Circular Economy & the Furniture industry: The state-of-the-art in the EU & Sweden

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Preface

This paper outlines the state-of-the-art of the furniture industry in relation to circular economy while highlighting policies, initiatives, actors, opinions and scenarios. It has emerged that several initiatives exist but also divergent options on future sustainable development paths. Therefore, recommendations are offered for the industry by pointing at some potential opportunities to progress in its “circular journey”.

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1 Introduction

In order to drive sustainable development within the planet's boundaries and to respond to today's significant environmental and sustainability challenges, our production and consumption systems need a new configuration. One strategy consists of transitioning to a circular economy (CE) (Stahel, 2019; Geissdoerfer et al., 2017; Ghisellini et al., 2016; Webster, 2015) – a regenerative and radically more efficient economic system where the value of resources is maximised, the overall use of resources is minimised while waste and toxic materials are designed out and the system is powered by renewable energy (Durán-Romero et al., 2020; European Commission, 2014; Konietzko et al., 2020; EMF 2012).

Environmental and economic benefits of a circular system require technical and organisational innovation that have to concur at the micro- (organisation), meso- (business ecosystem) and macro-level (socio-technical system) (Bauwens et al., 2020). The Swedish furniture industry has been showing a growing level of awareness of the urgency to pursue sustainable development via a more efficient use of resources and the adoption of sustainable business models. Thanks to world-renowned expertise in the design and manufacture of high-quality products with a value chain indicating potential to be adapted to a circular business ecosystem, Swedish furniture businesses could yield several environmental, social and economic benefits while leading by example for a system shift.

In essence, the transition to circular flows entails the design of new products and services, new business models and business relationships between suppliers and customers, but also the development of behaviours, regulations and information dynamics (Witjes and Lozano, 2016; Fogarassy and Finger, 2020).

Companies may contribute to a transition to a CE through the adoption of circular business models (CBMs) that take on slowing, closing, or narrowing resource loops (Geissdorfer et al., 2017). Previous studies have underlined the implementation of CBMs that slow and close resource flows for their expected economic and environmental benefits (Whalen, 2020; Nußholz, 2017).

Also, in order for a fundamental system change to a circular setting to occur even beyond a global economic crisis such as the current one due to the outbreak of Covid-19, there is a need for continuous development of preconditional measures at a system level. These may be actions that require coordination between stakeholder groups, such as systems for information, quality assurance, measurement, and follow-up of sustainability indicators, as well as issues related to regulations, labour market, education, and procurement with revised requirements and international development. For all the forces in this system to work together, it is therefore essential to draw plausible scenarios, clearer pictures of what a circular future might look like, how the roles of the various actors may change and how each stakeholder can influence and enable such a transition.

2 The current industry ecosystem: What do we know about it? Developments and uncertainties associated with the business environment for circular furniture.

Despite extensive discussion on CE, its development is not going fast enough to meet the sustainability challenges mankind is facing. The latest Circularity Gap Report from Circle Economy (2021) reveals that, including the twin headwinds of increased CO_2 emissions and resource extraction, the global economy is only 8.6% circular, showing a decline from the previous year (9.1%)[1]. The situation is therefore worsening with no clear sign of reversing. According to the Politico's CE index, in 2018 Sweden ranked only 14 out of the 28 countries in the EU[2].

In regard to **CO_2 emissions** – in the last 30 years they globally increased from 20.5 gigatons (Gt) in 1990 to 33.3Gt in 2019, although in the last two years the trend has flattened thanks to a sharp decrease in CO_2 emissions from the power sector in advanced economies due to the growing role of renewable sources (mainly wind and solar PV), fuel switching from coal to natural gas, and higher nuclear power output (European Environment Agency, 2020 and International Energy Agency, 2020).

Additionally, the world's total **resource utilisation** rose from 92.8 billion tonnes in 2015 to 100.6 billion tonnes in 2017 (+8.4% in 2 years). This is mainly because of three factors: 1. Dependence on extracting virgin materials; 2. The growing demand of further materials to meet the needs of an increasing global population; 3. Limited availability of products that are designed to be reused coupled with inadequate facilities for reprocessing materials at the end of their life.

The last point contributes to *waste generation* which grew - although at a declining speed with economic development - from 635 Mt in 1965 to 1999 Mt in 2015 (Chen et al., 2020) with high-income countries combined[3] generating more than one-third (34%) of the world's waste. According to the World Bank (2018)[4] solid waste alone is expected to soar from over 2bn (2016) to 3.4bn tonnes over the next 30 years.

These data showing **a clearly wasteful and unsustainable economy**, contribute drawing a concerning picture of our planet. Between 1970 and 2021 the overshoot day went from 29th December to 29th July meaning that the ratio between our consumption of natural resources and the capacity of the Earth's biosphere to regenerate went from 1:1 to 1.6:1 (Earth Overshoot Day, 2021).

[1] The result is based on a metric that measures "the amount of recirculated materials as a fraction of the total material inputs into the global economy in a specific year" (Circle Economy, 2021).
[2] "In general, countries with the highest circular economy scores — Germany, the U.K. and France respectively topped the ranking — have robust recycling systems and high levels of innovation in circular economy sectors. Bigger countries also tended to have higher circular economy scores, due in part to the fact that they have larger economies with more private investment and patents. The two metrics that most closely align with the final ranking are the number of patents and investment and jobs in circular economy sectors". https://www.politico.eu/article/ranking-how-eu-countries-do-with-the-circular-economy/
[3] They only account for 16% percent of the world's population.
[4] https://openknowledge.worldbank.org/handle/10986/30317.

Hence, the issue of managing both renewable and non-renewable resources efficiently and sustainably is critical for any sector (see for instance, "The New Nature Economy Report II: The Future of Nature and Business" by the World Economic Forum, 2020[5]) including the **furniture** industry that utilises not only wood and textiles but also metals and plastics. From one side replenishment cycle time must be taken into consideration, and from another side materials should be reused and kept in the "techno-sphere"[6] for as long as possible and at the highest value. As Hopkinson et al. (2018) point out, there is a clear need for *resource decoupling* which rests on the ability to identify opportunities and then extract higher value from reutilising assets (such as products, components, and their materials at the end-of-use phase) or finding value added from recycling.

This is in line with the recommendations by the United Nations Environment Programme's Life Cycle Initiative (UNEP/LCI, 2017) and the European Commission's CE Action Plan (COM(2020)98)[7] envisioning that a sustainable economic system could be established by extending the value chains of products and services in the economy (Moraga et al., 2021).

It is still unclear if a full transition to a CE will ever occur in the future and if so, how that might look like. In order to better appreciate and evaluate the impact, it is important to acknowledge that a transition to a CE must be understood as a radical systemic change instead of a phenomenon consisting in minor tweaking of the *status quo*. In other words, one must consider that the transition takes place in socio-technical systems where technologies and institutions are core drivers to change as they "co-evolve" by affecting each other (Bauwens et al., 2020).

Before considering possible system scenarios, it is useful to provide an outline of the furniture industry and the related policies, initiatives, challenges and trends.

[5] https://www.weforum.org/reports/new-nature-economy-report-ii-the-future-of-nature-and-business.
[6] See the butterfly diagram in the report "Towards the Circular Economy. Economic and business rationale for an accelerated transition" by EMF, 2012.
[7] https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1583933814386&uri=COM:2020:98:FIN.

2.1 The furniture industry in the EU and in Sweden: Key facts

Quick facts about the Furniture industry in Europe

Table 1 shows a snapshot of the key features of the furniture industry in Europe.

Table 1. Snapshot of the furniture industry in EU.

Number of companies	> 130,000 companies (mostly small or medium sized enterprises) (European Commission, 2021)
Number of Employees	ca 1 million people (European Commission, 2021)
Turnover	> EUR 96 billion (in 2020) which equates to approximately one fourth of the global furniture industry (European Commission, 2021)
Major producers (countries)	Germany, Italy, Poland and the United Kingdom are among the 12 largest furniture producers globally with more than 60% of Europe's production share and 15% of world production (CSIL, 2020)
Comments	Eastern Europe production is growing fast. Also, the European furniture industry is facing numerous challenges with China in terms of competition, innovation, ageing of the workforce, and higher operational costs in the EU due to higher standards in sustainability, including technical and environmental aspects (European Commission, 2020). Almost two-thirds of high-end furniture products sold globally are produced in the EU (European Commission, 2021).

Quick facts about the Furniture industry in Sweden

Sweden is a country dominated by forestry and therefore is one of the major world exporters of forest products. The related Swedish manufacturing industry produces a variety of wood products, including paper, boards, and prefabricated houses and furniture (Royal Swedish Academy of Agriculture and Forestry, 2015). Here is an overview of the furniture industry according to the annual statistics for furniture by TMF (2019) including key facts (Table 2) and Exports/Imports by product groups (Fig.1):

Table 2. Snapshot of the furniture industry in Sweden (Source: TMF, 2019).

Number of companies:	2,304 (mostly small or medium sized enterprises) • One-person company[8]: 1,462 • Other companies: 842
Number of Employees:	13,024 (average per company: 15 employees) • total number of employees in retail: 13,075 • people employed (including industry, retail and B2B, in the furniture industry and the furniture retail trade): ca 31,000
Total annual production:	SEK 25 billion (2019)
Total annual consumption (production minus export plus import):	SEK 27 billion (2019)
Total retail sales:	SEK 39.7 billion (2019)
Notes on export:	Over 75% of Swedish furniture is exported for a total of SEK 19.1 billion (2019). The export share EU and Europe equated to 92% with the major markets being Norway, Finland, Denmark and Germany
Notes on import:	In 2019 the total was SEK 20.8 billion with import share EU and Europe of 74% and 25% from Asia. Poland and China are the main countries from where Sweden imports.
Comments:	• The largest entries for exports and imports per product groups are parts of furniture and other furniture with over 4,000 M SEK each. • Eastern Europe production is growing fast. Also, the European furniture industry is facing numerous challenges with China in terms of competition, innovation, ageing of the workforce, and higher operational costs in the EU due to higher standards in sustainability, including technical and environmental aspects (European Commission, 2021)

[8] A one-person company includes woodworkers, joiners, upholsterers and similar.

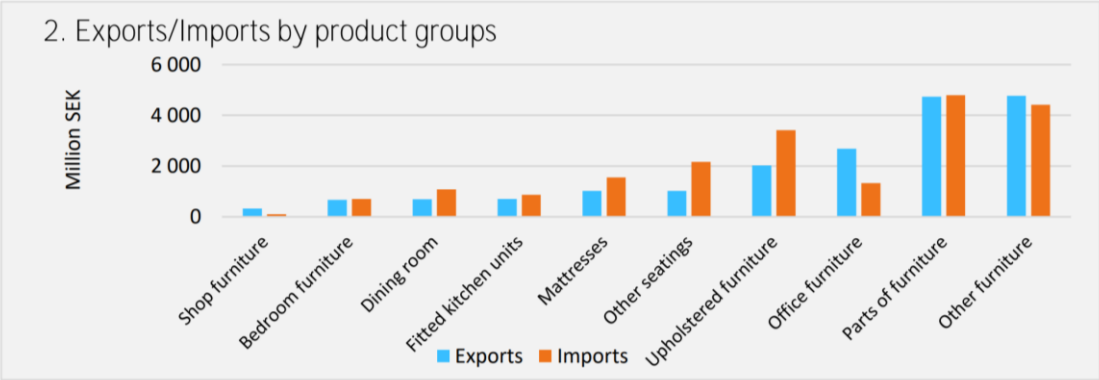

Figure 1. Exports / Imports by product groups in Sweden (Source: TMF, 2019).

It is encouraging to notice that a growing number of companies has been adopting the CE principles in their business models to attain more efficient use of resources and sustainable businesses (Ferasso et al., 2020; Pieroni et al., 2019; Kraus et al., 2018; Lüdeke-Freund et al., 2018).

The Swedish furniture industry is in line with this trend and is therefore well positioned to pave the way to a system shift from a linear to a circular logic since the country has a great expertise in the design and manufacture of high-quality furniture with a value chain showing potential to be adapted to a circular business ecosystem. A few exemplary companies that have formulated a circular strategy are presented in Table 3.

Table 3. Some examples of Swedish furniture companies with a high degree of CE ambition.

Gärsnäs – **Circular Vision 2030**: By 2030 at the latest Gärsnäs aims to be environmentally / climate neutral and completely circular by meeting the following three objectives / ambitions: 1) 100% circular design / design for long life and without waste; 2) 100% responsible offer; 3) 100% renewable energy[9].
Lammhults Möbel – **RE:USE programme** offers spare parts and repair services to prolong the life course of Lammhults' furniture. The company's sustainability policy clearly states that the "Development of new products shall be characterized by a circular approach and be designed to enable the reuse and recycling of materials"[10].
Kinnarps – **The Long-term goal 2030** is about designing all the products for a long life including interior design solutions as part of a circular flow that extends the life of products and materials. The company will use more recycled materials in its products and find innovative ways to use the waste materials that arise in its business. The goal is linked to the UN's sustainability goal 12 "sustainable consumption and production"[11].
Flokk – **RH Logic office chair**, made from 50% recycled and 92% recyclable materials and built to last[12].
Swedese – **Swedese Repair** is part of the company's strategic work to meet and develop new business models to address the need for recycling and sustainable consumption. It is a professional training programme for upholsterers in Sweden to learn how to renovate the Lamino chair with the original parts, and materials from the factory[13].
IKEA – **Circular strategy** to become 100% circular by 2030. Current examples of circular products include baby cots that can be converted into toddler beds, or modular products (e.g., PLATSA storage solution or VIMLE sofa), that can be adapted to constantly changing needs by adding or taking away pieces as needed[14].

Such companies with high circular ambitions have seemingly started embracing the concept of *value creation* as originating from "the ability to preserve the embedded labour, energy, material, and capital costs in higher forms of product and component integrity" (Hopkinson et al., 2018). In other words, companies are exploring the opportunity to turn inefficiencies in linear value chains into business value by looking beyond production waste and concentrating on underutilised capacities, premature product lives, unsustainable materials, wasted end-of-life value and unexploited customer engagements (Sitra et al., 2018). As an example, Hopkinson et al. (2018) offer four ways to achieve the above:

[9] https://garsnas.se/miljo-kvalitet/cirkular-vision-2030/
[10] https://www.lammhults.se/about/sustainability
[11] https://www.kinnarps.com/about-kinnarps/sustainability/
[12] https://store.flokk.com/sweden/en-gb/products/rh-logic
[13] https://swedese.se/press/swedese-repair
[14] https://about.ikea.com/en/sustainability/a-world-without-waste/why-the-future-of-furniture-is-circular#:~:text=What%20does%20becoming%20circular%20mean,%2C%20reselling%2C%20and%20recycling%20them

1. Extending the product usage through a performance business models;
2. Reuse or redistribute products by reselling to a new user with little or no rework;
3. Refurbishment and remanufacturing products using components to generate new or extended use of existing products;
4. Recycling materials by extracting resources to their most basic and most substitutable form (such as milling and re-melting metals into new metal feedstock).

Nonetheless, at the system level a critical issue to overcome still hindering the transition to a CE, is the amount of **furniture that becomes waste,** which is a **key priority on the EU agenda** to prevent climate change. In a circular system, waste is utilised as a resource by closing material loops through different types and levels of recovery, the so-called 4 Rs: reduction, repairing, remanufacturing and recycling (Barreiro-Gen and Lozano, 2020).

Furniture waste in the EU and in Sweden typically comprises of a variety of elements such as wood chipboard, medium density fibreboard, metal and aluminium, plastic and different textiles and even electric appliances (e.g., motorised beds). Some of the materials are recycled already however, Forrest et al. (2017, p.12) report that there is limited information of what happens to the EU used furniture with some evidence indicating that most furniture ends up in landfill. The European Federation of Furniture Manufacturers (UEA) reveals that 80% to 90% of the furniture waste is incinerated or sent to landfill, with only 10 % recycled (UEA as cited in Forrest et al. 2017). In Sweden, where circa 0.8% of all waste goes to landfills, furniture gets mostly incinerated (Avfall Sverige 2020). Low recycling rates might depend on the fact that furniture is treated as “bulky waste” (Eurostat, 2020, p.5), is not sorted from other municipal waste appropriately, and there is a lack of suitable recycling services.

The Swedish legislative framework on waste – which derives from the EU legislation – is based on the waste hierarchy that sees preventing the creation of waste as at the top and preferred option. The waste hierarchy priority includes *waste prevention » reuse » material recycling and biological treatment » other recycling (*e.g., energy recovery) *» disposal* (e.g., to landfill) (Avfall Sverige, 2020). The overall aim is to find ways to try to recover a substantial amount of potential secondary raw materials such as metals, wood, glass, paper and plastics that are lost in the EU economy (European Commission, 2013).

A specific challenge is related to the lack of information on the chemical content of the material used for furniture. Most furniture manufacturers do not receive this information from their material suppliers, and for recycled furniture and furniture materials, which may also contain chemicals that have being regulated since the furniture was produced, it is even more difficult to know that the material complies with current legislation.

2.2 Main policies in the EU and Sweden affecting the furniture industry

As discussed in the previous sections, the concept of CE has polarised the interest of governments, companies, citizens, and scholars as a means to achieve sustainable development. This is demonstrated by the increasing number of policies, targets, various initiatives, business sectors reports, and scientific papers (Corona et al., 2019).

An effective transition to a CE can only be realised as a **systemic shift** which, according to some scholars, could be facilitated by specific conditions or four building blocks: 1) Materials and product design; 2) New business models; 3) Global reverse networks; and 4) Enabling conditions such as public policies (Planing, 2015; Öhgren et al., 2019).

Focusing on the last point, the implementation of circularity actions has become a topic of paramount importance in sustainability policies in several countries (McDowall et al., 2017). There is indeed a wide range of **policy / legislative instruments and initiatives** at both the European and Swedish level which set out general rules for a more sustainable market or directly affect the furniture industry.

Overall, one could observe that instruments and initiatives address **four key areas**: **1) Production; 2) Consumption; 3) Waste management; and 4) Extracting value from waste**. A shortlist of the most relevant policy and initiatives is shown in Table 4:

Table 4. Overview of the main EU policies and initiatives to promote sustainable development.

Legislative Instruments	Voluntary Instruments
• Circular Economy Action Plan, CEAP (COM(2020)98 final) • The product passport (part of the CEAP 2020) • Waste Electrical and Electronic Equipment Directive (WEEE) • Restriction of hazardous substances in Electrical and Electronic Equipment (ROHS) • Regulations EU 2019/2020 on eco-design • Energy related Products Directive (ErP or eco-design directive (2019/2015) • Extended Producers Responsibility (EPR schemes) • Hazardous substances / REACH Regulation • The EU's chemicals strategy for sustainability towards a toxic-free environment • EU's rules on "end-of-waste" criteria • Renewable energy Directive (RED II) • Illegal logging and illegal timber trade	• Green Public Procurement • Environmental management in organisations • Eco design methodology • Eco labels (Type I, II, and III) • Product Environmental Footprint (PEF) and Organisation Environmental Footprint (OEF) methods (2013/179/EU) • Chain of custody certification • Green building certification • Standardisation in the field of all furniture (CEN/TC 207) • The ReSOLVE (Regenerate, Share, Optimise, Loop, Virtualise, Exchange) framework
	Other Policies and Strategies
	• Cascading use of wood • EU industry policy for Forestry • Forest-based Industries Blueprint • Bioeconomy

The most prominent framework is the Circular Economy Action Plan (CEAP) launched by the European Commission in 2015 as an ambitious scheme to *close the loop*, which comprises of several actions from the dismissal of single-use plastics to initiatives for promoting CE processes (European Commission, 2015). The Plan – which has been then updated in 2020 (COM(2020)98)[15] – more rigorously focuses on making sustainable products the norm in the EU by prolonging the value chains of products and services in the economy (Corona et al., 2019). The **CEAP 2020 is today one of the main building blocks of the European Green Deal**, Europe's new agenda for sustainable growth (European Commission, 2019).

Essentially, all the measures in the CEAP and the related policies and initiatives urge to move up the waste hierarchy and support waste prevention through designing more long-lasting products, energy and material efficiency measures (ecodesign), encouraging the *reuse*, *repair*, *remanufacturing* and *refurbishment* of products

[15] See footnote 7.

(Öhgren et al., 2019). The CEAP also includes the use of *circularity metrics* as a fundamental step to assess the impacts or benefits generated by any circular initiative (Corona et al., 2019).

It is worth mentioning a couple of aspects regarding the ecodesign measure adopted hitherto: 1) Additional harmonised EU standards are gradually being created to support the directive implementation, and 2) In 2020 the EU Commission, building on the COM(2012)765 report[16], announced that the prospect to add non-energy related product (also including furniture) in the main Directive will be further evaluated. Additionally, the digital product passport is a relevant upcoming measure that should complement existing instruments and be enabled by technical solutions such as blockchain technology and QR codes. These kinds of digital solutions will be important tools for passing on information about chemical content, which is a prerequisite for being able to show that the materials comply with current chemical legislation.

In order to ensure a high degree of protection on human health and the environment, the EU has developed a comprehensive legislative framework on the use of chemicals. that forms part of the EU chemicals strategy for sustainability (COM(2020)667 final)[17]. Published in October 2020, the strategy highlights the importance of transitioning to a CE, the importance of toxic free materials as a prerequisite for circularity, and the safe by design concept. The CEAP also corroborates such a concept by illustrating the numerous activities in such a field.

Numerous chemicals are widely used in the furniture industry such formaldehyde and flame retardants that are include in ROHS, WEEE, REACH, POPs[18] legislation.

It is interesting noting that the EU Commission policymaking process in the furniture industry has been informed among other, by the “Revision of EU Green Public Procurement (GPP) Criteria for Furniture” study (Donatello et al., 2017). The analysis, that was carried out by the Joint Research Centre, European Commission, investigated the main environmental impacts of furniture products in order to identify ways to minimise the impacts in line with prominent scientific, legal and political positions. The findings showed that the first and major impact to the environment (80 - 90%) resulted by materials and components used. The second largest impact was due to the manufacturing, assembly of components and the use of chemicals in surface coatings. The following types of impact were respectively due to packaging, transportation, the use phase, logistics and durability of a product. Also, it was found that the impacts of the end-of-life differ based on the materials used, and that disassembling products in components was hard (Silas, 2019).

Moreover, the final report of the “Business model innovation for circular furniture flows” project (funded by the Swedish Agency for Innovation Vinnova)[19] points out that, unlike linear business models, circular business models focus on maximising value from resources, reusing or minimising waste. In principle, this means that the environmental impact of circular business models is likely to be less as these require fewer resources

[16] https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2012:0765:FIN:EN:PDF
[17] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2020%3A667%3AFIN
[18] POPs stands for Persistent Organic Pollutants (Regulation EU 2019/1021).
[19] https://www.ri.se/sv/vad-vi-gor/projekt/affarsmodellinnovation-cirkulara-mobelfloden-steg-3

such as materials and energy for new production, emit less pollutants from production as fewer items are produced, and reduce waste which, according to another project report on sustainability, was estimated to be around 500,000 tons each year in 2012 (Bolin et al., 2017).

The above probably explains why CE strategies for furniture emphasise eco-design and design for disassembly which are actually the most commonly used initiatives (Rieckhof and Guenther, 2018) as further described in the paragraph. The EU's chemicals strategy for sustainability towards a toxic-free environment[20], both describes the importance of CE and the prerequisite of toxic free materials for circularity, including the safe by design concept. Design for disassembly will be an important part as chemicals legislation will develop, which might affect content requirements, for example functional additives for polyurethane foam or artificial leather. The Action Plan related to the strategy is extensive and includes numerous activities.

Overall, it is worthwhile noting that the EU considers a transition to a CE as the solution for achieving sustainability rather than an option as evidenced by its ambitious scheme to a CE that is corroborated by a series of reports such as the "Monitoring framework for the CE" (COM(2018)29)[21]. The report examines ten indicators of different areas including production, raw materials and waste management while depicting the CE as the greater opportunity to meet climate goals, preserve resources, maximise their value and generate job opportunities and social equality.

A systematic literature review by Mhatre et al. (2021) has elaborated the implementation of CE in the EU in various sectors. The study reveals that recycling is the most commonly used circular strategy in businesses especially in construction, metals and fabrication, textiles, wood and paper, rubber and plastics, waste management, electrical equipment, machinery and transportation equipment, along with the manufacturing industry at large. Moreover, technical nutrients[22] (i.e., inorganic or man-made synthetic materials such as metals, plastic, etc.) are looped more as compared to biological ones. The majority of CE initiatives have been implemented at a macro level, i.e., in cities or regions or nation-wide. The penetration of CE has had mixed results in various industries ranging from a high and rapid uptake of CE principles (waste management, electrical and electronic equipment and construction industries) to a slow approach towards CE industries (e.g., mining and quarrying, health equipment and entertainment and recreation.

A synthesis of the European Union's CE strategies in business in relation to the **sectors** of industry in which they have been adopted is depicted in Figure 3. Each green cell represents a specific strategy implemented by a sector. In the furniture sector (see the column circled in red in the below figure) the main CE strategies include customisation, ecodesign, ecolabelling, element recovery, functional recycling, reduction, reuse, take-back and trade in. One may infer that there is a growing attention on the use of materials, on extending the product lifespan and on extracting

[20] https://ec.europa.eu/environment/strategy/chemicals-strategy_sv
[21] https://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX:52018DC0029
[22] See the right-hand side of the Butterfly diagram elaborated by EMF, 2012.

more value from the products by keeping circulating longer. By reusing, renovating, upgrading and remanufacturing products and components to continuously meet the customers' furniture demand, both the need for natural resources and climate impact are expected to diminish while new business models emerge and maintain the industry competitive.

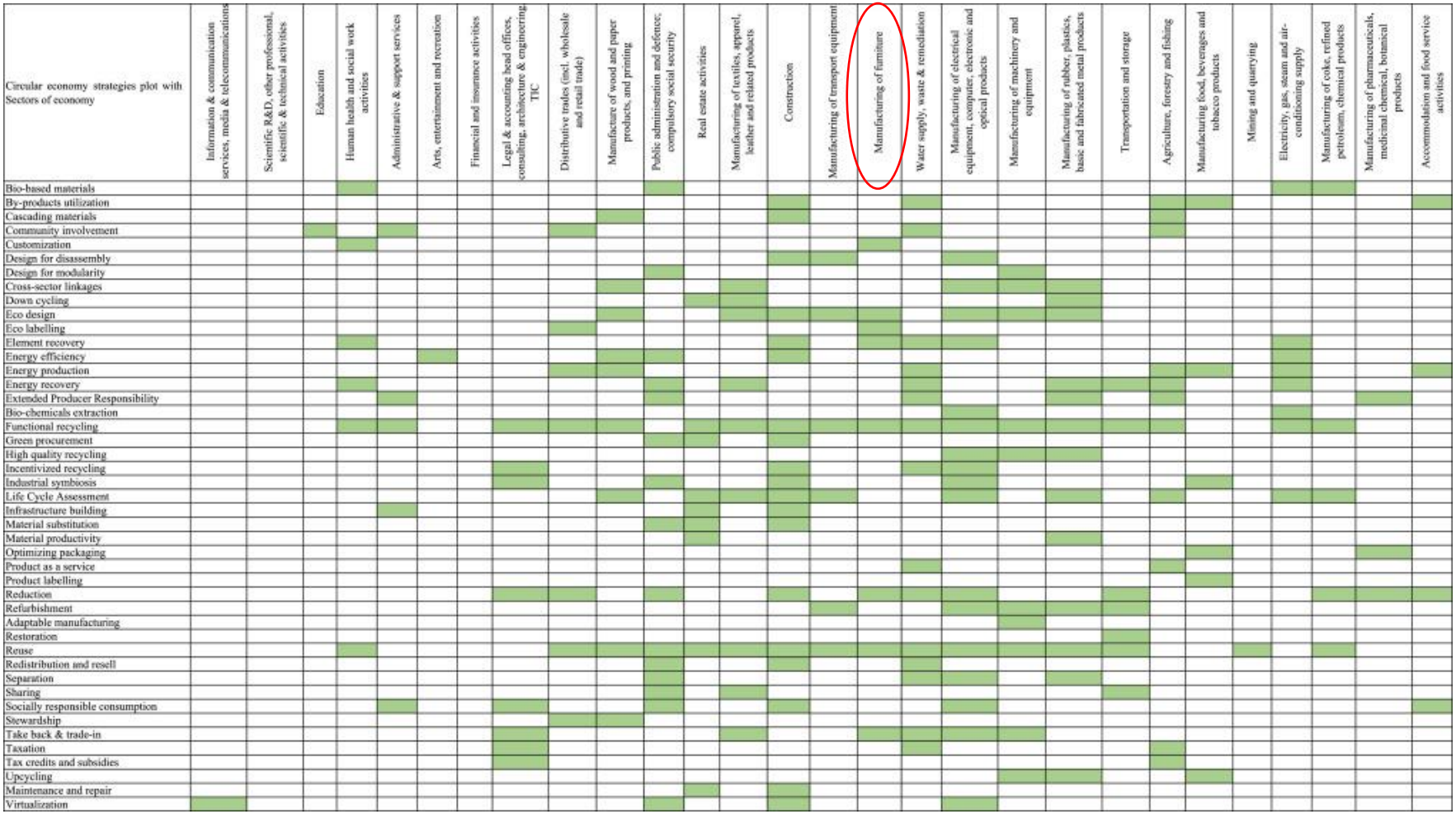

Figure 2. CE strategies in sectors (Source: Mhatre et al., 2021).

Policies initiatives in Sweden

In the context of the main policies initiatives to support the furniture industry to transition to a CE, here are some examples at national level in Sweden.

- "Circular economy: a strategy for change in Sweden" (M2020/01133) (Regeringskansliet, 2020) and Circular economy Action Plan 2021[23]
- Creation and appointment of the "Delegation for the circular economy" [24]. This is the "Government's advisory body tasked with being a knowledge centre and a coordinating force for the business sector's transition to a CE. It will also identify obstacles and act as a catalyst". This was based on a previous Government inquiry as documented in *SOU 2017:22 Från värdekedja till värdecykel – Så får Sverige en mer cirkulär ekonomi* (From value chain to value cycle - This is how Sweden gets a more CE). The last report[25] of the delegation included several suggestions of policy measures to increase CE.
- The Swedish Waste Ordinance (2020: 614)[26], last updated in 2020. The content of the ordinance derives from the EU's revised directive on waste. Emphasis is given to producer responsibility on waste (Chapter 15). The aim is to incentivise producers to design and produce products that are resource efficient, recyclable and free from hazardous substances. The producer has a responsibility for its product that extends until after the consumers end use. Around 1 million companies are affected by the changes as almost every type of business produces some form of hazardous waste, e.g., electronics, fluorescent lamps and various chemicals. It is interesting noting that in order for a waste that has undergone a recycling procedure to cease to be waste, certain conditions must be met (see SFS 2020: 601). According to the Waste Ordinance, there must be transport documents with information on sender, recipient and type of waste and amount of waste (Chapter 6, Section 19).
- The inquire to producer's responsibility for textiles[27] (SOU 2020:72, *Producentansvar för textiler – en del av den cirkulära ekonomin*), presented December 2020, is also an effect of the EU Waste Directive (2008/98/EC)[28]. The proposal includes home and interior textiles, while typical furniture textiles are not proposed to be included. The textile industry is working hard to cope with the high demand of recycling function with industrial sites, close to a commercial capacity. Sweden is a forerunner here, although also the

[23] https://www.regeringen.se/informationsmaterial/2021/01/cirkular-ekonomi---handlingsplan-for-omstallning-av-sverige/
[24] https://www.government.se/4ad42c/contentassets/d5ab250cf59a47b38feb8239eca1f6ab/circular-economy--strategy-for-the-transition-in-sweden
[25] https://www.delegationcirkularekonomi.se/download/18.544e1c0b1784a907392da50e/1618560001862/210414%20Delegationens%20rapport%20(tillg%C3%A4nglig).pdf
[26] https://www.lagboken.se/Lagboken/start/sfs/sfs/2020/600-699/d_4008636-sfs-2020_614-avfallsforordning
[27] https://www.regeringen.se/4af9e5/contentassets/46456fe9a2954a7fa5b5116aaee71930/betankande-producentansvar-for-textil.pdf
[28] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02008L0098-20180705

Netherlands recently decided for a textile producers' responsibility, similar to the Swedish proposal. Challenges are chemicals in textiles, mixtures of materials as well as details such as zippers, cuffs and buttons, as well as managing good quality of the circulated raw material.

- Swedish tax reductions for households for "RUT" (*rengöring, underhåll och tvätt*) on cleaning, maintenance and washing; and "ROT" (*reparation, ombyggnad och tillbyggnad*) on renovation and reconstruction, and to what extent they now and in the future also includes aspects of repair ("REP") and recycling[29]. In the latest version, from 1st January 2021 deductions are for example given to moving, assembling and disassembling furniture[30]. Currently deductions are not accepted for e.g., interior design services or furniture repair, but discussions are held on possible extensions of the incentives in the future[31].

[29] https://www.delegationcirkularekonomi.se/aktuellt/nyhetsarkiv/2021-05-06-skattereduktion-ska-stimulera-reparation-och-privat-uthyrning

[30] https://www.skatteverket.se/privat/fastigheterochbostad/rotochrutarbete.4.2e56d4ba1202f95012080002966.html

[31] https://www.delegationcirkularekonomi.se/aktuellt/nyhetsarkiv/2021-05-06-skattereduktion-ska-stimulera-reparation-och-privat-uthyrning

2.3 Actors' roles: current and emerging ones

When considering an industry, a key step consists of mapping out the ecosystem. A business ecosystem can be defined as the network of organisations — including suppliers, distributors, customers, competitors, government agencies, etc. — participating in the delivery of a specific product or service via both competition and cooperation. Each player in the ecosystem influences and is affected by the other players, shaping a constantly evolving relationship in which each party must be flexible and adaptable in order to survive, similarly to a biological ecosystem (Moore, 1993).

In the past few years, the conceptualisation of the ecosystem has evolved further as a new type of value creation and value capture system that are generated by the ever increasing and closer interdependencies between a variety of actors. This has created the need to deepen the understanding of strategic activities in ecosystem contexts (Adner, 2017). Penttiläa et al. (2020) highlight how an ecosystem approach can be instrumental in researching business environments undergoing a change. Additionally, the authors report studies describing how the formation of strategising in ecosystem contexts takes shape from interorganisational relationships and network formations, including the role of non-business actors.

The business ecosystem in the furniture industry has evolved due to several factors such as fast change in design and manufacturing technology, the upsurge of the information age and a rising level of globalisation which have conjunctionally considerably changed the competitive landscape or, in other words, the nature and pace of competition between firms (Anggraeni et al., 2007).

A representation of key players in the Swedish furniture industry has been accounted in the documentation produced during the Vinnova funded project "*Affärsmodellinnovation för cirkulära möbelflöden*" (Rex et al., 2021).

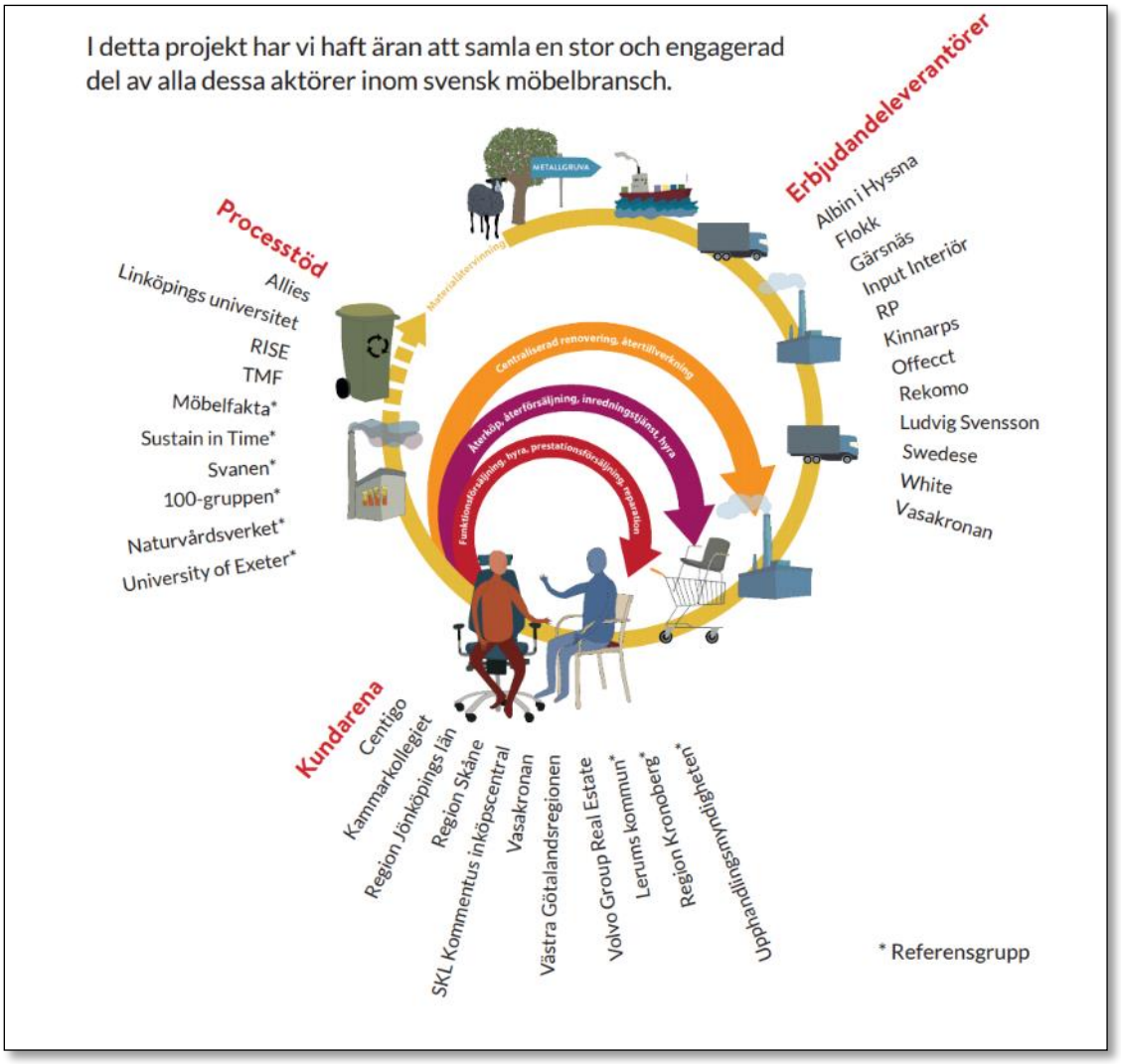

Figure 3. Affärsmodellinnovation för cirkulära möbelflöden project (Rex et al., 2020).

Figure 3 shows a "modern representation of the business ecosystem including the "traditional" industry representatives such as manufacturers, distributors, independent professionals (e.g., architects, reupholsters), and industry organisations (e.g., TMF) together with other supporting actors such as public authorities and research organisations. Waste organisations and logistics companies could also be included.

The concept of business ecosystem has clearly become more complex and wider especially in a context of a CE where flows of resources can be cascaded between different industries thus creating new configurations of business ecosystems. For example, a recently completed VGR funded project led by RISE has studied the formation of a business ecosystem between the three industries of furniture, textile and automotive fostered by the exchange of individual circular knowledge and practices for the creation of new value propositions[32].

[32] More information on the Knowledge Transfer for Circular Business Ecosystems project can be found at the following link: https://www.ri.se/en/what-we-do/projects/knowledge-transfer-circular-business-ecosystems

The current policy framework supporting sustainability and CE is complemented by a variety of initiatives including projects, networks and other actions. Some of them relating to Sweden are presented below.

Projects:

- *Affärsmodellinnovation för cirkulära möbelflöden* – This Vinnova funded project looked at how an industry can concretely switch to a more CE. With innovative business relationships and business models, the project showed that it is possible to combine strong competitiveness with a more sustainable societal development.
- *Centrum för cirkulärt byggande* (CCBuild) – An arena where industry players meet and collaborate on recycling and circular material flows during construction, demolition and management. Some projects also consider furniture flows. The vision for CCBuild is to create conditions for the recycling of construction products on an industrial scale and contribute to a change at the system level towards circular material flows.
- *CIRCit* – A project between the five Nordic countries, Denmark, Norway, Finland, Iceland and Sweden that tested and developed science-based tools for CE also including furniture industry.
- *Circular Hub* – A project for circular fashion and sustainable environments. The vision is to place Western Sweden as a world-leading partner and role model in the CE for textiles, fashion, interior design and furniture with special emphasis on small and medium-sized companies. The Circular Hub project is a collaboration between IDC West Sweden AB and Science Park Borås and is funded by the European Regional Development Fund, the Västra Götaland region (VGR), the City of Borås, the Borås region - Sjuhärad municipal association, the University of Borås and Skaraborg municipal association.
- *DMO.2* – This is a methodology developed by VGR to link interior designer with CE and recycling. The 2020 goal was to have a structure for furniture procurement, with one person from each municipality in a coordinating role.
- *Framtidsscenarier 2030: cirkulär upphandling i bygg- och rivningsprojekt* – A Vinnova funded research project on procurement requirements for circular flows in the construction and demolition process in Gothenburg. Led by the City of Gothenburg, the project involves the administration Consumer and citizen service (Cirkulära Göteborg), the Framtiden Group (*Bostadsbolaget* and *Framtiden Byggutveckling*), CS Riv och Håltagning and IVL Swedish Environmental Institute. Participating as consultants in the project are Forsen and Kjellgren Kaminsky. The purpose of the project is to sketch prepare a plan for how public procurement in construction and demolition projects can be designed future scenarios for circular procurement in construction and demolition projects in 2030.

- *Miljöprojektet Möbelbruket* – This was an environmental project, which was run by IDC, and focused on handing in chairs and ordering reconditioning of chairs and other issues, for example, related to CE. The lessons learned during the project have led to the creation of the company Sajkla AB in 2019.
- *Mätning av produktcirkularitet som ett sätt att öka resursproduktivitet* – A RE:Source project led by RISE and focusing on how to measure circularity of products with the RISE "C" metric. "C" has been used in the furniture sector and has now been incorporated in AB Volvo internal "furniture catalogue".

Networks:

- *100Gruppen*[33] – A platform for collaboration in interior design whose vision is "A long-term collaboration for continuous development of sustainable interiors. 100Gruppen is an obvious source of information and driving force."
- *Body & Space*[34] – A collaborative arena for circular business models in the textiles, fashion, interior design and furniture sectors.
- *Circular Sweden*[35] – A company forum that drives the development of circular material flows forward. The vision is to achieve 100% circular material flows and their goals include making Sweden a leader in circular material flows and drive development internationally by 2030.
- *Interior Cluster Sweden*[36] – A hub for furniture and the interior design industry in Sweden. The vision is to work together with member companies to generate growth, profitability and employment in the Swedish furniture industry, which in turn contributes to rural development. This in turn will contribute making Swedish design and furniture industry be perceived as world leader.
- *LOOP Ventures*[37] – A Nordic network that is part-financed by the Nordic Council of Ministers and aims to get circular start-ups started with the help of the design process. The network also includes furniture companies.

Other Actions

- *Kammarkollegiet*[38] – The Legal, Financial and Administrative Services Agency provide extensive support to the Swedish government which involves qualified legal and economic expertise. They produced a feasibility study showing that government agencies are seriously interested in buying and selling used

[33] https://100gruppen.se/
[34] https://www.bodyandspace.com/
[35] https://www.circularsweden.se/
[36] https://interiorcluster.se/
[37] https://www.nordicinnovation.org/programs/loop-ventures-circular-economy
[38] https://www.kammarkollegiet.se/

furniture. The study also points to several areas that public authorities need to develop to increase the degree of circularity for furniture purchases.

- *Materialbiblioteket*[39] – Started up in 2005, this is a permanent collection of about 3,000 materials such as plastics, metals, wood, composites, stone, glass and manufacturing methods, surface treatments and upcoming colour trends. The Material Library is only open to professional architects, designers, product developers and creators with professions where material choice is important for the project. The organisation also carries research for private companies and organise workshops for educational institutions, organisations and companies. assignments range from making an overview in a specific area to strategic material choices for the future.

- *Möbelfakta*[40] – It is an independent sustainability labelling system for furniture that takes into account both quality, environment and social responsibility. It meets the requirements for a so-called type 1 ecolabel, which means that it can be used in public procurement. Products that are approved by Möbelfakta thus meet environmental requirements that are established by an independent third party and that are developed from a life cycle perspective. It is a general reference system open to all. Möbelfakta Sverige AB is owned by IVL, Swedish Environmental Research Institute and The Swedish Federation of Wood and Furniture Industry, TMF. Today, Möbelfakta has about 60 affiliated companies with over 1000 approved pieces of furniture.

- *Nordic Council of Ministers*[41] – The organisation's Working Group for Sustainable Consumption and Production published the "Potential Ecodesign Requirements for Textiles and Furniture" report[42] based on a related project. The document focuses on potential ecodesign requirements that can be drawn up for non-energy-related products in the two industries. The findings confirm the viability to formulate relevant both quantitative and qualitative ecodesign criteria for non-energy related product groups using a proposed methodology.

- *Nordic Swan Ecolabel*[43] – It is the official sustainability ecolabel for products from the Nordic countries. The criteria for the Nordic Swan Ecolabel are continuously revised so that products and services are among the best in the market. Current updates focus on including CE principles in the industry.

- *Uppdatering av hållbarhetskriterier för möbler hos Upphandlingsmyndigheten* – Sustainability criteria for purchasing with a focus on environmental and social sustainability.

Regarding noteworthy dynamics and roles occurring on the Swedish industry one can find interesting insights described in literature and industry reports. For instance,

[39] https://www.materialbiblioteket.se/
[40] https://www.mobelfakta.se/?lng=sv
[41] https://www.norden.org/en/nordic-council-ministers
[42] http://norden.diva-portal.org/smash/get/diva2:1221509/FULLTEXT01.pdf
[43] https://www.nordic-ecolabel.org/

promoting consumption of more environmentally friendly products primarily through **eco-labelling** has been greatly dependent on **consumers' preference**, costs and community awareness (Prieto Sandoval et al., 2020).

Moreover**, recycling centres** (together with individual consumers, and smaller vintage or antique shops) play a role in the reuse of furniture. Recycling centres – which sell a variety of other commodities (e.g., clothes, tableware, etc.) – have been improving their operations. Around 60% of them have simplified the way they accept materials for reuse, such as household goods and furniture with the support of municipalities and often in collaboration with aid organisations that sell or donate the materials. Other recycling centres with recycling parks have expanded operations, including repairs and sales. Several municipalities are planning to develop their recycling centre to a centre for repair, rental, borrowing, and sharing activities (*Avfall Sverige Report 2020:08 Goda exempel på kommunalt återbruksarbete*; *Avfall Sverige*, Swedish Waste Management Report 2019).

It is worth mentioning the emergence of business propositions consisting of offering **products as a service** from established companies. Service elements are complemented and enhanced to increase innovation and revenue in manufacturing companies. The servitisation process is articulated in various ways depending on the properties of the manufacturing firm and its business contexts (Kim et al., 2015). The most notable of these is the emergence of new players that are not manufacturers and focus purely on offering solutions (e.g., Beleco).

Furthermore, **public authorities** have been identified as key enablers to transitioning to a CE via public procurement that is a key economic activity in governments (Witjes and Lozano, 2016; Brammer and Walker, 2011). For instance, in 2019 in Sweden the total value of purchase covered by public procurement regulations has been estimated to SEK 782bn. This equates to 18.3% of GDP at fixed price (Konkurrensverket, 2020). As major consumers and buyers therefore, some public authorities are attempting the route of procuring services, fostering early dialogues with suppliers and setting new circularity requirements in tenders. Adda is a procurement support organisation for the public sector that offers framework agreements for municipalities and county councils. Since 2021 they have introduced a specific focus on agreements for circulated furniture.

Industry associations such as TMF and EFIC are following thoroughly standardisation and industry initiatives on circular design claiming that the development of circular design criteria should stem from a consultative process between the industry and standardisation bodies. For example, CEN/TC 207 on Furniture is in the process of categorising circular economy standardisation needs to support the industry. At a more general level, work on CE is ongoing at ISO level within ISO / TC 323 developing a standard for a CE (EFIC, 2020).

3 Knowledge gaps

As emerged from the previous sections, the concept of CE and related initiatives are still evolving to shape possibly a more defined framework in the future, in all industries and at different degrees. Prior research indicates several gaps in knowledge and practice that require to be filled to increase the chances to transition to a CE. As examples, five contributions are here reported:

Firstly, Barreiro-Gen and Lozano (2020) point out that the gap between CE theory and practice needs to be closed and this could be facilitated by increased collaboration between various stakeholders that set and work shared CE and sustainability goals. In addition, they emphasise the importance of future research focusing on the micro level, in order to investigate how organisations are perceiving and implementing CE and to better link the micro, meso and macro levels.

Secondly, Durán-Romero et al. (2020) highlight the need to create new rationales between CE and climate change mitigation policies and eco-innovation. The authors propose that the interaction between five different subsystems (educational, industrial, political, social and natural environment) forming the so-called Quintuple Helix Model (QHM) could increase circulation of knowledge flows between them, promote and catalyse innovations, create value and contribute to a sustainable future.

Thirdly, studies at the micro level show that companies are new to circular business models and therefore lack of knowledge and skills within this field and therefore need to allocate resources to build them (Guldmann and Huulgaard, 2020).

Fourthly, the rapid evolution of technology in both the design phase (CAD) and the sale phase (advancing technology of Augmented Reality and e-commerce) are challenging the status-quo by opening to unexplored possibilities especially in with reference to the furniture industry (Siltanen, 2012).

Lastly, currently supply chains of green products suffer from weak information transfer and transparency related to material content as well as difficulties in fulfilling criteria on chemicals and recycling of furniture materials. This probably depends, among others, from the fact that the Ecodesign Directive does explicitly mentions any legal responsibilities of stakeholders (manufacturers, repairers, recyclers, brokers, etc.) that should be present in a circular supply chain (Polverini, 2021). It would be therefore desirable to introduce common criteria that would strengthen other current EU instruments (e.g., GPP and Ecolabel). Such criteria would encompass a variety of CE criteria on durability, the use of recycled material content, and reused components (i.e., remanufacture), hazardous substance removal, and to facilitate repair, remanufacture and recycling (Nordic Ecolabelling, 2020; Forrest et al., 2017; Schöggl et al., 2016).

The above points suggest that in order to achieve a more sustainable economy a new system thinking at all levels (macro, meso, and micro) is imperative and this would entail consolidation and understanding of circular business models with emphasis on

technology development, reconfiguration of supply chains and openness to collaboration within the industry and beyond.

It is nevertheless interesting noting that a plethora of scholars, policy makers and practitioners have sustained the concept of a CE as an alternative to the current linear economy that could promote a much-needed shift towards sustainable development (Guldmann and Huulgaard, 2020; Korhonen et al., 2018; Ghisellini et al., 2016). CE has gained favourable traction as an alternative model that can achieve patterns of production and consumption that have a negligible environmental impact whilst still encouraging growth (Geissdoerfer et al., 2017; Adams et al., 2016).

However, a conflicting argument comes from Millar et al. (2019) who posit that the conceptual relationship between the two notions of CE and sustainable development remains ambiguous and has yet to be thoroughly specified. For instance, it is not certain whether a CE can promote economic growth whilst at the same time protecting the natural environment and improving social equity for present and future generations. In other words, it is, according to Millar et al. (2019) not only unclear as to whether CE can be an effective way towards Sustainable Development, but also whether it is a more sustainable model than the current linear economy.

Perhaps the attainment of a clear definition across disciplines of CE and its relation to sustainable development could assist in clarify the nexus between the two concepts (Kirchherr et al., 2017). Also, further research should be devoted to the links between CE and social welfare and how to measure it. Moreover, priority should be given to verify that a CE can impact negligibly on the natural environment “through understanding the indirect effects of a CE including the “rebound effects” and the after effect of material flows (Korhonen et al., 2018). In doing so, greater clarification can be given to the extent to which the CE can be considered closed-loop and also to fully discover how its environmental impact differs from that of the linear economy”.

4 Scenario planning as a tool for discussing the future of circularity

As outlined in the previous sections, there are many uncertainties on how circularity will materialise in industry, and specifically in terms of definition of business environment, policies, potential impacts, and trade-offs. In addition, achieving the sought-after high-level CE goals requires broad participation across stakeholder groups. One way to start filling knowledge gaps, finding a common understanding between actors, and reflecting on opportunities could be considering **alternative futures**. **Scenario planning** is an approach within an emerging discipline of future studies that provides contrasting representations of how a certain phenomenon (in this case a CE) might look like and are particularly useful when a topic is associated with high degrees of complexity and uncertainty.

Bauwens et al. (2020) highlight the scarcity of research on the alternative circular futures and point out that, while there are future oriented studies on the topic, most of them focus on the impacts of CE. The authors attempt to bridge the gap by outlining *plausible*[44] scenarios for the circular futures: representations of what "could happen based on our current knowledge" (as opposed to future knowledge of "how things work"). The four scenarios developed consider two core drivers and the spectrum within each driver, namely Innovation ("Low-tech" and "High-tech") and Government ("Decentralized" and "Decentralized"):

- Scenario 1. Planned circularity: low-tech innovation and centralised government
- Scenario 2. Bottom-up sufficiency: low-tech innovation and decentralised government
- Scenario 3. Circular modernism: high-tech innovation and centralised government
- Scenario 4. Peer-to-peer circularity: high-tech innovation and decentralised government.

Bauwens et al. (2020) then describe which aspects of circularity, innovations, business models, actors are dominant in each of the four scenarios. As the next step, the impacts of the scenarios are assessed via focus group sessions on the basis of *four criteria* that refer to the triple bottom line of the concept of sustainability and specifically: 1. Economic efficiency; 2. Environmental effectiveness; 3. Socio-political feasibility; and 4. Fit with democratic values.

[44] Probable scenarios are events that are "likely to happen" whereas preferable scenarios are events "concerned with what we want to happen".

Here is presented a summary of the scenarios elaborated by Bauwens et al. (2020):

Scenario 1. Planned circularity emphasises the higher Rs of the waste hierarchy and a low-tech approach to reduce, reuse, recycle and recover and is characterised by the emergence of a variety of business models and particularly performance and accessed based ones. This is deemed to have a very high degree of environmental effectiveness with a low risk of rebound effect. In response to governments mainly regulating the economy to support circularity via a command-and-control approach, it is expected a high level of overall economic efficiency and a large behavioural change in citizens without necessarily a change in cognitive and emotional engagement. This in turn on the one hand is seen as highly effective from a social and political feasibility point of view (although not as much at the local level) but on the other hand is seen as negative in terms of loss of personal freedom and democratic values.

Scenario 2. Bottom-up sufficiency similarly to the Planned circularity scenario features the higher Rs of the waste hierarchy and a low-tech approach to reduce, reuse, recycle and recover. Likely business models to predominate are sufficiency-driven focusing on long-life, gaps exploitation, performance and accessed. The associated level of environmental effectiveness is positive however, it is envisaged a lack of mechanisms to set boundaries of a rebound effect. With citizens deeply involved from a cognitive and emotional viewpoint in leading the change and embracing dramatic behavioural changes, this scenario would ensure the highest level of democratic setting particularly empowering local communities. On the contrary, this scenario is considered negative as characterised by a low socio-political support with potentially large social and economic costs due to resistance to radical change by certain societal actors with powerful vested interests such as central government, large corporations and higher-income consumers.

Scenario 3. Circular modernism is characterised by the centralisation of economic and political decision-making processes of the government and few large actors setting standards and supporting large investments in technology to spur innovation in critical (i.e., more polluting and resource-intensive) sectors. The focus would be on improving eco-efficiency to recycle, recover and reduce approaches which would be developed in business models mostly compatible with linear business models (resulting in long-life and hybrid business models). Such a governance configuration from one side is likely to support economic efficiency (however, with no guarantee to achieve high environmental and welfare standards), from another side will see a very limited participation and behavioural changes from citizens/consumers who will accept or discard product innovations. If behavioural changes lessen or offset efficiency gains expected by the introduction of more efficient technologies such as AI automation and big data analytics, then a rebound effect is foreseeable.

Scenario 4. The Peer-to-peer circularity scenario is based on the assumption that a more decentralised organisation of economic activities will be empowered by several enabling technologies including platforms, blockchains and 3D additive manufacturing. This will most likely result in consumers shifting towards buying services and while deeply engaging in the economic change. User centric business models based on providing access and performance as well as collaborative platforms

to users will probably prevail also thanks to low barriers to entry (with low capital and operating costs). Easy accessibility of products coupled with low price on sharing platforms could lead to over-consumption and therefore a rebound effect, which would make the scenario environmental effectiveness uncertain. In terms of socio-political feasibility, it is expected to see a high level of resistance from powerful vested interests who might co-opt sharing economy initiatives, as well as difficulties in coordinating national interest interventions on, for instance, climate change or large-scale infrastructures.

Bauwens et al. (2020) propose a deep, high level analysis and a representation of alternative paths to circularity and provide a solid ground for a high level academic, policy and societal discussion. However, the scenarios are developed based on a literature review and a theoretical experiment, and thus do not necessarily capture a broad range of stakeholders' views on the future of circularity. In addition, the scholars focus on CE as a whole, and do not discuss the specifics and caveats of circular transition within various sectors, or in more specific geographic contexts.

A practical case application with broad stakeholder involvement at all stages of the process, a clearly defined sector, geographic scope and timeline could provide additional planning value and guidance for the stakeholders outside the academia. One example is offered by the work carried out during the VGR funded project "*Framtidsscenarier för cirkulära möbelflöden*" where about 50 organisations representing different parts of the furniture business ecosystem worked together to develop scenarios for the circular furniture industry in Sweden by year 2030.

The scenarios that have been chosen are based on two areas where there is uncertainty in how and how quickly the industry will develop – namely the degree of digitalisation and information sharing – and how the business relationships between actors develops in different degrees of centralisation in the value chain. Out of the four possible combinations, three scenarios emerged describing different development paths of these dimensions and what kind of future is foreseen for the furniture industry in 2030, as illustrated in figure 4:

• Scenario 1. Local loops – Low digitalisation development and Low degree of centralisation in the value chain. It promotes local economy but gives low circular system effects. It is seen as a starting point with relatively low risks and opportunities for the industry that should aim to greater ambitions for 2030.

• Scenario 2. The puzzle platform – High digitalisation development and Low degree of centralisation in the value chain. It promotes industry gathering and industry-wide collaboration but requires resources for data sharing and high knowledge among customers.

• Scenario 3. The turnkey contractors – High digitalisation development and High degree of centralisation in the value chain. By 2030 a few major suppliers have control over the value chain, while smaller players have either been acquired or engaged through cooperation agreements with major players. Large number of transactions take place through "function sales". Greater risks and opportunities are associated with scenarios 2 and 3.

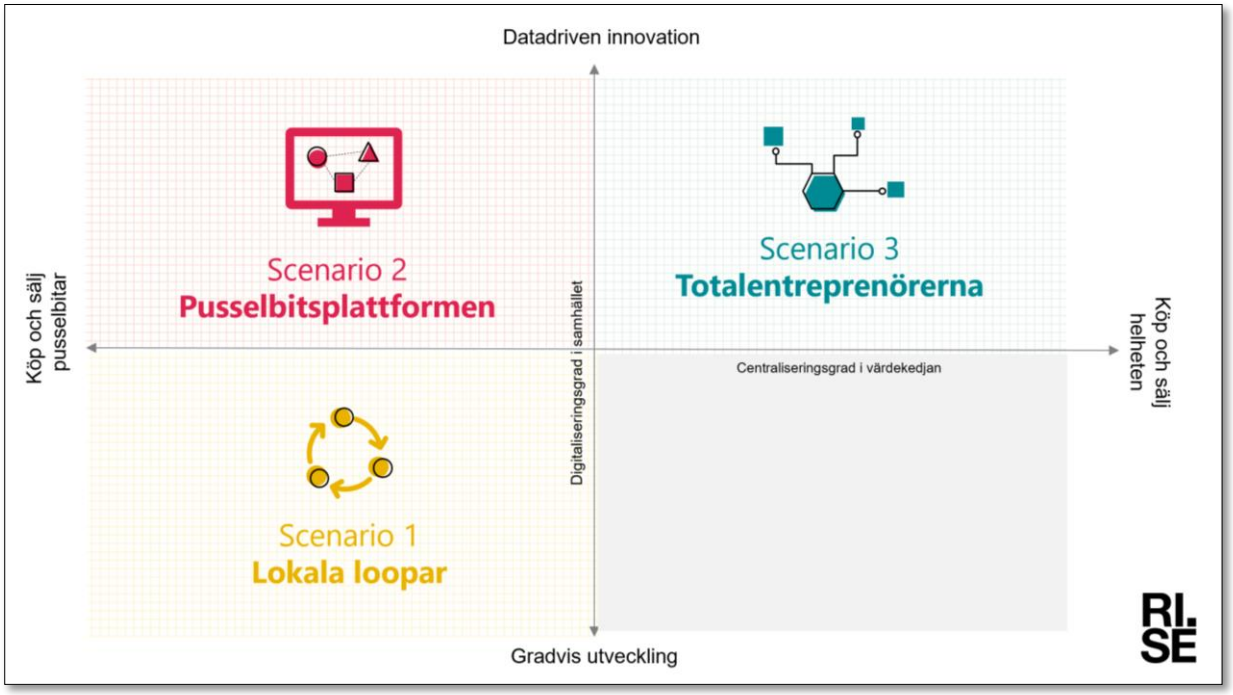

Figure 4. Possible scenarios for the furniture industry by 2030 (Source: Rex et al., 2021).

5 Conclusions and Recommendations

Since the 18th century when the first industrial revolution occurred, economies have been shaped according to a linear model, considering resources easily available, in abundance, and inexpensive to dispose of (European Commission, 2014). This logic based on the indiscriminate use of finite resources has led to severe economic, ecological and social unbalances that are threatening mankind's survival. In the last few years the CE has been put forward as a way of addressing sustainability (European Commission, 2018; Murray et al., 2015).

This paper has outlined the state-of-the-art of the furniture industry in relation to a CE highlighting policies, initiatives, actors, opinions and scenarios. Many initiatives exist but also divergent options on future development paths. To this end, it would be beneficial for policy makers, suppliers and customers alike to focus on further educating themselves on scenario development and analysis as a way forward to secure resilience and success in any circumstance.

Based on the above, some recommendations can be drawn for the industry by pointing at some potential opportunities to progress in its "circular journey".

The European policy and legislative trajectory – which directly influences the Swedish one – has the ambition to adopt increasingly clearer and more stringent measures to positively influence production and consumption patterns at all levels for achieving a more sustainable society (Ladu and Blind, 2017). Here, the EU considers a transition to a CE as **a major strategy** for achieving sustainability **rather than an option**, as illustrated for example by the new Circular Economy Action Plan (which plans to phase in mandatory tools such as mandatory circularity indicators for products) as part of the New Industrial Strategy (COM/2020/102 final)[45] that encompasses also the EU Green Deal (COM/2019/640 final)[46] and the EU's digital strategy (European Commission, 2020).

In parallel, research advocates the need for a **holistic and integrative approach** to guarantee the success of such policy measures as levers in a system transition to sustainability (Inigo and Blok, 2017; Ladu and Blind, 2017). A variety of aspects should also be considered such as business models (with emphasis on "slowing the loops", i.e., designing long-life goods and for product-life extension), governance, incentive mechanisms, organisational and social innovation, circular consumption traits and responsible research innovation (Inigo and Blok, 2017; Ladu and Blind, 2017). This applies also to the furniture industry that especially in Sweden could take advantage of a stronger and more supportive framework (top-down) and context (bottom-up) to continue thrive while contributing to a positive system change through the adoption of circular principles and practice.

A **low hanging fruit** could be to focus on better tackling **waste** generation and management (processes and programmes). Public authorities and specifically

[45] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0102&qid=1624026361180
[46] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2019%3A640%3AFIN

municipalities could support improvements along the Rs of the waste hierarchy (refuse, reduce, reuse, repurpose, recycle). The last point could be realised by enabling improvements of the recycling rates of municipal waste by separating furniture from waste streams and introducing an effective recycling system for furniture similarly to what has been initiated in Sweden and Finland in the 1990s with reuse and industrial plastic packaging and, in Sweden, with public plastic recycling for households in 2008 (Silas, 2019). Some studies (Forrest et al., 2017; EMF, 2012) show that unfortunately the EU has not clearly supported members states to harvest monetary and environmental benefits from recycled/reused furniture by incentivising actions to separate furniture waste from bulky waste. Since the furniture manufacturing industry utilises numerous raw materials including wood, chipboard, sawdust, fibreboard, metal, plastic, fabric, and electronic appliances, there is potential to increase the use of recycled materials. Recycling and nontoxic material use have to be conjunctively fulfilled, as stated for example, in the EU Chemicals Action plan.

Companies could also financially gain from **reverse cycling** by focusing on extracting value from their products at the end of their lives through for example, reverse logistics. According to the Ellen MacArthur Foundation (2012, p.9-10) this would entail taking back products for reuse or remanufacturing, boosting product resale, lower material bills and warranty risks while enhancing customer interaction and loyalty. The content of materials will also be easier to handle when the same company takes its own products back.

Moreover, in order for companies to become more sustainable, it is key to strengthen their 5Rs efforts (Refuse, Reduce, Reuse, Repurpose, Recycle) by finding innovative and better ways to connect CE principles and practice. These enhanced connections need to be implemented in a holistic way also outside the organisations throughout the value chain and beyond, i.e., at the **ecosystem level**. This could be achieved through **a better synergistic approach based on close and open collaboration with stakeholders including companies, civil society, corporate or public sector on CE efforts and activities** (Barreiro-Gen and Lozano, 2020).

At the company level an effective circular strategy could be **slowing the loops strategy** by investing in extending the life of products and reduce or avoid waste. Manufacturers could consider adaptive design and remanufacturing as a means of product life extension with potential for economic viability (Krystofik et al., 2018). Adaptive design and remanufacturing enable designers to update, reconfigure, and customise previously obsolete products by leveraging new technologies and meet current market demands. Adaptive design and remanufacturing mitigate the risk of obsolescence and allows to continue utilising the product's embodied value until further remanufacturing is required due to loss of environmental preferability (the environmental gains of product life extension through multi-cycle adaptive remanufacturing must offset the environmental costs of doing so) and material integrity affecting the economic viability. Some challenges of adaptive remanufacturing lie in a yet not developed take back system as well as in the development of technology to be able to reuse material economically and with negligible additional energy investment. As long as the materials contain hazardous chemicals in concentrations that might be

regulated, there is a need of smart technologies for information transfer and simple non-destructive methods of analysis, to manage recycling and regulatory compliance.

To conclude, as evidence has shown hitherto, the successful uptake of a CE to achieve a higher degree of sustainability will continue to depend even further on a wide array of support and collaboration from every representative in society (European Commission, 2019; Kirchherr et al., 2017). A further transition to a CE can be therefore enabled by government policies, infrastructure and technological availability, awareness, stakeholder collaboration and supply-chain integration (Mhatre et al., 2021). Certainly, the development and implementation of harmonised rules for a CE at EU level will be the crucial for a shared understanding for all stakeholders and thus a strengthening of the internal market. With that in mind, EU policy makers should cooperate with standardisation bodies at both international and European level to ensure the implementation of sustainability requirements at a global scale.

To this end, the exact operationalisation of many circular policy initiatives is still uncertain, as is the development of the business ecosystem for circular furniture flows. **Scenario planning** can serve as a basis for discussing the directionality of the policy mix and assessing alternative policy pathways, but also to deal with additional uncertainties in, for example, technology development and stakeholder relations. Scenario analysis can also be used to align multiple agendas, decide on a common vision and action plan for circularity and thus concentrate multiple actors' resources on achieving the same objective as opposed to dispersing the efforts. As such, it can be used as a tool to strengthen resilience and prepare for several futures, for suppliers, customers and supporting actors alike.

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