Preston (2012, 10) reported careful product design preferring eco-design philosophy assisted China to reduce 60% less energy in steelmaking in 2011 using waste steel than making steel from iron ore.

However, there are also few challenges associated with eco-design that need attention. For instance, Geng and Doberstein (2008, 235) posited that technological innovation ought to be state-of -the-art quality in terms durability and cost-effectiveness otherwise it is unlikely for the businesses to reduce total emissions and enhance eco-effectiveness from the product life cycle. Geng and Doberstein (2008, 235) further maintained that such technologies and their demands are still weak in present time which might delay the implementation of this eco-friendly strategy. Furthermore, Ramani et al., (2010, 4) suggested that adoption of life cycle assessment, and quality function deployment as eco-design tools are expensive and time consuming as such this may limit small organisations to adopt this eco-design strategy in their production panning, and design.

2.4.2.2 Cleaner production using renewable materials

Cleaner production using renewable materials is a well-established strategy to implement circular systematic thinking to closed loop manufacturing and a recognized stream of research under the premise of system change perspective (Preston 2012, 7; Ghisellini et al. 2015, 15, Lieder & Rashid 2016, 44). Preston (2012, 10) compared cleaner production using renewable materials as a direct approach towards cradle-to-cradle production approach. Whereas Lieder & Rashid (2016, 44) argued cleaner production using renewable materials as a profound systematic change perspective strategy that has emerged as a recognized stream of research under the primes of Industrial Ecology.

Drawing on previous research Lieder & Rashid (2016, 44) further maintained that industrial ecology adopts a systematic view that seeks to utilise clean production approach using renewable materials to ensure maximum optimization of total material cycles from virgin materials to product, to obsolete product, to final disposal of finished materials. Conversely, Van Berkel et al., (1997, 55) and Ghisellini et al. (2015, 15) held cleaner production using renewable materials strategy as a catalyst for three interrelated practices to achieve circular economy ambition such as *a) pollution prevention, b) toxic use reduction, and c) design for environment*.

Cradle-to-cradle or cleaner production using renewable materials strategy aims to high ambitious goals to achieve circularity in production processes that not only ensure profitability from production but also positively impact environment and society by deliberately avoid utilising harmful materials and components from the production processes (Preston 2012, 7). Highlighting how this strategy offers enormous environmental, social, and economic benefits, Preston (2012, 7) suggested cleaner production using renewable materials by utilising nanotechnology and biotechnology products can be manufactured using useful materials which will increase more strength, durability, reduce weight, and maximise reusability of the products as these products will be easily biodegradable or decomposable than that of the contemporary harmful materials such as plastics.

Adoption to cleaner production using renewable materials strategy also has implications for customer satisfaction, positive branding, and profitability of the companies (Preston 2012, 8). Preston (2012, 8) reported that adoption to cleaner production approach using toxic free materials, easy product design for disassembly, and enhanced recyclability assisted Desso, a Dutch carpet manufacturer to increase its profit margin significantly as its customers have appreciated the approach by paying a premium price for its product lines. On the other hand, Van Berkel et al., (1997, 57), and Ghisellini et al. (2015, 15) argued this strategy can ensure maximum customer satisfaction as the manufactured products through this approach comply with national and international environmental standards, are environment friendly, and ensure high quality product performance.

Extant literature also suggests few challenges associated with strategy such as Geng and Doberstein (2008, 235) suggested adoption to cleaner production approach requires fundamental shift in present day technologies and their weak demands might delay the implementation of this eco-friendly strategy. Lieder & Rashid (2016, 47) proposes that cleaner production using renewable materials ought to be considered as a bottom-up approach and countries and central governments might establish incentives to appreciate cleaner product design and cleaner production technologies to align their priorities with those of the private actors. However, collaboration and joint co-innovation require fundamental shifts and resources which might also delay the adoption or application of such strategy in practice (Lieder & Rashid 2016, 47).

On a similar research stream, Preston (2012, 8) argued making a radical shift towards renewable materials and product design require investments, commitments, and alignment among governments' environmental policies and private actors' long-term business objectives. Thus government' environmental policies should also consider the appropriateness of the radical shifts and allow enough time for the private sectors to redesign their production approach to meet with that of their government's environmental policies (Preston 2012, 8).

2.4.2.3 Zero waste policy

Zero waste policy represents a shift from business as usual (i.e., take-make-decompose) to an integrated systems that utilises everything without having to produce any waste at all throughout the life cycle of the products (Song et al. 2015, 200). This strategy promotes a systematic industrial transformation that inspires businesses to best utilise their finite resources through systematic design thinking, assists to reduce environmental impacts on the natural resource and teaches reusability of the available resources (Song et al. 2015, 200).

According to Song et al. (2015, 199), zero waste policy refers to the philosophy that supports the design of resource's life cycles in a manner where all products will be recycled, reused, recover, and eventually the product/resource life cycle will not produce any necessity for waste collection to be sent out to landfills and incinerators. Extant literature suggests that this policy has been utilised as a proven concept to promote a system change perspective in circular economy in many countries such as New Zealand, China, India, etc. (Song et al. 2015, 200). Ghisellini et al. (2015, 5) posited Zero Emission Strategy as equivalent to zero waste policy and proposes that Zero Emission Strategy aims to maximize the utility of goods yielding to zero environmental impacts.

Zero waste policy offers numerous advantages for organizations that wish to implement circular economy principle in their operations such as it helps organizations to comply with the national and international environmental regulations relating to waste management and landfills (Ghisellini et al. 2015, 14; Song et al. 2015, 200). Furthermore, this strategy helps organizations to increase profitability and cost effectiveness by carefully designing out the waste from the production processes and thereby help achieving the circular economy principle of reduction (Ellen Mac Arthur Foundation 2015, 7).

Furthermore, this policy also assists firms to recover, reuse, and recycle technical materials such as polymers, alloys, and other man-made materials, etc. which ultimately minimise the energy input and maximise the retention of economics and resources value of the products (Ellen Mac Arthur Foundation 2015, 7). On the other hand, this philosophy also assists industry leaders to showcase their concerns for the sustainability and generates a phenomenal brand awareness among its customers and stakeholders

(Preston 2012, 9). Preston (2012, 9) reported that such ambition assisted Walmart to communicate to its customers that the company has over 100,000 suppliers and its long-term goal is to create zero waste from its operations to sustain people and the environment by utilising 100% by renewable energy in its entire supply chains.

There are various strategic mechanisms in place to promote the idea of zero waste policy such as Zero Waste City Index (Ghisellini et al. 2015, 13), The 7th Environment Action Program of the European Union Policy (Ghisellini et al. 2015, 13), The European Commission Landfill Directive,1999/31/EC (Ghisellini et al. 2015, 13), different firm level zero waste principles i.e., commitment to the triple bottom line, responsibility to takeback products, and packaging, buy reused, recycled, composted raw materials to reduce dependency on virgin materials, commitment to prevent pollution and reduce waste, provide economic incentives to support zero waste policy, produce products that are non-toxic, etc. Song et al. 2015, 207).

However, implementing a successful zero waste policy can be extremely challenging (Ghisellini et al. 2015, 13; Song et al. 2015, 200). For instance, Ghisellini et al. (2015, 13) argued that the success of the zero-waste policy largely depends on the customers' awareness and willing to participate into the program by ensuring appropriate disposal of waste and recycling behaviour. Ghisellini et al. (2015, 14) further maintained that the regional governments' landfill policies and capacities ought to be coherently designed and planned related to the objectives of the local firms so that the firms will feel economic and social inceptives to implement the concept with minimum costs as possible.

Whereas Song et al. (2015, 200) argued that weak or no presence of strict environmental regulations may end up illegal dumping of the landfills and this might negatively affect the success of the program. Conversely, environmental regulations towards zero waste policy ought to be industry friendly and industry actors must be given reasonable time to adjust their production facilities relevant to zero waste policy Song et al. (2015, 200). Otherwise, Song et al. (2015, 200) argued that quick shift towards zero waste policy can impose extreme economic cost burden to the industry *(i.e., a European company may need to cost$1000 per ton to dispose of toxic waste, whereas illegal dumping cost will be about $2.50 for a ton in China)* as such transboundary illegal dumping can take place and disestablished global environmental health.

2.4.2.4 Increased producers' and customers' awareness

Extant literature suggests increased producers' and customers' awareness as one of the major catalysts for shift towards circular economy (Preston 2012, 17; Ellen Mac Arthur Foundation 2013, 11; Song et al. 2015, 209; Ghisellini et al. 2015, 17; Lieder & Rashid 2016, 47). Song et al. (2015, 209) argued without appropriate environmental awareness of the producers and customers, it is impossible to shift from a culture of unsustainable manufacturing and consumption towards a zero-waste circular economy environment. Suggesting the need for such awareness among the procedures and consumers, Song et al. (2015, 209) argued at least 25% of the reduction in emissions from various industrial processes would require fundamental behavioural change in the industry.

Recent studies also suggest that companies are increasingly aware about the economic, social, and environmental benefits that circular economy practices have to offer as compared to the liner economy functions (Geissdoerfer et al. 2017, 3). Lieder & Rashid (2016, 47) argued social awareness is a fundamental requirement for a successful transition to circular economy. Whereas Winans et al. (2017, 827) also suggests increasing economic benefits and maximum resource sharing for water, energy, and wastes can be ensured through circular economy strategy such as an eco-industrial park but to succeed in such an endeavour increased public, company, and customer awareness is required. On a similar note, Ghisellini et al. (2015, 17) argued in different regions such as in the European Union Area, the success of the circular economy endeavour largely depends on the companies and customers active participations as the EU regulations have devoted important active roles to the general member of the public and the local manufacturers.

Extant literature also suggests different mechanisms to ensure maximum producer and customer awareness related to the benefits of circular economy perspective, such as Song et al. (2015, 209) proposes *'Eco-labelling'* for products to enhance customer awareness. Eco-label program refers to the certification program where an environmental assessment authority certifies the products, services, or management systems of a firm that meet their environmental quality standards (Song et al. 2015, 209). Song et al. (2015, 209) argued this eco-labelling can offer significant strategic benefits to the member firms as the certification positively distinguish the manufacturers from non-sustainable suppliers and thereby enhances marketing advantages along with increasing customer awareness.

On the other hand, educational programs, public campaigns as well as seminars can play significant roles to increase customer and producer awareness about circular economy (Ellen Mac Arthur Foundation 2013, 62; Lieder & Rashid 2016, 47). Ellen Mac Arthur Foundation (2013, 60-62) argued the concept of sustainable circular economy must be integrated to the university education curricula and other outreach programs ought to be offered to the engineering communities, science, business, and public. Ellen Mac Arthur Foundation (2013, 80) further argued different social networks *(such as Facebook, Instagram, LinkedIn, YouTube, etc.)* can be utilised to motivate millions of consumers instantaneously and inspire to change behaviour that support circular thinking. Meanwhile, highlighting the importance of the certification or labelling strategies, Preston (2012, 17) argued this approach will not only increase public awareness but also it will offer tangible rewards to the leading companies by permitting them to secure a green premium from the markets.

However, there are also few challenges involved regarding how to foster approval of consistent and cross-country acceptance of similar methodology (Preston 2012, 17). Geng & Doberstein (2008, 236) argued often there are mismatch in the level of knowledge about circular economy between the public environmental authorities and government officials. In one hand, where different environmental authorities propose scientific sophisticated knowledge and techniques to foster circular economy awareness, the government officials who make important industry and environmental policy related decisions often lack comprehensive outlook of environmental principles (Geng & Doberstein 2008, 236).

Furthermore, professional accreditation programs often do not consider the local requirements and flexibility and not having appropriate university level circular economy education curriculum across different countries make it impossible to establish a common level of knowledge on the matter (Geng & Doberstein 2008, 236; Ellen Mac Arthur Foundation 2013, 62). Lastly, ensuring extensive interactions among different stakeholders, and exchange of information avoiding communication barriers, etc. ought to be carefully considered to raise a similar world view of the circular economy concept among worldwide producers and consumers (Geng & Doberstein 2008, 236).

2.4.3 The role of system change perspective in achieving circular economy principles

Closed loop manufacturing, i.e., the system change perspective can be considered as a solution to the problem of resource scarcity and maximum product returns to ensure reduction, recycling, reuse, and recovery principles from an industrial viewpoint (Rashid et al. 2013, 167). Korhonen et al. (2018, 45) concluded circular economy as a systematic change can offer tremendous inspirational strength and critical sustainability assessment to ensure global net sustainability.

Closed loop system thinking usually applied the principles of circular economy such as reuse, reduce, recycle, and recovery to prolong the useful life cycle of the products and thereby enhances the environmental performance of such products in terms of waste management (Rashid et al. 2013, 167). Rashid et al. (2013, 167) further continued that closed loop system thinking works as a positive driver for the development and execution of circular economy strategies to produce maximum resource conservation and value-added services for the products in circularity.

On the other hand, Van Berkel et al., (1997, 51), and Ghisellini et al. (2015, 9) argued cleaner production as a systematic circular economy strategy can integrated, prevent, and process products and services towards an environmental strategy to diminish the degree of damage and risks for humans and the environment as well as to increase overall economic efficiency. Conversely, utilising eco-design, another celebrated circular economy strategy can ensure manufacturing of products in a closed loop system where design for recycling is predetermined and offer various value-added economic benefits such as making products easy to service, disassemble, lease, and open hiring options (Prendeville et al. 2014, 8).

Application of system thinking perspective is also helping to achieve specific circular economy principles along with additional economic benefits (Mrowiec 2018, 18). Mrowiec (2018, 18) reports that applying closed loop system thinking perspective has enabled Europe to increase its plastic-based waste material sorting and recycling and it has a potential to create over 200,000 jobs in the region. Mrowiec (2018, 18) further maintained that appropriate recycling is making plastic waste materials not only as a tremendously valuable raw materials for many industries across the world but also it has the potential to make Europe less dependence on imported fossil fuels and reduce CO2 emissions.

Addressing the gigantic scope of recycling need, Ellen MacArthur Foundation (2013, 6) concluded that some 82 billion tonnes of waste raw materials is expected to be generated from the EU manufacturing industries and consumer households. As such, the ability to recycle and reuse such a vast quantity of waste raw materials through a systematic thinking can offer cost savings opportunity of up to USD 380 billion (Ellen MacArthur Foundation 2013, 6). Furthermore, an ambitious 95% collection of used mobile phones from the European mobile phone market and then reuse and remanufacturing of those phones alone can offer USD 2 billion and USD 160 million savings annually on material usage and energy respectively (Ellen MacArthur Foundation 2013, 41).

Closed loop system thinking perspective also has important implications for the success of reduction principle, for instance, Murray (2018, 8) argues better manufacturing and maintenance of products by prolonging their useful lives can significantly reduce the utilised raw material resources. Furthermore, Murray (2018, 8) argues a systematic thinking can ensure 'waste-as-food' concept where many of the circular economy principles such as reduce, reuse, and recycle is possible because waste materials as by-products from one industry can be utilised as raw materials for another industrial operation. Whereas Ellen MacArthur Foundation (2013, 16) suggested that a system change perspective enables companies to reduce dependency on upstream production, where the companies try to utilise recycled materials and do not use virgin materials as inputs each time the products are produced. This approach of reuse, recycle and eco-design offer significant savings on material bills and energy usage (Ellen MacArthur Foundation 2013, 8).

There is also overwhelming evidence of economic benefits that can be obtained through applying circular systematic thinking in the industrial processes to achieve the principles of reduction, reuse, and recovery (Ellen MacArthur Foundation 2013, 8; Rashid et al. 2013, 168). Rashid et al. (2013, 168) argued that adoption of reduce, and reuse principles can alone help firms to save over 20% in production costs as opposed to the conventional liner manufacturing, as 85% of a remanufactured product can be obtained from used components which can also reduce material and energy consumptions related to production.

Rashid et al. (2013, 172) further highlighted the practical implementation of closed loop manufacturing in Xerox (Xerox diverted 6000 metric tonnes of waste from landfills through remanufacturing), and Caterpillar (It remanufactured over 161 million pounds of material from over 2.2 million end-of-life units collected from its Cat Reman machines). As such, Rashid et al. (2013, 172) concluded that closed loop system thinking has enabled these industry leaders to encourage technology and business innovations and offered substantial competitive edge in the market.

Lastly, Ellen MacArthur Foundation (2013, 10) strongly highlighted that application of circular thinking as a systematic change has proven to be a catalyst for a more resilient economy which can promote creative solutions to produce environment friendly products and stimulate innovations in many industries.

However, the following section discusses the synthesis of system change perspective and presents the preliminary framework of the study.

2.5 Synthesis of system change perspective and preliminary framework

Preceding literature review analysis has demonstrated a strong presentation of system change perspective to closed loop thinking as an important area of research. The literature review analysis also presents recent research findings as to argue why this system change perspective is important and what are its various implementation strategies.

A careful analysis from Van Berkel et al. (1997, 55), Geng and Doberstein (2008, 235), Ramani et al. (2010, 3), Wrinkler (2011, 244), Preston (2012, 8), Mac Arthur Foundation (2013, 7), Ghisellini et al. (2015, 15), Song et al. (2015, 200), Ellen Mac Arthur Foundation (2015, 15), Lieder & Rashid (2016, 47), Korhonen et al. (2018, 9), and others have resulted to consider Eco-design, Cleaner production using renewable materials, Zero waste policy, and Increased producers' and customers' awareness as the implantation strategies of the system change perspective to closed loop thinking.

Whereas this study adopts the EU 2008 Waste Framework Directive for Circular Economy principles which addresses Reduce, Reuse, Recycle, and Recovery (European Commission 2008, 10). The literature review analysis also established linked to discuss how each of the circular economy principles can be achieved by utilising different system change perspective implementation strategies.

Thus, in the light of the preceding literature review analysis, this study proposes that different system change perspective to closed loop thinking implementation strategies can assist global firms to achieve a specific principle of circular economy from their operation, such as Eco-design as a system change perspective strategy can help a global firm to achieve the circular economy principle of Reduction in its operations, and so forth.

The following page represents this research proposition as a theoretical framework of the study. In this framework, the dotted two-sided arrows propose to the continuous feedback process to adjust implementation strategies to achieve the changing requirements of the circular economy principles.

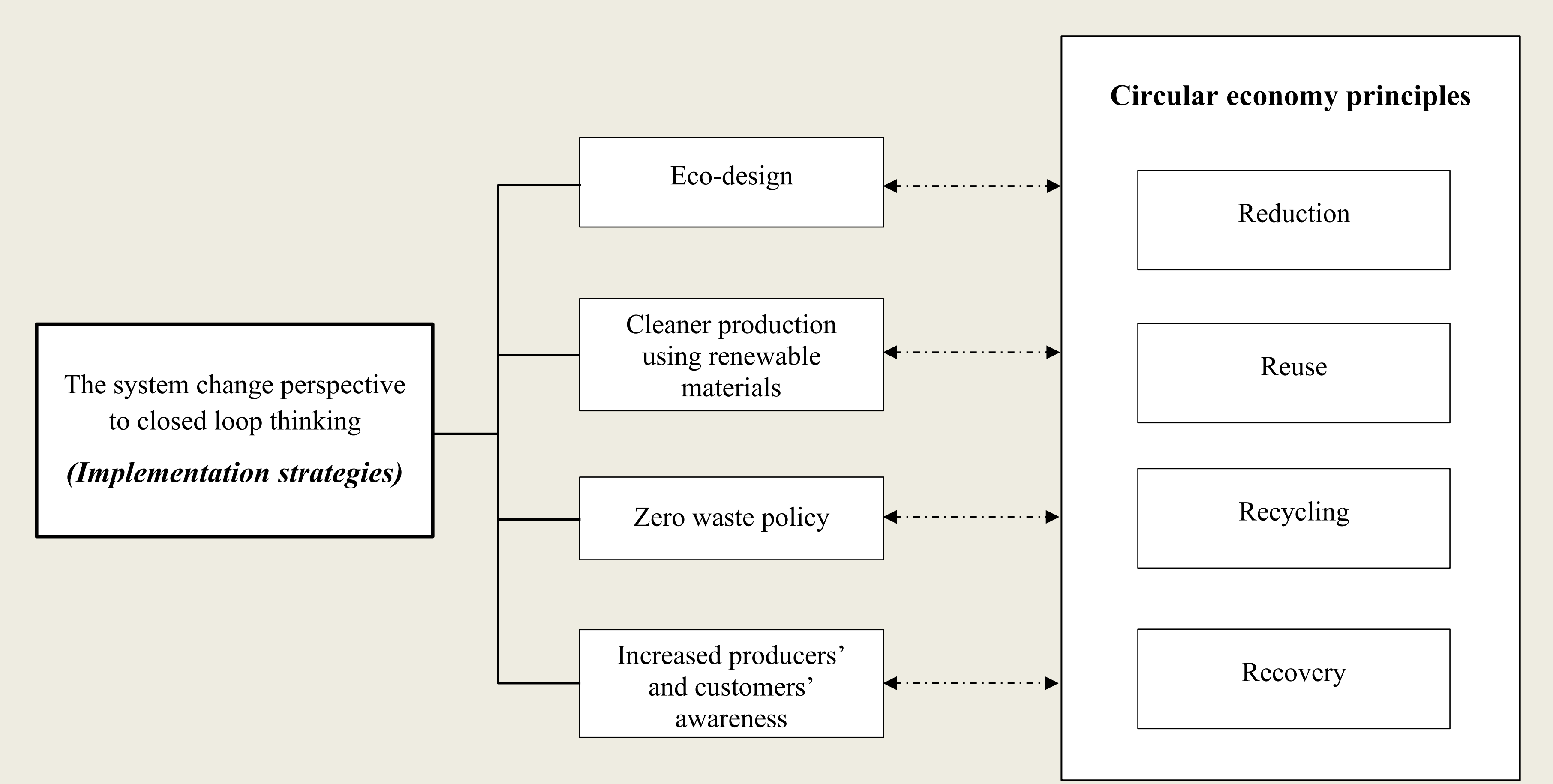

Figure 1. The preliminary theoretical framework of the thesis.

The following chapter discusses the research design strategies adopted for this study.

3 RESEARCH DESIGN

This chapter discusses the adopted research design strategies for this study. Firstly, it introduces discussion about the adopted research approach to conduct the study. Secondly, relevant discussion is presented to justify choosing a particular case company to conduct and test the formed theoretical framework. Consequently, relevant justifications are presented to choose a particular data collection and analysis technique. Finally, the chapter ends with an evaluation to justify the validity and reliability of the research.

3.1 Research approach

This research adopts a deductive approach to systematically analyse and answer the underlying research question. A deductive approach is adopted as the entire research and its proposed theoretical framework is built upon carefully analysing existing literature of system change perspective in circular economy. Saunders et al. (2019, 153) argue that a deductive approach becomes an imperative tool to answer the underlying research questions when the research and data collection approaches are aligned to test the theoretical framework and research propositions that are entirely built existing literature.

As such this study supports the adoption of deductive approach as suggested by Saunders et al. (2019, 153) and aims to test a proposed theoretical framework and the research proposition that ‘‘*different system change perspective to closed loop thinking implementation strategies can assist global firms to achieve a specific principle of circular economy from their operation’’* which was constructed based on the comprehensive analysis of the existing literature on the system change perspective to close loop thinking relevant to the circular economy.

However, from a research methodological perspective, Ghauri et al. (1995, 83) Eriksson & Kovalainen (2008, 16) and Saunders et al. (2019: 130) argued relevant to business, management, and marketing research, a qualitative, quantitative, or a mixed method (combination of both qualitative and quantitative) can be utilised to systematically measure and review the collected data to generate information in the pursuit of answering the research questions of the study. Ghauri et al. (1995, 84), Yin (2003, 5), Hirsjärvi et al. (2004, 163–165), Eriksson & Kovalainen (2008, 3-5), Ahmad et al. (2019, 2829), and Kross & Giust (2019, 26-27) offer important distinctions between qualitative and quantitative research methods.

Ghauri et al. (1995, 84) argued qualitative research method aims to collect and evaluate qualitative data to understand and gain an in-depth insight about a topic from a specific point view. Whereas Yin (2003, 5) and Kross & Giust (2019, 26-27) suggested qualitative research method as a tool to open 'the black box' of a social phenomenon to its entirety that seeks to answer the 'why', 'how', and 'what' kinds of research questions. Furthermore, Hirsjärvi et al. (2004, 163–165) argued qualitative research favours social interactions of human and their actions as subjective phenomenon and thus humans and their social interactions can be excellent instruments to collect data and thereby it is imperative to carefully choose the target samples that match with the subjective aspects of the study. In the similar chain of thought, Eriksson & Kovalainen (2008, 3-5), and Ahmad et al. (2019, 2829), argued qualitative research offers rich and profound understanding of a socially complex problem where a carefully chosen phenomenon is studied by narrowing and delimiting the focus of the research.

Based on the preceding discussion, a qualitative research methodology well suits the purpose of this study for many reasons. Firstly, the study aims to offer subjective in-depth understanding of the context of system change perspective to close loop thinking from the point of view that this approach can assist global firms to achieve specific circular economy principles, thus it delimits the scope of global firms' systematic thinking relevant to circular economy principles (Ghauri et al. 1995, 84; Hirsjärvi et al. 2004, 163–165). Secondly, the research aims to answer 'why', 'what', and 'how' kinds of questions to illustrate the importance of system change perspective to close loop thinking as a circular economy strategy to achieve certain circular economy principles (Yin 2003, 5; Kross & Giust 2019, 26-27).

Thirdly, the study carefully chooses a specific case depending on targeted rationales to test the proposed theoretical framework (Hirsjärvi et al. 2004, 163–165). Furthermore, this study delimits its analysis only relevant to the actions undertaken by a certain global firm to achieve circular economy principles and thereby does not seek to objectively interpret that all global firms regardless of their field of business should fall into the same ambition to achieve circularity in their operations (Eriksson & Kovalainen 2008, 3-5; Ahmad et al. 2019, 2829). Finally, the choice of a qualitative research methodology also corroborates with widespread popularity of the same method utilised in previous scholarly reviews such as in Geng and Doberstein (2008), Costa et al. (2010), Ramani et al. (2010), Rashid et al. (2013), Lieder and Rashid (2016), van Buren et al. (2016), and so on.

3.2 Research design strategy and case selection

Ghauri and Grønhaug (2005, 56) defined research design strategy as *"the overall plan for relating the conceptual research problem to relevant and practicable empirical research".* Whereas Saunders et al. (2007, 131) considered research design strategy as the 'blueprint' or 'the general plan' of the research. As such a research design strategy is particularly concerned with the choices of appropriate strategies to collect required data to answer the research questions of the study. Furthermore, Ghauri et al. (1995, 26) maintained research design strategy as the overall strategy to acquire critical information required to accomplish the objectives of the study.

Yin (2003, 15) and Saunders et al. (2007, 135; 2019, 130) offer various research design strategies that a researcher can choose from, for instance, case study: single vs multiple, experiment, survey, ethnography, archival research, action research, narrative inquiry, grounded theory, or a mixed method research strategy. However, the choice of a specific research design strategy must align with researcher's skill sets, available time, and the constraints of financial budget (Ghauri et al. 1995, 26). On the other hand, Yin (2003, 20) and Ghauri and Grønhaug (2005, 115) suggested that the nature of research questions *(i.e., 'Why', 'How')*, research objectives and availability of existing theories to answer the underlying research questions might also influence the choice of a particular research design strategy respectively.

Addressing the requirements of time, limited financial budget, and availability of extant theory to answer a 'why' and 'how' type of research questions, the selection of a case study method most resonates as a feasible strategy to conduct research such as this master thesis (Ghauri et al. 1995, 88; Yin 2003, 5; Ghauri and Grønhaug 2005, 115). There are several aspects that validate the choice of case study research methodology adopted for this study. Firstly, the study reports Eisenhardt's (1989, 549) findings who submitted that case studies are *''Particularly well suited to new research areas or research areas for which existing theory seems inadequate. This type of work is highly* *complementary to incremental theory building from normal science research and useful in early stages of research on a topic or when a fresh perspective is needed.''* This study concurs with a similar notion as extant literature presents paucity of research that explains how global firms utilize a system change perspective to closed loop thinking for creating circular economy strategy in different industries for instance in the energy and manufacturing industry (Rashid et al., 2013, 167).

Secondly, Yin (2003, 5), defined a case study strategy as *''an empirical inquiry that investigates a contemporary phenomenon within its real-life context when the boundaries between phenomenon and context are not clear''*. This study also aims to analyse the application of system change perspective from a global firm point of view that utilises a system change perspective to create circular economy solutions in tackling contemporary issue such as reducing carbon impact from industrial processing. Hence this empirical investigation to reduce the research gap of the importance of system change perspective also reinforces the choice of a case study research strategy as suggested by Yin (2003, 5). Last but least, Eriksson & Kovalainen (2008, 116-120) argued case study method is often utilised to present complex and difficult to understand business issues in an accessible way based on the existing theories in the field of research. This study also meets this expectation as the theoretical framework of the research is derived from analysing the complex issue of system change perspective to close loop thinking academic literature and aims to test this framework on a practical real case example to produce easy to understand research implications and findings.

However, this study adopts a single case study strategy as suggested by (Ghauri et al. (1995, 93), Stake (2005, 460), Saunders et al. (2007, 140), Siggelkow (2007, 20-21), and Yin (2014, 53). Ghauri et al. (1995, 93), and Saunders et al. (2007, 140) defined single case study a systematic way to review and analyse a single case or organization to conduct the study. Saunders et al. (2007, 140) further maintained that to observe and analyse a unique phenomenon that has received less or no through scientific investigation, a single case study method could be an ideal option. To support this view, Saunders et al. (2007, 140) continued that to generate a rich insight about new perspectives or to further an established theory single case study method can be an important research design strategy. Whereas Ghauri et al. (1995, 93) and Stake (2005, 460) argued that a single case study approach limits its findings to a less generalizable context to produce an initial scientific understanding of a phenomenon which can be considered as a pilot study of an upcoming comprehensive study.

However, Yin (2014, 52) outlined the five rationales to support argument of selecting a single case study such as critical, unusual or unique, common, revelatory, or longitudinal case. This study adopts the second criterion as it aims to analyse the context of applied system change perspective towards a circular economy strategy of a global firm which is unique and going through the primary commercial phase. A detailed description of its uniqueness is present in the following subsections. However, working with a unique single case is widely popular in the field of research, such as Siggelkow (2007, 21) embracing the idea argued if a single case is full of illustrations and demonstrates a conceptual insight then the selected case could be a resourceful and scientifically valid one.

The study corroborates with these suggestions and aims to contribute to the existing literature of system change perspective as a circular economy creation strategy and wishes to present how from the end of a global firm, the selected case company is pushing its boundary to embrace circular economy principles in its business operations. This study also seeks to explore how a global firm create and utilised the system change perspective to implement circular economy strategy and what is the role of system change perspective in achieving circular economy principles.

The following sections briefly introduce the case company and the selected single case.

The case company selected for this study is Wärtsilä Corporation (Wärtsilä Oyj Abp / Wärtsilä Corporation). Wärtsilä is a global leader for technology innovation and life cycle management for the sustainable marine technology, voyage, and energy markets (Wärtsilä Corporation 2022a). During the last financial quarter (January to March 2022), the corporation's net sales is EUR 1,231 million with operating profits of EUR 65 million (Wärtsilä Corporation 2022b). Last year in 2021, the corporation made a record per centage of operating net profit of 6.6% out of EUR 4,778 million net group sales (Wärtsilä Corporation 2022c). More information about Wärtsilä Corporation can be found in the Annual Report of 2021.

However, the following table 3 illustrates a summary of the corporation and its last financial year's highlights.

Table 3: A summary of Wärtsilä corporation. *(Source: Wärtsilä Corporation 2022c).*

Established	1834
Head quarter	Helsinki, Finland
Expert business fields	Marine, Energy and Business Services
Globalization	Over 68 countries
Net sales	EUR 4,778 million
Operating profit	EUR 314 million
Earnings per share (EPS)	EUR 0.33
Total employees	17,305

The following sub-section presents the selected case for this study.

The Power to X Project in Wärtsilä is an ambitious carbon capture technology which aims towards making the marine and energy industry completely carbon footprint free (Wärtsilä Corporation 2022d). The idea of this project is to create a technology that utilises indoor CO2 to turn into synthetic methane as a fuel to produce electricity, which is the ultimate carbon neutral sustainable way to generate energy for a machine (Wärtsilä Corporation 2022d).

In the technological blueprint of the Power to X project there is no resource input other than the thin air and there is also zero waste as the carbon capture technology utilises all the captured CO2 to produce synthetic methane to power the engine or machine in question (Wärtsilä Corporation 2022d). A recent but successful demonstration of this carbon capture technology was exhibited in the World Expo in Dubai 2020 (Wärtsilä Corporation 2022e). In this expo, Wärtsilä has successfully demonstrated how the Power to X project utilised the inside CO2 of the Dubai Expo to produce synthetic methane as energy to power the coffee machines (Wärtsilä Corporation 2022e).

This project has been an output of the joint technological commitments and financial investments of three Finnish technology experts namely Wärtsilä, Soletair Power and Q Power (Soletair Power 20222). More details of this successful system change perspective in the creation of a circular economy strategy can be read at Wärtsilä Oyj Abp: www.wartsila.com, Soletair Power Oy: www.soletairpower.fi, and Q Power Oy: www.qpower.fi.

3.3 Data collection

Data collection is the process of collecting empirical data from different sources needed to answer and analyze a research question (Wilson 2014,15). As such relevant to a qualitative study, interviews, surveys, observation, and information based on published materials are common and effective methods to collect data (Eriksson & Kovalainen 2008, 86). There are two kinds of data can be collected primary and secondary (Ghauri et al. 1995, 54; Saunders et al. 2007, 290). In terms of interview data collection method there are various methods available such as structured, semi-structured or unstructured, and in-depth or focus group interviews (Ghauri et al. 1995, 54; Saunders et al. 2007, 310-313).

In this research several data collection methods such as semi-structured interviews, academic and commercial published documents, corporate materials, publications by third parties etc. were utilized to collect both primary and secondary data. The primary data were collected utilizing semi-structured interviews. This method was suitable for this study as it offered the respondents the opportunities to illustrate professional opinions, experience and through analysis of the asked open-ended questions (Saunders et al. 2007, 310-313). As a result, the study has advantages in terms of obtaining information-rich primary data to answer the research questions (Ghauri et al. 1995, 65; Saunders et al. 2007, 310-313). Moreover, this method also provided the study a room for obtaining a plausible generalization of the research conclusion, flexibility, and versatility in terms of personal opinions and experiences of the research participants (Kallio et al. 2016, 2955).

To obtain the primary data, a purposive or judgmental sampling technique has been adopted for this study (Saunders et al. 2007, 230). Saunders et al. (2007, 230) argued a purposive sampling technique is the ideal choice to conduct a study with a particularly very small sample size such as a single case study research method and under the constraints of resources and time to complete the research. However, extant literature on research methodology suggests that there are five grounds to justify the selection choice of a particular purposive sampling technique i.e., *i) an extreme or deviant case, ii) a heterogeneous or maximum variation case, iii) a homogeneous case, iv) a critical case, v) a typical case or new phenomenon case* (Saunders et al. 2007, 232). This research corroborates with that of a typical or new phenomenon case situation because the emergence and future potential of the Power to X Project to unlock the groundbreaking system change perspective in creating circular economy strategy in the energy industry is still unknown to many stakeholders. Thus, this study seeks to provide an illustrative demonstration of the significance of the Power to X Project in creating a carbon free industrial circular economy strategy to the reader of this research. On the other hand, as Wärtsilä Corporation is one of the global leaders in the energy industry, this case will vividly provide a representative point of view regarding the importance of adopting a circular economy-based system change perspective in manufacturing and industrial process (Saunders et al. 2007, 232).

Moreover, to establish a chain of evidence and validity in data collection process, an interview guide (Bryman & Bell 2011, 482) was piloted before the actual semi-structured interviews. The interview guide was finalized after receiving several comments and feedback from the supervisors of this research. This guide was also sent together with the interview invitation emails to each participant at least 3 days prior to the interview schedule. This guide assisted in listing important thematic questions derived from the comprehensive analysis of the literature review as presented in the operationalization plan in table 4 below. The interview themes were *1) the approach of system change perspective, 2) Eco-design, 3) Cleaner production using renewable materials, 4) Zero waste policy, 5) Increased producers' and customers' awareness, 6) Reduce, 7) Reuse, 8) Recycle, and 9) Recovery.*

However, the interview guide consists of four sections and begins with background questions to establish a common understanding of the interview and reveal interviewees' professional expertise on the research topic. After that all the previously mentioned 9 interview themes have been grouped into three main thematic themes in the interview guide. For instance, the first theme of the guide addresses the approach of system change perspective. The aim of this theme is to discuss the idea of the Power to X Project, and how important the systematic change towards a circular economy relevant to the case company.

Whereas the second theme addresses the implementation strategies of the system change perspective in the Power to X Project. This theme has combined the main concepts such as eco-design, cleaner production using renewable materials, zero waste policy, and increased producers' and customers' awareness. The aim of this theme is to reveal how has the case company implemented the system change perspective in this project, and what were the strategies that have been utilized.

Meanwhile, the third theme presented questions relevant to the role of the system change perspective in the Power to X Project to achieve circular economy principles. This theme has combined the main concepts such as reduce, reuse, recycle, and recover. The aim of this section is to discuss important aspects such as in what ways has the Power to X project enabled the case company to achieve the principle of reduction, reuse, recycle, and recovery in its industrial or manufacturing processes. Finally, a reflection section enabled the interviewees to add on any incoming thoughts and ideas relevant to the interview topics. **Appendix A** provides a detailed account of this interview guide utilized for this study.

Table 4. Operationalization plan.

<table>
<tr><th>Research question</th><th>Sub-questions</th><th>Main concepts</th><th>Theoretical background (chapter number)</th><th>Operationalization of the main concepts (Linking concepts to the Interview Guide)</th></tr>
<tr><td rowspan="6">How does global firm utilise system change perspective to closed loop thinking for creating circular economy strategy?</td><td>What is the system change perspective to closed loop thinking?</td><td>The approach of system change perspective</td><td>2.3.1</td><td>- Background question

- Theme 1. The system change perspective in the Power to X Project</td></tr>
<tr><td rowspan="5">How does the system change perspective implement to develop a circular economy strategy?</td><td>Eco-design</td><td>2.4.2.1</td><td rowspan="5">- Theme 2. Implementation strategies of the system change perspective in the Power to X Project</td></tr>
<tr><td>Cleaner production using renewable materials</td><td>2.4.2.2</td></tr>
<tr><td>Zero waste policy</td><td>2.4.2.3</td></tr>
<tr><td>Increased producers’ and customers’ awareness</td><td>2.4.2.4</td></tr>
</table>

	What is the role of the system change perspective to achieve circular economy principles?	Reduce	2.2.2.1	- **Theme 3.** The role of the system change perspective in the Power to X Project to achieve circular economy principles (Reduce, Reuse, Recycle, Recover) - Reflection questions
		Reuse	2.2.2.2	
		Recycle	2.2.2.3	
		Recovery	2.2.2.4	

To ensure construct validity several recommendations from extant literature have been strictly followed such as Yin (2003, 36) suggested two criteria for selecting a case company and the interviewees. Yin (2003, 36) argued to select a firm as a case company it ought to have a considerable length of internationalization history and experience. As such Wärtsilä as the case company was selected as this firm has a long history of global scale internationalization experience over 68 countries. Secondly, Yin (2003, 37) and Tuomi & Sarajärvi 2009, 85) posited that to select interviewees care must be given to consider the suitability of them in terms of their knowledge, experience and influential decision-making abilities in the case company's strategies and operational aspects. As such only those who are working in managerial capacity such as Business Development Manager, Project Manager, etc. and have been actively involved in the feasibility study, early-stage development of the Power to X Project from Wärtsilä side have been considered to reach out for collecting primary data.

In total 3 semi-structured interviews were obtained during the month of March and April 2022 using Microsoft Teams software. Each of the interviews lasted in between 30 – 45 minutes. The author recorded and transcribed all the interviews having prior consent to do so from all the three interviewees. Research participants have been also given the anonymity aspect as per the regulation of the EU General Data Protection Regulation (GDPR) 2018 and each respondent has been reported as respondent 1, 2, 3, etc. in the data analysis section avoiding their actual names. However, the golden rule of transcribing interview data with the same day to avoid losing any important aspect of the interview has been strictly followed (Ghauri et al. 1995, 71; Saunders et al. 2007, 291).

The following table 5 below illustrates the data collection schedule and types of data utilised in this study.

Table 5. Data collection schedule.

Data type		**Interviewee / Discussion title**	**Software used / Source**	**Date & time**	**Duration**
Primary		1	MS Teams	17/03/2022 at 13:00	0:32:51
		2	MS Teams	18/03/2022 at 11:00	0:40:55
		3	MS Teams	5/04/2022 at 10:30	0:33:31
Secondary	Case specific	Global 100% RE insights with focus on Power to-X and flexibility	Online webinars	22/05/2020	0:54:15
		The Power to X opportunity: markets, technologies, and costs_Saara Kujala		7/10/2020	01:02:29
	Corporate material	- Wärtsilä Annual report 2021 - Interim report January–March 2022 - Public and internal publications, power point presentations, - Relevant web pages	Online	The materials were either provided by the interviewees or selected by the researcher. These materials comprise of official information about Wärtsilä Corporation, Power to X Project, its detailed description, its application, and its advantages.	
	Publications by third parties	- Videos and articles about Wärtsilä's Powe-to-X Projects - Newspaper and magazine reports	Online	The materials were either provided by the interviewees or selected by the researcher.	

In this study a variety of secondary data such as the Power to X Project related promotional webinars, contents of the company websites, annual reports, interim reports, newspaper articles, press releases, etc. have been extensively utilised throughout the study. Moreover, secondary data collected from various published academic journals, corporate materials and, publications by third parties etc. helped the study to construct the research questions, research proposition, theoretical framework, semi-structured interview questionnaire and to analyse the interviewee responses.

Finally, to ensure data collection accuracy and validity in this study, **the data triangulation** was guaranteed by comparing the collected secondary data against the primary data gathered through semi-structured interviews (Ghauri et al. 1995, 93; Saunders et al. 2007, 139).

The following sub-section presents the discussion around data analysis techniques utilised in the study.

3.4 Data analysis

Data analysis is the process of identifying, interpreting, shaping, and formulating the raw data into research material in a way that enables to answer the research questions (Hirsjärvi et al. 2004, 210). There are several data analysis methods available, but relevant to qualitative data, the thematic content analysis appears to be a perfect match for this study (Braun & Clarke 2006, 80).

A thematic content analysis is a flexible but effective method to produce rich and comprehensive analysis of raw qualitative data (Braun & Clarke 2006, 81). Aronson (1994, 4) suggested that this analysis technique assists in establishing critical evidence basis relation between the theoretical framework and the raw data and later corroborating the collected data against established literature. According to Braun & Clarke (2006, 5) this analysis enables a systematic processing of a set of complex data into manageable themes so that it is possible to generate, identify, analyse, and report interpretations as such precious and representative meaning of data against their respective themes can be realised.

This study utilises the thematic content analysis as suggested by Braun and Clarke's (2006) into the following six-phase approaches. They are, Firstly, a through *familiarization* with the collected raw data was ensured by recording the interviews, transcribing them within the same day of the interview, actively taking notes and making observation notes after the interviews (Braun & Clarke 2006, 86). To familiarize with the contents of the raw data, the researcher prepares a compilation of transcription texts which were more than 70 pages long. The transcription of the recorded voice was done via Otter.ai, a renowned cloud based qualitative data transcription and analysis software. Once the transcriptions were done, several rounds of reading and taking notes from emerging themes were undertaken in Microsoft Word documents. This measure ensure that notes are being written down momentarily as reading was undergoing so that making sense of the read data is possible. However, several rounds of reading enable comprehensive and intimate understanding of the pattern emerged from the raw data.

Secondly, *initial codes* were sought from the reading of the raw data and these codes were used to identify the features of the data (Braun & Clarke 2006, 88). At his level, initial codes and their corresponding texts were highlighted for a later possible use. Thirdly, these initial codes were organised into *potential themes*. This enabled labelling of the codes into workable themes or chunk of data sets, and assisted in recognizing patterns, similarities, and dissimilarities of data within those labels (Fossey et al. 2002, 729; Braun & Clarke 2006, 89). At this stage, to keep relevance with the aim of the study, a regular check has been sought against the theoretical framework and the semi-structured interview themes which have guided the construction of themes effectively into different categories such as *'Eco-design', 'Cleaner production', 'Renewable materials', 'Zero waste policy', 'Producers' awareness', 'Customers' awareness', 'Reduce', 'Reuse', 'Recycle', 'Recovery',* etc. (Braun and Clarke 2006, 90).

Consequently, Braun and Clarke's (2006, 91) suggestion were on board to critically *analyse the identified themes* for their relevance, internal consistency, coherence and to distinguish themes from one another. For instance, careful review of the themes revealed that separation of few themes was essential from one another as they refer to different research findings. For example, even though Producers' and customers' awareness was found to be an effective strategy in the extant literature, careful review of the themes and accompanying data set reveal that perhaps it's important to distinguish this into two themes as the awareness building processes and methods for producers and customers may differ significantly.

At the fifth stage, a thorough *analysis* was done to meaningfully understand the themes and their associated data set (Braun and Clarke 2006, 92). At this stage, attention was paid to the meaning of the data relevant to the research questions so that interviewees' responses can be theoretically analysed to validate research findings based on available extant literature (Sandelowski 1995, 374; Braun and Clarke 2006, 92).

Finally, out of a workable list of themes and their associated data sets, *the writing of this research's results* began. At this stage, attention has been invested to produce concise and relevant discussions to the present the interviewees' responses against the underlying research questions (Braun & Clarke 2006, 93). This step has assisted to answer the main and sub-research questions and to validate the findings of the study with acceptable previous literature in this field of study.

3.5 Evaluation of the study, validity, and reliability

In qualitative study, the validity of a study encompasses evaluation of the data collection and data analysis processes to demonstrate if the utilised techniques to collect and analyse data are in consistent alignment with the intendent research questions, objectives and research design strategy (Saunders et al. 2007, 150). On the other hand, reliability of a study provides a transparent chain of evidence to support the repetition of study as if with the similar data collection, data analysis techniques, and selected sample size, the study would produce a consistent research result on a later occasion (Saunders et al. 2007, 149).

Extent literature offers a few evaluation criteria such as credibility, transferability, dependability, and confirmability as means to produce documented trustworthiness of a qualitative study (Lincoln & Guba 1985, 300). This study corroborates with these evaluation criteria as suggested by Lincoln & Guba (1985) and presents its arguments in the following sub-paragraphs.

This study ensures the aspect of credibility by following several leading recommendations of the experts such as Lincoln & Guba (1985, 296), Yin (2003, 36), Saunders et al. (2007, 149), Eriksson and Kovalainen (2008, 294), Kallio et al. (2016, 2558) relevant to the utilised data collection and analysis techniques. Lincoln & Guba (1985, 296) and Saunders et al. (2007, 149) suggest a study's results can be evaluated as trustworthy additions to the existing knowledge if they are reliable research outcomes as if the outcomes are really what they appear to be. In this instance, Eriksson and

Kovalainen (2008, 294) recommended three underlying questions to guide researchers to enable producing reliable and valid research outcomes.

Firstly, Eriksson and Kovalainen (2008, 294) asked if there is sufficient theoretical knowledge exists on the research topic in question and has the study produced a chain of evidence relative to the observations made from the research materials. As such based on the comprehensive literature review analysis utilising both prior and current literature, this study sufficiently proves that the availability of theoretical knowledge was sufficient to carry on the research work. In this regard it is worthwhile to address that some 40 scientifically published academic research papers from many reliable journals in this field of research such as *Journal of Cleaner Production, Renewable and Sustainable Energy Reviews, Academy of Management Review, Journal of Environmental Management, Journal of Sustainable Development & World Ecology, Journal of Business Ethics, Sustainability,* etc. were utilised throughout the study to formulate research background, questions, theoretical framework, semi-structured interview guide, and validate research findings.

Whereas to produce a chain of evidence relative to the choices made against adopted data collection, data analysis, case section, interviewee section, etc. are well documented and arguments are offered in their respective sections. Moreover, to produce reliable research results this study has prepared the interview guide in the light of theoretical framework which was originally constructed from the existing knowledge base as presented in the literature review analysis.

Secondly, Eriksson and Kovalainen (2008, 294) asked if there are strong logical relationships between the observations and research themes. To establish such relationships Yin's (2003, 36) two criteria for selecting the case company or the case and the interviewees have been strictly followed and their justifications have been provided in earlier chapters. Moreover, the golden rule of transcribing interview data with the same day of the interview occurrence has been strictly followed (Ghauri et al. 1995, 71; Saunders et al. 2007, 291). Furthermore, all the selected research themes for analysis have been carefully selected from the comprehensive literature review and based on literature reviews the interview guide was formulated. As such no irrelevant discussion emerged during the interview and thus the observations made during the interview discussions perfectly reflect the previously identified research themes. Nevertheless, data triangulation has been ensured by comparing the interviewees' responses based on analysing the secondary data sources such as company websites, sustainability reports, the white papers, and analysing available Power to X Project related webinars and promotional materials (Ghauri et al. 1995, 71; Saunders et al. 2007, 291).

Thirdly, Eriksson and Kovalainen (2008, 294) posited if based on the interpretations made it is possible for another researcher to come down to relatively close research interpretations on a later occasion. This aspect has been ensured by properly documenting the data analysis technique, transcription techniques, utilisation of the interview guide, and the interview operationalisation table illustrated in previous discussions. This study has ensured reliability in this aspect also by constructing the interview guide framework following Kallio et al. (2016, 2959) instructions such as validating the need for utilising semi-structured interviews, utilising previous knowledge to construct interview themes, devising the preliminary semi-structured interview guide, receiving feedback and initial piloting of the interview guide, preparing the final semi-structured interview guide to conduct interviews.

Transferability of the study refers to the possible generalization of the research results to other similar settings (Tobin & Begley 2004, 392), similarities, and differences of the research results relative to previous research on a similar stream (Eriksson & Kovalainen 2008, 294). Whereas Lincoln & Guba (1985, 297) argued a study can be considered transferable if it provides necessary details on the specificity of the case, interviewees, case study context, etc. thus has a wide acceptance to the readers based on their own judgement on the similarity between the settings. As such this study has sets its theoretical boundary, provided sufficient arguments to choose a particular research design strategy, definition of circular economy, circular economy principles, circular economy creation strategies, etc., presented necessary details on the selected case company and the case study, and so forth. Furthermore, in the data analysis section the study presents its finding with appropriate corroborations with the previous studies in a similar research stream. Thereby the study claims to be in alignment with the aspect of transferability which assures that the research results can be acceptable transfer of knowledge in contexts that analyses the perspective of system change in creating innovative circular economy strategies.

Dependability of a study guaranties the production of truthful and reliable representation of the phenomenon under study (Lincln & Guba 1985, 299). Shenton (2004, 71), (Saunders et al. 2007, 149) and Eriksson and Kovalainen (2008, 294) argue dependability of a study could be visible if deploying similar research settings and utilised research strategies another researcher would reveal closely consistent research results on a future date. As such it is of extreme importance to properly document the research process as to provide a logical, and traceable pathways to validate the research outcomes (Eriksson & Kovalainen 2008, 294). This study aligns with these recommendations and offers a well-documented dependable pathway to trace the research process from constructing theoretical framework, to data collection, to interview transcriptions and to data analysis. Furthermore, all the correspondences with the thesis supervisors and interviewees are kept in an electronic data base to be provided upon request. Whereas all the interviews were video recorded, and transcriptions of the interview data are also kept enabling future audit if requested.

Finally, confirmability of study provides evidence that the research results are formed based on provided insights from the interviewees other than the researcher's subjective point of views on the study in question (Lincoln & Guba 1985, 300). As a result, the research outcomes are assumed by the facts that offers an objective view on the investigated research agenda by avoiding rather imaginary interpretations of the researcher (Shenton 2004, 72; Tobin & Begley 2004, 392; Eriksson & Kovalainen 2008, 294). This study confers with Koch's (1994, 978) suggestion to ensure this aspect of confirmability by presenting documented rationales and arguments throughout the study as to why the study has chosen a particular theoretical premise, methodological and analytical decisions as they are. Moreover, the collected data were reported in the study to arrive to research findings in direct quotations, interview related materials such as interview guide, video records, transcriptions, email correspondences etc. are stored in electric data base and can be made available for future validation. Thus, the study confidences to assist the readers to trace, audit and evaluate the trustworthiness of this research endeavour.

However, the following chapter introduces and analyses the collected primary and secondary data to offer research findings of the study.

4 ANALYSIS OF SYSTEM CHANGE PERSPECTIVE TO CLOSED LOOP THINKING IN GLOBAL FIRM

This chapter discusses the empirical findings of the study. The chapter is divided into three sections. These seconds are devised based on the research sub-questions and the identified themes as presented in the operationalization plan of the study. The first section presents the empirical findings regarding the utilised system change perspective in the Power to X Project such as the idea of system change perspective in the Power to X project, why such system change perspective is important, the idea of the Power to X project, what are the prerequisites for this project, how this project works and produces synthetic fuels, and what are the positive outcomes of this approach, etc. The second section presents empirical findings regarding the utilised circular economy implementation strategies in this system change perspective. In this section, relevant empirical findings are presented related to eco-design strategy, cleaner production using renewable materials, zero waste policy, increased producers' and customers' awareness, and value co-creation strategy. Whereas the last section presents empirical findings regarding the role of system change perspective in achieving circular economy principles such as reduction, reuse, recycle, and recovery in this project.

However, before starting the main discussions, the following paragraphs introduce the background information of the interviewees and the utilized webinars.

There were 3 semi-structured interviews and 2 webinars utilised to obtain both primary and secondary data for the empirical analysis. The interviewees are actively involved in Wärtsilä's corporate level and specially working under the Power to X Wärtsilä Energy Business department as Project Manager, Technology Development Manager, and Senior Business Development Manager. All these interviewees have relevant higher university degrees and working in the energy technology business for decades.

The Interviewee 1 reported that he is working as a Project Manager and looking after the project and technology development sides. He has more than 12 years of expert work experience and his area of expertise lies in the technology development of hydrogen fuel cells. He is an expert in electrical engineering and served different roles in the hydrogen business from offering technology development to managing teams of experts in that field. Whereas Interviewee 2 reported that he has a doctorate degree in the field of physical chemistry. He has been working as an expert in Wärtsilä for last three years. He is performing expert tasks related to the Power to X project such as investigating the feasibility of the Power to X, cost and benefit analysis of the project, analysing the technology development requirements to execute the project. On the other hand, interviewee 3 reported that he has been working for Wärtsilä close to 30 years in various positions and for last three years he has been working in energy, strategy, and business development team in the field of the Power to X.

However, there were two webinars utilized as indicated earlier. The 1st webinar was organized by Path 100, an objective based community of the industry through leaders and experts of the sustainable energy transition industry. This webinar titled *Global 100% RE insights with focus on Power to X and flexibility*. There were three participants in this webinar, and they are Emma Tallgren (Moderator), Marketing Manager of Wärtsilä Energy Business, Christian Breyer, Professor for Solar Economy, LUT University, Finland (Discussant 1), and Matti Rautkivi, Director of Business Development, Wärtsilä Energy Business (Discussant 2). The Webinar 1 addressed the role of the Power to X as part of the energy transition moving towards 100% renewable energy, how synthetic fuels can be created from renewable energy sources, what renewable synthetic fuels there are and their applications, and how that is driving the Power to X concept. To self-self-introduce this scientific community Emma Tallgren, Marketing Manager of Wärtsilä Energy Business addressed,

> *''Path 100 is an objective community intended to bring together thought leaders and industry experts to discover solutions raise awareness and create a dialogue on how to achieve an operationally and financially realistic approach towards 100%.''* (Emma, Webinar 1)

Whereas the second webinar was organized by ATA Insights, a technology development community. In this webinar relevant discussants including Saara Kujala, Business Development Lead at Wärtsilä Energy Business presented the company. This webinar titled *The Power to X opportunity: markets, technologies, and costs*. In this webinar, discussants presented their views related to market potential and economic viability of Power to X solutions and how various countries are currently promoting this technology development. The following section introduces empirical findings related to the utilised system change perspective in the Power to X project.

4.1. The utilised system change perspective

Wärtsilä's strategic position to accept the challenge of the future and respond to the increasing need of creating circular economy strategy to become carbon neutral is reflected in its corporate strategic level. This approach also assures conformity with initiative that can be adopted by leading organizations at the micro level influenced by the decisions made by governments and regional organizations at the macro and meso level (van Buren et al. 2016, 2; Kirchherr et al. 2017, 127). As an energy business industry leader, Wärtsilä sees a clear connection between the possible system change perspective that can be emerged from the Power to X project and expectations of the governmental and regional organizations to become more carbon neutral in business operations. As such Matti Rautkivi, Director of Business Development of Wärtsilä Energy Business and the Interviewee 3 respectively argued,

> *‘‘100% renewable energy is the future, and we shared that vision. We have been sharing the vision already for a while.’’* (Matti, Webinar 1)

> *‘‘A concrete way to allow this change (to become carbon neutral as expected by the meso and macro level actors) is to use synthetic carbon neutral fuels with the Power to X technologies where we combine renewable hydrogen with carbon and combine various chemical processes to produce the synthetic fuels.’’* (Interviewee 3)

Wärtsilä's the Power to X project is already a proven phenomenon where this project has been modelled and its feasibility has been pilot tested to see the technological application at Vantaan Energia (A Finnish district heating company located in Vantaa, Finland) who wanted to be completely fossil fuel free in generating district heating for its customers in Vantaa. Highlighting such already successfully implemented the Power to X system thinking technology in Vantaa Energia, Saara Kujala, The Business Development Lead at Wärtsilä Energy Business argued,

> *‘‘Collaboration project that I'm also personally working on here in Finland together with one electricity generation utility company (Vantaa Energia). One who wanted to make the district heating production completely fossil fuel free.’’* (Saara, Webinar 2)

Interviewee 1 pointed out that the future for the Power to X is very clear and visible. As the project heavily involved in producing renewable energy utilizing hydrogen it has the potential to bring about a revolutionary system change perspective towards closed loop circular economy thinking. As such, Interviewee 1 posited that,

> *''I mean, hydrogen will play a major role in decarbonisation of our society and then will be a huge benefit us, and for our businesses.''* (Interviewee 1)

A system change perspective to circular economy thinking provides important insights to overcome the shortcomings of a society that is so dependent on utilizing finite fossil fuel resources. In one hand, this usage of fossil fuel is creating a global warming by emitting significant amount of CO2 along the way. On the hand, this is not a sustainable solution towards generating power by using finite resources. Thus, the Power to X project works as a catalyst of change towards offering a sustainable solution in multiple dimensions. For instance, while this project is utilizing CO2 to produce sustainable synthetic fuel, on the other hand, it proving to an effective system change in the power generation industry to completely reduce dependency on the usage of finite fossil fuels. Thus, a multitude of social, economic, and environmental benefits are clearly visible as important milestones out of this project. These findings corroborate with Castellani et al. (2015, 374) and Ghisellini et al. (2015, 5) who suggested that circular economy principles (i.e., reuse) can bring numerous environmental benefits such as it can help to consume fewer resources, energy, and labour as opposed to the manufacturing of the new products from virgin materials. To highlight such a notion, Interviewee 2 argued,

> *''Right now, of course, we are burning fossil fuels. That is not circular and sustainable. But then another thing is that resources are finite. So, we cannot keep on using these resources.''* (Interviewee 2)

In terms of Vantaa Energia, it is a proven case that the systematic he Power to X system thinking is enabling creation of renewable electricity from waste materials such as the produced CO2 while generating heat from the power plant. As such the more CO2 is produced the better the amount of synthetic fuel that the power plant can produce. As such, the emitted CO2 becomes a vital raw material for he Power to X project. Thus, it can be argued that in this point of view, the system change perspective considers the CO2 that the plant produced is a renewable material. This finding also corroborates with Su et al. (2013, 216) who argued that the used items and wastes coming out of one industry can be considered as the direct input resources for other firms or industries. However, to highlight this aspect Interviewee 2 reported,

> *''So, what they do is that by burning the waste they create electricity for the city which produce a lot of CO2 as well. But then the produced CO2 is utilized to create synthetic fuel via the Power to X project concept. In this point of view, the CO2 that the plant creates is renewable.''* (Interviewee 2)

At point it is imperative to introduce in greater detail that what is the Power to X project technology, what is the X in the Power to X project, what is synthetic fuel and how it is created/manufactured, what are the prerequisite for the Power to X and how it works to bring out revolutionary change in the future energy business.

The Power to X project can be characterized as a joint industry expert collaboration between Soletair Power, Q Power, and Wärtsilä to create a sustainable energy future (Wärtsilä Corporation 2022e). The Power to X project is a direct output of Soletair Power's research on carbon capture technology where CO2 captured from thin air transform into synthetic fuels. Wärtsilä as an energy manufacturer sees the huge future potential of synthetic fuels and made the initial seed investment to fund the commercialization of the project. This also exemplifies how industry expert collaboration can work together to bring about game changing industrial processes in achieving circular economy principles.

> *''We have then made an investment in solitaire power, which is a spinoff from university research in a bitfield upon 100% renewable future and this company is making the Power to X fuels or synthetic fuels available in that small scale.''* (Matti, Webinar 1)

In the Power to X technology the X can be any outcome of the processes such as mobility, heat few, chemicals, desalinated water even CO2, and the synthetic fuels i.e., methene, hydrogen, kerosene, etc. Highlighting what X means in the Power to X project, Christian argued,

> *''And we have a strong consideration for all various kinds of the Power to X. And this x when x ever I talk on the Power to X it is about mobility, heat few. It can be*

chemicals, desalinated water even CO_2, which is important when a sustainable CO_2 source is needed.'' (Christian, Webinar 1)

The Power to X project's main outcome is to produce synthetic fuels from the captured CO_2 (Wärtsilä Corporation 2022d). Data analysis reveals that the process of producing synthetic fuels under this technology is a perfect example of system change perspective to close loop thinking. During this process there are no such by products or wastes that go out of the system to reverse the circular economy thinking of the technology. Highlighting how such process works to produce synthetic fuels out of thin air under this technology, Matti argued,

''Synthetic fuels are not using fossil fuels, nor they are taking anything from the underground but using renewable electricity. So, electricity is a raw material for synthetic fuels. And then we are combining that renewable electricity to break water into the hydrogen and oxygen and then we are using the hydrogen and combining that with the CO_2 or nitrogen and can produce green energy.'' (Matti, Webinar 1)

The Power to X project turns CO_2 captured from the thin air into synthetic fuels such as hydrogen and methane needed to produce heat and energy for high temperature processes. Highlighting how the Power to X project works, Interviewee 3 explained it in very simple words as,

''We take water, we take the green electricity, we split the water into hydrogen and oxygen compounds. And then we combine the carbon dioxide. As a chemical reaction we get green hydrogen, and we can make various fuels out of it as well! Our goal with this is to reduce the CO_2, mitigate climate change, meaning reducing the impact of our business operations towards the society and environment!'' (Interviewee 3)

However, the following figure 2 illustrates the entire technological working manual regarding how the Power to X project produces fuel out of thin air.

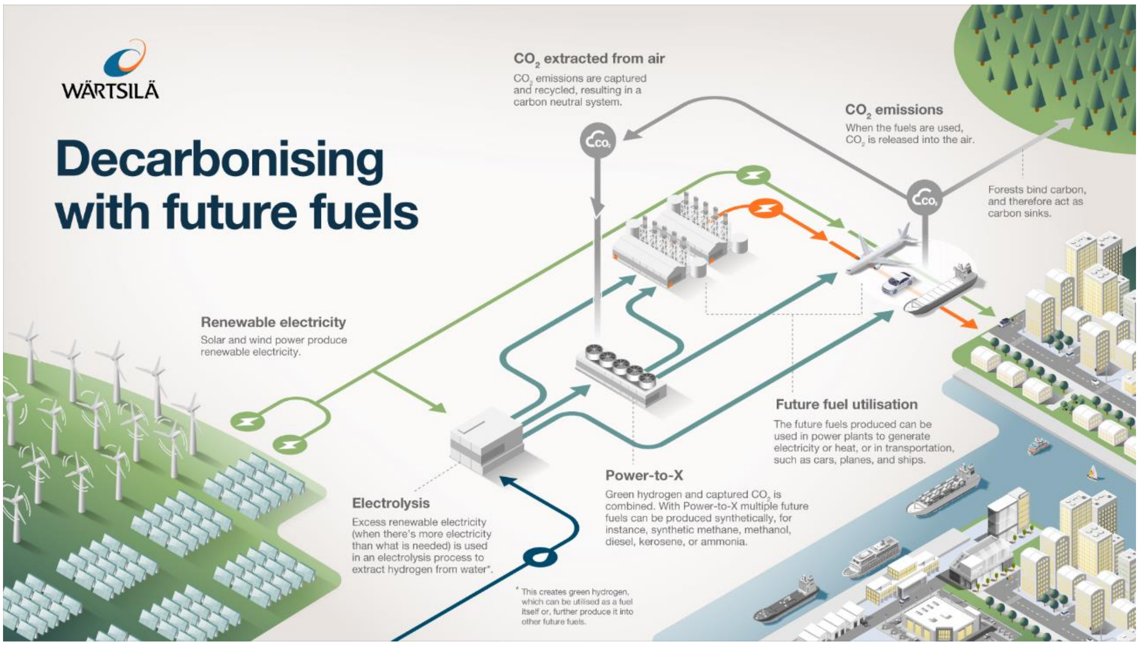

Figure 2: How does the Power to X project produce fuel out of thin air? (Source: Wärtsilä Corporation 2022d).

However, there are certain prerequisites for this project to emerge as a system change technological shift towards circular economy. Interviewee 1 highlighted the need for involvement of the central and regional policy makers into the dialogue of creating a sustainable synthetic energy generation project. This claim of requesting help from the regional and central policy makers in other words involvement of different institutions at the Macro and meso level corroborates with the previous research findings to promote circular system change perspective (van Buren et al. 2016, 2; Kirchherr et al. 2017, 127) such as the case for the Power to X project. As such, Interviewee 1 argued,

> *''I cannot solve the problem! We can be the provider for solutions in that transition but in general that needs must come from policies, political decisions that green transition must happen.''* (Interviewee 1)

Experts believe that there is a need of political assistance at the macro and meso levels to support the adoption of this system change perspective. Politics can critically assist the smooth transition to the circular system thinking approach. Although there are several governmental (macro-level) pledges in place to make the economies of Europe, to the context of Finland, carbon neutral by 2050 according to the Paris Agreement, The EU Green Deal Agreement, etc. Furthermore, this macro-level decisions are also influencing meso, and micro levels initiatives taken by different regional authorities and corporate entities such as Vantaan Energia has pledged that this major district heating and waste to power plant would like to become carbon neutral already by 2025 (Interviewee 2). Whereas, Wärtsilä has also expressed a similar notion and invested many million euros to bring the Power to X project in the pursuit of creating sustainable societies. However, referring to the need of political support in the long run, Interviewee 2 submitted that,

> *''And the discussion at political level is a marvellous topic or concept because it can enable sustainable ways to use technology or any thermal power generation assets. Yeah! Enabling the use of power plants of the future as well in a sustainable way. And I think that politics in the long run is very important concept.''* (Interviewee 2)

There are several advantages that can be realised from the data analysis. For instance, the Power to X project is a strategic standpoint for Wärtsilä where the company is convinced that the project can bring out sustainable energy transition. It the professional expectation of the experts that the project can significantly assist to mitigate climate change issue. The experts also assume that the project can also assist Wärtsilä's customers to adjust their business models towards net zero-emission. Highlighting this aspect, Interviewee 3 argued,

> *''The Power to X project is a way to, let's say, mitigate the climate change and adjust their business accordingly. And that is then part of the energy transition as we consider.''* (Interviewee 3)

Wärtsilä is committed to bring out sustainable innovations towards building smarter societies (Wärtsilä Corporation 2022a). In this spirit the global firm has investment more than €200 Million EUR and dedicated a group of experts to carry on the project's innovation development that aims to capture 15,000 kilos of carbon dioxide per year from the thin air (Wärtsilä Corporation 2022d). The project is focusing on creating co-innovation with many incumbent industries such as the Vaasa District heating plant, and Vantaa District heating plant, etc. As such the project aims to create and integrate all the energy produced across different usages ensuring the implementation of the eco-design, cleaner production using renewable materials, and zero waste policies, etc. However, highlighting the scope of the project and its co-innovation management with relevant industries, Interviewee 3 reported that, *''So, we have recently invested a lot of money in this project. We have new factory here in Vaasa which may be ready end of this year and would be open to public for raising public awareness. Its investment is roughly €200 million EUR, and, in that factory, we are just beside a power plant. We hope to capture something like 15,000 kilos of carbon dioxide per year in that machine from the thin air. So, everything is integrated, and we have massive heat storages and all energy produced can be utilized effectively.''* (Interviewee 3)

Apart from the strategic benefits of the project, there are other advantages can be realised. For instance, the project can lower the insider CO2 level and thus it can assist to improve workability inside a building, improve health and wellbeing of children and adults, improve work efficiency more than usual inside a building that has a lower CO2 level than that of a counterpart building with no measure taken to reduce the level of inside CO2 amount, getting better air quality, significantly low costs to produce synthetic fuels as less as a cup of coffee per day per employee, etc. These findings also corroborate with Preston (2012, 7) who held circular economy strategy as to reduce harmful impact of the businesses to its societies and environments. However, highlighting the health benefits of the project and significant low costs power generation capability, Interviewee 3 argued respectively,

''And there in one meeting room where we demonstrated the project that captured CO2 and the level of CO2 was lower to its prehistoric air quality. As a result, we felt actually very good for cognitive processes. So, brain works well in that room.'' (Interviewee 3)

''The best part of the deal that you get lower CO2 content you get better or better air quality, working environment carbon sink and then you get the carbon neutral fuels out of your own breaths, and it costs less than a cup of coffee per day per employee.'' (Interviewee 3)

The project also has a unique capability to offer long term power system balancing to flexibility in avoiding seasonal variations. For instance, the project can produce synthetic fuels even during the colder winter months when there is less possibility to produce renewable energy. As such, Christian argued that, *‘‘It makes sense for the other parts of the year to produce synthetic fuels. We with the excess renewable and then utilize those in power generation at times when there are lower renewable energy sources available.’’* (Christian, Webinar 1)

However, the Power to X project is also not immune to its shortcomings. For instance, Interviewee 1 pointed out that consistent supply of electricity produced from renewable energy sources such as wind, solar, geothermal, etc. is a must have condition and without having such green electricity supply the meaning of the whole project casts shadow on it. As Wärtsilä is in Northern Hampshire with a long and cold winter months thus constant supply of green electricity to be utilized in this project as raw material could be considered as a challenge. To highlight such consideration, Interviewee 1 submitted,

‘‘Well, at least one big challenge and it's not necessarily the biggest one is currently the source of green hydroelectricity. So, these provinces will utilize a lot of electricity for this to make sense at all it needs to come from green source or from a low emission source. So, the availability of electricity is an enabler for this without this the concept doesn't make sense. And that's a challenge!’’ (Interviewee 1)

Another challenge for this project to succeed is to understand the end customer's motivation behind utilizing this technology and based on these drives the project ought to be customized. Highlighting this bipolarity, Interviewee 3 argued,

‘‘It is significant, I would say, but there is sort of two things to consider. Let's say our today's vision or strategy is shaping decarbonization in the marine and energy industries. So, we cooperate pretty much with end customers in these industries. And that is super important. Whereas there is money or investment involved and cost, but then also it's important to understand the motivations of our end customers. However, in our case we want to become carbon neutral in all our own operation soon.’’ (Interviewee 3)

Furthermore, there is a challenge of the Power to X project to become commercially acceptance by the target customers considering its possible costs and benefits analysis. The actual success of the project lies on the willingness of the customers to pay the price and invest the initial start-up costs associated with the project. Moreover, this project must be aligned with that of the vision of the firm or customers towards carbon neutrality and sustainability. If a company is not 100% committed towards a sustainable business model, then the adoption and application of the project is not possible. Thus, it is of a paramount importance to assess the suitability of the target customers and their willingness to become more sustainable. Meanwhile, the supply of renewable electricity as input material for this project also remains as an important barrier for adopting the project in countries or areas where there is no possibility to produce renewable electricity owing to weather conditions or lack of infrastructural development in the country in question. However, to address this issue, the Interviewee 2 reported that,

> *''The main challenge is of course commercial one. So, this is a costly project and customers need to be willing to pay for the expertise, and it must come from customers themselves that they see that being sustainable has some value to them, and to their customers eyes.''* (Interviewee 2)

However, Wärtsilä recognizes that the Power to X is a new business idea with an innovative technological breakthrough. As such the firm is adopting many awareness development camping such as presenting the concept in recent Dubai World Expo 2020. Furthermore, Wärtsilä also recognizes that this will bring new customers to the company and add significant corporate values towards making sustainable development. As such, the Interviewee 3 argued,

> *''There are few challenges such as it's a new business idea for new customers, and new value change. So, strategy wise, it (The Power to X Project) is a new situation for companies like Wärtsilä. And then of course, so we need to have the financing.''* (Interviewee 3)

To recapitulate, the Power to X project has tremendous opportunity to categorically transform the ever-polluted transportation industry by offering renewable synthetic fuel from the project. As such highlighting the future potential of the project relevant to the transportation industry, Interviewee 2 argued,

> *''Renewable power is one way to create renewable transportation fuels.''* (Interviewee 2)

The following section introduces empirical data analysis relevant to the utilised implementation strategies of the system change perspective in the Power to X project.

4.2 The utilised implementation strategies of the system change perspective

Wärtsilä as a technology provider perceives the Power to X project as a steppingstone towards achieving sustainable development, carbon neutrality and above all implementing a system change thinking towards circular economy strategy. The focus of the strategic management level for the project is very clear and the firm believes that involvement in this project is a timely but important step in the right direction. As such Interviewee 2 reported that,

> *''I also think the importance of being sustainable, developing thinking that we have made our targets to be carbon neutral, so that's a good step in the right direction.''* (Interviewee 2)

Interviewee 3 argued that the Power to X project has utilized several identified key circular economy strategies in the literature review analysis such as Eco-design, Cleaner production using renewable materials, Zero waste policy and Enhanced customers' and producers' awareness.

However, beyond the scope of the literature review analysis, this study finds that Value co-creation and industry alliances as an important circular economy creation strategy relevant to the Power to X project. Highlighting the utilized strategies, Interviewee 3 mentioned,

> *''The Power to X project is the process efficiency where we convert renewable electricity to end products. Then I think the process efficiency relates to eco-design, meaning better efficiency and then cleaner production.''* (Interviewee 3)

Nevertheless, among the many utilized circular economy strategies, according to the Interviewee 3 the strategy of cleaner production technology utilizing renewable materials absolutely triumphs all others. As such Interviewee 3 reported that,

> *''So, I will say that to me the focus should be the cleaner production. Because a cleaner production using renewable materials, I think that's the true colour of the Power to X.''* (Interviewee 3)

The following sub-paragraphs summaries the data analysis relevant to the utilised circular economy implementation strategies of the Power to X project.

Eco-design

Wärtsilä as a technology provider assisting Vantaa Energia to utilize its existing waste to power plant. The technology Wärtsilä is cooperating with is enhancing Vantaa Energia's ability to produce green energy from its by-products. For instance, the CO2 output from the energy generation, wastewater coming from the exhaust gas cleaning system, etc. are utilized as fed stocks or raw materials for the Power to X unit. There is also a technical aspect available which is the presence of the Electrolyser that takes the wastewater to break it down to its chemical molecules such as hydrogen and oxygen. Consequently, captured CO2 is then mixed with hydrogen compounds to have a chemical reaction as to produce the target synthetic biogas.

As such technical mechanism synthetic biofuel is produced without making any waste thus achieving the Zero Waste policy circular economy strategy as well. This technical blueprint can also be argued as a classic example of the key circular economy strategies such as Eco-design and Cleaner production utilizing renewable materials. To highlight the relevance of this project to eco-design strategy for instance, Matti argued,

> *‘‘This plant is waste to energy plant that has some solid feedstock of fuel, we will get CO2. We will get the electricity directly from the plant and we will get water from the exhaust gas cleaning system. So, we are taking these ingredients from the waste. Then the ingredients water, electricity and CO2 are fed into the Power to X unit. So, there's an electrolyser that takes the water and mix those to separate and break down to hydrogen and oxygen particles. Then the electrolyser is also connected to the district heating system. And that’s how we get the hydrogen. Then we combine that hydrogen with the clean CO2 and can produce synthetic biogas that is then connected to them.’’* (Matti, Webinar 1)

Data analysis reveals that the Power to X project has ensured the sustainability and environmental aspects into the early stages of product design and development. As such, the project can ensure the durability and optimal performance throughout the product life cycle to match with environmental aspirations as suggested by Van Berkel et al., (1997, 53) and Ghisellini et al. (2015, 15). To highlight this aspect the Interviewee 1 argued despite considering green electricity supply as capital to the project, it can also be argued that this demand side of the Power to X project is accelerating the necessity of having green electricity generation for many other value-added industries. The demand for renewable electricity for the Power to X project is showcasing how much we can achieve for the environment and industry partners if we can ensure renewable power generation under the premise of Eco-design strategy. Thus, this the Power to X project is not only solving the present-day CO2 emission problem but also creating a level field for green energy generation industry as key provider of raw materials for technological companies. As such, Interviewee 1 argued,

> *''And of course, the direction implies more and more renewable electricity in that integrated planning, becoming base mode on some share on time like that needs to kick in as a sort of wide global escape.''* (Interviewee 1)

Whereas the ideology of the Eco-design strategy in the Power to X project is also shaping the future of hydrogen. This strategy is showcasing the role that the Power to X system change thinking can play to shape the future of hydrogen, methane, and ammonia as natural gas fuels to power the ships in the Baltic Sea and offer tremendous savings on water for the Steel manufacturing industry. This finding also corroborates with Van Berkel et al., (1997, 53), Ramani et al., (2010, 3), Wrinkler (2011, 244), and Preston (2012, 10) who argued that eco-design aims to enhance the environmental performance of the product throughout its life cycles and from product design to decomposing, and also assist to reduce the raw material inputs, save costs and accompanying wastes. To highlight such aspect, Christian argued,

> *''Hydrogen becomes to the second most important energy carrier for what the hydrogen will be finally used of course, some hydrogen is used in the direct use some hydrogen is converted to methane what we call today gas Natural Gas Chemical it's the same it can be in the gaseous form it can be liquefied as LNG. And the Power to X can produce that hydrogen and this can be used for example for ships on the Baltic Sea.''* (Christian, Webinar 1)

Furthermore, Eco-design strategy in the Power to X project is bring about revolutionary change in the renewable power generation and storage systems, specially to the renewable electricity and hydrogen businesses. This finding also corroborates with Ramani et al., (2010, 2) who argued that eco-design strategy transforms environmental considerations into business opportunities and thereby enhances product branding to capitalise superior market competition position. Supporting this view, Christian commented,

> *''Renewable Electricity is the central and dominating energy area while green hydrogen is the second fundamental carrier which could be the part of a long-term solution.''* (Christian, Webinar 1)

Lastly, the strategical implication of Eco-design is also enhancing industry collaboration and alliances with many incumbent firms which corroborates with previous studies such as Winans & Deng (2017, 826) and has been detailly explained under Value co-creation strategy section.

Cleaner production using renewable materials

Cleaner production utilizing renewable materials is one of the main motoes of the Power to X project (Interviewee 1, 2, 3). Based on the data analysis it is possible to argue that the Power to X project could be a catalyst of system change in generating, storing, and distributing 100% renewable energy for various end customers such as district heating, battery energy storage firms, etc. As such, Saara argued,

> *''The research we do it's completely clear that the Power to X will be the ingredient that enables the final portion 100% renewable electricity is that this is a technology that in together with battery energy storage will be used for storing energy.''* (Saara, Webinar 2)

Interviewee 1 agreed that the Power to X project has utilized cleaner production using renewable materials (for this project supply of renewable sourced electricity is a must requirement) and zero waste policy (eventually there is no waste materials out of this project), the project in fact utilizes thin air from inside air environment, waste water from existing infrastructure, and break the water compound into hydrogen and oxygen molecules and an electrolyser assists to produce synthetic fuels such as biogas, diesel, kerosene, etc. which in turn can be sold to the transport industry to use as biogas that doesn't emit any CO2 or it can make the process completely zero CO2 emission. Thus, the whole process is designed to phase out CO2 from our existing environment and utilizes that amount of CO2 to produce synthetic fuel to offer power generation for many polluting industries such as the transportation industry.

This finding corroborates with extant literature that held cleaner production using renewable materials strategy as a catalyst for three interrelated practices such as a) pollution prevention, b) toxic use reduction, and c) design for environment Van Berkel et al., (1997, 55) and Ghisellini et al. (2015, 15). Highlighting this point, Interviewee 1 mentioned,

‘‘The main implementation strategies (circular economy) are cleaner production, renewable materials for sure. green electricity or zero emission.’’ (Interviewee 1)

On the other hand, Interviewees 1, 2 and 3 unanimously agreed and ranked cleaner production using renewable materials as the number one priority circular economy strategy that can be visible under the scope of the Power to X project. This finding also corroborates with previous studies that suggest cleaner production strategy as a most utilised method to implement a cradle-to-cradle strategy (Preston 2012, 7; Ghisellini et al. 2015, 15; and Lieder & Rashid 2016, 44). However, in this instance, the interviewee 1 and 2 reported respectively,

‘‘I would say cleaner production using renewable materials. That's in the core. So, that's mostly (almost all of them are or can be part of it). But that's the core of these qualities.’’ (Interviewee 1)

‘‘I think the cleaner production using renewable materials is the very core of the Power to X project’s concept.’’ (Interviewee 2)

Highlighting the utilized strategy and the intended outcome of the Power to X project, Interviewee 2 referred that the entire the Power to X project is built around the idea that it will work as a carbon sink tank and will utilized renewable CO2 captured from the inside atmosphere and then it will transform the captured CO2 into renewable synthetic fuel. This finding also corroborates with Preston (2012, 7) who suggests cleaner production strategy utilizes renewable materials into production processes. Addressing this aspect, Interviewee 2 mentioned,

‘‘We had the whole concept around the production of renewable materials because they're a specific project designed to take from an industrial process that is a huge source for carbon dioxide which is needed in the power.’’ (Interviewee 2)

Zero waste policy

There is essentially no waste in the industrial parameter of the Power to X project. The game changing technology can produce synthetic fuels out of thin air (CO_2) floating inside a building. Thus, the raw materials production can source without any investment needed as such no economic value of the raw materials. The technology then transforms the captured CO_2 into synthetic fuel such as hydrogen and methane.

The produced hydrogen and in particular the methane can be used as a green fuel for the transport industry. Moreover, it can also be used for energy storage and can be utilized as alternative to natural gas. However, there is literally no by product coming out of the system other than captured CO_2 from the inside air make the surrounding environment more eco-friendly and naturally refreshing as there are less CO_2 compound inside a building's environment. As such Matti argued,

> *''So, when we have CO2 available, we are combining that with hydrogen to produce synthetic methane in small scale.''* (Matti, Webinar 1)

Experts in this project also supports the view of implementing zero waste policy. In this project essentially there is no waste materials. In practice the project is systematically designed to capture CO_2 from the thin air that is a constant by product in everything we do. The project then burn the captured CO_2 to produce synthetic fuel and energy. As such at a larger scope the project has the potential to phase out the usage of fossil fuels in producing energy or it can power the ever-polluted transport industry by providing the produced synthetic fuels. This finding supports the extant literature that argues Zero waste policy as an integrated system to utilise everything without having to produce any waste at all throughout the life cycle of the products (Song et al. 2015, 200). To highlight such a scope and implementation of the zero-waste policy, Interviewee 2 mentioned,

> *''It also relates to the zero-waste policy, because definitions inherently are not carbon neutral. Take CO2 from the air to burn and that was the waste specifically what we have been doing the most.''* (Interviewee 2)

The Power to X project is a proven concept that builds on the idea of zero waste policy and recycling. Technically there are no waste in the production pipeline rather the project enables recycling or capture industrial or inside building's CO2 a common by-product of many industrial processing. This finding also corroborates with Ghisellini et al. (2015, 5) who proposes the idea as the Zero emission Strategy to maximize the utility of goods yielding to zero environmental impacts. Highlighting the scope of this excellent CO2 recycling capability, Interviewee 3 argued,

> *''We recycle the carbon dioxide meaning this carbon capture technology captures and utilizes the carbon dioxide to produce synthetic fuels.''* (Interviewee 3)

Increased producers' and customers' awareness

Wärtsilä recognizes increasing producers' and customers' awareness for the Power to X is extremely crucial for its future success (Interviewee 2). Experts suggest that by enhancing knowledge and public dialogues about this project, global firms can overcome the possible shortcomings of shifting customers attitude towards a sustainable energy solution. For instance, if customer and public awareness about this project can be ensured then public and businesses will support this idea and they can as well influence the central government to promote sustainable cities and cleaner production technologies. This finding supports previous studies that argued social awareness as a fundamental requirement for a successful transition to circular economy (Geissdoerfer et al. 2017, 3; and Lieder & Rashid 2016, 47). Highlighting this aspect, Interviewee 2 reported,

> *''I think that the public discussion is very much focused on the CO2 emissions, specifically. So, there's a lot of talking about that as well. Thus, if the concept can be made clear to the public then I think that more and more businesses and corporations will also become a supporter of the sustainable cities.''* (Interviewee 2)

Wartsila's recent demonstration in Dubai Expo 2020 (held in March 2022) and other published white papers, webinars, research papers, etc. are immensely assisting to develop enhanced customers' and other competitors' awareness in the industry. This successful execution of the model is enabling thinking to take necessary actions that will promote more innovation towards decarbonization. Many industrial end customers of Wärtsilä are already considering subscribing to this kind of innovation to help minimizing their business impacts to the recent climate change issue. This finding also corroborates with Song et al. (2015, 209) who argued that awareness initiatives taken by firms can fundamentally impact behavioural change in the industry. However, highlighting this space, Interviewee 3 reported that,

> *''Wartsila's many of the customer businesses are currently based on some sort of fuels and that then strongly relates to the climate change. As a result, it's of course that our customers are now thinking how to become carbon neutral.''* (Interviewee 3)

At the recent Dubai World Expo 2020, Wärtsilä attempted to create an enormous branding effort to showcase how in real life the intended the Power to X project works. This practical demonstration has been welcomed as an important awareness message to the relevant stakeholders. Addressing this event and its intended awareness campaign, Interviewee 3 explained the whole process of the Power to X Project that utilized indoor CO2 of the Dubai Expo and converted those CO2 to produce synthetic fuel which powered the Coffee machine to make a warm cup of joy to the visitors of the expo. This view also supports previous studies that considered educational programs, public campaigns such as exhibitions and seminars as important measures to increase customer and producer awareness about circular economy (Ellen Mac Arthur Foundation 2013, 62; and Lieder & Rashid 2016, 47). However, the Interviewee 3 mentioned,

> *''We have been demonstrating lately in Dubai World Expo, which just ended last week in Finnish Pavilion. We had a machine there. Demonstrating recycling of carbon dioxide, meaning we made fuel out of the breathing air where we and the pavilion visitors emit carbon dioxide. So, we captured that and make fuel from that and use that in brewing coffee for the pavilion visitors.''* (Interviewee 3)

Wärtsilä's experts really feel for this project, and they are extremely optimistic on its merits. Wärtsilä's standpoint on this project is very clear. The firm aims to showcase a revolutionary innovation that can solve many problems including the global climate crisis. Highlighting such optimism, the Interviewee 3 argued,

> *''By this Expo we would want to demonstrate that this kind of technology is already possible today. This is not science fiction; it can be done. And it should be done!''* (Interviewee 3)

Value co-creation and industry alliance

By the means of the Power to X project Wärtsilä is trying to establish co-operational initiatives with its likeminded customers to help them becoming circular economy-based organizations for the future to come. As such Matti argued,

> *''And that's why we are doing this to help our customers and help their energy, energy industry and, of course, support and accelerate the energy transition.''* (Matti, Webinar 1)

The collaboration between Vantaa Energia and Wärtsilä exemplifies how the Power to X project is assisting Vantaa Energia's district heating ambition of a completely fossil fuel free operations. The output of the project is offering more than one benefit such as utilizing CO2 emitting from its waste to power plant, producing synthetic fuels from this amount CO2, and powering the transportation trucks that bring waste materials from the neighbourhood to the waste to power plant. Thus, the technological system is not only helping to reduce carbon footprint but also it is helping to save money on fuels for transportation and above all the produced fuels is coming from 100% renewable sources and thereby helping Vantaa Energia to assume its carbon neutral philosophy towards business operations.

As such this successful case study is paving the way towards proving feasibility study for Eco-design technology, implementing a zero-waste policy in manufacturing industry, and creating plausible promotional materials to increase customer and producer awareness about circular economy strategy.

This view corroborates with extant literature that argues circular economy strategy such as Eco-design can assist to enhance industry collaboration and alliances *(such as the most scientifically referred case of the eco-industrial park in Kalundborg, Denmark)* that established a system of industrial symbiosis to ensure maximum waste recovery, reduction, recycle and reuse among interrelated industries within the region (Winans & Deng 2017, 826). To address such aspects Saara argued,

> *''They (Vantaa Energia) have made a pledge to stop using all fossil fuels by 2026. They are already a long way there. But one of the most challenging elements that they are facing is to get rid of fossil natural gas for those really cold winter days*

here in Finland where they need to use heat boilers to top up the district heating network. And the concept that we are studying is to utilize their existing waste to energy plant and take all the raw material, electricity, clean water, CO2 emissions from the stacks and make them into a process to produce synthetic fuels that could then be transported through existing natural gas network and utilized in winter times for district heating surplus. Surplus gas can then also be useful for transportation, for example, for the trucks that already transporting the wastes to the energy plant.'' (Saara, Webinar 2)

The following section introduces empirical data analysis relevant to the role of system change perspective in achieving circular economy principles.

4.3 The role of system change perspective in achieving circular economy principles

The system change perspective calls for approaches that transform waste materials into resourceful raw materials for other industry (Su et al. 2013, 216; Winans & Deng 2017, 826). As such the approach not only offers environmental and economic incentives for recycling bust also assist to reduce the necessary input of raw materials thus achieve the principle of reduction along the way (Su et al. 2013, 216). In terms of the Power to X project such approach is clearly visible. The project has proven that it can utilize wastewater from the existing power plant and capture CO2 from ambient atmosphere to create energy that can substitute the need of purchasing fuels for the vehicles for instance. Thus, the project is a proven case that supports the view of recycling, reduction, and reusing energy from the waste materials in a renewable way.

The following sub-paragraphs present empirical data analysis relevant to the circular economy principles found in this Power to X project.

Reduce

This project is a testimonial for Wärtsilä on a global scope to bring new clients and to assist them with their decarbonatization goals. For instance, because of being an Eco-design strategy that reflects circular economy system thinking, Wärtsilä is cooperating with Vantaan Energia to produce synthetic fuels and achieve circular economy goal of 100% renewable energy production. This finding corroborates with previous research that argue circular system thinking can enhance industry alliance and value co-creation (Winans & Deng 2017, 826). As such Matti mentioned,

> *''I'm from Finland and there is this Vantaan Energia which is a municipal energy company that seems to be going to produce synthetic methane for four months. And we have signed a cooperation agreement and unlocked this opportunity together. Thus, this opportunity will work as a learning curve for us for the future and would help one to decarbonize their whole overall energy production by 25 timeframe and support the whole energy transition to a 100% renewable future.''* (Matti, Webinar 1)

The Power to X project is proving to be an example on how large-scale energy corporation utilizes the existing infrastructure and significantly less investment to produce valuable green energy outputs. For instance, the Power to X project technology doesn't need significant new investments and can utilize existing infrastructure such as the gas boilers to be used as a mechanism to work and produce synthetic fuels along the way without having to rebuild a whole new infrastructure. Thus, this approach also conforms with the circular economy principles such as reduction and reuse as suggested by Rashid et al. (2013, 167), Ellen MacArthur Foundation (2013, 16), and Murray (2018, 8). However, Matti mentioned in this respect that,

> *''We can use that existing plant there to provide us the raw material for the Power to X. You're able to use the existing gas from boilers there and then just change the fuel for this plant and this is kind of the beauty of that we don't need to rebuild the overall system.''* (Matti, Webinar 1)

The Power to X project outcomes has a multitude of positive effects in terms producing renewable energy, carbon neutral synthetic fuels, providing the manufactured synthetic fuels to the transport industry, reducing CO_2 emissions from the ever-polluted transportation industry, etc. Thus, the project is proving to be one of a kind in systematic change towards generating carbon neutral power to uphold the ideology of reduction circular economy principle. As such, Saara reported that,

> *''And that's really enabling us to have a reliable and cost efficient 100% renewable power system the other obvious use for synthetic fuels will be for carbon neutral, renewable transportation.''* (Saara, Webinar 2)

On the other hand, the manufacturing process for the Power to X synthetic fuel is extremely minimal. Comparing to the contemporary power gird or power manufacturing processes such as nuclear fusion energy requires a lot of investments and input of raw materials (Saara, Webinar 2). Whereas, in the roadway towards synthetic fuel production, the Power to X project only requires three inputs and these are renewable electricity, water to produce hydrogen and captured CO2 from open air. Thus, the blueprint of this project corroborates with the principal of reduction of raw material inputs to produce sustainable energy which confirms the application of circuital economy thinking towards making a systematic change in the power generation industry (Ellen MacArthur Foundation 2013, 8; Rashid et al. 2013, 168). As such Saara submitted,

> *''Whatever the synthetic fuel or it's a power generation for transportation, whether it's gases or liquid, we only need three main elements for that and those are renewable electricity, water to produce hydrogen, and then we need CO2.''* (Saara, Webinar 2)

Reuse

The direct output of collaboration with Vantaa Energia is that the output synthetic biogas is sold to the transport industry and utilize as additional power to aid in the district heating system. This project is ensuring reuse of waste materials to produce energy and synthetic fuels for its (Vantaa Energia's) delivery transport trucks. These results can be argued as achieving the circular economy principle, i.e., reuse of waste material as captured CO2 and wastewater coming from the exhaust gas cleaning system, etc. are utilized as fed stocks or raw materials for the Power to X unit. These findings support earlier research that argue reusing principle can save costs (Ellen MacArthur Foundation 2013, 41) and enhance environmental performance of the products (Rashid et al. 2013, 167). As such, Matti and the Interviewee 2 respectively argued,

> ‘‘*We sell it (produced synthetic fuels) to the transportation to the trucks that are bringing the waste to the plant. And it's also connected to existing gas infrastructure in the batteries and the gas can be then used during the wintertime to provide peaking power and heating for the city when that's needed.’’* (Matti, Webinar 1)

> *‘‘That you can reuse the ways of the city and create electricity. The city reusing some stuff and making other commodities out of the waste.’’* (Interviewee 2)

Recycle

The study reveals that the boarder scope of the circular economy principles is somewhat limited to recycling. It is believed among the Interviewees 1, 2, and 3 that if recycling of materials can be ensured, a manufacturing process can be classified as following circular economy principles (Interviewee 1, 2, and 3). This view is somehow limiting the adoption of appropriate corporate and functional level initiatives to ensure other circular economy principles such as reduction of raw materials to be utilized in the industrial process, reuse of the materials to ensure maximum economic gain, and recovery of energy or resources from the waste materials. However, the view towards considering recycling as the most important circular economy principle corroborates with previous studies such as Prendeville et al. (2014, 11), and Ghisellini et al. (2015, 6). Furthermore, supporting this view, Interviewee 2 argued,

> *‘‘But there's still a long way to go to become like a real circular economy that we recycle everything that we use, etc.’’* (Interviewee 2)

> *‘‘So, of course we create waste in the cities and then we must do something with the waste. Of course, a good thing would be to recycle as much as possible of that waste.’’* (Interviewee 2)

Although recycling offers significant values in the adoption of circular system change, but its drawbacks towards downgrading the utility and value of the recycled materials into further processing ought to be carefully reviewed. For instance, recycling materials as raw input always must consider as downgraded compared to its once original values. Thus, not in every project or product manufacturing recycled materials can be utilized. And this can be considered as a challenge towards truly achieving the principles of circular economy in industrial processing. This finding also corroborates with Prendeville et al. (2014, 11) and Ghisellini et al. (2015, 6) who argued that continuous recycling may downgrade the original value or utility of the products owing to the law of entropy. However, highlighting this challenge, Interviewee 2 argued,

> *''By recycling today, we use the material again but not for the same application. Some other application that probably downgrade we have like a piece of white paper that we put that paper in the paper craft. Then paper trash recycled to brown paper is no longer the same white paper, less valuable products for the sort of dark recycling and then it will be difficult to operate maintains the same product for the recycled product That's a big challenge!''* (Interviewee 2)

It is noteworthy to mention that the empirical data analysis did not support the application of recovery principle under the scope of the Power to X project. One of the main reasons for this could be that the Power to X project utilises minimal number of raw materials to produce green energy and the project is not designed to processes other waste materials (i.e., plastic, garbage, rubber, aluminium, steels, etc.) than that of the captured CO2 from the inside building infrastructure.

However, the following chapter presents the theoretical contributions, managerial implications, limitations of the study and future research direction.

5 CONCLUSIONS

This chapter summaries the theoretical contributions, managerial implications, limitation of the study and direction for future research.

5.1 Theoretical contributions

In the extant literature, the contributions of the global firms that are applying successful circular economy concepts utilizing a system change perspective to closed loop thinking are less represented (Rashid et al. 2013, 168; Prendeville et al., 2015, 12). There is a significant paucity of research available that explains how global firms utilize a system change perspective to closed loop thinking for creating circular economy strategy in different industries (Rashid et al., 2013, 167). However, experts argue that a system change perspective to closed loop thinking can help those global firms to ensure adoption of circular economy principles (Rashid et al. 2013, 173). But this system change is a complex issue and requires considerable changes in various subsystems (van Buren et al. 2016, 2). Furthermore, this concept also lacks common understanding in terms of its definition and key considerations across different industries and thus impeding the successful adoption of this concept in practice (Rashid et al. 2013, 167).

To overcome this research gap, this study sets its theoretical framework based on a comprehensive literature review to answer the main research question of *How does global firm utilise system change perspective to closed loop thinking for creating circular economy strategy?* In order to answer this question in a logical manner the study also sets three sub-questions, and they are *SQ1: What is the system change perspective to closed loop thinking?; SQ2: How does the system change perspective implement to develop a circular economy strategy?; and SQ3: What is the role of the system change perspective to achieve circular economy principles?*

However, the empirical data analysis section relevant to *What is the system change perspective to closed loop thinking?* reveals critical understanding of how a global firm in the energy industry (for instance) utilizes the approach for creating a circular economy strategy. Thus, it has contributed to the existing literature of system change perspective as a circular economy creation strategy. Whereas the empirical data analysis section relevant to *How does the system change perspective implement to develop a* *circular economy strategy?* reveals critical understanding on how a global firm implements the system change perspective to develop certain circular economy strategy. Lastly, the third empirical data analysis section reveals what role the system change perspective plays to achieve certain circular economy principles. As such the study contributes to the theoretical understanding of the system change perspective relevant to a global energy firm by investigating the case of Power to X project in implementing circular economy strategy.

The study has empirically analysed four of the widely accepted circular economy implementation strategies under the premise of system change perspective to close loop thinking and these are Eco-design, Cleaner production using renewable materials, Zero waste policy, and Increased producers' and customers' awareness. The study has empirically identified that all these four implementation strategies have been utilised in the Power to X project and especially cleaner production using renewable materials, and zero waste policy have been found to be most effective strategy from the experts' point of views. Based on the data analysis it is possible to argue that the Power to X project could be a catalyst of system change. These findings corroborate with extant literature that held cleaner production using renewable materials and zero waste policy as catalysts for three interrelated practices such as a) pollution prevention, b) toxic use reduction, and c) design for environment (Van Berkel et al., 1997, 55; Ghisellini et al. 2015, 15; and Song et al. 2015, 200).

The empirical analysis also reveals that Wärtsilä's Power to X project has ensured implementation of different circular economy strategies by utilising certain measures. For instance, the Power to X project has utilised a balance between Wärtsilä's corporate mission with the circular economy vision for the future, design thinking, and adopting an environment friendly approach to reduce CO2 level, etc. to implement the Eco-design circular economy strategy. This finding corroborates and extends current literature of the eco-design strategy (Van Berkel et al., 1997, 53; Ghisellini et al. 2015, 15). Whereas a carbon neutrality pledge, making renewable electricity as mandatory input supply for the project, and generating renewable green synthetic fuels as output, etc. have been utilised to implement the concept of cleaner design using renewable material strategy. This finding corroborates and extends current literature of the cleaner design using renewable material strategy (Preston 2012, 7; Ghisellini et al. 2015, 15; and Lieder & Rashid 2016, 44).

Consequently, minimum input requirement, utilizing waste materials or by products such as CO2, wastewater, etc., supply of produced fuels to delivery trucks have been utilized to implement the zero-waste policy strategy. This finding corroborates and extends current literature of the zero-waste policy strategy (Ghisellini et al. 2015, 5). Subsequently, practical demonstrations of the project (i.e., Dubai World Expo 2020), webinars, seminars, conferences, published white papers, and reports, etc. have been found to be used to increase producers' and customers' awareness about the Power to X project. This finding corroborates and extends current literature of the enhanced producers' and customers' awareness strategy (Geissdoerfer et al. 2017, 3; Lieder & Rashid 2016, 47).

Furthermore, beyond the scope of the identified literature, this study contributes to the existing system change perspective literature by adding value co-creation and industry alliances as a new effective circular economy implementation strategy. The empirical analysis suggests that Wärtsilä has utilized industry alliances with incumbent local industries, cooperating in joint design and research, engaged in joint investment to create jobs, etc. in implementing value co-creation and industry alliance strategy. Thus, it is a novel finding that value co-creation and industry alliances can be considered as an effective circular economy implementation strategy.

The empirical analysis has also presented important theoretical contributions relevant to the circular economy principles such as reduction, reuse, and recycling. For instance, the empirical analysis reveals that the Power to X project aims to reduce the environmental impact of the business and wants to ensure maximum reuse of waste materials to enable production of green energy. And as such, the global firm has joined hands with a Finnish local energy company to co-create a system change perspective to close loop thinking. This finding corroborates and extends previous research that argue circular system thinking can enhance industry alliance and value co-creation (Winans & Deng 2017, 826). Thus, this approach also conforms with the circular economy principles such as reduction and reuse as suggested by Rashid et al. (2013, 167), Ellen MacArthur Foundation (2013, 16), and Murray (2018, 8).

However, the empirical analysis reveals an anonymous agreement among the interviewees to consider recycling as the priority number one circular economy principle that the Power to X project wishes to address. This view towards considering recycling as the most important circular economy principle corroborates with previous studies and extends the current literature of recycling as an important circular economy principle (Prendeville et al. 2014, 11; Ghisellini et al. 2015, 6). However, it is an unexpected empirical finding that recovery principle has no influence for the Power to X project.

The empirical analysis also contributes extant literature of so-called Net-zero emission pledge scenarios. The study reveals that cleaner production using renewable materials requires moderate and leadership scenarios to conceptualize the commercialization of system change perspective such as in the Power to X project. A similar meso level actions are also required for the zero-waste policy under the landscape of European Green deal. The moderate scenario aims towards enabling a zero-greenhouse gas emission from industrial operation by 2050 through European Green Deal, whereas a system change perspective looking forward to achieving circular economy principles such as 100% reduction in waste and by-products from industrial operations. As such Christian (Webinar 1) argued *''The moderate might be a kind of a baseline scenario, it's practically equivalent to the European Green Deal, which is the target of European commission, and its clear target is zero greenhouse gas emissions by 2050.''*

On the other hand, in the light of the empirical analysis experts suggest that the initial investment of the project can outrun its possible benefits. The project is a cost expensive technology coupled with demand for the renewable electricity supply as raw materials which in turn becomes another costly measure of producing electricity. Although there are few costs and benefits analysis ought to do but it is the opinions of the experts that the project has huge future potential to create a lot of jobs and numerous business opportunities to the incumbent industries. As such, Interviewee 3 argued, ''*It has a huge cost or price tag! On the other hand, I personally think that it offers a lot of job opportunities and lot of business to various companies.''* (Interviewee 3). However, these findings of possible job creation and business opportunities for incumbent firms also corroborates with previous studies and contributes to the literature by highlighting the economic and environment benefits of utilizing circular economy strategies (Elen McArthur Foundation, 2013, Kirchherr et al. 2017; and Mrowiec 2018, 18).

Thereby, based on the preceding empirical evidence it can be argued that the study has achieved its objective to study and answers the identified main research question and its associated three sub-questions. Thus, with substantial empirical analysis this study validates and confirms it research proposition which states,

> *The identified system change perspective to closed loop thinking implementation strategies in the revised theoretical framework below can assist global firms to achieve a specific principle of circular economy from their operation, such as Eco-design as a system change perspective strategy can help a global firm to achieve the circular economy principle of reduction, reuse, recycle in its operations, and so forth*.

However, the following figure 3 illustrates the revised theoretical framework of the study which has been influenced by the empirical data analysis. In this framework, the dotted two-sided arrows propose to the continuous feedback process to adjust implementation strategies to achieve the changing requirements of the circular economy principles.

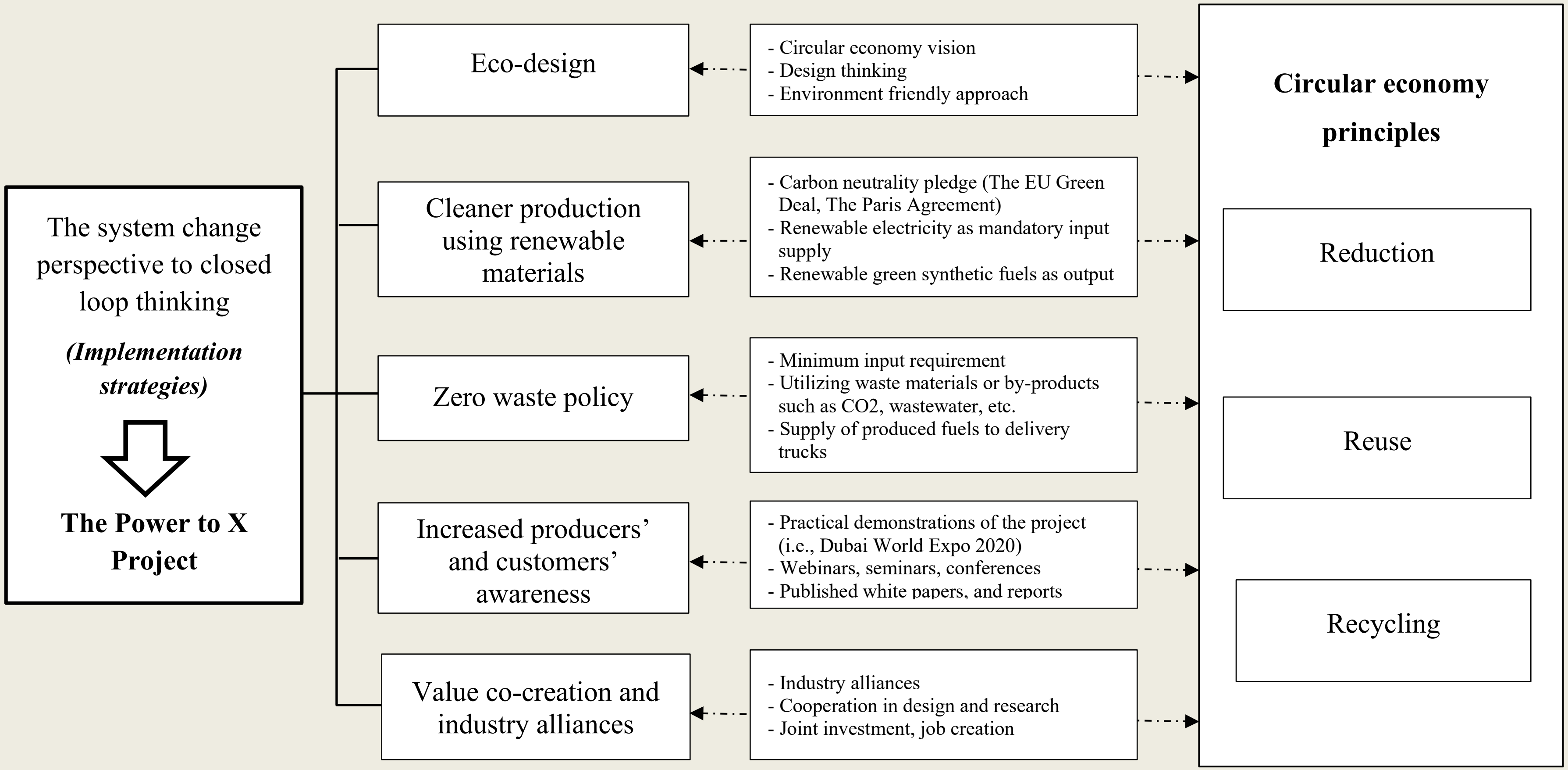

Figure 3. The revised theoretical framework of the thesis based on the empirical findings.

The following section presents the managerial contributions of the study.

5.2 Managerial implications

The findings of the study provide some important managerial implications for the business development managers, technology development managers and innovation project managers of the global firm working with circular economy strategies. Firstly, this study informs the relevant stakeholders who wishes to implement circular economy strategies that the leadership scenario ought to be considered as a driving force towards achieving the Power to X goals and thus it has the potential to influence decision makers at the meso and micro level to promote policies that aim towards achieve circular economy strategies such as Eco design, cleaner production using renewable materials, zero waste policy etc.

Secondly, the study reveals to the business and innovation technology managers that the boarder scope of the circular economy principles is somewhat limited to recycling. It is believed that if recycling of materials can be ensured, a manufacturing process can be classified as following circular economy principles. This view is somehow limiting the adoption of appropriate corporate and functional level initiatives to ensure other circular economy principles such as reduction of raw materials to be utilized in the industrial process, reuse of the materials to ensure maximum economic gain, and recovery of energy or resources from the waste materials. The study also wishes to inform to its wider readers that considering recycling as the only core principle of circular economy may limit the scope of the Power to X project to be one-of-a-kind innovation towards implementing an effective closed loop thinking under the premise of circular economy literature.

Thirdly, the empirical analysis provides substantial evidence to consider the Power to X project as a significant milestone for the future business growth of Wärtsilä, per say for the growth of a typical global firm. However, experts at the firm believe that there few things to consider while assessing all the advantages that this project to the shore. For instance, firstly this project is funding important seeds for Wärtsilä's global mission of becoming a carbon neutral business. On the other hand, the project has causal relationship between a so-called costs and benefits analysis by the end customers. In fact, if the customers see commercial value along with its proven environmental value, then the project can realize its full commercial potential.

Fourthly, the empirical evidence provides insights to other global firms across various industries to appreciate and welcome emerging technologies as a mean of business growth development. For instance, empirical analysis illustrates that Wartsila's business development unit considers the futuristic outcome of this project as a new business growth strategy as the concept is becoming a proven study to offer unique business opportunity for development as well as complements and supports the functioning of current businesses in more eco-friendly and sustainable manner.

Subsequently, the study reveals to the current project managers and technological innovation experts that there are several benefits that the Power to X project can bring about ranging from environmental to economic to personal wellbeing and health. Practical experience of the experts from the project execution and testing stages suggests that the inside air quality and functioning of the cognitive process of the people felt much better while being inside the environment where the project is on run as compared to the other part of the building. Experts argue that this is possible because of less concentration of CO2 inside the building where the project is capturing the CO2 as compared to the area of building where CO2 concentration is at level higher because of no capturing.

Nevertheless, the empirical analysis also provides important insights relevant to economic value of the project. On a small scale the project can produce a multitude of outcomes such as removing CO2 from the air thus works as natural air purification technology without any additional cost, producing a great amount of green synthetic energy to power cars or machines. In the light of the empirical evidence, it can be argued that the technology which is at work inside Wärtsilä headquarter compound is ensuing a better working environment for its 500 staff, utilizing the building as CO2 sink, producing annually around 8000 kilos of CO2, utilizing such amount of CO2 to produce around 50 litters of synthetic gasoline per day to power the company cars, etc.

Finally, to provide a practical demonstration of how the Power to X project can make good economic sense and achieve ambitious climate goals such as generating 100% renewable energy, Matti (Webinar 1) argued, *''We are taking on a global level that has great potential. Making good business, profitable business already today for our customers. It's not something that will require 10s of years to make it happen, but it's a reality already today.* However, the following section presents the limitations of the study and indicates the possible avenues for future research.

5.3 Limitations of the study and future research

Although the study provides justified answers to the research questions and offers important theoretical contributions, it is not immune to certain limitations. Firstly, the research delimits its research scope to offer subjective in-depth understanding of the system change perspective from the point of view a global firm in the energy industry who aims to achieve specific circular economy principles. Thus, this study delimits its analysis only relevant to the actions undertaken by a certain global firm to achieve circular economy principles and thereby does not seek to objectively interpret the research findings for all global firms regardless of their field of business. Therefore, to offer more generalizable research conclusions, future research can investigate this approach to a wide range of industries such as manufacturing, logistics, and mining, etc.

Secondly, only 3 semi-structured interviewees were conducted from Wärtsilä's Power to X project side. Further interviews could have been conducted from one of the Wärtsilä's industry alliance partners (i.e., Vantaa Energia) to reveal its (Vantaa Energia) satisfaction of the implemented project and how it is experiencing commercial and environmental benefits. This approach could have provided critical managerial implications for the adoption of Power to X project in other industries. It could have also provided important research quality insights such as accurate data triangulation, cross check, and interpretation of the qualitative data.

The study offers few future research directions based on the empirical findings. The study confirms that the Power to X project has assisted Wärtsilä Corporation to implement some circular economy strategies such as Eco-design, Cleaner production strategy, Value co-creation, etc. The study also confirms that due to these strategies Wärtsilä Corporation was able to achieve some of the circular economy principles in its business operations such as Reduction, Reuse and Recycling. However, the study could not statistically or causally prove how much benefit Wärtsilä was able to produce out of this project. Thus, future quantitative research (i.e., factor analysis, correlation, regression analysis) can reveal casual cost and benefit analysis for this project and present what strategy is positively and/or negatively correlated to which of the principles in producing effective social and environmental outcomes. Such research endeavour would certainly promote this circular system change perspective across different industries.

However, the following chapter summaries the main findings of the study.

6 SUMMARY

Global firms are at the forefront of present-day worldwide economic prosperity and development. However, this vast fortune produced by the global firms has also contributed to a social problem, popularly known as climate change and carbon dioxide (CO_2) gas emission in the natural environment from industrial processing and supply value chain activities. As a result, adoption of circular economy concepts in business operations are gaining much research interests. Extant literature argues that circular economy concepts in business can be considered as an effective tool to implement overwhelmingly discussed sustainable business development strategies. A such a system change perspective to closed loop thinking can help those global energy and manufacturing industries in particular to ensure adoption of circular economy principles.

Wärtsilä's the Power to X project reflects its strategic vision for a carbon neutral smarter society. The global firm believes that decarbonization has a generalized essential part for the firm's global operations and strategic missions. However, the empirical data analysis has identified that all the four implementation strategies discussed in the theoretical framework have been utilised in the Power to X project and especially cleaner production using renewable materials, and zero waste policy have been found to be most effective strategy from the experts’ point of views. Based on the data analysis it is possible to argue that the Power to X project could be a catalyst of system change. These findings corroborate with extant literature that held cleaner production using renewable materials and zero waste policy as catalysts for three interrelated practices such as a) pollution prevention, b) toxic use reduction, and c) design for environment.

The empirical analysis also reveals that Wärtsilä’s Power to X project has ensured implementation of different circular economy strategies by utilising certain measures. For instance, the Power to X project has utilised a balance between Wärtsilä’s corporate mission with the circular economy vision for the future, design thinking, and adopting an environment friendly approach to reduce CO_2 level, etc. to implement the Eco-design circular economy strategy. Furthermore, beyond the scope of the identified literature, this study contributes to the existing system change perspective literature by adding value co-creation and industry alliances as a new effective circular economy implementation strategy. The empirical analysis suggests that Wärtsilä has utilized industry alliances with incumbent local industries, cooperating in joint design and research, engaged in joint investment to create jobs, etc. in implementing value co-creation and industry alliance strategy. The empirical analysis also reveals an anonymous agreement among the interviewees to consider recycling as the priority number one circular economy principle that the Power to X project wishes to address. This view towards considering recycling as the most important circular economy principle corroborates with previous studies and extends the current literature of recycling as an important circular economy principle. However, it is an unexpected empirical finding that recovery principle has no influence for the Power to X project.

The empirical analysis also contributes extant literature of so-called Net-zero emission pledge scenarios. The study reveals that cleaner production using renewable materials requires moderate and leadership scenarios to conceptualize the commercialization of system change perspective. The study communicates experts' opinions on the future potential of the Power to X project to create a lot of jobs and numerous business opportunities to the incumbent industries. However, these findings of possible job creation and business opportunities for incumbent firms also corroborates with previous studies and contributes to the literature by highlighting the economic and environment benefits of utilizing circular economy strategies.

Finally, the findings of the study provide many important managerial implications for the business development managers, technology development managers and innovation project managers of the global firm working with circular economy strategies.

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APPENDICES

Appendix 1 The Interview Guide

Background question

- Could you please briefly introduce yourself and talk about your professional background?
- How long have you been working in your current position?
- What does the concept of circular economy mean to you?
- How is this concept perceived in your organization?

Theme 1. The system change perspective in the Power to X Project

- Could you briefly discuss the idea of the Power to X Project?
- How important the systematic change towards a circular economy is to your company? Why? Why not?
- What is the role of this project in the change towards a circular economy in the energy industry in general?

Theme 2. Implementation strategies of the system change perspective in the Power to X Project

- How have you implemented the system change perspective in this project?
- What are the strategies that your team have utilised?
- Based on your experience, what are the most effective strategies for creating a circular economy strategy?

Theme 3. The role of the system change perspective in the Power to X Project to achieve circular economy principles (Reduce, Reuse, Recycle, Recover)

- In what ways has the Power to X project enabled you to achieve the principle of reduction in your industrial/manufacturing processes?
- How does this project help your industrial/manufacturing operations to achieve the principles of reusing input materials?

- How does this project help your industrial/manufacturing operations to achieve the principle of recycling waste materials?
- How does this project help your industrial/manufacturing operations to achieve the principle of recovering waste materials for future material inputs?

Reflection

- What has been the most important learning about the system change perspective and the circular economy strategy from the Power to X Project?
- What are the main challenges that you have identified while utilizing a system change perspective?
- How did your team overcome those challenges?

If you have anything else to share, please feel free to mention it before the interview ends.