Tampere University

Sohaib Hussain

CIRCULAR SUPPLY CHAIN MANGMENT

EVALUATING CIRCULAR MODELS, TECHNOLOGY AND COMPETENCIES IN MANUFACTURING INDUSTRIES OF FINLAND

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ABSTRACT

Sohaib Hussain:
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For any foreseeable economy and society, the industry is an integral part as a provider of employment and essential materials as it is connected to almost all industry value chain. Yet, the industry faces major challenges and uncertainties. The Finish manufacturing industry have experienced rapid growth in recent years. The rapid growth has raised both hopes concerning the economic benefit and fears of environmental degradation.

The industry in Finland has is heavily dependent on the imported concentrates and the research is focused on defining the level of impacts of the environmental impacts of the domestic and international supply. Environmental sustainability is the point of focus among the Finnish companies with major adjustment seen in the production machinery and the source of raw materials. Manufacturing companies have in the recent time implemented the circular supply chain management whereby in addition to mining raw material the recycles material what is already in the field to create a new product. Companies are looking to implement the circular supply chain management to ensure that raw material sourcing is sustainable through the wide application of recycling. Supply chain management has a significant role in closing the circulatory gap in resource sustainability in the industry in Finland. While the focus is significantly on circular business model, technology and how it can be used to enhance the supply chain and sustainability in the industry.

PREFACE

This paper was written as the Master Thesis of Industrial Engineering and management department. This paper presents the circular economy integration into the supply chain management. The research topic was based on the circular business model, technology and competencies

I would like to thank Assistant Professor Mohammad Moshtari for supervising my work, and for complete guidance and assistance. His precious remarks helped me to find and visualize ideas.

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List of Symbols and abbreviations

CE	Circular Economy
CSCM	Circular supply Chain Management
GSM	Green supply chain
SSC	Sustainable supply chain (SSC),
ESC	Environmental supply chain (ESC)
CLS	Closed loop supply chain
DFD	Design for Dismantling
CBM	Circular Business Model

1. INTRODUCTION

The industrial sector in Finland has experienced rapid growth in recent years. The rapid growth has raised both hopes concerning the economic benefit and fears of environmental degradation. The industries in Finland is thriving to reduce more impact on the environment through higher quality material produce globally, sustainable procurement solution, efficient transportation throughout all the circular flows of raw material with a lower weight, fuel consumption and increased load capacity and using more scrap metal in the production instead of virgin raw material (Farouqe et al, 2019). All these steps can lead to minimizing the circulatory gap and CO2 emissions.

Environmental sustainability is the point of focus among the Finnish companies, with major adjustments seen in the production machinery and the source of raw materials. As a result, the companies have made a significant investment in energy efficiency to reduce emissions and increase sustainability value. Supply chain management is at the core of sustainability since this is where value creation mechanisms can be implemented, and reverse supply chain imposed (Genovese et al. 2017). Circularity in the supply chain is highly valuable; however, the linear supply chain is also equally valuable and easy to achieve (De Witet al. 2019). Consequently, it is imperative to identify the drivers and the impediment of the circular chain management in order to model the way forward.

Research Question

The research question is based on the understanding of the CSCM business model that can transform the linear supply chain mnagement into the CSCM. The business model in the circular economy is important as it is the base of transformation. The second research question is the technology which can assist the CSCM in industries in Finland. New technology and digitization are important factors and understanding of the emerging technology as well as scale-up technology can help in circular supply chain management. The third question is skills and competency that the companies required in the supply chain management position. In this question, we tried to figure out the weightage of circular and sustainability knowledge and skill required in the position.

Research Objective

The companies are looking to implement the circular supply chain to ensure that raw material sourcing is sustainable through the wide application of recycling. For instance, Boliden companies have in the recent time implemented the circular supply chain management whereby in addition to mining raw material it recycles what is already in the field to create a new product (Boliden website). In this thesis, research objective is to understand the circular business model in Finnish Industry to the and to identify the technological innovations and competency that facilitate implementing circular supply chain in the Finnish manufacturing industry.

In this thesis, we plan to identify circular business model that can help in achieve the circularity in business model. Second objective is that these SSCM technology and competencies require updates and development over time, especially in the age of circular economy and growing digitalization. In this thesis, we plan to identify emerging, improving, mature as well as scale up technology. On the other side new knowledge and skills required in SCM position In Finland.

WHY CIRCULAR SUPPLY CHAIN MANAGEMENT?

There is a major gap in the industry that is aiming at achieving circular resource use to attain sustainability. However, the integration of a circular economy and strategic supply chain management can significantly reduce the gap. In particular, understanding the circularity value, the flow of material from a wider perspective is required through supply chain management. Notably, the linear supply integrated with activities from the circular economy can significantly close the chain leading to resource sustainability with minimal value losses (DE Angelis, Howard and Miemezyk 2018). Therefore, there is a need for research regarding the role of supply chain management in resource sustainability through the closure of the circularity gap. So, the research in circular supply chain management is the need of today. Finland has an opportunity to support the global shift to a circular economy through a leading innovation in technology and new business models.

Why Finnish Manufacturing Industries?

Notably, environmental sustainability is the point of focus among the Finnish companies, with major adjustments seen in the production machinery and the source of raw materials. As a result, the companies have made significant investment in energy

efficiency in order to reduce emissions and increase sustainability value. For instance, in 2017, Outokumpu invested EUR 114 million for environmental sustainability activities (Annual Report 2017).

The manufacturer company in Finland are working in the circular economy .Steel making company Ovako are also making most of ther product from recycled steel scrap (Source Ovako Website). The business value chain of steel sector desribe how value is created ,which takes different type of inputs and transform them int output through business activities. The company like SSAB aims to increase the sustainability of their product in every phase of the life cycle from a raw material exraction to recycling at the end of product life cycle. (Source: SSAB website).

The strategy has seen changes in the outlook of supply chain management as the manufacturing companies are looking to implement the circular supply chain management to ensure that raw material sourcing is sustainable through the wide application of recycling (De Angelis, Howard and Miemezyk 2018). For instance, Boliden companies have in the recent time implemented the circular supply chain management whereby in addition to mining raw material it recycles what is already in the field to create a new product Boliden website). Therefore, supply chain management has a significant role in closing the gap in resource sustainability in the manufacturing industry in Finland.

The manufacturing industry in Finland are thriving to reduced more impact on the environment through higher quality material produce globally, sustainable procurement solution, effecient transportation throughout all the circular flows of metal with lower weight, fuel consumption and increased load capacity and using more scrap metal in the production instead of virgin raw material. All this steps can lead to minimize circulatory gap and Co2 emmision.Manufacturing company like SSAB and Ovako are working to reduce the environmental impact from supply chain, including the use of large proportion of rail fright , increased co loading and modern vehicles. The manufacturer in Finland wants a substantial proportion of delivery directly to the customer which means that it will reduce unnecessaary transport.

Thesis Process

The research method for this thesis were entail the systematic literature review. A systematic literature review facilitates the use of varied written sources that are relevant to

the topic. Therefore, the methodology entail the use of various databases and universities library to identify books, journals, and paper to be used in the project (Bowen 2009). Consequently, the initial step included the identification of the relevant papers from varied sources over the internet and physically from the library. The filtering process was follow using keywords which were supply chain management, circular supply chain management, circular economy, sustainable supply chain, and manufacturing industry in Finland

Further filtering was done to include recent material dating at almost 10 years back; however, the classic literature works will not be eliminated from the pool of references. The filtering process will usher a more explorative method where each resource was analyzed according to the theoretical perspective, the methodology used, and the final findings before being recorded (Bowen 2009). The results from the systematic literature review will be used to identify themes in a circular economy that link to the supply chain management to resource sustainability in order to develop propositions for the thesis.

In the first phase, the literature review was conducted regarding the circular economy, circular supply chain, and supply chain management process. How the circular economy integrates into the supply chain management value chain, the procurement process, waste management process, etc. In the data gathering, the data was collected about the business model using by the Finnish manufacturing company with the help of articles, statistic from the official website, and company website. The second research was on the technology that can assist in the transformation from linear supply chain management to CSCM. And in last the research was conducted about the skills or requirements that the company is asking for which is related to the CSCM with the help of the job portal or LinkedIn website. Through this, we will be able to understand the role of the circular supply chain, to how extent the companies are working on the circular business model. And what are the technology that can assist in the transformation and got an idea related to the skill and competency in the job requirement of SCM?

In the third step analyzed the information generated in the previous steps. 1) provide insights for Finish metal companies regarding that which circular business model is using by the manufacturing industries, identify the role of technology in CSCM in closing the circulatory gap to achieve resource sustainability in the Finnish manufacturing Industry. 2) Discuss the skills and competency requirement in the CSCM position in Finnish industry, 3) offer suggestion for the implementation and future perspective in the field of technology and the skills in Finnish industry and discuss the local and global opportunity.

LIMITATION

The literature review has some limitation. We have just included the paper that are in English and may be some important loss of knowledge for not including paper, articles in other language. Due to pandemic the limitations were faced in the research process too. In the data collection most of the data were gathered from the literature study, articles, statistics department and paper. In the competency and technology, the data were gathered mostly from the web. So, there is no expert opinion related to the topics were involved as it was mostly depending on the data which are on the web. We were not able to include the expert opinion from the industrial sector regarding the business model, technology and competency. CSCM is rapidly developing and technology, competency need to be update in years to keep with the progress.

In future the expert opinion can be valuable in understanding these research topics and by visiting the manufacturing site can also bring the insights regarding the circularity and supply chain management. Competency topic was more focused in the literature sections and in data analysis we were unable to include the industries required skills and competency outside from web. In future, the interviews from the supply chain manger can also reveal the new competencies and skills in CSCM.

2. CIRCULAR SUPPLY CHAIN MANAGEMENT

2.1 Circular Economy

Circular Economy (CE) is highly identified as an alternate to the linear economic model (make, use and dispose). CE philosophy is based on an effective driving force which is recognized as of the great potential to support industries in sustainable and economic performance too. (Hobson et al 2018). The CE is defined as the regenerative system as it is shown in Figure 1.

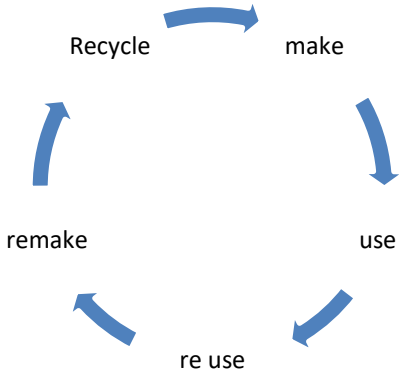

Figure 1: *Circular Economy (Adopted from Catherine Weetman 2016).*

The economy prior is on the linear system that have one way of producing goods. Linear do not concerned to the regenerative ideas. And this economic paradigm has raised the concerned related to the resources in the future. Because planet has the limited amount of resources and its accessibility includes a lot of process (Zakarya et al 2018).

Figure 2: Model Linear Economy (Adapted from Jianguo et al 2016).

According to the statistics approx. 269,000 tons of plastic contaminate the world ocean and USA dispose 40 % of its food stuff and 70 to 80 % of its construction and demolition waste to landfills and Europe send approximately half of its wastes which is approx. 2.3 billion ton to the landfills (Barbara Kaiser,2016).

The CE can also be defined as the process that is restorative and treating everything in the economy as the valuable resources. CE also describe as a process where product

through repair refurbishment and remanufacturing can extend the product life and maximize the value of the product, material (Carter.M 2019). This idea is progressing into a powerful pushing force that is sustainability both in practice and writing (Hobson et al,2016) and it can help the industry to achieve an innovation in sustainability. CE describe a world where the use of material is maximizing to its highest level of value and the business opportunities from CE are potentially huge but it required more circular product service solutions which means rethinking in business model from manufacturing, supply chain , reverse logistics , remanufacturing and logistics to marketing and communication (Carter M, 2019). The CE is a system in which the material will be in a closed loop and the product can generate more value and can be used for more cycles.r Second is remanufacturing in which end life product are returned (Wang and Kuah,2018), third is sharing or collaboration for the maximize utilization of utility. Fourth is product life extension in product are design for longer period of time (Tse et al..,2015).

The CE terms drew other concept launched such as space economy (Boulding 1996), limits to growth (Meadows et al 1972), Steady state economy (Daly 2005), performance economy (Sthael,2010). Circular Economy other definition have been found in the literature is as follows:

1) The flow of material in an industrial economy should be circular at a high rate without entering the biosphere (EMF, 2012).
2) An industrial economy relies on renewable energy, through circular deign it can eliminate toxic chemical and remove waste. (EMF,2013).
3) Different value creation mechanism which can help the industry to grow (EMF 2015 a, EMF 2015 b).
4) Reusability of product and material in an economy which minimize the value destruction and maximize the value creation (Bastien et al).

It should be noted that the above list of CE definition is not complete and may existing the non-reviewed literature The most common principle is stock optimization that maximize the resources It recognized the resources are limited and from this many concept can be established
:

1) The “spacemen economy”, which suggested that the replacement of the conventional linear value chain to the cyclic or circular system. (Boulding 1996).
2) The “steady state economy “
3) The “limits to growth” the exponential growth of the economy and population with

finite resources supply.

4) The concept in which there is a closed loop and the approach that is cradle to cradle (Stahel and Reday-Mulvey 1981).

One of the approaches that can be used in CE is Eco efficiency. It is described as that this approach helps to decrease the waste and in the same time also increased the productivity (EMF 2012). There is another concept which is eco effectiveness (EMF, 2012). which transform the product and material flows. The objective of this approaches to (EMF 2012) is to be more cradle to cradle rather than slow down the cradle to grave process. The approach of circularity differs among the approaches that is back to the original manufacture. (WEF 2016) suggest the complete cycle of the for-CE extent.

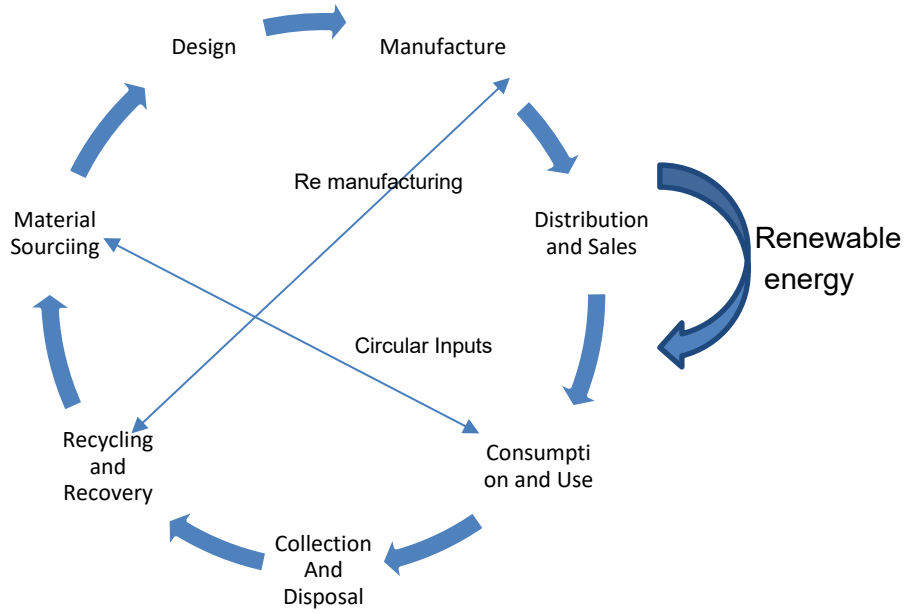

***Figure 3**: Resource Flow Through a Value Chain. (Adapted from Yulia et al 2018).*

In Figure 2 the value chain driven from the renewable energy and the material flow is in the closed loop. And in the closed loop sharing between the use and material sourcing can be possible because that used and consume product have sometime valuable material. The other sharing is between recycling and manufacture which is possible to re-manufacture or refurbish to be used again.

2.2 Circular Supply Chain Management

The planet resources are limited so therefore the term circular supply chain management CSCM have gained a lot of importance in this era, the degradation of environment is also a factor that the economy and value chain shifting towards the sustainable and circular practices. The interest in investigating in circular supply chain is increases over the past decades (Agarwal et al 2015). Supply chain is defined as the process that include the sourcing of raw material then manufacturing and assembling and then deliver the final product to the customer (Beamon ,1999). Sarkis (1999) believed that a traditional supply chain is based on the linear flow of material and fail to include environmental aspect and management of life cycle product. Through sustainable supply chain management, it can Minimize the material flow in production and can reduce the waste through the supply chain (Sarkis et al 2011). In SCM there are number of concepts such as Green supply chain (GSM), Sustainable supply chain (SSC), Environmental supply chain (ESC) and Closed loop supply chain (CSC) has been used (Gurtu et al 2015). While “circular supply chain” can be used to link CE with SCM (Canning,2006).

According to Elkington’s (2004) idea of a triple bottom line (TBL) which say that sustainability of organization depends on the natural environment, society and economic performance (Carter and Dale,2008). Based on these three components different terminologies can be emerged from the literature for e.g. sustainable supply chain, green supply chain and closed loop supply chain (Souza 2013). CSCM is applicable to manufacturing as well as a service product with a circular economy approach. Now in compare with the circular supply chain the linear and closed supply chain can be illustrated in Figure 4.

In this linear supply chain, the raw material extract from the environment and the End of Life (EOL) product and the waste material dispose to the to the landfills as shown in Figure 4. While closed loop supply chain improves the performance of environment by recycle the useful material and packaging to the producer (Guide Van Wassenhove,2006). However, the closed loop is limited if the recovery is concerned because there is restriction with original supply chain and there is no secondary supply chain is involved (Toffel,2004). But still closed loop can recycle a substantial amount of useful material within the same supply chain (Weetman 2017).

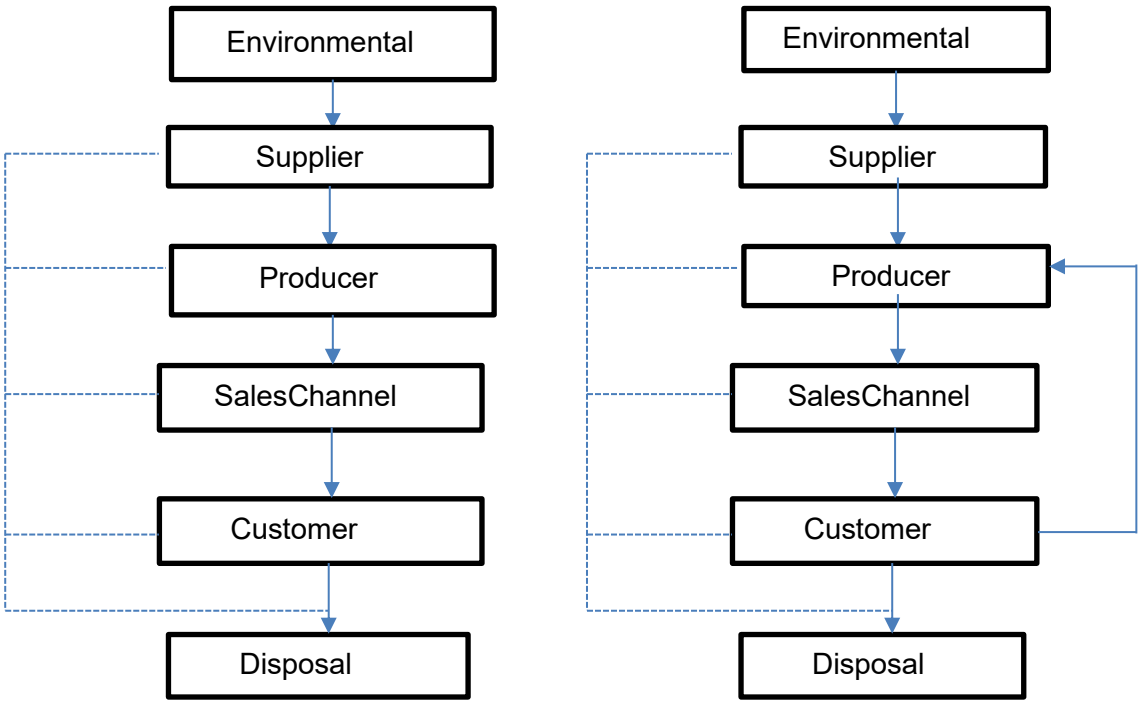

Fig 4. *Linear and closed Supply Chain (Adapted from Farooуqe et al)*

Circular supply chain goes further step and it is recovering from waste by involving or cooperating with other organization in the same sector or different sector as shown in Figure 5.

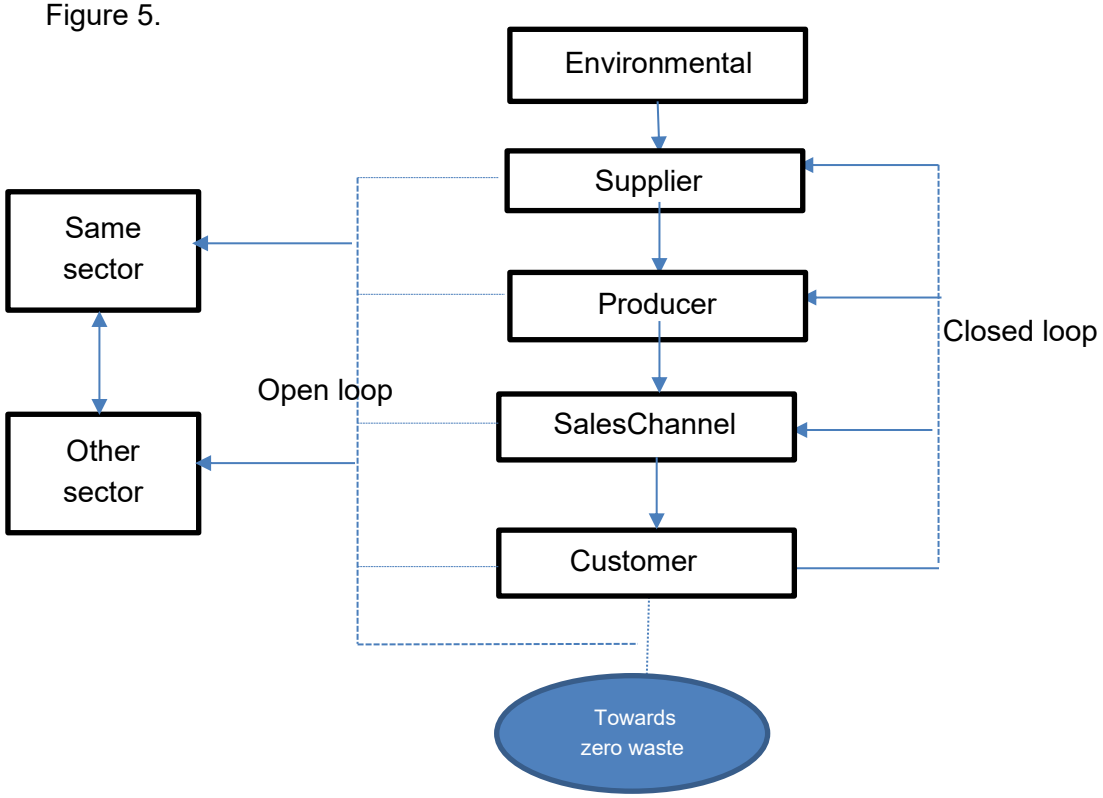

Figure 5. *Circular Supply Chain (Adapted from Farooуqe et al)*

CSCM is the concept that based on the no waste or zero waste because it can restore in to the same industrial sector or the waste can be used to other sector too.(Faroouqe et al 2017).The two type of resource are as follows

1) Primary Resource Flow
2) Circular Resource Flow

The resource in which the goods flow in the linear and closed loop supply chain is known as Primary resource flow as shown in Figure 4. Whereas the re type flow of goods, material or energy that can be recycled, retained, reused is known circular resource flow. Through system wide innovation CSCM endeavour to produce zero waste. For example, textile product or PET bottle recycles can be used in construction industries (Nasir et al 2017) while a food waste can be used to produce energy (Genovese et al 2017).

The idea of CSCM emerged in the early 1970 in which environmental factor is concerned in the supply chain. Michigan University (Manufacturing Research Association) put into view the concept the CSC in 1996.CSCM aims for full reflection of the environmental degradation and resource utilization. It helps to minimize the impact of the supply chain management of manufacturing industry and resource utilization. It introduces new supply chain design from the perspective of sustainability. The design is made for the whole supply chain from raw material purchase, manufacturing process, end user consumption to the waste recycling. The close cooperation among inside the industry and between the industry for the environmental management in the whole supply chain to achieve the better environmental optimization. The comparison between circular supply chain management and linear can be made as follows:

1) Circular supply chain management considered three problems i) supply chain management problem ii) Environmental problem iii) resource optimization problem while linear or traditional supply chain didn’t concern with the environmental protection.
2) CSCM focuses on the economic activity as well as the environmental protection as well as the resource optimization while traditional supply chain mostly focusses on the economic benefit.
3) The information transmission involved in the linear supply chain is very common and present while CSCM increases the information regarding environmental effect, resource protection and energy flow of supply chain management.

4) The function of the tradition supply chain is Time Quality, Cost, Services while the function CSCM is Time, Quality, Service, Environment and Resources.

2.3 CE Integration into CSCM

Each function of supply chain management must integrate into CE so the transition from linear economy into the CE can be possible. This required a change in business model and a practice related to the product design to the consumption and re used (Hobson et al 2017). This start from the circular or green design and then the different practices in each function of supply chain management such as green procurement and production, consumption and re used or recycled must adopted. Consumption and recycle are the most important and critical part of value chain and CE (Masi et al 2012).

2.3.1 Design of the Business Model or product

Product and business model design are the most essential part for the material and energy consumption so therefore the design of product/service have the great influence in the supply chain (De los Rios and Charnley 2017). Designers must look to the different aspect such sustainable packaging, product labelling and must reply to the different social, economic and environmental aspect. The approach must be in accordance to circular business model and match all criteria that lead to the CE transition (Andrews,2015). There are great number of literatures regarding the design strategies on circular business model and the different product design practice in accordance with the circular business model as shown in Table1.

	Product or Service. Design Practices	**Practice accordance to the Circular Economy Model**
1	**Design for Re Used**	The design for reused is practice in which the product are materials that have the long life and can be reuse for the primary phase of the production. By using the recycled material, it can slow down of resource flow. (Moreno et al 2016).
2	**Design for Repair and Maintenance**	This referred to the prolonged use of the products during the use phase (van den and Bakker,2015). To retain the functionality and restoring the product

		to a good condition after decay of the serviced product the maintenance and repairing is required.
3	**Design for Redistribute or Re use**	This referred to the discarded good can be reuse or distribute to the same segment or other segment so the life span of goods beyond the first life cycle. (Potting et al 2017).
4	**Design for Re furbish**	It concerns with the practice that is less than remanufacturing but more than repair. But the quality becomes more valuable as compare to repair. (Sihvonenand Ritola, 2015).
5	**Design for Remanufacture**	It is referred as the restoring the product to as new quality. It can restore the activities which affect the related reverse flow strategies. (Bakker et al 2014).
6	**Design for Dis assembly**	It is referred as the product and part can be assembled and separated quickly and easily that can be used for different cycles in circular economy (Bocken et al 2016).
7	**Design for Recycling**	Allows recycling of material and it is a recovery operations b which waste material are reprocessed into original or other purpose. (Bocken et al 2016).

***Table 1**: Product or Service Circular Design*

European waste framework directive (EC,2009) is one of the guiding principles that can help to design the whole process of circular. Design for a circular product is an important for CE because the whole process is based on the circular design and therefore it has a great importance in CE.

2.3.2 Procurement and CE

According to (Meehan and Bryde, 2011), CE will redefine price, quality, time and value for money principle in the procurement function. Generally, CE requires raw material that is restorative or biologically regenerative and have negative impact on the environment (Genovese et al 2014). There are three types of models for implementing circular procurement:

1) *System level*: The purchasing organization can make the contract on the basis of circularity. For example, take back agreement or product service system.

2) *Supplier Level*: It depends on the supplier that how much their system and processes are circular in order to ensure the product and service they offer meet circular procurement.
3) *Product Level*: Focused on the product that suppliers to public authorities may themselves procure further down the supply chain.

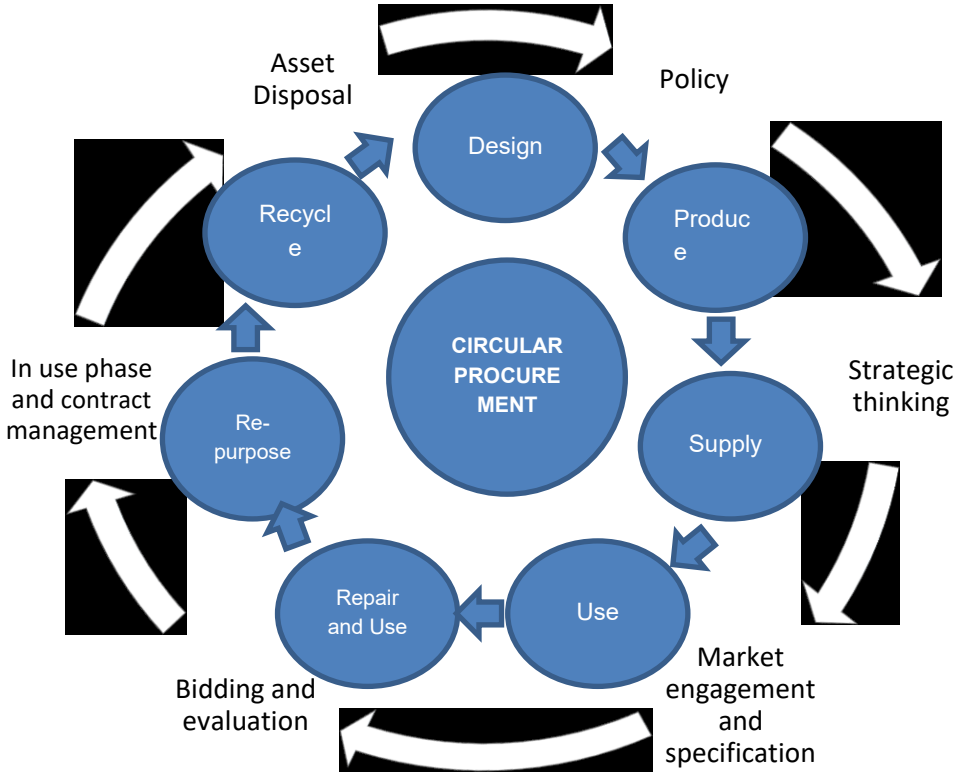

***Figure 6**: Circular Procurement*

Public procurement framework based on the CE includes technical and non-technical product/service procurement and the it provides the guidelines for reducing raw material use and improving resource optimization through recover and lower waste. (Witjes and Lozano 2016).

2.1.3 Production and CE

For a manufacturing industry it is essential to reduce a resource consumption in the production process to maintain a competition and survive in today's sustainable era. (Ridaura et al 2018. Sustainable manufacturing practices and CE have started adopting by a manufacturing industry to diminish environmental risk. (Moktadir et al 2018). By adopting sustainable production practices nowadays, it can not only cut down the cost, but it also improves the brand image and investor interest (Dubey et al 2015).

Many method and strategies have been developed in the manufacturing industries due to increase in the material efficiency (Shabazi et al 2016). Green manufacturing and cleaner production are two highly used term in the material efficiency context, but cleaner production not only cover cleaner production but also service activities. The method to produce clean, environmentally friendly, conserve the energy and reduced the waste and also economic benefit is known as cleaner production (Cui and Song 2009). In cleaner production it is also essential to stop the use of non-re-new able and harmful input. Clean production aim to increase efficiency and in the same side reducing damage and risk of the environment (Brown and Stone, 2007). Integrating CE into sustainable production can achieved substantial energy saving and reduce carbon footprint (Li and Ma 2015). Sustainable and circular production can enable the CE practices for other supply chain functions.

2.1.4 Logistic and CE

The government legislation has pushed organization to Redesign the logistic network to ensure the environmentally friendly and cost efficient. (Frato Neto et al). Taking account of environmental and social factor Green Logistic is identified as generating and distributing goods in a green way. The distribution strategies should be made according to the environmental impact measures. Traditional logistics based on the forward distribution i.e the transport, ware housing and inventory management form supplier to customer, whereas reverse logistic is known for the sustainable logistics. So far reverse logistic have been mostly integrate to CE. The definition of reverse logistic given by the Rogers and Tibben (1998) " the process of designing ,executing and managing the effective flow of material from the point of utilization to the point of origin for the purpose of re capturing value or proper dumping. Remanufacturing and re furbishing can be included in the reverse logistics. According to Rogers and Timbekken reverse logistics also include the re stock, excess inventory, damage product to be used again. Marco Serrato gives the relationship of the product life cycle and rate of returns with reverse logistic. The six phase of the life cycle product which is given be Tibben -Lembke (2002) as shown in Fig 5:

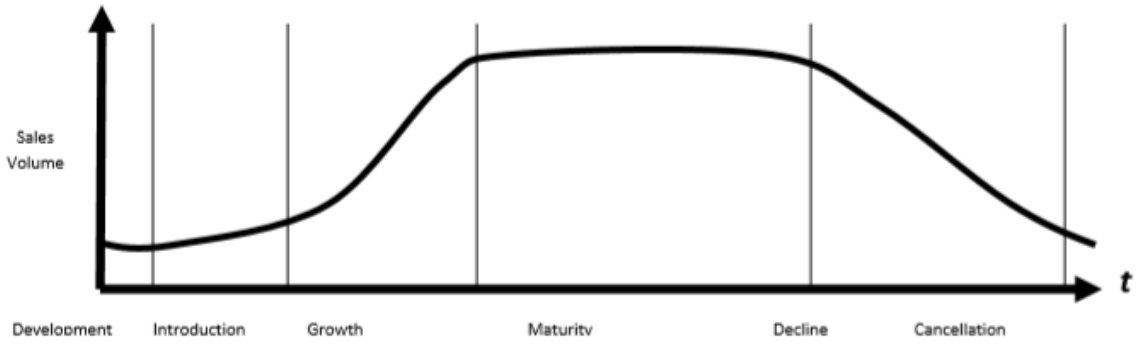

Figure 7: Product Life Cycle

As shown in Figure 5 the first stage is development phase in which there is no return in because there are minor changes in the product. Second stage is introduction in which firms started to make plans with the product that will be return at this stage. Because in this phase the new product with minor modification can replace the existing product and the demand can be expected to be very similar as the previous model. In third stage Growth phase means the product is accepted in the market and the sales increases and in the same side the return is also increased. Fourth stage is the maturity, in this phae the sales of the product reaches to the maturity so the return of the product meet stability. The volume of return depends on the volume of the sales in the same period. Next stage is decline phase in which the reverse logistic worked till the end of this phase. In this the phase the sale and price started to decline. Last stage is cancellation in which the rate of return will continue to decrease and at some point, it stopped. Retailer can also send back the product which is unsold.

CE have many effects in the logistics management and so far, reverse logistics have been observed that is most relevant integrate in CE. The importance of secondary market in take out the value from product and helped to encourage the re use of product in relation to reverse logistics (Dhakal et al 2016).

2.1.5 Consumption and CE

Circular economy philosophy has proposed more sustainable model in which useful resources are re used and reduced waste (EMF 2013). In the CE context consumption is an area of interest and it depends on the consumer. According to the studies of electronic waste collection program in mobile phones which is conducted by Canninng (2006). He suggested that customers start to accept refurbished mobile and must cooperate to return unwanted phones. van Weelden et al analysed that mostly consumer rejected the refurbished product due to lack of awareness. The transition towards CE requires

change in consumer perspective and behaviour and it can achieve by the effective awareness campaign and sustainable education.

2.1.6 EOL and waste management and CE

End of Life (EOL)and waste management in CE context is critical important for recovering the value and increase the use of resources. With the increase of waste generation under inefficient management can lead to the major challenge in the developing and non-developing countries. The generation and types of solid waste in Table 2 as

Source	**Type of waste generator**	**Solid waste**
Residential	General Public, Family,	Food waste, Paper, glass, polymer, electronic item, household waste
Industrial	Manufacturing plant, Chemical plant, Power plants etc	Packaging waste,
Commercial	Hotels, restaurants, markets, offices.	Paper, construction and demolition material, food waste, glass, metal, e-waste
Institutional	Schools, University, Airports etc	Same as commercial
Construction and demolition	New construction sites, new building demolition of building	Steel, concrete, bricks, tiles.
Municipal service	Street cleaning, parks, beaches, wastewater treatment	General waste from park, beaches
Process	Chemical plants, Refineries, Mineral extraction and process.	Industrial process waste, scrap, slag etc.
Medical waste	Hospitals, nursing home, clinic	Blood, medical waase
Agricultural	Crops, diaries, farms etc	Agriculture waste, Hazardous waste (Pesticides).

Table 2: *Type and Generation of Solid waste (Adapted from What a Waste: A Global Review of Solid Waste Management 2012).*

SWM is a system which is consist of the process that include from collection to the recovery or for land filling as shown in Figure 6.

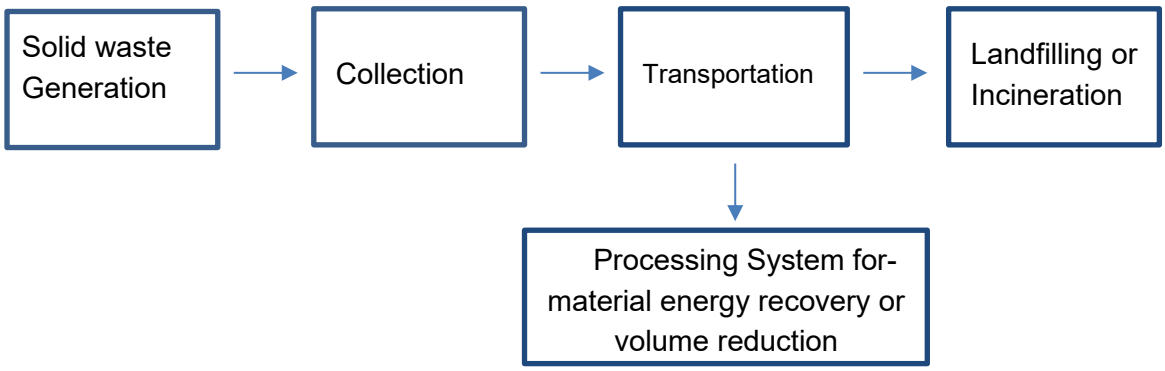

Figure 8: *General Waste Management (Adapted from A.V Shekdar)*

Waste management Hierarchy is an approach to take full advantage of the upstream waste management hierarchy and also known as EOL resource recovery methods. These include repurposing, refurbishing, remanufacturing and recycling as shown in Figure 5.

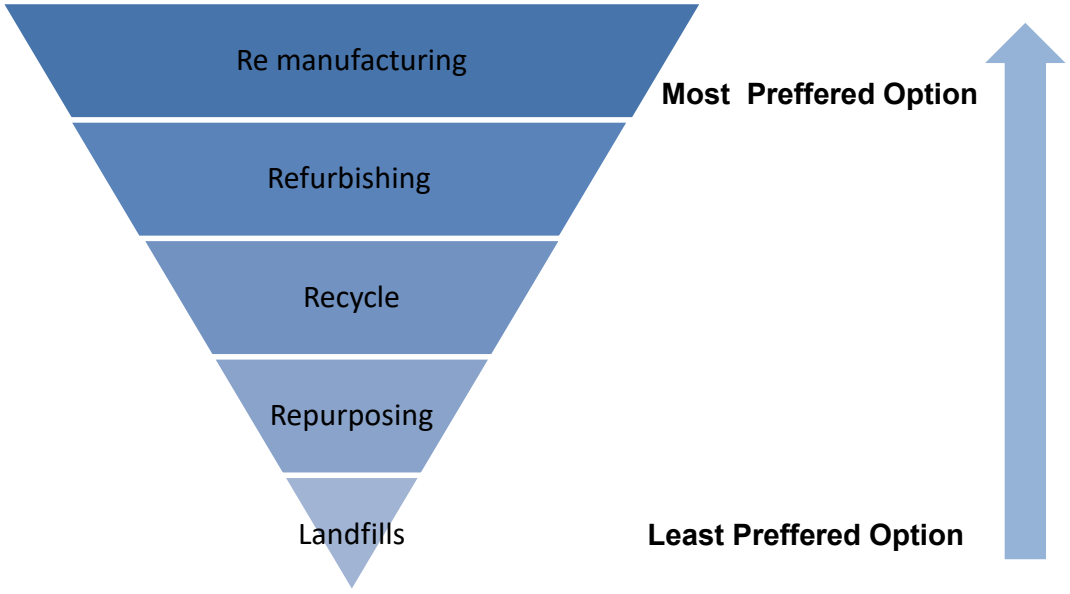

Figure 9*: Waste Management Hierarchy*

Remanufacturing: It improves the remaining value of used product by transforming them in new condition.(Debo et al, 2015). This process is preffered to other EoL process because remanufacture part is additional green and environmental, advanced in quality and has a long exended lifecycle (King et al , 2016).

Refurbishing: It ia process to restore used product to a fnctional condiion without disassembling the product entirely (Rathore et al, 2011). .It can be useful to recover

value from the used product to re used product. Refuurbishing process allows easy conservation , recapture of product after the EOL cycle. (vaan Weelden et al 2016).

Repurposing: Identified a novel usage for a product that can extended to used by its original form (Long et al 2016). In a CE context the study found that 9 percent of EoL notebook can be re purposed as thin computer without acquiring any expense (Coughlan et al 2018).

Recycle: It can help to to decrease the amount of waste and return of material to economy. In steel industry the waste is an valuable source for steel making which can be recovered from product. (Broadbent, 2016). Various strategy have applied in different industry for recycle. Tires and agriculture product recycle and other plastic waste recycling are examples where pyrolysis technique has been sucessfully used. In construction industry used performance indicators and performed best methods for the mangement of EoL (Navarro 2016). For post user of plastic packaging have huge latent to contributre towards circularity.

2.4 Technology and Competencies in CSCM

In Supply chain management (SCM) technology can help in assist the transformation from linear supply chain management to circular management. It is important to know the trends and understanding of technology and in the same way new circular competencies are among the top required skills for entrepreneurs and managers in the commercial and public sectors (Carter et al., 2009; Isenberg and Coates, 2015; Council of Supply Chain Management Professionals, 2018; Lengacher(2018) to effectively and efficiently conduct SCM tasks like forecasting needs, capacity analysis, logistics and transportation planning, purchasing and supplier management, coordination, and sustainable and responsible supply chains.

2.4.1 Technology

As emerging technology can help in the transition towards CSCM, so understanding and knowing of technology is essential in CSCM. Fourth Industrial revolution technology such as Industry 4.0 which is enabled by smart technologies such as Internet of Thing IoT, augmented reality, big data analytics, cloud computing, simulation, industrial automation 3D technology and cyber security (Nascimento et al, 2018). Recently Waste Electrical Equipment (WEEE) has become a severe environmental thread due to the pace of technological change over and the throw away culture in most end user society. For smart

and zero waste sustainable cities IoT enabled waste management (WEEE) framework helped in linking waste management to the whole product life cycle. (Esmaeilian et al 2018). This suggested idea is based on the four strategies such as waste prevention, upstream waste separation, on time waste collection. According to Alvarez et al (2017) the induction of co-operative robots into recycling lines can help to enhance the recovery of valuable components and material. A new product design methods/technique including Design for Dismantling (DFD) has grown in many business sectors. DFD offers value to the product at EoL stage but also during the consumption and maintenance stages (Sabaghi et al, 2016).

3D printing has possible application in CE but there is inadequate knowledge on the scope to which 3D printing modifies the sustainability. There is a noteworthy case of 3D printing application in CE perspective, Zhong and Pearce (2018) collects the plastic from electronic waste into 3D printing filament and produce useful consumer product such as camera, tripod etc. With the help of above literature, we tried to figure out the new technology competency requirement in each circular supply chain management function in Table 3.

Supply chain Management Function	**Recent Technology Used in Supply Chain**
Procurement	1)Cloud based technology and IoT things. 2) Big Data Analytics 3) Block chain technology
Production	1) Clean production technology 2) 3D printing 3) Industrial automation 4) ERP software
Logistics and Transportation	1) RFID 2) Robotics and automation 3) Artificial Intelligence 4)Transportation management system 5) Block chain technology

EoL waste management	1) Internet of thing IOT 2) Industrial Automation 3) Design for Dismantling

***Table 3**: Recent Technology Used in Supply Chain*

Even though each technology has the specialist in every organization but as a supply chain specialist the knowledge of this technology is essential.

2.4.2 Policy Maker or CSCM Business Model Design Competency

CSCM requires complete rethinking in the whole supply chain management process, the whole process required competencies in designing product, processes and supply chain (Bakkar et al 2014). According to den Hollander et al (2017) the European waste Hierarchy described about the waste hierarchy is one of the guiding principles for eco design which gives a detail of managing waste. There are several competencies in the literature related, but the five key sustainable generic competencies for policy makers and designer for circular supply chain . There are (1) system thinking, (2) anticipatory (3) normative (4) strategic and interpersonal competencies as it it shown in Table 3:

Generic Competencies	**Design for Circular Economy**	**Concept and Methods**
System thinking competencies	• System thinking and holistic thinking.	**Concepts:** • Restorative and regenerative by design • Circularity thinking **Method:** • Circularity compass and circularity grid

Anticipatory Competency	• Considering product wear over time during process • Designing for multiple use cycle • Anticipate how the circular offering will evolve over multiple life cycle.	**Concepts** • Multiple used cycle **Method:** • Circular business model mapping tool • Framework on material change
Normative competency	• Setting circular criteria • Assessing circular solution • Consider the environmental impact On a system level over multiple life cycle.	**Concept** • Measuring circularity • Circular impact assessment. **Methods:** • Circularity indicator • Tool to measure impact of circular strategy
Strategic competency	• Customer perceived value. • Procurement contract on the basis of circularity • Consider circular logistics with user • Connecting reverse logistics with user • Develop circular business model	**Concept** Circular supply chain business model User experience (CRM) **Method** Circular business model canvas

Interpersonal competency	• Circular Supply chain understanding • Circular economy story telling • Facilitate collaboration between internal and external stake holder	**Concept** • Collaboration across value network • Circular economy vocabulary **Method** • Value mapping • Co creation in experimentation lab

Table 4: *Generic Competency*

The supply chain manger should have the knowledge in this particular area in related to CSCM as shown in Table 5 :

Supply Chain Knowledge areas and Technical Competencies	Description
1) Performance Trade off	Design an efficient supply chain according to circularity and deliver high quality product in short lead time
2) Warehouse Management	Control the storage of material within a warehouse in a circular way
3) Transportation Management	Manage transportation operations according to CE framework.
4) Risk management	Identify risks affecting supply, transformation according to CE
5) International Regulation	Know the international regulation, port act, import and export taxes, custom regulation.
6) Customer Relation Management	Effectively collect and analyse sales and marketing. Awareness regarding circular economy consumption

7) Lean tools and six sigma	This tool are used for lean activities. Some tools are follows: Just in Time Kaizen Value stream mapping

Table 5: *Knowledge and Technical Competency*

2.4.3 Occupational Related Competency

The organization and occupational requirement are an important for the graduate student of supply chain management. From the literature we tried to figure out the new trends and requirement criteria of the organization for supply chain specialist in Table 6:

Competency	Description
Post-Secondary Education	Bachelor or master's degree (Supply chain management)
Certification	The professional certification can help to pursue the career in supply chain management the certification in supply chain professional, production and inventory management, transportation and logistics.
Associate Membership	There is some associate membership to develop the network across supply chain management. There are lot of association and society in supply chain management for e.g • Council of Supply Chain Management Professionals (CSCMP) • American Society for Transportation and Logistics (ASTL) • Warehousing Education and Research Council (WERC)

Table 6*: Occupational Related Competency*

Circular supply chain has introduced more new technology, practices and competencies in the supply chain management. The Generic, knowledge and technical and occupational competencies are required regularly update and develop over time especially in the age of circular economy and growing digitization.

3. RESEARCH METHADOLOGY

3.1 Research Process

The systematic approach to the research will help to recognize the requirement and understanding of the circular supply chain management business models and technology that can help to transform linear supply chain management into circular. In this section we proposed a framework for analysing the circular supply chain management and identify the new or existing business models and technology. Furthermore, our research framework and its related process on certain guidelines suggested by Platts (1990) as shown in Figure 8

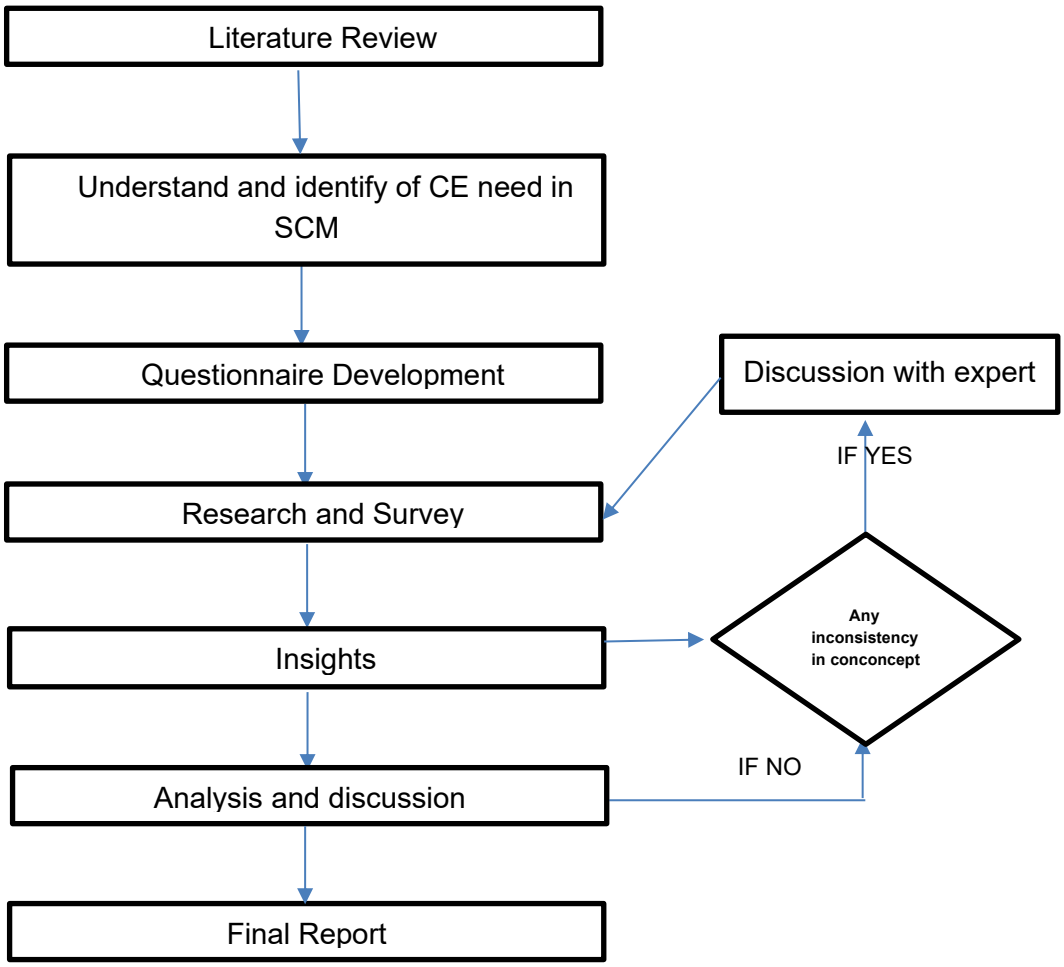

***Figure 10**: Research Flow Chart*

The process involved collecting the literature selecting the competencies and research methodology all are linked to the purpose of this work. And each process of this framework is grounded on literature support. The research framework consists of two phases as it is shown in Figure 9. The literature survey and expert feedback were used to identify the CSCM competencies and skills in Phase 1. The literature based CSCM and its competencies finalized by the supervisor. Phase 2 deal with the competencies identified in the survey and by the expert from the industry.

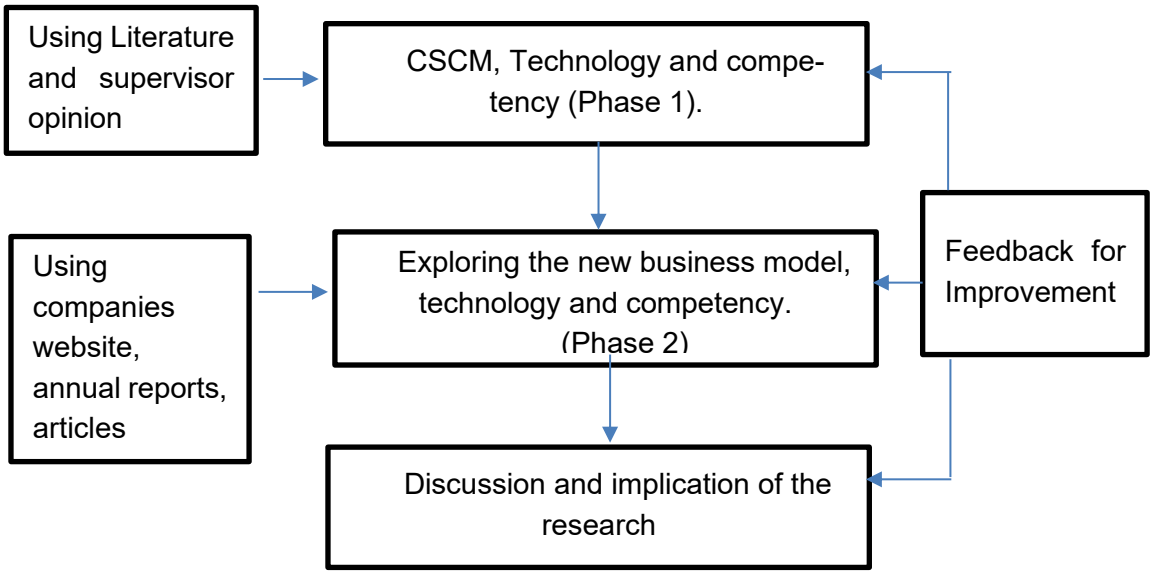

***Figure 11**: Research Framework*

Following are the details that we will carried out in each step:

Step 1: Literature review.

In the first steps, we reviewed the literature using keywords like circular supply chain management, circular economy, sustainable supply chain. While we have already identified and reviewed several studies; we will assess the literature carefully for more recent articles and further possible advances. The sourcing of the article is done by the help Google Book, TUNI web service. To maintain the quality of content the search was restricted to the Clean Journal, Review article and published in peer review journal. And only English review was the limitation and the key words used for the search are as follows.

S no	KEY WORDS
1	Circular economy
2	Circular supply chain management

3	CE integration into CSC
4	Design of the product and CE
5	Procurement and CE
6	Logistic and CE
7	Consumption and CE
8	Waste management and CE
9	Supply chain management competencies
10	Generic competency of CE
11	Technical and knowledge area competency
12	Technology and Circular economy

Table 7: Key words for searching

Step 2: Research

We will conduct a research survey that is based on the data such as papers, news article, interview with mangers available on web and the latest trend in the SCM business model. Through these researches, we will be able to understand the specific issues that are of interest to Finnish companies. Following table shows the research topics and sample question:

Topics	Research
Circular Business Model	The circular business model that the company is working on and practice to develop the circular solution in SCM?
Support and Technology	Which prominent method or technology and tool did the company use in the circular solution?
Competency	What were the missing competencies or required competencies that could have helped in terms of mindset, knowledge for the supply chain management employee?

***Table 8**: Research question.*

The survey carried out for the different companies in Finland and figure out the circular business model that the companies are using and try to figure out some challenges. In the second step what prominent method or technology that Finnish company using in the circular solution and what were the missing competencies that could help in terms of mindset and knowledge and compare it with existing supply chain management course outlines in Finnish universities.

Step 3: Analysis and Discussion

In the third step, we will build the results based on the literature review and research survey results to develop an analysis. From the above literature and survey, we try to figure out the CE integration it into in SCM. The Circular business model that Finnish industries should be acquired, the barriers and technology and missing competencies.

Steps 4: Final Report

In the fourth step, we will analyse the information generated in the previous steps to address the research two objectives. In this section derived the main insight of the research and survey. And the final thesis report will gather all the information and try to figure out the conclusion and future competencies perspectives.

3.2 Research Method

The research method is an important element of a case study, the choice of which influences the result heavily. According to Gummensson (1993), the data gathering is one of the most important decision and it can be performed through qualitative and quantitative in research According to Gummessen 1993 there are five research methods that could be used in case study research. First, existing data are the data that are already existing and conveniently accessible, like books, maps, charts, computer databases. Second, questionnaire surveys are a way to formalize and standardize interviews, and although they are used more frequently for quantifications, they can support qualitative methods. Third, an interview is a qualitative way of gathering data, which enables an interviewer to have direct interaction. The interviewer can ask an interviewee questions and receive answers while observing body languages and expressions. Fourth, observation requires the use of all the five senses to gather the necessary data. This method can be divided into participant observation and direct observation. Finally, there is action science that states that is the combination of all above methods. Action research involves the process of actively participating in an organization change situation whilst conducting research.

3.2.1 Thesis Research Method

In this study, the data gathering was done by the existing data from web, organization report, article and company website. The problem was identified, analysed and a solution was developed. When solution was applied, it triggered discussions towards a predominant solution.

In the first research topic which is based on “Circular Business Model” that are using in Finland industry. Data gather from the different articles and websites and these articles were based on the statistics and research based. From the data analysis we tried out to figure out the different models that are using in the Finnish industry. Then in the second step we tried to figure out the manufacturing companies that are using these circular business model from the company website. Along that we also try to point out some barriers that can be faced by the companies.

The second research topic is technology analysis which can be helpful in the transition from linear supply chain management to CSCM. In this research topic we gather data from different innovative article, paper and Journal publication. In this research we categorize the technology into emerging, improving, maturity and scale up. In the second step we analysed the four manufacturing companies in Finland that what technology they are using for circular solution.

Third research topic is competency or skills which is required by the manufacturing industry. Although we must interview in this research process to get the complete real information in this regard but due to pandemic and busy schedule these days it was not possible. In this research we gather the information through the job portal and the LinkedIn website. We have research almost four companies and list out the requirement for the supply chain assistant or manager and try to figure out how much weightage the circular economy related requirements were there. As shown in table

4. EVALUATING CSCM IN FINNNSIH INDUSTRY

4.1 FINNISH INDUSTRY

The economy of Finland is highly industrialized with mixed economy in which service sector is also huge. With respect to export the key economic sector is manufacturing (Statistic Finland 2007). The largest industries are electronics, machinery, vehicles and other engineered metal product, forest industry and chemical. According to the Technology of Finland the industry of technology is the largest export sector which account 51 percent of total Finnish exports and some 300,000 employed directly in the sector, 700,000 employed in total, equally about 30 percent of the entire Finnish labour.

Manufacturing Industry: The manufacture industry involves machinery and equipment industry, vehicle and other engineered product, which plays a major role in the Finnish industry. Many companies in the Finland is also global leader in their segment. Major segment in Finnish manufacturing industries are chemical, energy, marine, automotive and pulp paper.

High technology manufacturing in Finland ranked second largest. Finland exports are based on steel, copper, chromium zinc and nickel and finished product such as steel roofing and cladding, welded steel pipes. The Finnish motor industry consist mostly of manufacture tractors such as Valmet tractor. Forest machine company is Ponsse, Sisu, Patria trucks Sisu Auto. The steel industry such as Outokumpu, SSAB are known for the manufacture of steel and copper with the help of smelting process. In the ship industry Aaker Finn are the largest cruise ship manufacturer and Diesel engines are also produced by the Finnish company Wartsilla and as a market share of 47 percent. In the forest industry the Stora Enso and Metsa are the biggest paper supplier. On the elevator and

Some of the manufacturing companies as shown in Table 9.

List of Manufaturing companies			
No	Machine and Equipment Industry	No	Automotive Sector
1	Valmet	1	Volvo
2	Outotech	2	Uber Freight
3	CAT	3	Alstom
4	SRH	4	Scania
5	Kone carnes	5	Renault
6	Zent robotics	6	Nokian Renkaat
7	Ameco	7	Ford
8	Metso	8	Volvo
9	Generaal Electric	9	Michilan
10	Tamturba		
No	Energy Sector	No	Chemical Industry
1	Danfoss	1	Amroy Europe Oy
2	Sonen	2	Biohit
3	Schneider Electric	3	Kem Fine
4	ABB	4	Kemira
5	Helvar	5	Kemira GrowHow
6	Siemens	6	Woikoski
7	Philips		
8	Solnet		
No	Marine Sector	Pulp and paper	
1	ABB	1	UPM
2	Wartsilla	2	Stora Enso
3	Evac	3	Metsa Group
4	Maersk		
5	Rolls Royce		
6	Wartsilla		

***Table 9**: Companies List in Finland (Source Statistics Finland)*

4.1.1 CBM IN Finnish Manufacturing Industry

According to Statistics Finland the circular economy represents growth potential of Eur 300-450 million for the manufacturing industries. Estimate is based on the new business model using the circular economy approach. This shows a greater opportunity to the industrial sector to boost their sales and provide customer needs. There are many companies such as Caterpillar, Rolls Royce , Kingfisher and Renault are experiencing this change. In the industrial sector particularly machinery and equipment industry there is still plenty of value to capture in the industry. Finland has strong machinery and equipment industry which exports shares is almost 8.9 billion (Statistics Finland). According to statistics Finland the Finnish manufacturing sector comprises ten major companies and their sub-contractor. These company's expertise is based on the forest and minerals such as Ponsee (harvester and transport vehicles) and Valmet paper machines. In mining and construction, Metso strength lies in the crusher while Normets strong point is

tunnelling machine. Sandvik has strong expertise lies in area such as equipment for mineral quarrying and loading while Outotech expertise is based on the mining technology and construction projects. Ship building in Finland has declined but Cargotec and Kone cranes are major player in in cargo. They also are the supplier in other sector such as metal industry (Rautatarukki and Outokumpu). For medium speed engines for ship Wartsilla is the key supplier and Kone is the largest lifting equipment industries (Statistic Finland and Company Website).

The key inputs of this sector mainly consist of the labour, engineers as well as component service as well as steel. In this sector the raw material is steel, and the cycle of this raw material is almost forming a closed loop. Equipment and machinery industry is a part of Finnish metal Industry value as shown in the Figure

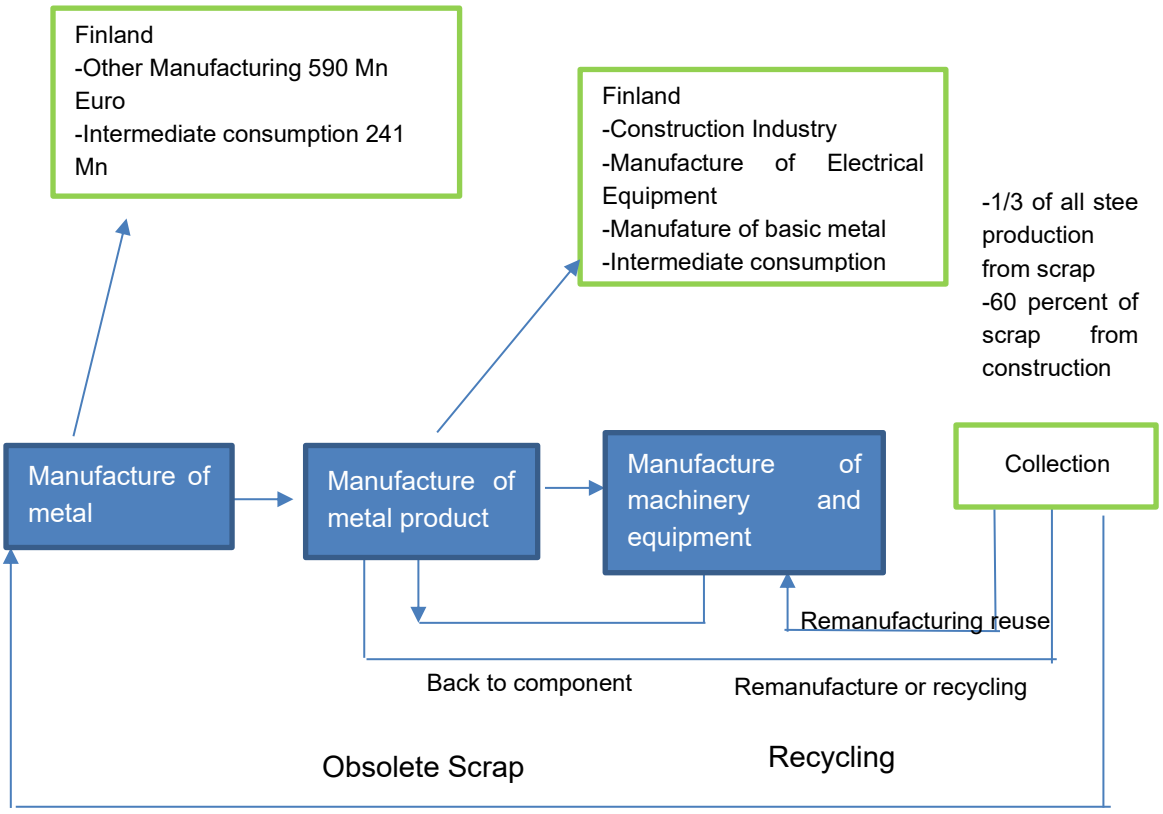

Figure 12: *Equipment and Machinery industry as a part of Finnish metal Industry (Source Statistics Finland, team Analysis, Euro stat)*

Due to the sustainability issue the liner economic model has been outdated and new business model based on CE philosophy is essential (Gorrisen et al 2016). Several researches have contributed to the Circular Business model CBM. For a circular value chain, the process of CBM development proposed explicit question for creating a business model for circular value chain (Roos 2014).

In this thesis, research from the different company websites, articles were conducted. We concluded that five business models for the circular economy in Finnish industry were widely used in different stages of value chain.

1) *Product Life Extension*: In this type of business model the product use as much possible with the help of refurbishing and repair technique and this can reduce the need of purchasing.
2) *Product as a service*: In this circular business model the customer rent or pay for the service instead of taking owner ship. In this model the service provider keeps the ownership and earned by the rental or leasing agreement.
3) *Sharing Platforms*: Finnish companies are using digital based platforms to promote the increased the used of goods. In this model it helps the to extend the product life cycle.
4) *Renewability*: In this type of model use of renewable material or fuel that can be recycle and model is also based on the principle of eco design.

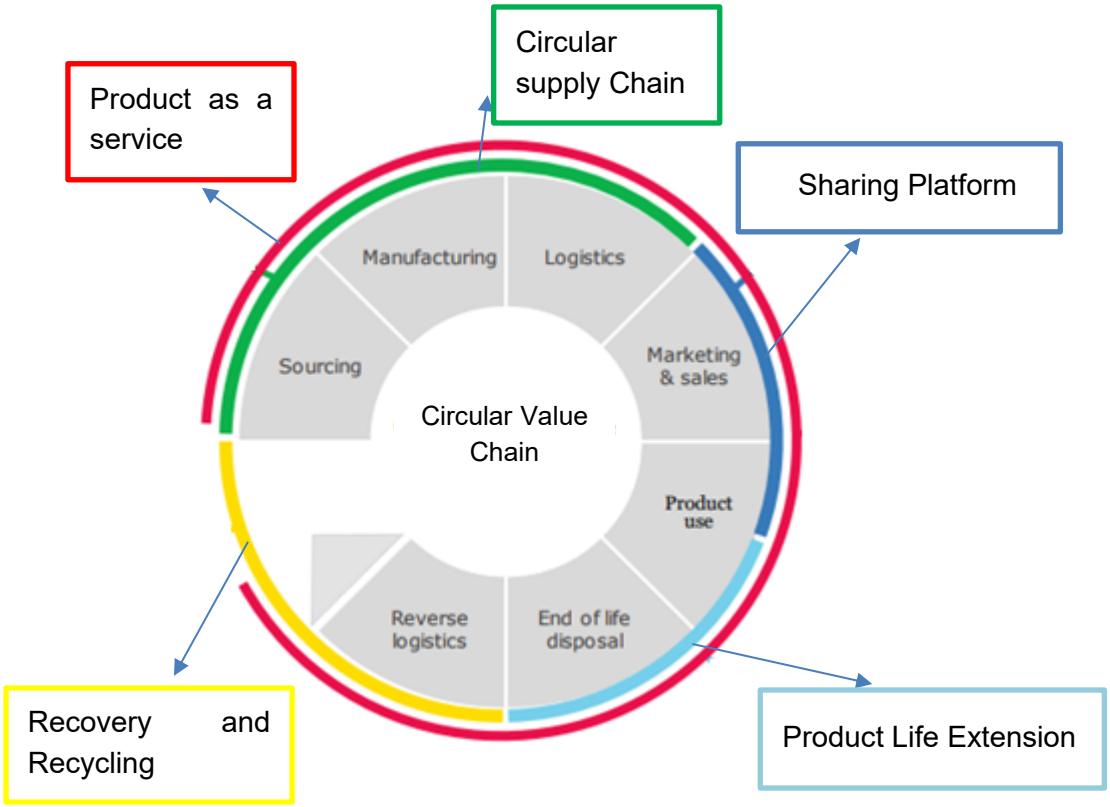

Figure 13: CSCM Business Model in Each Stage of Value Chain(Adapted from Technology of Finland Sitra)

Business Model	VALUE CHAIN	Advantage
Sharing Platform (Optimize Capacity use)	1) Marketing and Sales 2) Product Use	Increased usage rates through collaborative models for usage, access or ownership
Product Life Extension (Extended lifecycles)	1) Product Use 2) End of life disposal	Prolongation of the life cycle through repair, refurbishing reprocessing
Recovery or Recycling (Recovery value in waste)	Reverse Logistics	Recovery of usable resources or energy from waste or by product
Product as a Service	Complete Cycle	Offer of product use with retention of the product at the producer to increase resource productivity

Table 10: *CSCM BUSINESS MODEL*

In the research from the web we come to know the different industries in Finland using this four-circular business model to ensure the CSCM and circular economy. The manufacturing industries in Finland as shown in Table

CIRCULAR BUSINESS MODEL	Machinery and Equipment	Marine Sector	Energy Sector	Transportation Sector
Sharing Platform	-Valmet -Erent -Equipment Share	-	-Sonnen	-Uber Freight
Product Life Extension	-CAT -Kone Cranes -PONSSE -SRH	-ABB -WARTSILA -SCHOTTEL	-Helvar -Schneider Electric -ABB	-ALSTOM -Renault
Recovery and Recycling	-Zen robotics	-Wartsila -Maersk -Sea2Cradle	-Schneider Electric -Siemens	-FORD -GM
Product as a service	-Ameco -Metso -Tamturba	-Rolls-Royce -Wartsila	-Philips -SOLNET	VOLVO -MICHELIN

Table 11*: List of manufacturing industries in Finland Using CBM (Source; Statics Finland, Technology Industries of Finland, Company Website).*

By selecting the business model which is based on the Circular value chain can bring the competitive advantage and increase the turnover and the margins on current output. But the preparation for barriers is also essential. Following are the barrier that Finnish industry can face

BARRIER	Type of Barrier	Challenge
Organization and Culture	Internal	-Difficulty of customer centric innovation and cross functional collaboration. -Mindset of employees -Lack of skills in new technology -Let of skill in solution selling
Financial	External	-High funding required to implement this circular business model (Produt as a service require high capital). -Insufficient understanding of risks and mitigation strategies
Eco System	External	Complex supply chain makes it difficult to control products after sale tracking material and component

Table 12: *Prepare for Barriers*

4.2 CSCM TECHNOLOGY

In this section detail research is conducted that innovation and technology can help the transition towards the CSCM Finnish industries. Technology can help Finnish industries to create circular advantage. According to Lorentz and Himola (2012) globalization and urged to be circular has caused many supply chain to be noticeable to automation and other technologies. This shift to the technology can be witness in the value chain. Firstly, from the chart we categorize some technology into emerging, improving, maturing and scaling in CSCM.

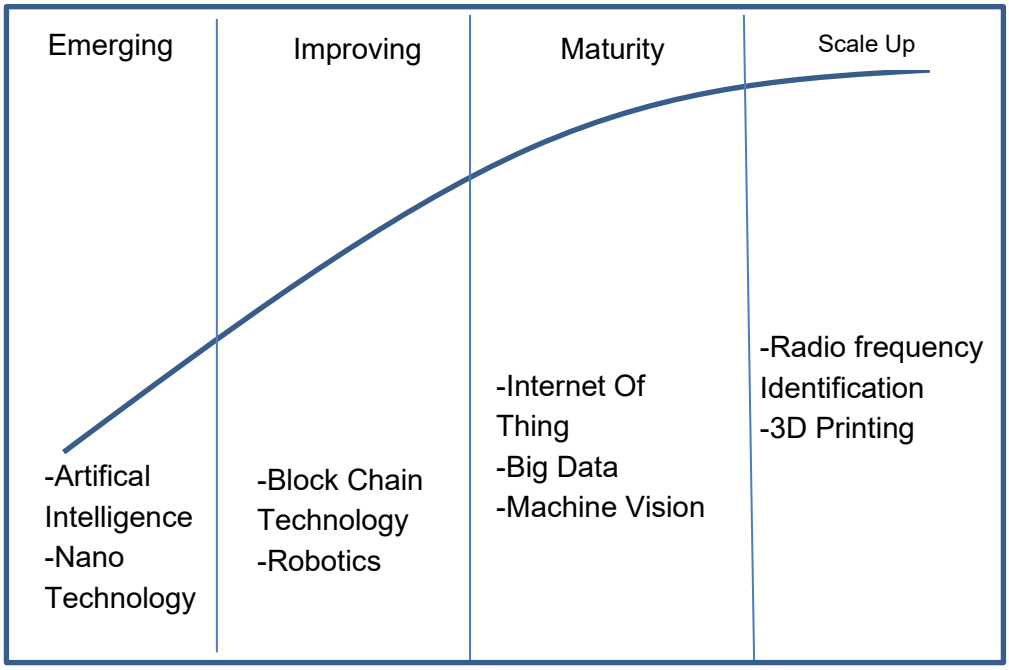

***Figure 14**: Technology Enables Circular Model In Supply Chain*

Emerging Technology:

Artificial Intelligence was developed to create thinking machine and now it is also emerging in the Supply chain management. AI shows a great response in improving the decision-making process and it shows the productivity in different business activities such as in recognizing in lean business, different business pattern, search for information, analyse the data logically. Despite of AI widely used it is seen limited application in supply chain management. However, there are some effort have been made to utilize AI in SCM. AI has been utilized to solve the SCM issues involving warehouse management, purchasing, location facilities, cargo consolidation and routine works and problem.

In inventory that are vital to sustain high level of customer serve which cause a substantial cost. In the CE competitive market, firm's success is in the best utilization of sources at minimum cost and make sure the availability of inventory for the customer when needed. It can be possible by the precise, actual time information, customer utilization, the scope of inventory and the number of cycle time to achieve the customer order. This estimation is difficult to obtain and predict, AI expert system can replace the tradition decision rule grounded on mathematical models such economic order quantity.AI expert system can better handle the situation in decision making of inventory control and planning decisions (Hokey 2010). In transportation there are lot of problem such as road network design, vehicle routing and scheduling problem, parking space utilization can be solving by AI technique can help these problems. In purchasing sector but there are lot of factor that must be taken in account that what volume to produce, how much investment required, how much risk involved, what is the demand etc. Due to this complexity of the make or buy decision AI solution expert system can help in decision making. (Humphreys et al 2002) develop an expert system that can help in assessment the supplier, assisting make or buy decision and reducing the time. Kim et al 2004 proposed automate purchasing system which assist the online ordering system from the global supply base. In customer relationship management CRM. There is also an agent-based model that interact between customer and member (Baxter et al 2003). This AI based agent aided the firm in assessment of its Return on investment in CRM. Although there are a lot of application of AI in SCM but there are still a lot of challenges that have to be focused. AI heavily depend on the computer software, if it is programmed incorrectly than it may lead to the wrong decision. AI decision is not easy to implement and difficult to understand also. But despite these challenge AI shows a great prospect in circular supply chain management and it draw more attention for both professional and academicians.

Nano technology is one of the most promising among emerging technology. There is a shortage of literary work focus on SCM by nano technology. But there is a focus of the industry on time delivery, quality, customer satisfaction and supplier performance. This technology is improving the vehicles used to transport and tracking for logistic but there is also other aspect of the SCM. The CSCM core issue involving choosing the right product, pallet size in a manner that will lower the inventory, transportation and packaging cost. In a packaging nano technology is used to make material for packaging such as Nano composites that can help in logistics and inventory problem.

Improving Technology

Bock chain is one of the key technologies that is revolutionizing digital supply management. Supply chain management has become more complex due to integration of CE, involve diverse stakeholders, block chain emerged as technology that de tangling all the document, data, communication exchanges happening with in the supply chain management. Supply chain mangers realize a great benefit from cost saving and increased efficiencies in procurement, digital payment and contracts, logistics and manufacturing. In procurement it provides single source of truth for all entities (suppliers, partner). Block chain-based database can store data and can give the three dimensions view of the purchases of all the partner. Due to this the audit will conduct automatically which eliminating the resource activity such as extra verification. In logistics still the company rely on the massive paperwork and reduce the visibility of the companies. Bock chain can do several things to solve this issue. It provides faster and sustainable logistics in global trade and improving traceability in supply chains. In manufacturing, blockchain are the most prosperous business opportunity. Block chain system cannot be tampered and any mishap in the supply can be spotted immediately and can be acted upon. Producers that are converting raw material to the final product can have a greater control over the flow of incoming from suppliers and gain better control over production,

Robotics are proven to be the important part of the supply chain management. In future this technology will find a broader range of CSCM. According to study in the Information Service Group 72 percent of enterprises in Finland will increase their investment in robotic process automation by 2021. Supply chain and robots have a natural connection from an automation to the autonomous task. Robot are not now limited to the basic application in ware housing but for more advance supply chain operations, they can used from the manufacturing and packaging to the transportation as well. Future of robotics integrated supply chain is promising. There is a great scope in terms of productivity and quality for firms. Robots will further be integrated with technique of truck unloading, collecting order, transporting goods and examining inventory. Reliability and accuracy will increase, and the chance of failure will be minimum. At the sorting centre a robot will unload and categorize the parcel based on the destination address. But still a lot of improvement required in robotics and every company needs to ensure that the automated robots are highly secure and not easily can be hack and required high investment in security and maintenance.

Maturity:

The Internet of Thing is an interconnected physical device that monitor, report and send an exchange data and it is connected to the data or WIFI network. IoT devices sensors to measure specific aspect such as location, temperature, humidity, movement, handling speed etc. In the supply chain IoT are the effective way to track the product and shipment using GPS and other technology. They can also monitor the warehouse condition of products which enhance the quality in supply chain. IoT devices have a major benefit for all aspect of supply chain management. Goods can be tracked both at rest and motion and IoT can identify the issues with goods getting lost or delayed. From IoT we get to know the real time shipment update and visibility of inventory. It enhances the better-quality management to keep raw materials and processed good in good condition. By 2022 (Gartner,2020) predict that half of the new business will incorporate some element of IoT. Data from IoT sensor can integrate the supply chain system to provide rich business intelligence. IoT is powering the supply chain management into the transformation into CSCM . Emerging tool such as machine learning are enabling huge gain to efficiency and in future through IoT supply chain industry is ready to gain great visibility.

Big data refers to the huge amount of data that is structured or non-structured that helps organization to analyse the and predict the future trends. It used a powerful statistical method and it helps in operations, strategic choices such as right business model. In supply chain management the planning needs a lot of data. Big data can help in analysing of inventory data and production in a real time and it makes planning. Manufacture can analyse the quality of the product in actual time to get the quality assessment for each product. The IoT with its camera and sensor can enable other manufacturing chances in the CSCM. Data sources and analytical technique are generating new opportunities in warehousing. In transportation the companies can select the right transport mode to cut the carbon footprint by using analytics in their operation. Other technology such as Machine vision are used by the companies in supply chain which enables 100 percent verification accuracy for the receiving, shipping and loading of pallets. It provides complete and correct data throughout the production, distribution and retail operations. It is efficient, speed and accurate for today’s logistics operation. Machine vision is key technology in warehousing, it can optimize goods receiving and shipping process that can remove error and boost efficiency and cost savings. It helps in speeding the loading and unloading at the dock door and remove cost from supply chain stake holders. Also reduce order lead times and faster shipping turn around.

Scale up

RFID (Radio frequency identification) is one of the fastest growing technologies in the world that uses radio waves of high frequency for both transmission and identification of information The data carrying device is also called a transponder that receives a signal and in turn reflects it back, i.e. passive system, or broadcasts it, i.e. active system.
RFID technology can be broken down into three major constituents:

- RFID Tag
- Reader antenna and computer system
- Decoder which is a part of the transceiver

Unlike other identification technologies such as barcodes, RFID doesn't rely on line of sight between the transponder and the reader since it utilizes Radio Frequency spectrum. The reader transmits a signal to the tag which in turn reflects a backscatter signal carrying specific information, e.g. ID stored on the chip. The backscattered signal is detected by the reader, and the information is then decoder through a backend database present on the computer system. RFID technology operates on different frequencies categorized as ultra-high frequencies, high frequencies and low frequencies. RFID tags can be further broken down into three types. First one is Active tags that has its own source of power and transmitter. Information stored on the microchips of these tags is broadcasted continuously. This makes them suitable for applications where they pose as "beacons", allowing assets' real-time locations to be tracked. The tags operate at specific intervals varying from 433MHz to 5.6GHz, having a range of 100 meters. Passive Tags require "waking up", which means the reader antenna transmits a radio signal that is absorbed by the tag. These tags have no internal power source. Transmitted signal by RFID tag is used to power on and to reflect energy back to the reader. Passive RFID systems can operate in the low, high and ultra frequency radio bands. . Semi-Passive Tags are powered by batteries but do not transmit signals continuously unlike Active Tags. They communicate with the reader through back scatter similar to passive tags, with the on-board battery being used to power the chip. These tags are usually used to monitor physical parameters designed with onboard sensors, such as temperature, light and sound. Compared to other two types, semi-passive tags have shorter read distances.

In supply chain mangement these tags can be used for the information for a variety of tasks. When the product goes through the RFID scanner the information in tags can be

read. The information can be any type such as order number, invoice number, location , serial nmber etc. The cost of RFID has come down significantly making it more attractive in supply chain industry. Speed and understanding are the part of RFID in ware houses RFID speed the process activities and understanding of each step and each shipment. RFID can also improve the inbound movement . RFID function in the future can be merged with emerging technology such as block chain ,.However implementing a RFID program is not easy and have to take the full organization ecosystem in account.

Now risinng demand and due to customer satisfaction the innovation in manufacturing and supply chain is necessary. Customer are making delivery on the basis that how faster the consumer get their product due to the inclusion of companies such as Amazon and Alibaba. In order to stay in competetion companies are turning to 3D printing to manufacture their product quickly. 3D printing can also have a positive impact to the environment. Companies are now working begining to explore on demand manuafacturing it means that instead of deliveing into warehouse. This will reduce cost associated with supply chain mangment.

The above technology have the crucial role in the transition from linear supply chain management into CSCM. In this competetive market the company who take the advantage of this technology will not just increase its profit but in the same time it will reduce the environmental degradation too. We will discussed the manufacturing companies in Finland that are working on the innovative technology in their supply chain to make it more circular and sustainability. We choose the comapny on the basis of higher sales revenue.

COMPANY A:

Company A is one of the largest manufacturer moving walkaways, elevator, gates and automatic door. The company provides local service for builders, devrelopers, building owners, designers in 1000 offices in over 50 countries. Company A has using new technology and innovation to cut down the energy consumption. For example the Ultra Rope tecchnology launched for a high rise building. They used the carbon fiber material that is light in weight and can help in reducing the weight of the elevator. Ultra rope have also the higher resonanse frequency than steel cable. These quality can help to reduce the energy consumption in high rise building. Other technology such as Eco disc motor use for hoisting can reduce he amount of energy lost. The motor control sytem and brakes make the elevator ride easier and quieter.

The comapny contibution start from the reducing mateirlas , energy and other resources. And they are providing customer with reliableand energy effecient equipment. Digitial service transformation is the main core of the circular business development which is providing transperent , on time and qality services

SUSTAINABLE SOLUTIONS	**SERVICES**	**Operational Resource Effeciency In Future**	**Technological resource**
Durable solution with long life time > 25years	Modernization Tailored product life extension	More than 80 percent of waste recycled currrently	Manufacturing excellence an material effeciency
High performance and relability	Maintenance Modularity maximized up time	50 percent green electricity by 2021	Digital technologies and connectivity
Top class energy effeciency	24/7 Connected services	Zero waste to landfill by 2030	Robotics and Automation
Sustainable and healty material			Recyclable and packaging

Table 13 *:Company A Solution, Services and Technological resources.*

In manufacturing Company A, optimize the robotics and automation and power the operation with renewable resources. They are maximize the recyclability and dthe opurtunities for reuse in the operations. As part of the logistics is concerned they are circulating the specific packaging between manufating, distribution centres and suppliers.

COMPANY B:

Company B is a Finnish company in a proces and manufature industry . t customer include companies in the mining , rock crushing, oil and gas sectorsand in the recycling, paper , pulp and process industries. Company A provides technology , processes , equipment and mineral processing and they are rhe market leaders in grinding mills, mining crusher and screening plant in construction industry. Company automation segment provides process industry a flow control solutions automation and information mangement sytems and applicaations and services.

Company B using digitization as a matter of sustainability and there customer are benefitiing from such innovation for maintenance and optimization solution. They are also using 3D printing technology for manufacturing and new components design. The company aims to work with supplier that are scoially and envirinmentally responsible. Their supplier coode of conduct sets the standard that their suppliers follows such as healt and safety environmnet and climate change. The company belives three dimension are critical environment, people and the economy throughout the value chain and technologies and innovation can only bring the current ways of operating. CE economy starts with the design and extending the life cycle of product and operations, and taking valuable mateirla back in to the cycle

Value cahin	Solution
Product Design	Circular design . R&D projects are sustainable about 80 percent
Production	Automation Process, 3D printing technology. Energy rffecient
Logitics	Digitaization, Focus on 20 percent reduction of traansport by 2025
Recycle	Recycle solution such as metal waste , construction and mining.

Table 14 : *Value Chain Solution*

4.3 CSCM COMPETENCY

New capabilities and competency needed to become a circular leader from circular design to transform mindset. Different competency has been discussed in the literature review. In this section we conduct a survey in the Finnish market that what is the demand competency required in the Supply chain management and how much is the weightage of the circular competency.

First Company A provides the sustainable renewable product for transport, business and consumer needs. They are working on th less carbon emission and minimizing the environmental degradation. They are also dealing with avaiation industry and introducing renewable solution. There revenue in 2019 was 15.8 billion Euro. In the list of sustainable companies of the world Company A placed 3rd on the global. We have searched thought the job portal and looked the job requirement of supply chain specialist in this Company A which are as follows. (Source Linkeden).

- Manage sustainability criteria of our renewables in supply chain operations
- Ensure end market compliance requirements throughout the company value chain
- Provide customers and authorities with promptly and timely reporting on sustainability information of our renewable products
- Cooperate with suppliers and customers in biofuel market compliance issues
- Collaborate with key internal stakeholders such as Supply, Sales, Operations, Supply Chain Management, Public Relations and Sustainability
- Carry out supplier and internal audits as well as participate in 3rd party audits
- Maintain and develop supplier compliance related tools and documentation.

We’re Company B is the biggest telecom provider. Thety are the service provider in all of the europe , they have the strong conectivity base and the y are helping the companies and societies to keep in touch with 24/7. This company supply chainmanger requirement is as follows (Linkeden).

- Device business KPI’s: customer happiness/NPS, sales, margin and market share in selected categories
- Optimal support for company’s core businesses: mobile and fixed connectivity as well as entertainment

- Help in Journey towards Company's 2030 daring goals – especially Zero CO2 and Zero Waste
- Utilizing cross border and cross company synergies and global best practices to make sure above happens with competitive cost levels.

Company C is the combination of the talent acquisition and to help the companies in maximizing the value in supply chain. They are working in Europe, Nort America and Asia Pacific. Theiir methadologies and market intelligence deliver insights that can help the compainies in the borderless fashion.

- Impeccable integrity, passion for supply chain consulting, creative, and energetic
- Demonstrated expertise in demand planning, supply planning, capacity planning, and S&OP processes
- Significant and documented project experience involving circular design and implementation
- Ability to work creatively and analytically, both independently and in a problem-solving team-oriented environment
- Solid project management skills demonstrated across multiple industries

Above research showsthat companies in Fiinalnd are demanding for the Circualr Supply chain skill in their supply chain job position. Most of the companies in Finland are now working towards circualr solution so they need a circular supply chain competency in their candidate. Due to the pandemic interviews from the company representation cannot be conducted and this all skills and requirement are gathered from the job portals. These can be different from the actual requirement.

5. CONCLUSIONS

The Finnish industry is unique and the most efficient in the world. Notably, the industry is highly environmentally aware as evidenced by the various originating technological advancement seen in the world. Therefore, while addressing the challenges in the linear supply chain management, it is imperative to understand that the industry is aware of its role in sustainability (Hasanaj and Jansson n.d). In particular, the industry is famed for its efficient use of energy and raw materials in the production. Finland's industry is among the world leader in some process used in production. Therefore, the thesis is relevant to the role of the industry supply chain in enhancing the sustainability of raw material in production.

From the literature study we are unable to understand the CE and how it integrates into the SCM. The thesis addresses the shifts from a linear economy to a circular economy as a way of achieving economic and environmental sustainability. Supply chain management is identified as being at the center of achieving a fully circular economy in the non-homogeneous industry in Finland. While recycling has been widely used among the companies in Finland, there still exists a major gap in circularity in the global economy. Therefore, the thesis addresses the role of supply chain management in achieving resource sustainability, especially the manufacturing industry. While the focus is significantly on technology and how it can be used to enhance the supply chain and sustainability in the industry, the supply chain models need to significantly change since their role is equally important. As a result, the research thesis is unique since it explores an area that is not widely investigated. The research dwell on supply chain management, the relevant models, the circular economy, circular supply chain and resource sustainability concerning Finish industry. Therefore, it involved various stakeholders from different backgrounds such as the manufacturing companies, the logistics companies, and Finnish supply chain community.

The manufacturing companies in Finland are among the most renown in the world; hence there are significant in the country's and worlds economy (De we Wit et al. 2019). Supply chain management is at the core of sustainability since this is where value creation mechanisms can be implemented, and reverse supply chain imposed (Genovese et al. 2017). This strategy leads to the potential increase of resources recycled bank into the economy, reducing the circulatory gap, and achieving sustainability in the industry. This

can only be achieved by the proper understanding of the business model which is based on the circular value chain. In this thesis we identified the four-core business model that are using by the industries in Finland which is Product life extension, Product as a service, sharing platform and renewability. These are the business model that are also used by the industries in Finland. These are the successful business models and they are also implemented by many of the companies in Finland. Second finding is the different technology innovation that can help in assisting the transformation into circular supply chain management. The detail research on the innovation technology, which was divided into emerging, improving, mature and scale up technology. This provides a great insight about the present and future technology which can bring the revolutionization in the circular supply chain management. On the other hand, the research was also conducted about the companies that are using the technology to overcome the barriers in sustainability. The little research also carried out about the requirement of the competency and skills in Finnish industry for the supply chain management job position. From the insights it has been clear that the companies required a knowledge of circularity and sustainability by the candidate. Although due to pandemic we cannot interview the company's representation so it might be different from the job portal and LinkedIn.

Future Learning

More research is required in the field of business model that can help in transformation into circular and sustainable business model. Also, complete insight must collect from the companies in Finland about their business model and the improvement they need to overcome the barrier of circularity. More focus is also need in the understanding of technology that can help supply chain management to be more circular. These need a regular update about the new technology and important to know that how it can assist the circularity in supply chain management. The skills and competency also need to be update that can help in understanding the current and future requirement. More study is required in this field to know more about the competency and skills that will important in the future for the supply chain profession.

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