Monitoring industrial ecosystems

RETAIL

Analytical reports – 2024 edition

This report was prepared by Orestas Strauka, Carmen Moreno and Kincsö Izsak, Technopolis Group for the European Commission Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs. However, it does not necessarily reflect the views of the European Commission.

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Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs
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European Innovation Council and SMEs Executive Agency (EISMEA)
Unit I.02 - SMP/SME Pillar, Internal Market and Support to Standardisation
E-Mail: EISMEA-SMP-COSME-ECOSYSTEMS@ec.europa.eu

European Commission
B-1049 Brussels

PDF ISBN: 978-92-9412-158-5 doi: 10.2826/2498802 EA-01-25-083-EN-N

Luxembourg: Publications Office of the European Union, 2025

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Executive summary

This report has been prepared within the 'European Monitor of Industrial Ecosystems' (EMI) project with the objective to analysing the green and digital transformation of industrial ecosystems and progress made over time, in this specific case retail.

The second edition of the Industrial Ecosystems series has divided the analysis into two sections meaning, 'green transition' and 'digital transition' followed by three subsections each showing: a) industry efforts, b) framework conditions and c) the impact on the environment and on productivity.

The key findings of this year's analysis are being presented below:

Green Transition

What progress has the industry made in taking action for the environment?

- Despite growing environmental pressures, **only 17% of companies in the retail ecosystem had adopted climate neutrality strategies** by 2024, a figure unchanged since 2021.

- While many retailers have improved resource efficiency, progress between 2021 and 2024 remains incremental. **Energy-saving technologies are the most adopted technologies for resource efficiency**, with 42% of companies investing in them. Adoption of advanced materials and waste management lags behind at 23% and 20%, respectively. **Carbon capture technologies remain niche,** with adoption at just 6%. According to the EMI Enterprise Survey, near-term investment priorities will be led by energy-saving and recycling technologies.

- **Startups in the retail ecosystem are pioneering circular economy models**, focusing on extending the lifecycle of materials and maximising value retention. However, mainstream adoption of the circular economy remains at a nascent stage, with most retailers still reliant on linear practices.

- **16% of companies in the retail ecosystem** have relied on environmental services provided by third-party providers.

- Achieving green transformation requires investments equivalent to 0.3%–0.9% of revenue by 2030, a challenge for a low-margin retail industrial ecosystem. Data shows that **26% of retail companies do not invest in resource efficiency, while 49% of companies invest less than 5% of their annual turnover**. Nevertheless, surveyed companies are planning to invest more in the future.

- **Own financial resources will not be enough to finance the green transformation of the retail industrial ecosystem**. One-third of companies overall and more than one-half of high-emitting businesses reported access to capital as a major obstacle. The shortfall in investment hampers the ability of retailers to adopt sustainable practices and technologies, which are essential for reducing their environmental impact and meeting evolving consumer expectations for sustainability.

To what extent do framework conditions such as public financing and skills support the green transition?

- The retail industrial ecosystem received **EUR 2.4 bn in support from the European Regional Development Fund** according to the analysis of ERDF data from the period 2014-2020. Projects that addressed specifically the **green transition of retail accounted for over EUR 170 m.**

- The largest share of funding (36%) was allocated to projects **supporting the development and implementation of energy efficiency measures in both SMEs and**

large enterprises. This was followed by projects aimed at greening businesses (32%) and promoting circular economy service models (27%).

- Besides the ERDF, the **green pillar of the Recovery and Resilience Fund** includes specific measures fostering the green transformation of retail companies by reducing their primary energy consumption.

- In 2024, **only 2.94% of retail professionals possessed skills relevant to the green transition**, reflecting the limited availability of green talent. However, the share of self-reported green skills grew by 23.4% between 2022 and 2024, signalling growing awareness and upskilling momentum important for green transition among the retail workforce.

- **Critical skills gaps in the retail industrial** ecosystem relate to frontline green professions (repair specialists, circular product designers) and experts in renewable energy installations.

- **The rising demand for green products and solutions is a pivotal force behind the green transition, shaping the competitiveness of the EU retail industrial ecosystem**. Key consumer trends driving this shift include the growing demand for sustainable/ecological products, demand for locally produced goods, growth of interest in circular economy, recommerce and zero waste packaging/shopping.

How is the industrial ecosystem's impact on the environment changing?

- **Retail's environmental impact has seen a slight increase potentially led by growing energy consumption and growing e-commerce**. However, only about 2% of emissions stem from the operations of individual retailers and wholesalers and the energy they consume. About 98% of CO2 emissions fall under Scope 3, i.e. are emissions related to the ecosystem's vast supply chains. While many retailers and wholesalers have made significant progress in addressing direct emissions, value-chain-related emissions remain a persistent challenge.

- **The retail industrial ecosystem plays a crucial role in contributing to the zero pollution targets for air set by the Zero Pollution Action Plan. However, progress in this area has been limited so far**. Due to the growing use of transportation for the delivery of goods, the particulate matter emission following consumption-based account increased from 2018 (4.4M) to 2021 (5.2M) and then declined in 2022 (to 4.7M)

- **Material extraction** have been fluctuating over the entire period from 2016 to 2022.

- **Water extraction and pollution** are also significant negative externalities of the retail industrial ecosystem. Water consumption almost doubled in 2022 compared to 2016.

- **Waste production is still a key concern for the retail industrial ecosystem. Retail accounts for 7% of food waste generation in the EU**. In addition, the retail industrial ecosystem has a key role in reducing the waste from electrical and electronic equipment paper and cardboard packaging waste (predominantly used in the retail sector).

Digital Transition

What is the progress of industrial efforts towards digitalisation?

- In 2024, **18% of companies had a concrete strategy in place for digital transformation** in the retail industrial ecosystem.

- **The EMI Enterprise Survey revealed an increase in the uptake of digital technologies**. The largest increase is seen in cloud technologies, Internet of Things and artificial intelligence, the latter increasing by 10%, and the Internet of Things, which increased by 6%

- In the retail ecosystem, around 17% of businesses that adopted AI did so within the past year. **22% of retail enterprises use AI in marketing and sales, with businesses leveraging AI to personalise customer interactions and optimise campaigns.**

- VR and AR technologies are still in their nascent phase for use by retailers, and immersive, functional ways to showcase products and services remain a niche. The EMI survey shows that it is a low share, notably around 2-3% of retailers that actively engage with this technology.

- In terms of **startups, artificial intelligence and software solutions are the major technological focus areas**. The former represented 30% in 2022 and 43% in 2023. In terms of Venture Capital and Private Equity, most investments were allocated to online platforms/e-commerce solutions, followed by software solutions and AI. Investments in artificial intelligence surged in 2022. This trend reflects the dynamic shift in digital investments, particularly influenced by the COVID-19 pandemic.

- **The vast majority of retail companies invest less than 1% of their annual turnover into advanced digital technologies**. Investment levels are slightly higher for robotics, with 28% of companies allocating 6–10% of their turnover to its adoption. This higher investment is largely attributed to the greater capital intensity required for implementing robotics systems.

To what extent do framework conditions such as public financing and skills support the digital transition?

- The European Regional Development Fund (ERDF) plays a vital role in the digital transition of retail. Over the period 2014-2020, **10% of all retail ERDF projects are related to the digital transition, accounting for 16% of the funding (EUR 370m).** Advanced digital technologies accounted for 22% of the ERDF funding dedicated to the digital transition of retail, with artificial intelligence being the most commonly supported advanced technologies.

- In 2024, **4% of professionals registered on LinkedIn and employed within the retail industrial ecosystem possessed advanced digital skills and 20% possessed other more moderate digital skills, marking an increase from the levels observed in 2022**. The most prevalent advanced digital skills are artificial intelligence, augmented and virtual reality and cloud technologies. However, the overall percentages remain modest, and while there has been some increase, it is not substantial.

- **Requirements both for moderate and advanced digital skills listed on online job advertisements within the retail industrial ecosystem have been growing steadily** over the period from 2021-2023. In 2023, **13% of online job advertisements in the EU27 required moderate digital skills and 5% advanced digital skills**.

- Specific skill needs of the industry relevant to the digital transition include **digital literacy**, **use of AI** and **e-commerce-related skills**.

- **Consumer preferences are rapidly shifting retail from a supply-driven to a demand-driven, personalised experience**. Key trends include the **rise of mobile commerce,** enabling fast, efficient, and convenient shopping and str**ong demand for an omnichannel shopping experience**, blending online and offline touchpoints seamlessly. Also, there is a growing emphasis on **data privacy and digital security**, reflecting heightened consumer concerns in the digital era.

What is the impact of digital technologies on competitiveness?

- Retailers have become more digital, mobile and personalised affecting the retail ecosystem across three dimensions: **1) supporting internationalisation and entering new markets; 2) improving shopping experience; 3) improving productivity**

- The survey of retail companies indicates **that on average the adoption of advanced digital technologies increased productivity by 16.5%** as proxied by the output per hour worked. The technology that respondents identified as having the greatest impact on increasing productivity was artificial intelligence, followed by cloud computing.

- The largest share of respondents witnessed an **increase in productivity as a result of AI followed by Cloud technologies.**

1. Introduction

1.1. Objectives

This report has been prepared within the '**European Monitor of Industrial Ecosystems' (EMI)** project, initiated by the European Commission, Directorate General for Internal Market, Industry, Entrepreneurship and SMEs and the European Innovation Council and SMEs Executive Agency (EISMEA). The overall objective of the project is to **contribute to the analysis of the green and digital transformation of industrial ecosystems** and progress made over time.

The EU's updated industrial strategy[1] has identified 14 industrial ecosystems[2] – one of them being **'Retail'**[3] - that is in the focus of this report. The industrial strategy defined industrial ecosystems as encompassing all players operating in a value chain: from the smallest startups to the largest companies, from academia to research, service providers to suppliers. The notion of ecosystems captures the complex set of interlinkages and interdependencies among sectors and firms across the EU. Industrial transition is driven by technological, economic, and social changes, and by the adoption of green and digital technologies and that move towards sustainable competitiveness. The process is however characterised by complex, multi-level, and dynamic developments. To make transition sustainable, technological change needs to be coupled with new business models, the necessary investments and financial tools, skills, regulatory framework conditions and behavioural change across the ecosystem.

The indicator framework includes a **set of traditional and novel data sources that allow shedding new light on ongoing transformation patterns.** The novelty of the analysis lies in the exploratory and innovative data sources used across the different chapters of the report. **Due to its effort to analyse industrial ecosystems using a standardised set of indicators, the study cannot address all aspects of the green and digital transition.** Therefore, additional analysis and industry-specific data sources should be used to supplement a full assessment.

Measuring performance and change is vital to allow policymakers and industry stakeholders to track progress over time and get feedback whether the system is moving in the desired direction. To measure performance, a dedicated **monitoring and indicator framework** has been set up for the purposes of this project with an aim to capture them in regular intervals (see the overview of the monitoring framework in Figure 1).

The **methodological report** that sets the conceptual basis and explains the technical details of each indicator is found in a separate document uploaded on the EMI website. Moreover, some of the specific industry codes used throughout this analysis have been also included in Appendix B. The green and digital technologies considered in this study include the following:

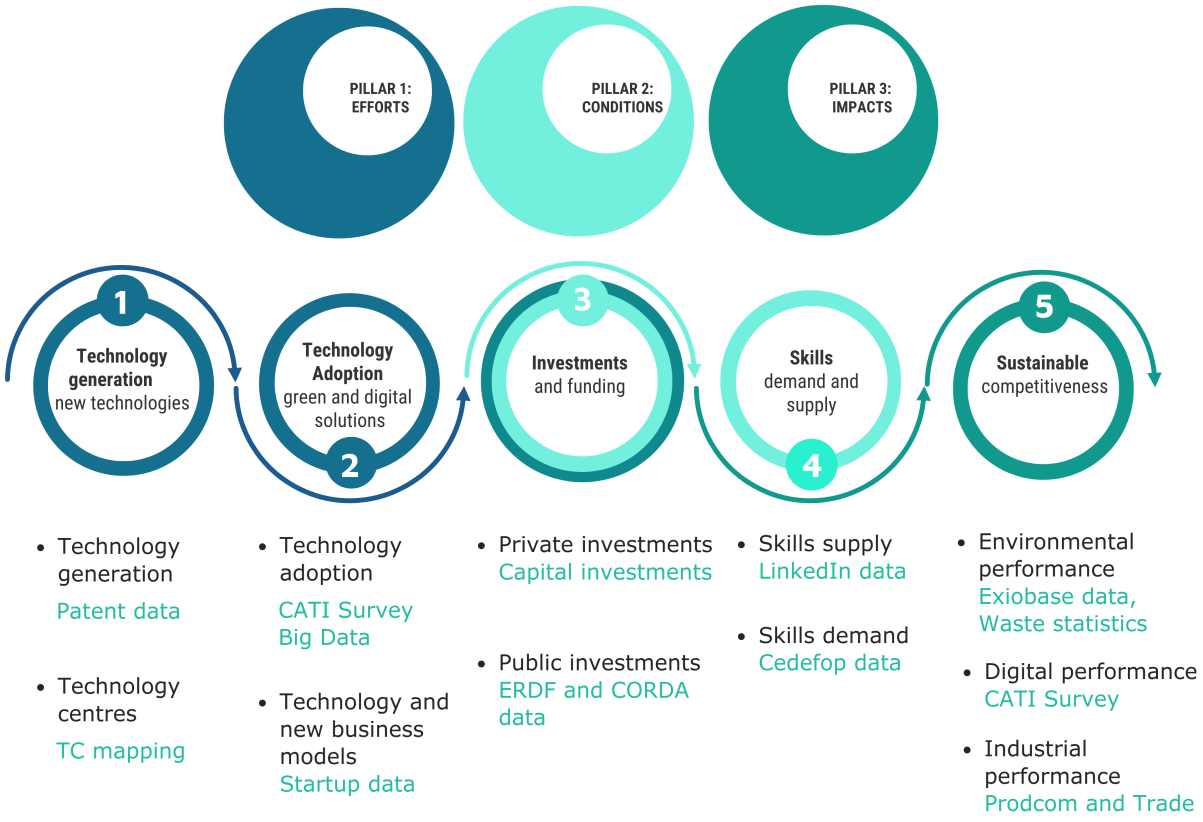
- *Green transition technologies*: advanced materials, biotechnology, clean production technologies, energy saving technologies, recycling technologies, renewable energy.
- *Advanced digital technologies*: advanced manufacturing and robotics, artificial intelligence and big data, augmented and virtual reality, blockchain, cloud computing, Internet of Things, digital security.

[1] European Commission (2020). A New Industrial Strategy for Europe, COM/2020/102 final and European Commission (2021). Updating the 2020 New Industrial Strategy: Building a stronger Single Market for Europe's recovery, COM (2021) 350 final

[2] The 14 industrial ecosystems include: construction, digital industries, health, agri-food, renewables, energy intensive industries, transport and automotive, electronics, textile, aerospace and defence, cultural and creative culture industries, retail, proximity and social economy, and retail

[3] Within the scope of the report, the Retail industrial ecosystem encompasses NACE codes G46, G47 and H53.

Figure 1: Overview of monitoring industrial ecosystems and relevant data sources



Source: Technopolis Group, IDEA Consult and Fraunhofer ISI

This report contributes to the analysis of the **key pillars put forward in the 'Blueprint for the development of transition pathways'**[4] of the Industrial Forum developed in 2022.

1.2. Scoping the retail industrial ecosystem

Retail is one of the most important industries in the EU27 due to its size, number of employees and EU added value. The retail ecosystem accounts for 11.5% of EU value added. It directly employs almost 30 million people in 5.5 million companies, 99.9% of which are SMEs. SMEs account for two-thirds of the ecosystem's employment and generate almost 60% of its value added. Retail and wholesale SMEs are also the largest group among all EU27 SMEs in the non-financial business sectors, accounting for almost 24%[5]. The retail ecosystem is diverse in terms of subsectors and the type of enterprises. Within the scope of the report, the Retail industrial ecosystem encompasses NACE codes G46, G47 and H53.

Retail is interlinked with the other industries across the whole retail supply chain. For instance, retail is closely connected with primary producers, manufacturers, importers, packaging and waste management companies, transportation and logistics service providers, postal and courier service providers, fulfilment centres, marketing, financial and payment services, shopping centres, real estate etc. In terms of interlinkages with other industrial ecosystems, the strongest links are with the agri-food, textiles, tourism and proximity and social economy ecosystems. With regards to the latter, retail companies,

[4] https://ec.europa.eu/docsroom/documents/49407/attachments/1/translations/en/renditions/native
[5] https://single-market-economy.ec.europa.eu/single-market/services/retail_en

particularly SMEs, are considered as key element of the social fabric in urban and rural local communities as they offer proximity to consumers and contribute to vibrant cities.[6]

As part of a highly interconnected global economy, the retail ecosystem is undergoing a transformation, driven by technological development, changing consumer preferences and growing environmental awareness among consumers[7]. For instance, retailers are increasingly embracing digital technology and multi-channel retailing, combining traditional brick-and-mortar shops with online sales or developing their sales online.[8]

The digital and green transitions of the retail industrial ecosystem must be placed in a broader context of the competitiveness of the EU industry. The Council Conclusions approved on 24 May 2024 entitled 'A competitive European industry driving our green, digital and resilient future' stresses that green and digital transitions should be combined with increased competitiveness.[9] Closely related to industrial competitiveness are the following industrial policy priorities that impact the retail industrial ecosystem:

- **Strategic autonomy:**[10] the retail sector in the EU is reliant on global supply chains, which expose the industrial ecosystem to vulnerabilities such as geopolitical tensions, trade disputes, and supply chain disruptions.
- **Technology sovereignty**:[11] embracing key technologies enabling digital and green transition (e.g., AI, robotics) empowers EU Retail Industrial Ecosystem to innovate and compete globally.
- **Stronger Single Market:**[12] the Council of the EU called for a new strategy to strengthen the EU internal market focusing on a more efficient regulatory framework adapted to the green and digital transitions and fast-changing global realities, enhancing the four freedoms and the use of the single market as a global standardisation power. The new strategy will be particularly relevant for the retail industrial ecosystem considering that it is a main driver of Single Market integration. It accounts for 14% of EU cross-border establishment which is the third highest share among all the industrial ecosystems[13].

[6] European Commission, Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs, Perez Fernandez de Retana, M., Strauka, O., Iannacci, A. et al., Study on the twin transition of SME retailers, Publications Office of the European Union, 2024, https://data.europa.eu/doi/10.2873/184606
[7] Ibid.
[8] Ibid.
[9] Council of the EU (2024) A competitive European industry driving our green, digital and resilient future - Council conclusions. Available online at: https://data.consilium.europa.eu/doc/document/ST-10127-2024-INIT/en/pdf
[10] Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic And Social Committee and the Committee of the Regions a New Industrial Strategy for Europe. Available online at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0102
[11] EPRS | European Parliamentary Research Service (2021). Key enabling technologies for Europe's technological sovereignty. Available online at: https://www.europarl.europa.eu/RegData/etudes/STUD/2021/697184/EPRS_STU(2021)697184_EN.pdf
[12] A Single Market for the benefit of all - Council conclusions (approved on 24 May 2024). Available online at: https://data.consilium.europa.eu/doc/document/ST-10298-2024-INIT/en/pdf
[13] European Commission (2024). Retail Transition Pathway. Retrieved from https://single-market-economy.ec.europa.eu/document/download/a7ebd214-2262-4d7e-856c-563382a61ff8_en?filename=2024%2003%2011%20Retail%20Transition%20Pathway%20final_amended_en.pdf

2. Green transition

2.1. Industry efforts to green the industrial value chain

What progress has the industry made in taking action for the environment?

- Despite rising environmental pressures, **only 17% of retail ecosystem companies had adopted strategies for climate neutrality** by 2024 – unchanged since 2021 – indicating a lack of progress.

- While many retailers have improved resource efficiency, progress between 2021 and 2024 remained incremental. **Energy saving technologies are the most adopted technologies for resource efficiency**, with 42% of companies investing in them. Adoption of advanced materials and waste management lags behind at 23% and 20%, respectively. **Carbon capture technologies remain niche**, with only 6% uptaking these technologies. According to the EMI Enterprise Survey, **energy saving and recycling technologies will dominate near-term investment priorities**.

- **Startups in the retail ecosystem are pioneering circular economy models**, focusing on extending the lifecycle of materials and maximising value retention. However, mainstream adoption of the circular economy remains at a nascent stage, with most retailers still reliant on linear practices.

- **16% of companies in the retail ecosystem** have relied on environmental services provided by third-party providers.

- Achieving green transformation requires investments equivalent to 0.3%–0.9% of revenue by 2030, a challenge for a low-margin retail industrial ecosystem. Data shows that **26% of retail companies do not invest in resource efficiency, while 49% of companies invest less than 5% of their annual turnover**. Nevertheless, surveyed companies are planning to invest more in the future.

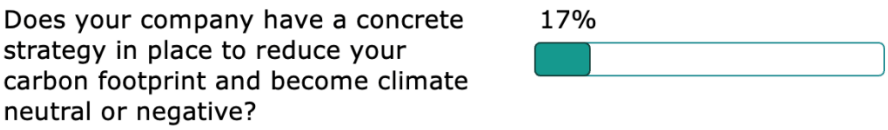
- **Own financial resources will not be enough to finance the green transformation of the retail industrial ecosystem**. One-third of companies overall and more than one-half of high-emitting businesses reported access to capital as a major obstacle. The shortfall in investment hampers the ability of retailers to adopt sustainable practices and technologies, which are essential for reducing their environmental impact and meeting evolving consumer expectations for sustainability.

This section reports on the progress of firms within the industrial ecosystem towards the green transition, focusing on the adoption of environmental technologies and circular business models. The section analyses how startups and young companies that provide environmental solutions exclusively for retail contribute to the transformation of the industrial value chain. Moreover, it examines the level of investment by retail companies in the green transition including green technologies, renewable energy, and circular economy solutions.

2.1.1. Uptake of environmental technologies and circular business models

The adoption of technologies and circular business models in retail has been investigated in detail by the Eurobarometer 2024[14] and has been complemented by a large-scale CATI survey conducted as part of the EMI project over the period from July-September 2024 with a sample of 667 retailers. According to the Eurobarometer 2024 survey results, 17% of companies have a concrete strategy to reduce carbon footprint or become climate neutral or negative.

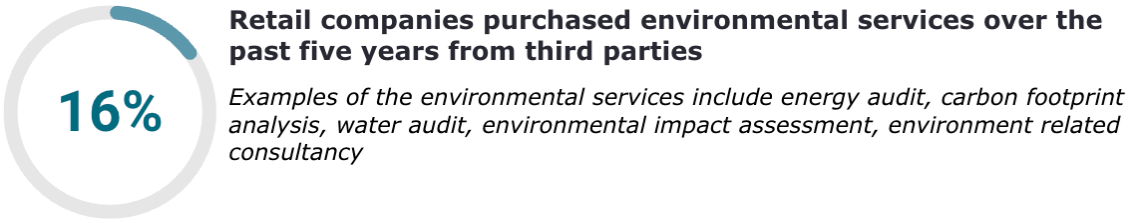
Figure 2: Share of companies in the retail industrial ecosystem that has adopted a strategy to reduce their carbon footprint



Source: Eurobarometer survey 2024

While the adoption and procurement of technologies increased in 2024 compared to 2021, retailers are less likely to develop these solutions internally. The EMI Enterprise Survey supports these findings. To further contribute to the green transition, companies in the retail industrial ecosystem have relied on environmental services provided by third-party providers (as illustrated in the Figure below).

Figure 3: Purchasing environmental services



Source: EMI Enterprise Survey 2024

In 2024, 38% of retail companies offered green products or services, while 10% were planning to do so within the next two years according to the Eurobarometer 2024 survey. In terms of resource efficiency activities in 2024, 66% of retail companies saved energy, 63% aimed to minimise waste, 55% saved materials, and 51% recycled by reusing materials or waste within the company.

[14] Flash Eurobarometer 549 (2024) SMEs, resource efficiency and green markets. Available online at: https://europa.eu/eurobarometer/surveys/detail/3221

Figure 4: Share of companies in retail industrial ecosystem that have undertook specific actions to become resource efficient in 2021 and 2024.

Environmental measures	***Share of adoption (2021)***	***Share of adoption (2024)***
Saving energy	62%	66.3%
Minimising waste	64%	63.2%
Saving materials	56%	54.8%
Recycling, by reusing material or waste within the company	49%	51%
Saving water	48%	47.3%
Switching to greener suppliers of materials	35%	35.7%
Designing products that are easier to maintain, repair or reuse	23%	28.8%
Selling your residues and waste to another company	23%	23%
Using predominantly renewable energy	15%	22.8%

Source: Eurobarometer survey 2024

As a result of these actions, 29% of the companies observed decreased production costs, while for 36% of the companies, the production costs increased. This suggests that for many retailers, the transition to greener practices may initially involve higher investments or operating costs, which could challenge their competitiveness, at least in the short term. However, the long-term effects still offer potential competitive advantages, such as improved brand reputation, compliance with regulations, and alignment with consumer preferences for sustainability.[15] Consequently, within the next two years, saving energy, minimising waste, saving materials and water are areas where more than 40% of retail companies are planning to dedicate additional efforts.[16]

In addition to measures aimed at improving resource efficiency and supporting climate neutrality, retail enterprises have directly implemented specific green technologies. **The EMI Enterprise Survey indicates that 42% of retail companies invested in energy saving technologies** (a smaller share than those taking also other non-technological measures).

Figure 5: Adoption of green technologies by companies in retail

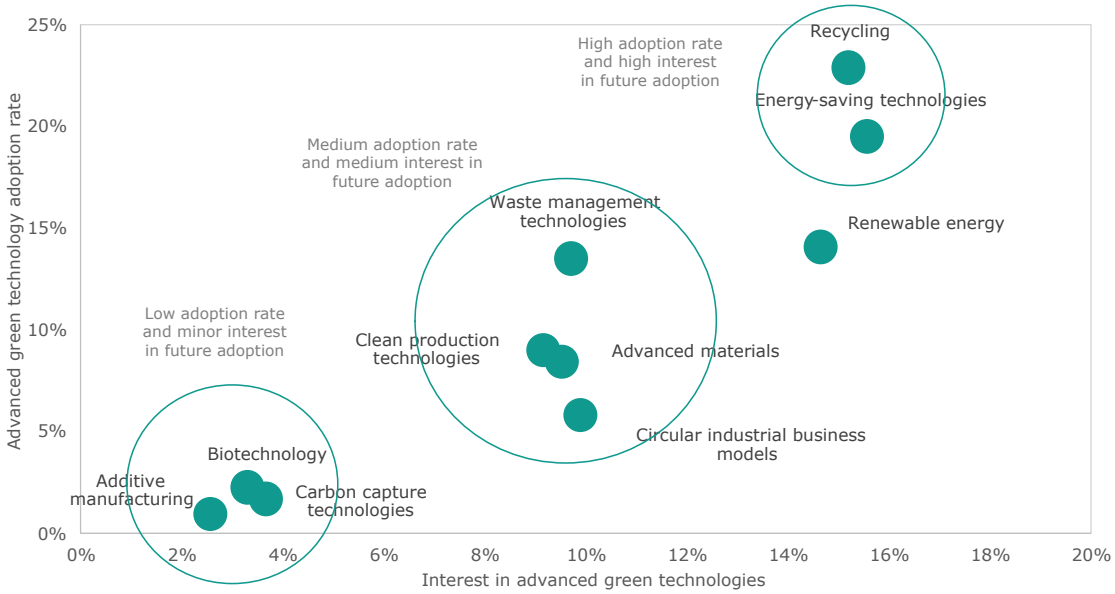
Green technologies	***Share of adoption***
Energy-saving technologies	42.49%
Advanced materials	23.32%
Waste management technologies	20.73%
Clean production technologies	16.58%
Carbon capture technologies	5.70%

Source: EMI Enterprise Survey 2024

[15] For example, Hermundsdottir, F., & Aspelund, A. (2021). Sustainability innovations and firm competitiveness: A review. Journal of Cleaner Production, 280, 124715.
[16] Flash Eurobarometer 549 (2024) SMEs, resource efficiency and green markets. Available online at: https://europa.eu/eurobarometer/surveys/detail/3221

The survey data cross analysis indicates that the current adoption rate of energy saving, and renewable energy technologies is relatively higher than of other green technologies (approximately between 15% and 20%). Secondly, the same technologies have the highest interest among surveyed companies to be implemented in the future.

Figure 6: Green technology adoption and technology generation in retail industrial ecosystem



Source: EMI Enterprise Survey 2024

Note: Advanced green technology adoption rate is based on the responses to survey question "Which environmental technologies and measures has your company adopted or implemented?" Interest in advanced green technologies is based on the responses to survey question "Which environmental technologies and measures is your company planning to adopt or implement?"

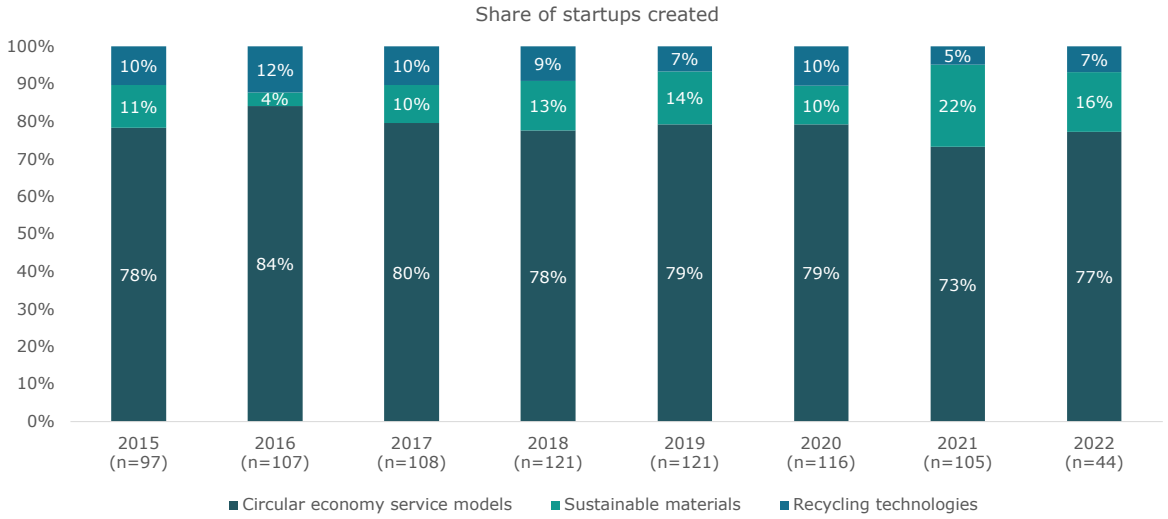
The green transition of the retail industrial ecosystem is often driven by entrepreneurs who offer new environmental solutions. These entrepreneurs and startups play a crucial role in the green transition of the retail sector by stimulating innovation, offering sustainable solutions, and facilitating the adoption of environmentally friendly practices. Startups are at the forefront of promoting circular economy solutions, such as recycling, reusing, and upcycling products. In retail, they help develop sustainable product lifecycles that reduce waste, extend the lifespan of materials, and decrease reliance on raw material extraction. The analysis of retail tech startups that offer new environmental solutions for retail was based on Crunchbase[17] and Net Zero Insights[18] data. The findings indicate strong focus on circular economy service models among retail startups.

The share of new startups that focus on the circular economy services models (sharing, renting, repairing) **slightly fluctuated but ranged between 73% and 84% of all green retail startups over the period from 2015-2024.**

[17] Available online: https://www.crunchbase.com/

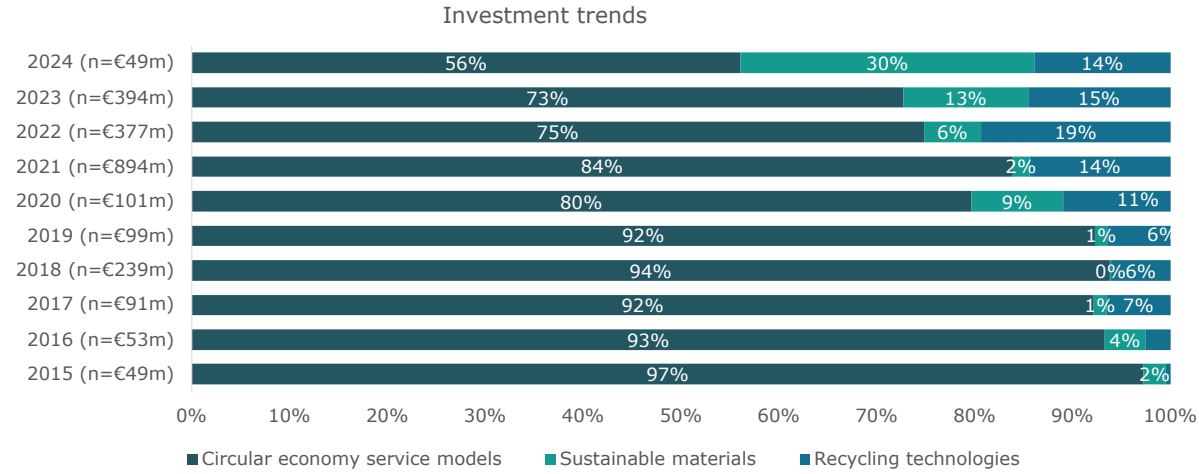
[18] Available online: https://netzeroinsights.com/

Figure 7: Share of environmental startups in retail created between 2015 and 2022 (N is the size of the sample (number of retail tech and innovative startups) created each year)



Source: Technopolis Group based on Crunchbase and Net Zero Insights

Figure 8: Share of investments attracted by specific green technology startup between 2015 and 2024



Source: Technopolis Group based on Crunchbase and Net Zero Insights

Circular economy, recycling and waste management technologies in retail

Circular economy in retail extends beyond merely managing waste; it focuses on maximising the value of materials and ensuring they remain in use for as long as possible. This approach emphasises durability, repairability, and the reuse of products, thereby prolonging their lifecycle. Additionally, it aims to minimise unnecessary material consumption, striving to eliminate waste from the economy altogether. By prioritising these principles, retailers can contribute to a more sustainable and resource-efficient economy.[19] Consequently, the circular economy is important for the retail industrial ecosystem in the EU27 where 73% of respondents indicate that the impact of the product

[19]EEA (2024). Accelerating the circular economy in Europe State and outlook 2024. Retrieved from: https://circulareconomy.europa.eu/platform/en/knowledge/accelerating-circular-economy-europe-state-and-outlook-2024#:~:text=Accelerating%20the%20circular%20economy%20in%20Europe%20%E2%80%94%20State%20and%20outlook%202024,-EEA%20Publications&text=This%20European%20Environment%20Agency%20report,to%20speed%20up%20the%20transition

on the environment is 'very important' or 'rather important' when making a purchasing decision[20]. This is indicated by the results of the EMI Enterprise Survey in 2024 which found that overall, **10% of retail companies adopted and 12% are planning to adopt circular economy solutions. However, when comparing these results to those from a year ago, we do not observe significant progress overall.** In 2023, it was found that 10.6% of the respondents adopted resell, reuse and second-hand operation followed by repair and maintenance services. Renting, leasing and related service models were taken up by 5.9% of the respondents.

Despite the slow adoption of circular economy business models, the data on environmental startups indicate a strong focus on such service models. Since 2020 an increase can be observed in the share of investments attracted by startups focusing on the circular economy. Among environmental startups specialised in retail, several transitioned to scaleups or high growth firms[21]. Several examples are provided in the Table below.

Table 1: Examples of environmentally focused scaleups linked to the retail ecosystem

Circular economy business models	
	Vestiarie Collective has raised a total of EUR 626.5 m in funding over 9 rounds. Their latest funding was raised on 2022 from a late VC round. (Crunchbase)
Companies with a green purpose	
	JOKR, JOKR (Berlin) is a grocery and delivery platform that provides hyper-local product delivery services (a localised approach to delivering products or services). It has raised a total of EUR 456 m in funding over 4 rounds over the past 3 years. Their latest funding was raised on 2023 from a Series D round. (Crunchbase)
Sustainable materials	
	**Paptic** is a sustainable packaging material made of renewable wood fibres. It has raised a total of EUR 48.2 m in funding over 10 rounds, with the last one being a Series A in 2024 (NetZero)

Source: Technopolis Group based on Crunchbase and Net Zero Insights.

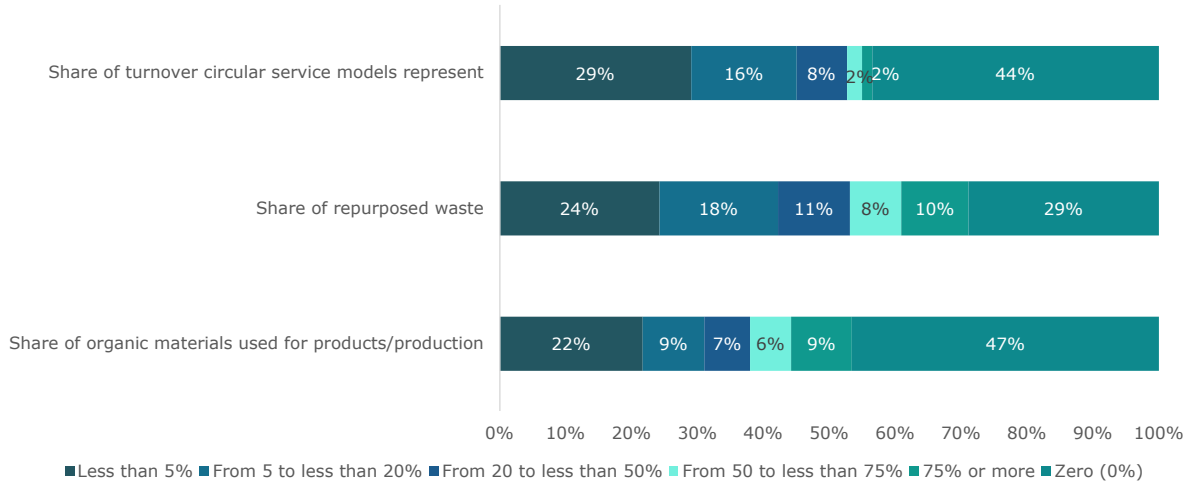
For more established larger retailers and SMEs, the circular economy solutions encompass packaging, products, and end-to-end waste reduction. In general, circular solutions can reduce the use of raw materials, save energy and water, reduce waste but also can lead to potential benefits such as incremental revenues from new business models (such as rental, refurbishment, or resale), cost savings through waste reduction, and improved long-term relationships with customers[22]. The Figure below provides a snapshot of circular economy adoption among surveyed companies.

[20] The 2022 edition of the Flash Eurobarometer on small and medium enterprises (SMEs), resource efficiency and green markets. Retrieved from: https://europa.eu/eurobarometer/surveys/detail/2287

[21] Scale-ups or high growth firms (HGFs) are defined according to Eurostat-OECD recommendations as enterprises with at least ten employees at the beginning of a three-year period that saw average annual growth of over 10%.

[22] McKinsey and Eurocommerce (2022) Transforming the EU Retail & Wholesale sector. Retrieved from: https://www.mckinsey.com/industries/retail/our-insights/transforming-the-eu-retail-and-wholesale-sector#/

Figure 9: Circular economy adoption among surveyed companies



Source: EMI Enterprise Survey 2024

The data reveals that for 29% of the respondents circular service model represents less than 5% of their turnover and for 16% of the companies, circular service models represent between 5% and 20% of turnover. In terms repurposing waste, 24% of companies repurpose less than 5% of waste followed by 18% of companies that repurpose from 5% to less than 20%. Overall, the survey data shows that most of the companies do not implement circular economy business models or are at very early adoption stages. Specific examples of adopted circular economy solutions/business models are provided below.

Figure 10: Examples of circular economy solutions in retail

Repair

The LVMH Group and its Maisons are adopting initiatives for promoting sustainable product lifecycles related to repair and refill services. Notable initiatives include the introduction of refillable jars at Guerlain, Louis Vuitton's repair of more than 600 000 leather goods items each year and the creation of a "repair and care" taskforce that brings together 14 Maisons.[23]

Reselling

Vinted Marketplace is an online C2C marketplace for second-hand fashion items[24]

Repurposing

O'Benefício, offers innovative and sustainable products including backpacks made of end-of-life seat belts, a solution to the problem of non-utilisation of seat belts in the recycling process[25]

Source: Technopolis Group based on Crunchbase and Net Zero Insights.

[23] Retrieved from: https://www.lvmh.com/commitment-in-action/for-the-environment
[24] Retrieved from: https://careers.vinted.com/company
[25] European Commission: Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs, Perez Fernandez de Retana, M., Strauka, O., Iannacci, A. and Coroler, E., *Study on the twin transition of SME retailers – Compendium of success stories*, Publications Office of the European Union, 2024, https://data.europa.eu/doi/10.2873/016103

Renewable energy and energy saving technologies

In addition to implementing circular economy solutions and business models, retail companies have also embraced renewable energy solutions and energy efficiency technologies. Energy, encompassing both electricity and heat, plays a crucial role across all operational phases of retail, including stores, warehouses, fleets, and manufacturing. The energy consumption in the retail industry varies depending on the type of store but heating and lighting typically represent the largest portions of energy use. Additionally, refrigeration constitutes a significant percentage of costs where applicable, further highlighting the importance of energy management in retail operations[26]. Consequently, consuming renewable energy and enchanting energy efficiency can support retail industrial ecosystem in contributing to achieving general EU targets of at least 32% share for produced renewable energy and an energy efficiency increase of at least 32.5%.[27] In addition to environmental concerns and regulation, the energy crisis inflicted by the war in Ukraine created competitive pressure to use renewable energy and adopt energy efficiency solutions.

In this context, some retailers produce electricity from renewable energy sources themselves. For example, retailers and wholesalers who own stores and warehouses install solar panels on the roofs to generate electricity, either for their own operations or for shoppers to charge electric vehicles (EVs) in the parking. However, it should be noted that stakeholders in the retail ecosystem see the lack of adequate infrastructure as one of the reasons slowing down or even preventing the green transition to happen. Therefore, they see a need to simplify permit procedures for Renewable Energy Sources (RES) installations, provide infrastructure to sort and recycle waste, upgrade the grid to take up excess self-generated energy and provide attractive input tariffs, adapt the transport infrastructure and mobility plans, including solutions for green last mile delivery, and support eco-renovation of stores in the context of the Renovation Wave.[28]

Other retailers aim to purchase electricity produced from renewable energy sources. For example, larger retailers, to increase the use renewable energy, are leveraging power purchasing agreements, i.e. long term (10-20 years) fixed price contractual agreements between renewable energy producers and consumers (see one example in the box below).

Box 1: Example of a green transition action in retail

The Carrefour Group announced in July 2024 that it has entered a partnership with GreenYellow, the leader in decentralised energy transition in France and internationally, **for the installation and operation of photovoltaic power production equipment on around 350 of its hypermarket and supermarket car parks in France**. The energy produced will cover around 20% of Carrefour stores 'need**s**.[29] The benefits of the PPA include a) reduction in energy bills thanks to self-consumption; b) contribution to the objective of using 100% renewable energy in the Group's total electricity consumption by 2030; c) Improved customer path and satisfaction, thanks to shade structures protecting from bad weather and sun.

Source: Carrefour partners with GreenYellow to produce photovoltaic power in France

Shifting to the consumption of electricity generated from RES is only one part of the story. To reduce energy consumption, some retailers aim to increase the energy efficiency. More specifically, retailers apply digital solutions, such as building management software (BMS) and remote digital management, to optimise and control energy consumption in their

[26] Retrieved from: https://www.opusenergy.com/help/energy-efficiency-in-retail/
[27] Retrieved from: https://energy.ec.europa.eu/topics/renewable-energy/renewable-energy-directive-targets-and-rules/renewable-energy-targets_en
[28] A transition pathway for a more resilient, digital and green retail ecosystem. Retrieved from: https://single-market-economy.ec.europa.eu/publications/transition-pathway-more-resilient-digital-and-green-retail-ecosystem_en p.17.
[29] Retrieved from: https://www.carrefour.com/en/news/2024/carrefour-partners-greenyellow-produce-photovoltaic-power-france

stores.[30] Other adopted energy efficiency measures by retailers include lighting efficiency (e.g., LED lighting or smart lighting control), HVAC (Heating, Ventilation, and Air Conditioning) optimisation, improved building insulation or smart metering.

However, the adoption of green technologies and circular business models pose challenges for retailers. Firstly, circular retail business models face costs linked to managing product flows across sales cycles. This includes handling product flow logistics, performing quality controls, and washing and relisting returned products. As opposed to selling items one-off, circular sales cycles generate costs that may be difficult to recoup from consumers. To achieve financial sustainability, retailers must increase consumers' willingness to pay for circular models by creating clear upsides when compared to linear consumption. [31] The survey of companies in retail industrial ecosystem, however, reveals that only for 37% of companies the benefits of circular service models outweighed the costs.

Secondly, producing electricity from renewable energy sources require significant upfront investment, as do energy-efficient upgrades such as efficient HVAC systems, building insulation, LED lighting, and energy management systems. Smaller retailers may find these costs prohibitive, especially if they have limited access to financing.

To further support sustainability, some retail companies are sourcing materials and products locally. Schemes such as dedicated supplier networks, tri-partite contracts and voluntary initiatives help address emerging trends and often include a direct reward to farmers investing in these changes.[32] For example, Carrefour prioritises short distribution circuits while limiting fuel consumption.

Use of biomaterials in retail

Advanced materials and in particular biomaterials are used most importantly as part of sustainable packaging in retail such as bioplastics and recyclable composites to develop eco-friendly solutions. In fashion retail, biomaterials allow retailers to explore sustainable clothing solutions.

2.1.2. Private investments

The total amount of funding required for the green transformation of retail was estimated at EUR 335 bn in 2022, with a more conservative estimate of EUR 135 bn investment over eight years according to a recent study by McKinsey and Eurocommerce[33]. More specifically, **retailers need to invest between 0.3% to 0.9% of their total revenue by 2030** for green transformation. Consequently, the private investments in green transition will be key for maintaining the ecosystem's global competitiveness and sustainability.[34] Following the Eurobarometer results, retailers mainly rely on their internal financial resources to enhance resource efficiency and offer green products and solutions.

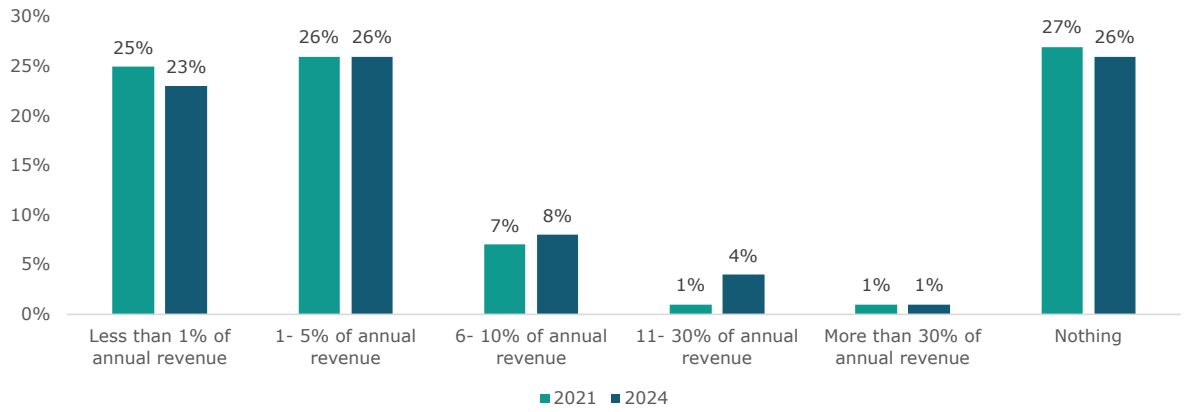
[30] McKinsey and Eurocommerce (2022) Transforming the EU Retail & Wholesale sector. Retrieved from: https://www.mckinsey.com/industries/retail/our-insights/transforming-the-eu-retail-and-wholesale-sector
[31] Retrieved from: https://www.bcg.com/publications/2023/circular-economy-in-retail
[32] EuroCommerce: https://www.eurocommerce.eu/sustainable-commerce/support-to-local-farmers/
[33] McKinsey and Eurocommerce (2022) Transforming the EU Retail & Wholesale sector. Retrieved from: https://www.mckinsey.com/industries/retail/our-insights/transforming-the-eu-retail-and-wholesale-sector
[34] A transition pathway for a more resilient, digital and green retail ecosystem. Retrieved from: https://single-market-economy.ec.europa.eu/publications/transition-pathway-more-resilient-digital-and-green-retail-ecosystem_en

Figure 11: Use of financial resources for resource efficiency and producing green products or services

Source: Eurobarometer survey 2024

However, as the retail industry is marked by relatively low profit margins, achieving annual investments of between 0.3% to 0.9% revenue will be challenging. This is reflected by the Eurobarometer survey results that reveal that 26% of retail companies do not invest in resource efficiency, while 49% of companies invest less than 5% of their annual turnover.

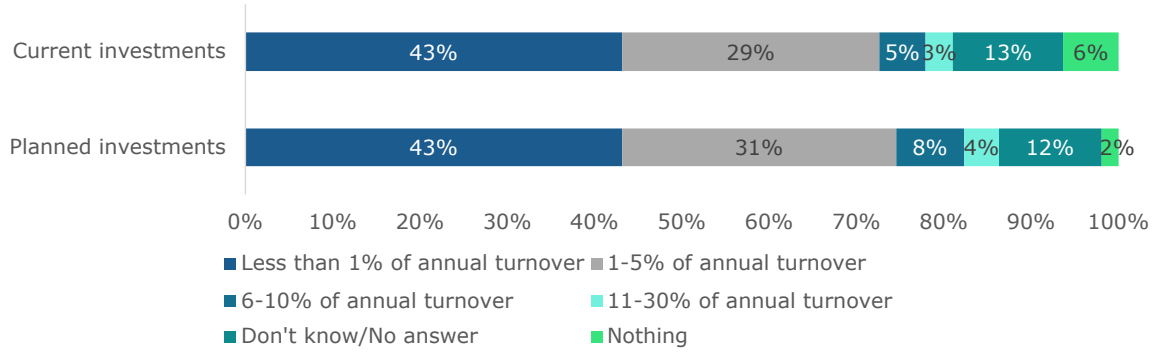
Figure 12: Share of annual revenue invested on average per year to be more resource efficient



Source: Eurobarometer survey 2024

The findings of the EMI Enterprise Survey 2024 complement the Eurobarometer results. **The data indicates that most companies either do not invest in environmental technologies or allocate less than 1% of their annual turnover to such investments.** However, it is important to note that surveyed companies are planning to increase their investments in the future. For instance, the percentage of companies intending to invest 1-5% of their annual turnover is 31% compared with 29% currently investing 1-5% of their annual turnover.

Figure 13: Current and planned investments in environmental technologies and measures.



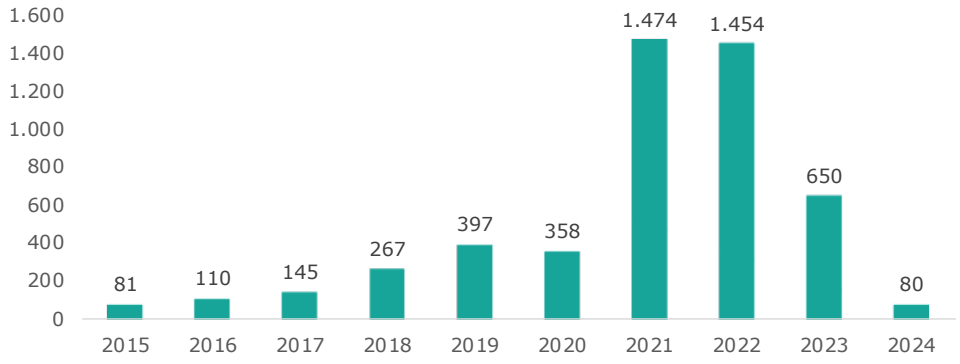
Source: EMI Enterprise Survey, 2024

Own financial resources are not enough to finance green transformation of the retail industrial ecosystem. One-third of companies overall and more than one-half of high-emitting businesses reported access to capital as a major obstacle. Following the results from the Eurobarometer, only 14% of retail companies received private funding from bank, investment company or venture capital to produce green products or services and only 22% received funding for enhancing resource efficiency.

In terms of private investments, recent studies indicate that investors and lenders prioritise the 'Environmental, social, and governance' framework but remain cautious. For example, the Invesco 2021 survey indicates that 79% of surveyed investors declared that sustainability was an important factor in their investment decisions. Additionally, the report by Oliver Wyman and CDP found that 87% of financial institutions have implemented strategies to assess whether their selected clients (in the case of banks) or investees (in the case of investors) are aligned with the 1.5 degrees Celsius target[35].

When looking at venture capital and private equity investments into environmental companies specialised in developing retail solutions, a significant increase can be observed in terms of funding in 2021 and 2022, followed by a rapid decrease in 2023 (see Figure below).

Figure 14: Venture capital and private equity investments into environmental companies specialised in retail in. the EU27 (EUR m).[36]



Source: Technopolis Group, Crunchbase and NetZero.

[35] Oliver Wyman & CDP Europe Report February 2023 Strengthening Europe's corporate climate transition. Available online at: https://cdn.cdp.net/cdp-production/cms/reports/documents/000/006/843/original/CDP_Europe_Report_AW_16_02_23.pdf

[36]

The decrease in 2023 is reflected by global trend when VC investment fell from EUR 484 bn in 2022 to EUR 313 bn in 2023, the lowest level since 2019.

Retail companies differ in their capacity to attract private investments. While some companies, particularly larger retailers, engage and adopt innovative practices to attract private investments (example provided in the box below), other retailers face difficulties.

Box 2: Example of a green transition related investments in retail

REWE Group has established **sustainability-linked bond framework and** placed a **sustainability-linked bond issue** in September 2023. The repayment amount of the bond is linked to the achievement of sustainability goals of REWE and PENNY. The bond, with a nominal amount of EUR 900 million and extending over a term of seven years, will support the company's investments necessary to achieve its greenhouse gas emissions reduction goals throughout the entire supply chain.[37]

The main challenges in attracting private investments stem from financial intermediaries perceiving green investments as riskier. Green technologies are often more expensive and require higher capital expenditures (CAPEX) and longer repayment periods, as seen in renewable energy projects and industrial energy efficiency initiatives. Additionally, green financing entails complex assessments and requirements for both lenders and recipients, making the process more intricate and less attractive compared to financing traditional activities[38]. Overall, in the retail industrial ecosystem, the decline in venture capital investments, coupled with the challenges retailers encounter in accessing private funding, highlights an increasing investment deficit that is critical for facilitating the green transition.

The shortfall in investment hampers the ability of retailers to adopt sustainable practices and technologies, which are essential for reducing their environmental impact and meeting evolving consumer expectations for sustainability.

[37] Reducing emissions in Germany's food retail industry. Retrieved from: https://wholesale.banking.societegenerale.com/en/news-insights/clients-successes/clients-successes-details/news/reducing-emissions-in-germanys-food-retail-industry/

[38] Investment Committee of the InvestEU Fund Conclusion (2022). Retrieved from: https://investeu.europa.eu/document/download/b0392597-690b-4bb4-89ff-0aa7a1112155_en?filename=INVEU-ICR-0067-2022---SMEW-SIW-IC9-%28EIF%29Banca-Comerciala-Romana--%28Romania-MS-C%29_conclusions.pdf

2.2. Framework conditions – assessment of the broader ecosystem supporting the green transition

To what extent do framework conditions such as public financing and skills support the green transition?

- The retail industrial ecosystem received **EUR 2.4 bn in support from the European Regional Development Fund** according to the analysis of ERDF data from the period 2014-2020. Projects that addressed specifically the **green transition of retail accounted for over EUR 170 m.**

- **The largest portion of funding was directed towards projects that support development and implementation of energy efficiency measures and in both SMEs and large companies** (36%). This was followed by projects aimed at greening businesses (32%) and promoting circular economy service models (27%).

- Besides the ERDF, the **green pillar of the Recovery and Resilience Fund** includes specific measures fostering the green transformation of retail companies by reducing their primary energy consumption.

- In 2024, **only 2.94% of retail professionals possessed skills relevant to the green transition**, reflecting the limited availability of green talent. However, the share of self-reported green skills grew by 23.4% between 2022 and 2024, signalling growing awareness and upskilling momentum important for green transition among the retail workforce.

- **Critical skills gaps in the retail industrial** ecosystem relate to frontline green professions (repair specialists, circular product designers), experts in renewable energy installations and EV fleet operations.

- **The rising demand for green products and solutions is a pivotal force behind the green transition, shaping the competitiveness of the EU retail industrial ecosystem**. Key consumer trends driving this shift include the growing demand for sustainable/ecological products, demand for locally produced goods, growth of interest in circular economy, recommerce and zero waste packaging/shopping.

Framework conditions that support the green transition refer to various structural and institutional elements that create an enabling environment for businesses to transition towards more sustainable and environmentally friendly practices. These conditions are crucial for driving the adoption of green technologies and fostering circular economies. Key components of these framework conditions include public policy, skills demand and supply and demand-side factors among others that are analysed in the sections below.

2.2.1. Public investments – the role of the European Regional Development Fund and the Recovery and Resilience Fund

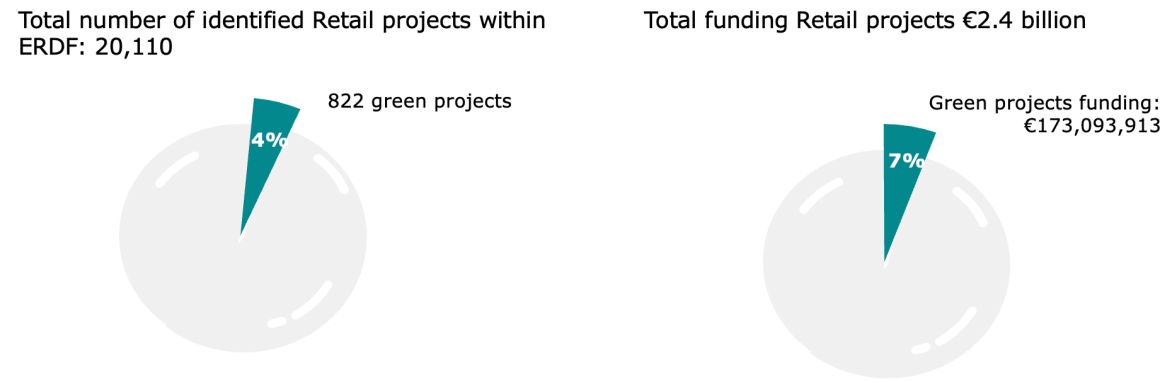
The **European Regional Development Fund (ERDF)**[39] plays a crucial role in supporting the green transition of retail by providing financial resources to regions within the European Union to promote sustainable development. The ERDF has a particular focus on less-developed regions with the objective to reduce regional disparities. In this section, we investigate to what extent the ERDF has been used to foster the twin transition in retail. This has been done based on the in-depth data mining of the Kohesio database[40].

[39] More information available online: https://ec.europa.eu/regional_policy/funding/erdf_en
[40] More information available online: https://monitor-industrial-ecosystems.ec.europa.eu/about/monitoring-framework

In 2024, 32% of retailers considered financial incentives for developing products, services, or new production processes as the most effective support for expanding their range of green products or services, as found by the Eurobarometer survey.[41] The investments needed include adoption of renewable energy solutions (solar panels, heat pumps, wind), refurbishing and modernising transportation fleets, electric charging infrastructure for staff, company fleets and customers, energy efficiency for stores and warehouses (insulation, lighting etc.). Consequently, the role of public intervention programmes is to upgrade infrastructure and incentivise companies in switching to green energy and foster energy efficiency.

Data on ERDF shows that projects that aim at the green transition of retail represent 4% of all retail projects co-funded by the ERDF and 7% of the total funding going into retail.

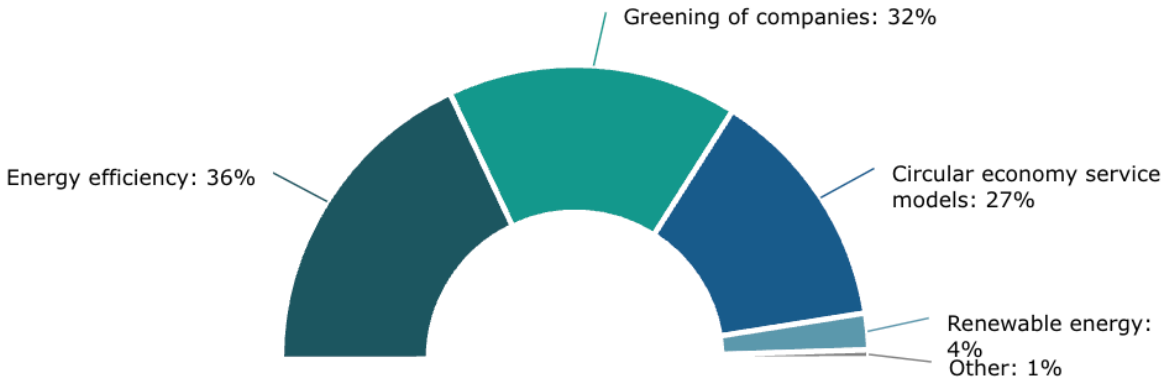
Figure 15: Number of projects and volume of public funding (EUR) allocated to retail projects co-funded by the ERDF



Source: Technopolis Group based on data from Kohesio including all ERDF co-financed projects

Secondly, the largest portion of funding was directed towards projects that support development and implementation of energy efficiency measures, both in the case of SMEs and large companies (36%). This was followed by projects aimed at greening businesses (32%) and promoting circular economy service models (27%).

Figure 16: Share of ERDF funding allocated to specific green topics



Source: Technopolis Group based on Kohesio data

[41] Flash Eurobarometer 549 (2024) SMEs, resource efficiency and green markets. Available online at: https://europa.eu/eurobarometer/surveys/detail/3221. Survey question: What type of support would help you the most to expand your range of green products or services ?

Some examples of ERDF co-funded projects include funding for the **purchase and installation of a solar panel system** in the Georgikon Coop Zrt shop in Hungary. The ERDF project reduced the negative impact on the environment and contributed to strengthening economic competitiveness of the company by achieving savings through a reduction of energy consumption. Another example of ERDF co-funded green projects is related to **energy efficiency**. For example, a project in the Czech Republic focuses on implementing energy-saving measures in retail store buildings. These measures include insulating the building, replacing windows, upgrading lighting systems, replacing cooling cases, and modernising or reconstructing existing energy production facilities. These improvements aim to enhance energy efficiency and reduce overall energy consumption.

Besides the ERDF, the **Recovery and Resilience Fund (RRF)**[42]**,** established as part of the EU's response to the COVID-19 pandemic, contributes to the retail sector by providing financial support aimed at driving the green and digital transitions. This fund is particularly focused on helping businesses, including retail, recover from the economic impacts of the pandemic while enhancing their resilience to future challenges.

The **green transformation pillar under the RRF includes specific measures fostering the green transformation of retail companies**. For example, the RRF supports actions to reduce the primary energy consumption of both private and public buildings, notably through wall insulation, replacement of windows and doors and the replacement of heat generating appliances with cleaner and more efficient alternatives[43].

Regarding national and regional public programmes, there are limited examples specifically targeting retailers' green transformation. Typically, retailers can participate in general national programmes that encompass various components. These often include initiatives focused on energy efficiency measures, renewable energy generation, circular economy practices—such as recycling promotion—sustainable heating solutions, and sustainable packaging efforts. The decarbonisation of the retail industrial ecosystem is supported by policy measures in several EU Member States. For example, in France, ApER Law obliges to install photovoltaic panels on car parks of over 1 500 sqm[44]. Some examples are presented below.

Figure 17: Examples of programmes co-funded by the Recovery and Resilience Fund

The National Climate Initiative (NKI)

The NKI has funded climate action projects throughout Germany since 2008. Each of these projects makes an important contribution to climate action and thus to attaining the national climate targets. The funding priorities cover a broad-spectrum a) funding to support the realisation of climate action projects; b) drawing up climate action concepts; c) personnel for climate action management and energy management; d) measures to support investments, e.g. in new lighting systems (LED), investments in sustainable mobility and in the modernisation of sewage plants and plants for drinking water supply. In the period from 2008 to the end of 2021, projects worth around EUR 1.35 billion were funded in the context of the NKI. And every euro of funding mobilised more than three times as much for climate action: the total investment in the projects amounts to EUR 4.3 billion.[45]

[42] Retrived from: https://commission.europa.eu/business-economy-euro/economic-recovery/recovery-and-resilience-facility_en

[43] Recovery And Resilience Scoreboard (2024) Thematic analysis Energy efficiency in buildings. Retrieved from: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_efficiency.pdf

[44] Retrieved from: https://www.twobirds.com/en/insights/2024/france/energy-transition-new-obligations-on-the-integration-of-photovoltaic-and-charging-stations#:~:text=The%20French%20law%20relating%20to,contre%20le%20d%C3%A9r%C3%A8glement%20climatique%20et

[45] National climate action policy. Retrieved from: https://www.bmwk.de/Redaktion/EN/Dossier/national-climate-action-policy.html

Access Advice: GreenStart

The Access Advice: GreenStart, provided by Enterprise Ireland supports businesses in improving their environmental performance through greater resource efficiency, driving competitive advantage and reducing costs. The grant covers the cost of hiring a sustainability consultant to introduce best practice sustainable systems and structures to the business. Maximum grant funding available is EUR 5 000. The grant can be used for implementing a structured environmental management and reporting system, developing a decarbonisation strategy and action plan, aligning environmental practices to global/Irish sustainability reporting initiatives.[46]

At the EU level, the retail sector often does not represent fair share in funding allocation compared to other industries and not benefitting from research and development projects under Horizon Europe as much as other ecosystems[47]. This imbalance is why Horizon Europe data was not analysed in this report, unlike in the case of other industrial ecosystems.

2.2.2. Skills supply and demand underpinning the green transition

This section analyses the demand and supply side of the labour market in terms of green transition skills (green skills relevant for environmental protection, implementation of green technologies, or the circular economy). Retailers are faced with the challenge of up- and reskilling their employees amid a rapidly changing world of work and the digital and green transformation in retail[48]. **As customers increasingly prioritise sustainability in their purchases, basic sustainability skills are also becoming more important for retail staff**. The availability of skills and resources influences the organisation's decision to adopt green technologies[49] . During the 4th OECD Digital4SMEs roundtable, multiple stakeholders stressed the importance of the internal capabilities of the enterprise, notably the skills of employees, for successful green transformation.

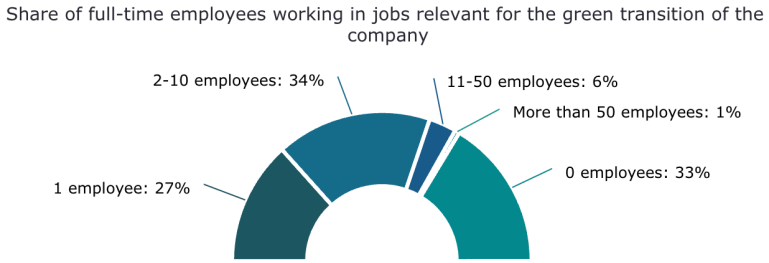
2.2.2.1. Supply of skills relevant for the green transition

The Eurobarometer 2024 found that **the share of retail enterprises, employing between one and five employees (full time equivalents) working in green jobs some or all the time, has increased from 32% in 2021 to 35% in 2024**[50].

Figure 18: Share of surveyed companies that have created new positions related to environmental sustainability and share of employees working in jobs relevant for the green transition

[46] Access Advice: GreenStart: https://www.enterprise-ireland.com/en/supports/access-advice-green-start
[47] European Commission (2024) A transition pathway for a more resilient, digital and green retail ecosystem
[48] EuroCommerce et al (2022). Contribution 29 November 2022- Pact for Skills – Skills Partnership for the Retail Ecosystem.
[49] McKinsey & Company, (2022), Transforming the EU retail and wholesale sector. https://www.mckinsey.com/industries/retail/our-insights/transforming-the-eu-retail-and-wholesale-sector
[50] Flash Eurobarometer 549 (2024) SMEs, resource efficiency and green markets. Available online at: https://europa.eu/eurobarometer/surveys/detail/3221

of retail companies have created any new positions / job titles dedicated to environmental sustainability over the past five years



Source: EMI Enterprise Survey 2024

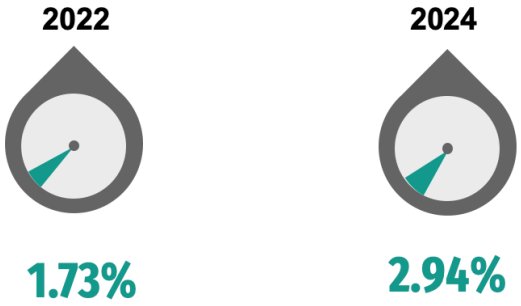
To better reflect the characteristics of the EU retail labour markets, Cedefop's Skills-OVATE (Skills Online Vacancy Analysis Tool for Europe) database was analysed. In 2023, online job advertisements in the retail sector across the EU27 countries that required digital or environmental skills totalled 172 556, accounting for 19% of all job postings.[51]

The supply of professionals with skills for the green transition in retail was assessed using LinkedIn data. In April 2024, there were **5 147 796 retail professionals** with profiles on LinkedIn, which represents approximately **31% of the workforce in retail**. This data reflects a moderate engagement with the platform by nearly a third of those employed in the sector, indicating the presence of a digital footprint and the potential for analysis and skill tracking. Out of this total, 690 000 professionals worked in food and beverage retail and 938 000 in fashion retail. Other types of retail such as electronic appliances or pharmaceuticals are less represented (17 000 and 12 000 professionals).

The analysis of green transition related skills followed the definition of Cedefop, notably "*the knowledge, abilities, values and attitudes needed to live in, develop and support a sustainable and resource-efficient society*" (Cedefop, 2012). Green skills have been defined as skills related to environmental protection, environmental services, resource efficiency, biodiversity, low carbon technologies, renewable energy, the circular economy, waste management, management of food waste, and clean production technologies and business models related skills (the list of keywords that have been used and are possible to track with the algorithm of LinkedIn is included in Appendix B).

According to LinkedIn data, the share of professionals with skills relevant for the green transition in 2024 was 2.94%. The share of self-reported green skills increased by 69% in 2024 compared to 2022.

Figure 19: Share of professionals with green transition skills in retail as reported on LinkedIn profiles



Source: Technopolis Group based on LinkedIn data

[51] Technopolis Group based on Cedefop data.

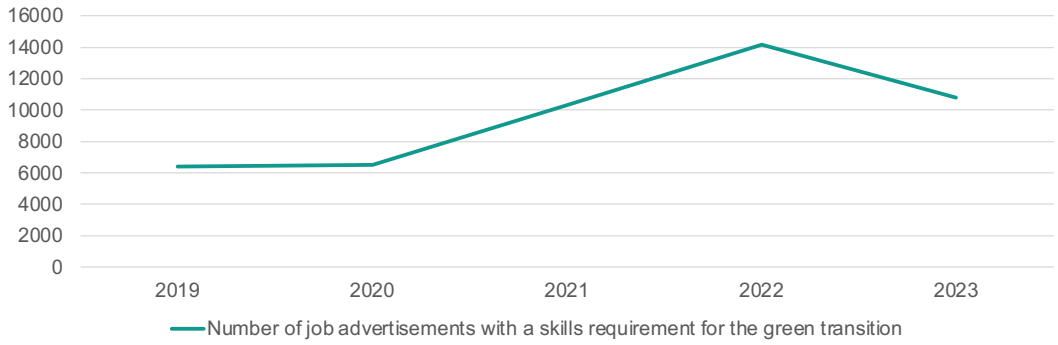
2.2.2.2. Demand for skills relevant for the green transition

Skills demand in the retail industrial ecosystem has been analysed following the skills intelligence insights of European Centre for the Development of Vocational Training (Cedefop)[52]. This dataset covers the EU27 Member States (plus UK) and is based on the collection and analysis of more than 530 online job advertisement sources (424 distinct websites) which are open-access sites. The dataset provides information on most requested occupations and skills across European countries based on established international classifications, e.g., ISCO-08 for occupations, ESCO for skills, and NACE rev. 2 for sectors.

Specific to the retail industrial ecosystem[53], there were **3 795 262 unique job advertisements** from companies between 2019-2023 in the EU27. These job advertisements have been text-mined and the required skills analysed from the perspective of the green transition.

The share of online job advertisements requiring skills related to the green transition in 2023 was minimal, appearing in only 1% of cases that is just a very slight increase compared to 2022 where this share was 0.7%. The drop from 2022 to 2023 is due to the overall drop in the total number of online job advertisements.

Figure 20: Share of online job advertisements with a requirement for environmental skills



Source: Technopolis Group based on analysis of Cedefop data

From the analysis conducted by Skills4Retail, it is understood that the main skill gaps are related to emerging green professions, such as frontline green professions (e.g. repair specialist; circular product designers; transport and mobility specialist; environmental protection specialist) and green managers (e.g. logistics manager; waste manager; renewable energy manager), net zero operators (e.g. installation of renewable energy, use of EV fleet); sustainable offering designers (sustainable and eco-design products); and circularity and waste managers.[54] Sales workers form the core of the wholesale and retail trade sector's workforce. They fulfil various roles in the sector such as selling and demonstrating goods in shops, at stalls and markets, via telephone or other means. Jobs within this group include market and street food vendors, shop supervisors, sales assistants, cashiers. Therefore, sales workers will need to adjust to the demand for sustainable products by receiving training for sustainability principles and understanding the frameworks that set the conditions for sustainable products and services, such as the circular economy and communicating about own company's external actions to promote sustainability. This will enable them to communicate and inform customers about which

[52] https://www.cedefop.europa.eu/en/tools/skills-online-vacancies
[53] In the case of the retail industrial ecosystem the dataset was filtered for the NACE industries as defined in the Annual Single Market Report.
[54] Skills4Retail (2024). Occupational Profiles & Needs Analysis. Retrieved from: https://skills4retail.eu/wp-content/uploads/2024/07/S4R_WP2_D2.1_Occupational-Profiles-Training-Needs-Analysis_20240604.pdf

products are eco-friendly and how do they compare with other products and/or services offered by competitors.[55]

In terms of specific **training needs**, while all staff should receive comprehensive training in sustainability awareness and best practices, management training should go beyond awareness, focusing on the strategic value of sustainability and its bottom-line impact. This includes measurement and reporting practices to track progress and demonstrate the financial benefits of sustainable operations.[56] **Implementing the basics of sustainability** is considered as the first specific area of knowledge for all staff. This includes: [57]

- **Environmental awareness** (understanding the typical impacts of retailers across sustainability topics).
- **Sustainable resource use** (responsible travel; efficient energy and water use).
- **Materials and waste management** (managing paper, plastic, and non-recyclable packaging, and reducing food waste).
- **Adopting green technologies and processes** (measuring and reducing carbon emissions, as well as striving to become a net-zero, nature-positive and socially responsible business).
- **Translating existing best practice principles** into real-life case studies and top practical actions for common frontline roles in retail could make this most relevant.

Managing a business sustainably was identified as a second complementary body of knowledge for business leaders in the smallest retailers, SMEs and sustainability managers in larger retailers. This includes understanding of how various sustainability topics connect to cost, revenue and compliance drivers for retailers and 'where to start' (given the broad range of ESG topics). Useful deep dives could include mapping on how key EU and national regulations impact different sizes of retailers, and how to implement sustainability reporting in practice.

2.2.3. Demand for green products

This section analyses the demand for eco-retail, ecological services and products. **17% of retailers indicated that lack of demand for resource efficient products or services was the main barrier for offering source efficient products or services.**[58] Consequently, demand for green products/solutions is one of the main drivers of green transition and addressing these demands will be key for the competitiveness of the EU retail industrial ecosystem.

Growing demand for sustainable/ecological products

To explain the consumption patterns and trends of retail products, EU citizens survey on EU Ecolabel can be used as a proxy indicator. First, more than three quarters (77%) of EU citizens think climate change is a very serious problem at this moment. Second, 73% say the impact of the product on the environment is 'very important' or 'rather important' when making a purchasing decision. 60% report that they have bought products specifically because of their lower environmental impact and 38% report that they often or sometimes buy products with the EU Ecolabel. These findings complement survey of retail companies, according to which **45% of surveyed companies believe that there is a tangible shift in consumer preferences and purchasing (consumer demand) towards environmentally sustainable products/services.** The figures below highlight the most

[55] https://www.cedefop.europa.eu/en/data-insights/sales-workers-skills-opportunities-and-challenges-2023-update#_looking_forward

[56] Skills4Retail (2024). Occupational Profiles & Needs Analysis. Retrieved from: https://skills4retail.eu/wp-content/uploads/2024/07/S4R_WP2_D2.1_Occupational-Profiles-Training-Needs-Analysis_20240604.pdf

[57] Skills4Retail (2024). Occupational Profiles & Needs Analysis. Retrieved from: https://skills4retail.eu/wp-content/uploads/2024/07/S4R_WP2_D2.1_Occupational-Profiles-Training-Needs-Analysis_20240604.pdf

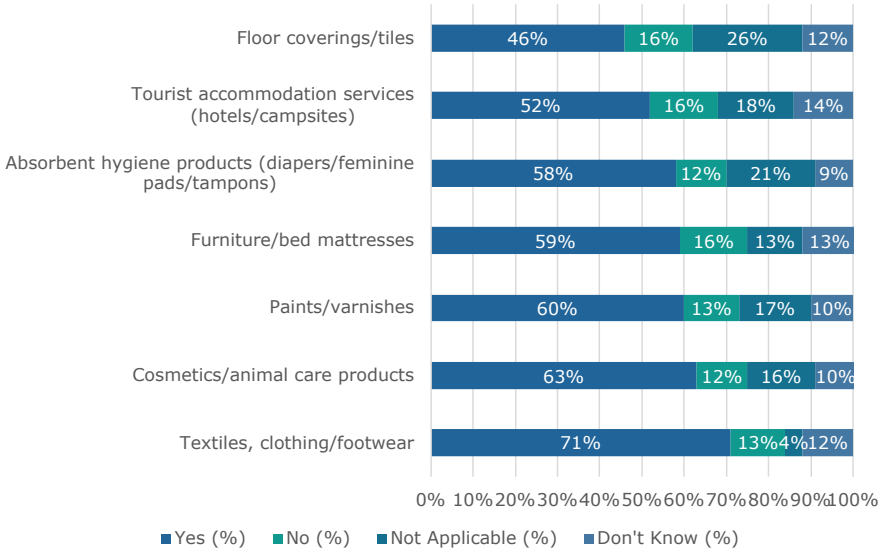
[58] Flash Eurobarometer 549 (2024) SMEs, resource efficiency and green markets. Available online at: https://europa.eu/eurobarometer/surveys/detail/3221

popular products carrying the EU Ecolabel by sector, as well as the existing demand and need for a broader range of EU Ecolabel-certified products.

Figure 21: Responses to the question: Which of the following products did you buy in the past 12 months, share of products purchased with the EU Ecolabel

Source: Technopolis Group based on the Flash Eurobarometer 535 The EU Ecolabel Report, 2023

Figure 22: Responses to question: Would you like to find more products with the EU Ecolabel in any of the following categories?



Source: Technopolis Group based on the Flash Eurobarometer 535 The EU Ecolabel Report, 2023

The results indicate growing consumer demand for specific greener products. For example, while 15% of EU citizens purchase textile, clothing and footwear with EU Ecolabel, more than 70% would like to find more sustainable clothing and footwear options. The box below provides a specific example of growing demand for sustainable luxury products.

Box 3: Consumer demand for sustainable luxury products

Consumer demand for sustainable luxury products

According to the 2023 Europe Luxury Report, 77% of shoppers in Europe indicated that they are interested in buying sustainable luxury products. Moreover, 51% of shoppers are willing to pay up to 10% extra for items sustainably made or shipped[59]. Additionally, luxury brands have started offering recycling and upcycling services for high-value garments and accessories. This marks an important step towards sustainability: the destigmatising of second-hand items, especially where resource-heavy specialist materials are involved. A leader in this space is Gucci Vault which merges past, present, and future trends in a singular, more sustainable place. Vintage Gucci products are upcycled by young designers to create one-of-a-kind pieces that sell out almost immediately.

One important element that underpins the demand for the green products in retail industrial ecosystem is consumer trust. According to the Eurobarometer survey on the EU Ecolabel 9% of respondents indicated that products with the EU Ecolabel are not truly environmentally friendly. On average, across the EU, about eight in ten respondents, in total, agree that companies often make misleading environmental claims, leading customers to believe that their product or service is environmentally friendly (30% 'strongly agree' and 48% 'somewhat agree'). This indicates that **transparency is also becoming more important, with consumers demanding to know more about the origins and production of the products they buy**.

[59] RetailX (2023). Europe Luxury Sector Report 2023. Retrieved from: https://internetretailing.net/report-hub/europe-luxury-sector-report-2023/?checkout_id=d6abbab3-d3f2-4e77-9f99-1c4eab754e85

Another important element is the price of products with an EU Ecolabel. In total, 14% of respondents indicated that they do not purchase products with EU Ecolabel because they are too expensive.

Increasing demand for locally produced goods

Additionally, **there is a growing demand for green, sustainable goods that are produced locally**. AgroBRIDGES study reveals that, on a monthly basis, more than half of the respondents (51.3%) buy between 1% and 25% of their food from Short Food Supply Chains (SFSCs), while fewer than one in ten (9.3%) buys more than 50% of their foods from SFSCs.[60] Other, studies have shown that consumers are more likely to buy local products from large chain stores than from smaller manufacturer-owned stores, and prefer domestically produced goods, which is reflected in an ethnocentric attitude toward the local market.[61] However, the study has been carried out specifically on the Polish population and the results may not apply to other nations. Additionally, 2020 survey conducted with fashion consumers in France, Germany, Italy, and Spain, the share of consumers who thought buying clothing that was produced locally was important varied between 10 percent in Italy and 18 percent in Spain.[62]

Growth of circular economy and recommerce

Another consumer trend that resonates strongly in Europe is connected to the demand for **circular economy business models, including recommerce**. For consumers, second-hand purchases are often viewed as a cost-effective way to support a sustainable lifestyle, and tech advancements help make this possible on a larger scale. Therefore, the revenue of the second-hand e-commerce, otherwise known as recommerce, market in Europe is forecast to continuously increase between 2024 and 2029. After the fifth consecutive increasing year, the industry's revenue is estimated to reach EUR 57.8 billion in 2029.[63] For example, along with electronics, fashion is the most often purchased second-hand good by online shoppers. By revenue, online apparel resale generated over EUR 15 bn in 2023 and continues to consistently attract the majority of second-hand e-commerce users throughout Europe. By 2029, the online market for second-hand clothing is forecast to generate a total of over EUR 31.9 bn from an expected 98.5 million users.[64]

Increasing interest in zero waste packaging/shopping

There is also a significant opportunity in the retail industrial ecosystem to **build upon a rise in consumer awareness and the growing popularity of sustainable/zero waste packaging**[65]. For example, the global market for Zero Waste Shops was estimated to be worth EUR 31.9 m in 2023 and is forecast to a readjusted size of EUR 44.7 m by 2030 with a Compound Annual Growth Rate (CAGR) of 4.7% during the forecast period 2024-2030.

2.3. The impact of the industrial ecosystem on the environment

How is the industrial ecosystem's impact on the environment changing?

[60] Retrived from: https://www.agrobridges.eu/
[61] Dudziak, A., Stoma, M., & Osmólska, E. (2023). Analysis of consumer behaviour in the context of the place of purchasing food products with particular emphasis on local products. International Journal of Environmental Research and Public Health, 20(3), 2413.
[62] Statista: Retrieved from: https://www.statista.com/statistics/1238836/eu-consumer-opinions-on-locally-produced-clothing/
[63] Statista. Retrieved from: https://www.statista.com/statistics/1412517/europe-second-hand-e-commerce-revenue-category/
[64] Statista. Retrieved from: https://www.statista.com/statistics/1412517/europe-second-hand-e-commerce-revenue-category/
[65] Commission Staff Working Document Impact Assessment Report Accompanying the document Proposal for a Regulation of the European Parliament and the Council on packaging and packaging waste, amending Regulation (EU) 2019/1020, and repealing Directive 94/62/EC.

- **Retail's environmental impact has seen a slight increase potentially led by growing energy consumption and growing e-commerce**. However, only about 2% of emissions stem from the operations of individual retailers and wholesalers and the energy they consume. About 98% of CO2 emissions fall under Scope 3, i.e. are emissions related to the ecosystem's vast supply chains. While many retailers and wholesalers have made significant progress in addressing direct emissions, value-chain-related emissions remain a persistent challenge.

- **The retail industrial ecosystem plays a crucial role in contributing to the zero pollution targets for air set by the Zero Pollution Action Plan. However, progress in this area has been limited so far**. Due to the growing use of transportation for the delivery of goods, the particulate matter emission following consumption-based account increased from 2018 (4.4M) to 2021 (5.2M) and then declined in 2022 (to 4.7M)

- **Material extraction** have been fluctuating over the entire period from 2016 to 2022.

- **Water extraction and pollution** are also significant negative externalities of the retail industrial ecosystem. Water consumption almost doubled in 2022 compared to 2016.

- **Waste production is still a key concern for the retail industrial ecosystem. Retail accounts for 7% of food waste generation in the EU**. In addition, the retail industrial ecosystem has a key role in reducing the waste from Electrical and Electronic Equipment paper and cardboard packaging waste (predominantly used in the retail sector).

This section summarises the main indicators that capture the environmental impact of the retail industrial ecosystem. It also reflects on the progress made over time and to what extent targets are being reached.

The retail industrial ecosystem due to its size has a large impact on the environment. In 2022, it represented 1.5% of the greenhouse gas (GHG) emissions among all 14 industrial ecosystems according to the production-based account of Exiobase data. It should be noted that the share of GHG emissions differs depending on the definition of the retail industrial ecosystem. For example, according to EuroCommerce and Oliver Wyman, Europe's retail and wholesale sector in 2022 emitted 1.6 gigatonnes (Gt) of carbon dioxide equivalent (CO2e) emissions, equal to one-third of the European total[66]. These emissions are linked to the retail and wholesale sector and its value chains, including all products bought and sold through the European retail and wholesale sector. Consequently, 98 percent of these emissions are categorised as Scope 3[67], which are those generated by the value chain and typically outside the direct control of retailers and wholesalers. In turn, reducing Scope 3 emissions depends on the engagement and efforts of all value chain actors, including producers, processors, suppliers, distributors, and consumers, as well as other public and private sector actors—a retailer cannot realise these reductions in isolation.[68]

In the EU, the emissions of the five main air pollutants[69] continue to decline, maintaining a trend seen since 2005. This is achieved considering an increase in gross domestic product over the same period[70]. However, according to the European Environmental Agency (EEA) achieving further reductions for 2030 and beyond will be a significant challenge for nearly

[66] EuroCommerce and Oliver Wyman (2024) NET ZERO GAME CHANGER – Tackling the hidden carbon footprint in European retail and wholesale value chains

[67] The GHG Protocol provides the most widely used framework for businesses' carbon accounting, categorising a company's GHG emissions into three scopes. Scope 1 covers all direct emissions from the company's activities. Scope 2 accounts for indirect emissions from the generation of purchased energy. Scope 3 includes all other indirect emissions that occur within the company's upstream and downstream value chain.

[68] McKinsey (2024): Retailers' climate road map: Charting paths to decarbonized value chains.

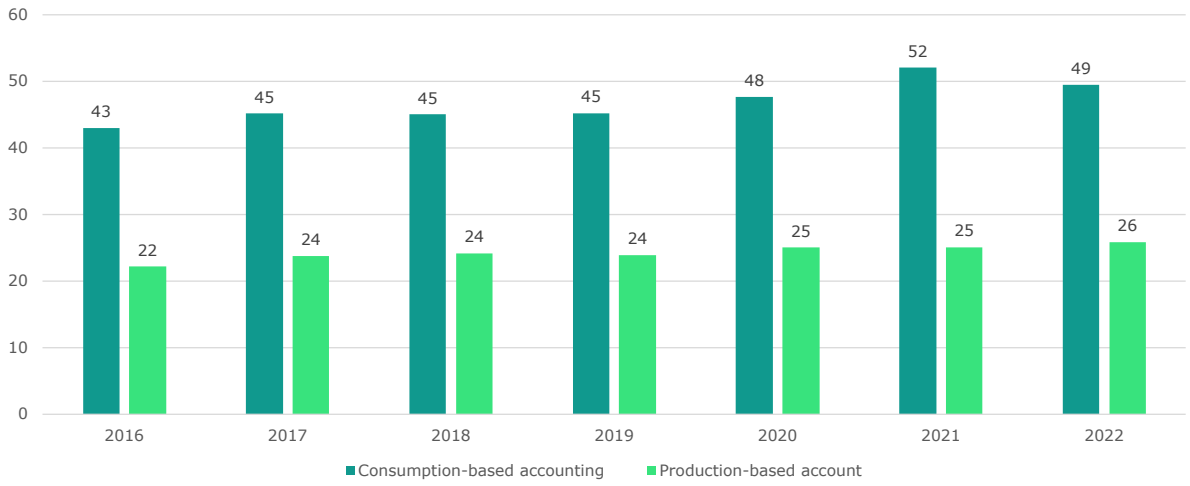
[69] The National Emission reduction Commitments Directive (NEC Directive) sets obligations to reduce national emissions of five air pollutants, namely fine particulate matter (PM2.5), nitrogen oxides (NOx), non-methane volatile organic compounds (NMVOCs), ammonia (NH3) and sulphur dioxide (SO2)

[70] Air pollution in Europe: 2024 reporting status under the National Emission reduction Commitments Directive. Retrieved from: https://www.eea.europa.eu/publications/national-emission-reduction-commitments-directive-2024

all EU countries and for almost all air pollutants[71]. **Consequently, the retail industrial ecosystem has an important role in contributing to the 55% GHG emissions reduction target by 2030[72]. However, the data on CO2 emissions indicates limited progress to-date**.

The Figure below reveals that from 2010 to 2022, the **CO2 emissions of the retail industrial ecosystem slightly increased** (from 22M to 26M tones yearly following production-based accounting). Following the consumption-based accounting, Exiobase data shows that the CO2 emissions increased as well (from 43M to 49M).

Figure 23: CO2 emissions of the retail industrial ecosystem in EU27 (consumption and production accounts) million tones



Source: Technopolis Group based on Exiobase data, calculations in 2024

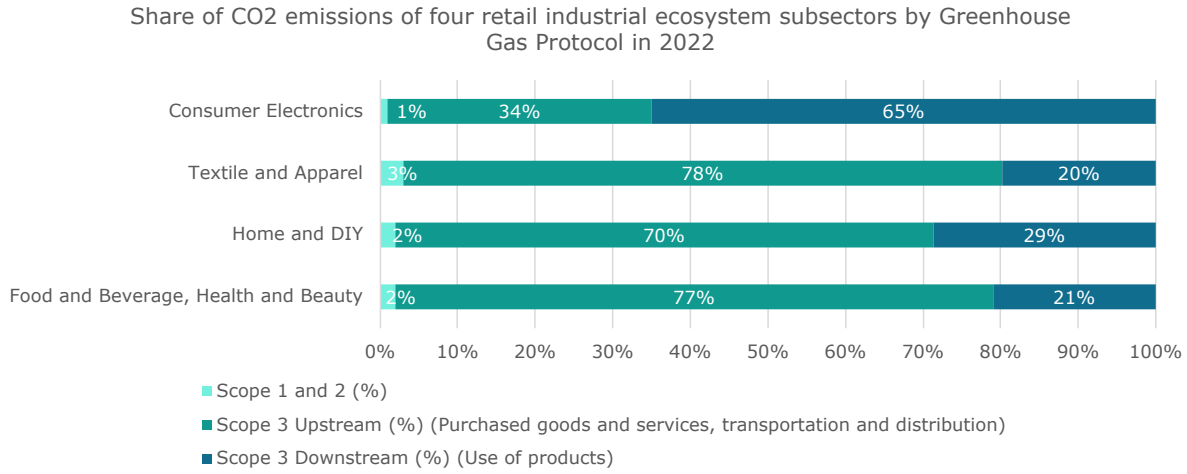
One of the potential explanations for the growth in CO2 emissions from 2020 can be attributed to the increased domestic net energy use by retailers. For example, according to the Eurostat, the net domestic energy use by retail enterprises in 2021 increased to 721 thousand terajoules compared with the 681 thousand terajoules in 2020.[73] Another explanation for increasing CO2 emissions is related to surge in demand of e-commerce and delivery of goods, thus increased use of transportation. Overall, when assessing the CO2 emissions of the retail industrial ecosystem, it is important to note that only **about 2% of emissions fall under Scope 1 and Scope 2, i.e. are emissions** stemming from operations of individual retailers and wholesalers and the energy they consume. About **98% of CO2 emissions fall under Scope 3, i.e. are emissions related to ecosystem's vast supply chains,** including, for example, transportation of raw materials and product to market, as well as emissions created when consumers use products. [74]

Further breakdown of the Scope 3 emissions into upstream and downstream emissions indicates that, the upstream emissions (emissions related to the production of goods) are more prominent than emissions from downstream activities (emissions related to customers, selling goods and services, their distribution, use)[75]. This is indicated in the

[71] Air pollution in Europe: 2024 reporting status under the National Emission reduction Commitments Directive. Retrieved from: https://www.eea.europa.eu/publications/national-emission-reduction-commitments-directive-2024
[72] Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 ('European Climate Law'). 2030 climate target of at least 55% reduction of net emissions of greenhouse gases as compared to 1990, with clarity on the contribution of emission reductions and removals
[73] See: https://ec.europa.eu/eurostat/databrowser/view/env_ac_pefa04__custom_15171221/default/line?lang=en
[74] EuroCommerce and Oliver Wyman (2024) NET ZERO GAME CHANGER – Tackling the hidden carbon footprint in European retail and wholesale value chains, p6.
[75] EuroCommerce and Oliver Wyman (2024) NET ZERO GAME CHANGER – Tackling the hidden carbon footprint in European retail and wholesale value chains.

figure below, which shows that, for instance, **textile and apparel, home and do-it-yourself (DIY), food and beverage & health and beauty subsectors** have larger upstream emissions. Consumer electronics, on the other hand, has higher Scope 3 downstream emissions.

Figure 24: Share of CO2 emissions of four retail industrial ecosystem subsectors by Greenhouse Gas Protocol in 2022



Source: EuroCommerce and Oliver Wyman (2024) NET ZERO GAME CHANGER – Tackling the hidden carbon footprint in European retail and wholesale value chains.

Note: The contribution of each Scope 3 category within a subsector was determined by calculating weighted sector-average Scope 1–3 emissions. This included a detailed analysis of the 15 Scope 3 categories as defined by the GHG Protocol. Data for 1,600 companies was sourced from the self-reported CDP database, filtered to include only those that represent typical retailers or wholesalers and provided detailed Scope 3 emissions breakdowns. The EuroCommerce and Oliver Wyman study ultimately used data from 40 firms that met these criteria. For companies not covered by the CDP database, supplementary data was sourced from public sustainability reports, with each datapoint manually evaluated for emission disclosure gaps of methodological inconsistencies.

Overall, the different emission breakdowns indicate that while **many retailers and wholesalers have made significant progress in addressing Scope 1 and Scope 2 emissions**, **Scope 3 emissions present a persistent challenge**. Overall, the emissions of the retail industrial ecosystem mainly stem from the production of agricultural-based and energy intensive products, manufacturing processes, transportation of goods, and electricity used by retailers for store operation.

The retail industrial ecosystem plays a crucial role in contributing to the zero pollution targets for air set by the Zero Pollution Action Plan. However, progress in this area has been limited so far[76]. More specifically, by 2030 the EU should reduce health impacts (premature deaths) of air pollution by more than 55%[77]. In Europe, exposure to fine particulate matter and nitrogen dioxide levels above the World Health Organisation recommendations caused an estimated 52 000 premature deaths in 2021. In the retail industrial ecosystem, the particulate matter emissions following production-

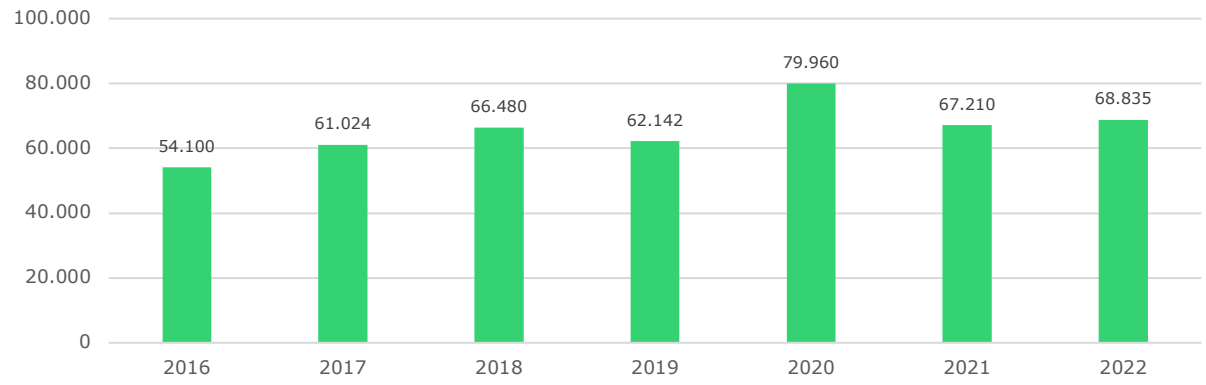
[76] European Commission (2021). Pathway to a Healthy Planet for All EU Action Plan: 'Towards Zero Pollution for Air, Water and Soil', Brussels, 12.5.2021 COM (2021) 400 final
[77] Ibid

based account have remained almost the same since 2018, while the **particulate matter emission** following consumption-based account increased from 2018 (4.4M) to 2021 (5.2M) and then declined in 2022 (to 4.7M). Specifically, **the retail industrial ecosystem's heavy reliance on extensive transportation networks is a major contributor to particulate matter emissions.** The surge in e-commerce during the late 2010s and early 2020s likely intensified transportation activities, especially in regions with high warehouse densities, leading to increased air pollution. Recent studies have highlighted the environmental impact of e-commerce-driven logistics, noting significant rises in air pollution near warehouses due to increased truck traffic.[78]

In addition, due to its vast supply chain, the retail industrial ecosystem also contributes to noise, water and soil pollution. For example, large shopping malls or outlets attracting high volumes of traffic, delivery trucks, and service vehicles contribute to increased noise and air pollution levels. By selecting to use electric vehicles, for example, retailers may mitigate such emissions and reduce the noise pollution[79].

Beyond emissions and air, water and soil pollution, the retail industrial ecosystem has a significant impact on resource extraction. Retail relies on the extraction of agricultural and non-agricultural resources such as fossil fuels and involves processing of raw materials into components like ingredients, packaging, or other materials. The graph below provides insights into material extractions in retail. **Material extraction (fibres, synthetics, petrol etc) has increased** from 54 thousand megatons to 68 thousand megatons over the period from 2016 and 2022.

Figure 25: Material extractions (used and unused) in kilotons (Production Account)

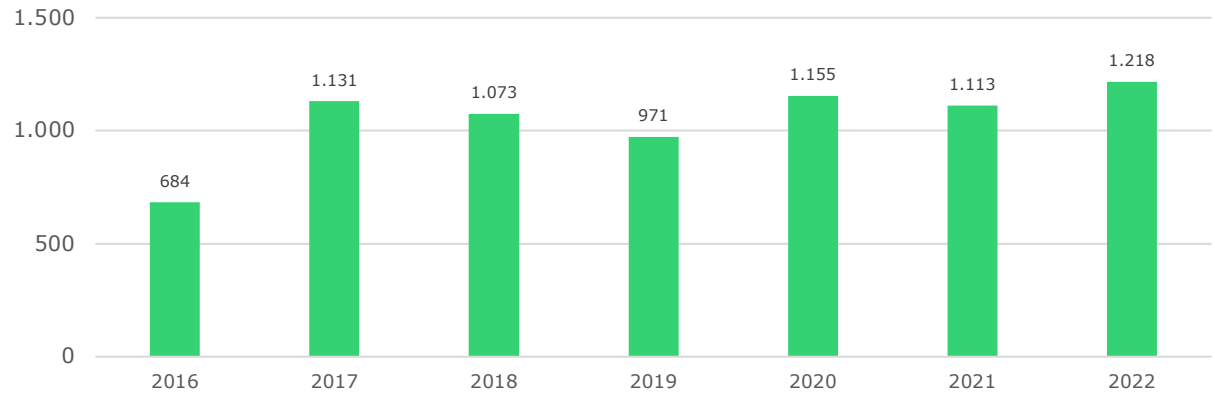


Source: Technopolis Group calculations based on Exiobase

Water extraction and pollution are also significant negative externalities of the retail industrial ecosystem. The graph below provides information on water extraction measured in million cubic meters. The indicator refers to water sourced from surface or groundwater resources incorporated into a good, used for a service, or returned to another source after the good or service has been produced, or returned at a different time. The figure reveals that **water consumption almost doubled** in 2022 compared to 2016.

[78] For example, Kerr, G. H., Meyer, M., Goldberg, D. L., Miller, J., & Anenberg, S. C. (2024). Air pollution impacts from warehousing in the United States uncovered with satellite data. Nature communications, 15(1), 6006.
[79] Tsoi, K. H., Loo, B. P., Li, X., & Zhang, K. (2023). The co-benefits of electric mobility in reducing traffic noise and chemical air pollution: Insights from a transit-oriented city. *Environment International*, *178*, 108116.

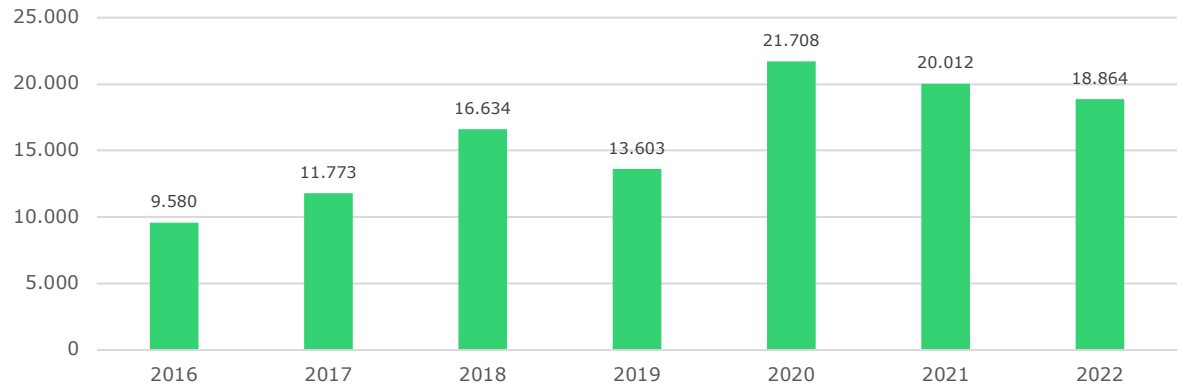
Figure 26: Water Extraction in million cubic litres



Source: Technopolis Group based on Exiobase

Retail industrial ecosystem relies also on the availability of land. It impacts all primary drivers of biodiversity loss, including land and sea use changes that lead to habitat degradation, direct species exploitation, climate change acceleration, pollution, and the spread of invasive alien species[80]. The graph below provides information on **land use measured in square kilometres showing a recent decline.**

Figure 27: Land use in square kilometres of the tourism industrial ecosystem (consumption account)



Source: Technopolis Group based on Exiobase

Last mile transportation

[80] Sorakunnas, E., Räikkönen, J., Konu, H., Grénman, M., & Tyrväinen, L. (2024). Biodiversity, leadership, and resilience in a national sustainable tourism program. *Scandinavian Journal of Hospitality and Tourism*, 1–19. https://doi.org/10.1080/15022250.2024.2332308

Given the importance of e-commerce, the last mile transportation has become a crucial element of retail ecosystem's logistics and a critical factor of customer experience. An item that is undelivered, damaged or late is arguably the most important service failure on the part of the merchant. The last mile delivery, however, is complex and environmentally costly. For example, the carbon footprint of last mile delivery accounts for 40% of all e-commerce emissions.[81] To address the emissions stemming from the last mile deliveries, retailers have adopted several measures. First, retailers shift to Electric Vehicle (EV) fleet. In some urban areas, delivery by (electric) cargo bikes could also be a viable solution, provided safe bike lanes are available[82]. For example, data from Green Postal Day 2023 highlights a positive trend, showing that 22 global postal companies have increased the use of eco-friendly vehicles, with electric and biogas vehicles now constituting 26% of their fleets, up from 12% in 2012.[83] Secondly, retailers' shift towards the use of Parcel lockers and pick-up/drop-off points (PUDOs), which generate lower transport emissions, could make last mile delivery greener. However, it should be noted that 64% of European shoppers prefer their online orders to be delivered to their homes, which might limit the use of PUDOs. Still, with home delivery being the default e-commerce delivery method for most retailers, it is interesting to note that 36 percent of Europeans prefer an out-of-home delivery method. Parcel lockers and parcel shops are a preferred delivery option for 24% of respondents (with 14% choosing parcel lockers and 10% parcel shops) and 12% prefers having the parcel left with the neighbour or in a safe place. [84]

Impact of e-commerce on the environment

E-commerce, through the use of non-sustainable packaging, delivery, and return practices, has a significant negative impact on the environment and calls for sustainable solutions. First, the packing materials used to ensure safe delivery, particularly plastic, contribute to environmental harm. The production of these plastic materials emits substantial amounts of CO2. Secondly, consumer expectations regarding delivery times have shifted dramatically. While several years ago, most consumers were satisfied with waiting up to 10 days for their orders, this preference has changed to expecting delivery within 3-4 days, and now even 2-day or same-day delivery is often anticipated. These faster delivery demands further strain the environment due to increased transportation emissions.[85] This demand for short delivery windows has driven companies to compete for faster shipping to clients. However, fast shipping produces significantly higher (by 15%) CO2 emissions since it imposes a challenge for cargo consolidation.[86] Additionally, on average, customers return up to 30% of products bought online[87], placing a vast and unnecessary strain on the environment. While many retailers offer free returns to attract more customers, our planet is paying the price. According to the estimations of Optoro, up to 24 million metric tons of CO2 emissions are attributed to ecommerce returns each year[88].

Overall, the **most important elements influencing GHG emissions of retail transport chains are long-distance pre carriage** before the first parcel hub inside the EU and

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[81] Last Mile Experts (2024) Green Last Mile Europe Report 2024. Retrieved from: https://lastmileexperts.com/wp-content/uploads/2024/05/Green-Last-Mile-Europe_Report-2024.pdf

[82] McKinsey and Eurocommerce (2022) Transforming the EU Retail & Wholesale sector. Retrieved from: https://www.mckinsey.com/industries/retail/our-insights/transforming-the-eu-retail-and-wholesale-sector#/

[83] Last Mile Experts (2024) Green Last Mile Europe Report 2024. Retrieved from: https://lastmileexperts.com/wp-content/uploads/2024/05/Green-Last-Mile-Europe_Report-2024.pdf

[84] Statista Most popular delivery methods for European online shoppers in 2023. Retrieved from: https://www.statista.com/statistics/1428400/delivery-preference-europe/

[85] https://www.eurosender.com/en/resources/shipping-speed-expectations

[86] Muñoz-Villamizar, A., Velázquez-Martínez, J. C., Haro, P., Ferrer, A., & Mariño, R. (2021). The environmental impact of fast shipping ecommerce in inbound logistics operations: A case study in Mexico. Journal of Cleaner Production, 283, 125400.

[87] Ecommerce Returns: Expert Guide to Best Practices (2024) Retrieved from: https://www.shopify.com/enterprise/blog/ecommerce-returns

[88] The Environmental Impact of Returning Online Products. Retrieved from: https://blog.cleanhub.com/ecommerce-returns-environmental-impact

post carriage legs after the parcel distribution centre (last mile)[89]. While GHG emissions for the last mile are heavily influenced by load factors and mode choice, GHG emissions for long-distance legs are influenced by the distance between origin and destination of the retail item[90].

To address the impact of e-commerce on the environment, the use of electric vans and bikes for final-mile deliveries has been promoted in Denmark via the introduction of a Nordic trust mark on green delivery called Svanemaerket[91]. In France, the question of returns is dealt with in Charter for Sustainable e-commerce logistics. Businesses must implement measures that may help to limit returns, yet the challenge is to prevent returns that could have been avoided without calling into question the customer's right to return. In Netherlands, there is an increase of online shops that charge return costs – some a symbolic amount, others the full price. This is important step in raising awareness that both delivery and returns are not free of charge. In Hungary, there is an emphasis on more sustainable delivery methods and the share of PUDO points and parcel lockers is increasing. Several logistics service providers have installed electric vehicles and are using bicycles for downtown deliveries.

Waste generation in retail

Waste generation in retail is linked to the sale of goods and services provided to the customers. To further support waste management and recycling actors in the retail ecosystem develop infrastructure to collect, sort, reuse and recycle waste or products.[92] The main waste streams of retail include food waste, electronic (e-) waste, packaging and textiles. Within these subsectors, companies have different roles in reducing waste:

- **Retail accounts for 7% of food waste generation in the EU**[93]. The food waste generated by retail and other food distribution sectors increased from 4m tonnes generated in 2020 to 4.2m tonnes in 2021.[94] To achieve the Sustainable Development Goal Target to halve per capita global food waste by 2030 and reduce food losses along the food production and supply **additional efforts are needed in the retail industrial ecosystem.** Retailers and wholesalers have a pivotal role to play in supporting upstream suppliers, improving logistics, stock in store, and supporting consumers in reducing their food waste. For example, ALDI has committed to reduce absolute operational food waste by 50% by 2030 (relative to 2017 baseline). To achieve these commitments, the company is preventing waste in operations and building partnerships to distribute surplus food to charities[95].
- **The retail industrial ecosystem has a key role in addressing the waste from Electrical and Electronic Equipment (EEE)**. More specifically, the amount of EEE put on the market in the EU increased from 7.6 million tonnes in 2012 to 13.5 million tonnes in 2021. The total collected electrical and electronic equipment increased from 3.0 million tonnes in 2012 to 4.9 million tonnes in 2021.[96] Within this context, the WEE

[89] European Commission: Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs, Wolff, J., Labinsky, A., Eckert, S., Esser, K. et al., Study to assess and analyse the impact of e-commerce driven transport and parcel delivery on air pollution and CO2 emissions – Executive summary, Publications Office of the European Union, 2022, https://data.europa.eu/doi/10.2873/868271

[90] European Commission: Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs, Wolff, J., Labinsky, A., Eckert, S., Esser, K. et al., Study to assess and analyse the impact of e-commerce driven transport and parcel delivery on air pollution and CO2 emissions – Executive summary, Publications Office of the European Union, 2022, https://data.europa.eu/doi/10.2873/868271

[91] Ecommerce Europe and Eurocommerce (2023) European E-Commerce Report 2023.

[92] A transition pathway for a more resilient, digital and green retail ecosystem. Retrieved from: https://single-market-economy.ec.europa.eu/publications/transition-pathway-more-resilient-digital-and-green-retail-ecosystem_en p. 17

[93] Sala, S., De Laurentiis, V. and Sanye Mengual, E., Food consumption and waste: environmental impacts from a supply chain perspective, European Commission, 2023, JRC129245.

[94] Eurostat data on Food waste and food waste prevention by NACE Rev. 2 activity - tonnes of fresh mass. Retrived from:https://ec.europa.eu/eurostat/databrowser/view/env_wasfw/default/table?lang=en&category=env.env_was.env_wasst

[95] Aldi, How we are tackling food waste Retrieved from: https://www.aldi.ie/food-waste

[96] E-waste in the EU: facts and figures. Retrieved from: https://www.europarl.europa.eu/topics/en/article/20201208STO93325/e-waste-in-the-eu-facts-and-figures-infographic

Directive indicates that distributors (retailers) should allow waste collection in the shops[97].

- **In absolute amounts, paper and cardboard packaging waste (predominantly used in retail sector) increased the most.**[98] The amount of packaging waste generated in the EU also increased between 2010-2021. To address this the recently adopted Packaging and Packaging Waste Regulation[99] imposes various obligations on economic operators, including retailers. For example, the regulation introduces waste reduction goals to cut packaging waste by 5% by 2030, 10% by 2035, and 15% by 2040, compared to 2018 levels. Achieving these targets will impact the retail industrial ecosystem.
- **The retail industrial ecosystem has a role in reducing directly generated textile waste**[100]. Most textile waste comes from clothing and home textiles discarded by households, which mostly ends up being incinerated or in (often rogue) landfills across the globe (with a negative impact on local ecosystems)[101]. The remainder of the waste comes from post-consumer commercial waste, post-industrial, and pre-consumer waste (the smallest share). In this context, the largest brands and retailers represent a small share of total volumes of textile waste[102].

[97] According to the directive, EU MS have to ensure that the distributor provides for the collection, at retail shops with sales areas relating to EEE of at least 400 m2 , or in their immediate proximity, of very small WEEE (no external dimension more than 25 cm) free of charge to end-users and with no obligation to buy EEE of an equivalent type, unless an assessment shows that alternative existing collection schemes are likely to be at least as effective.

[98] Eurostat data on Packaging waste statistics. Retrieved from: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Packaging_waste_statistics#Conclusions

[99] Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L_202500040

[100] More detailed overview of textiles waste is available in the Textiles Industrial Ecosystem analytical report (2025).

[101] McKinsey (2023) Scaling textile recycling in Europe—turning waste into value. Retrieved from: https://www.mckinsey.com/industries/retail/our-insights/scaling-textile-recycling-in-europe-turning-waste-into-value

[102] Ibid

3. Digital transition

3.1. Industrial efforts in transitioning towards digital retail

What is the progress of industrial efforts towards digitalisation?

- In 2024, **18% of companies had a concrete strategy in place for digital transformation** in the retail industrial ecosystem.

- **The EMI Enterprise Survey revealed an increase in the uptake of digital technologies**. The largest increase is seen in cloud technologies, Internet of Things and Artificial Intelligence, the latter increasing by 10%, and the Internet of Things, which increased by 6%

- In the retail ecosystem, around 17% of businesses that adopted AI did so within the past year. **22% of retail enterprises use AI in marketing and sales, with businesses leveraging AI to personalise customer interactions and optimise campaigns.**

- VR and AR technologies are still in their nascent phase for use by retailers, and immersive, functional ways to showcase products and services remain a niche. The EMI survey shows that it is a low share, notably around 2-3% of retailers that actively engage with this technology.

- In terms of **startups, artificial intelligence and software solutions are the major technological focus areas**. The former represented 30% in 2022 and 43% in 2023. In terms of Venture Capital and Private Equity, most investments were allocated to online platforms/e-commerce solutions, followed by software solutions and AI. Investments in artificial intelligence surged in 2022. This trend reflects the dynamic shift in digital investments, particularly influenced by the COVID-19 pandemic.

- **The vast majority of retail companies invest less than 1% of their annual turnover into advanced digital technologies**. Investment levels are slightly higher for robotics, with 28% of companies allocating 6–10% of their turnover to its adoption. This higher investment is largely attributed to the greater capital intensity required for implementing robotics systems.

This section analyses the uptake of digital technologies, the evolution of retail tech startups and private investments in the retail industrial ecosystem. It explores the progress retailers have made in integrating digital technologies to enhance operations, streamline processes, and improve customer experiences over the past years.

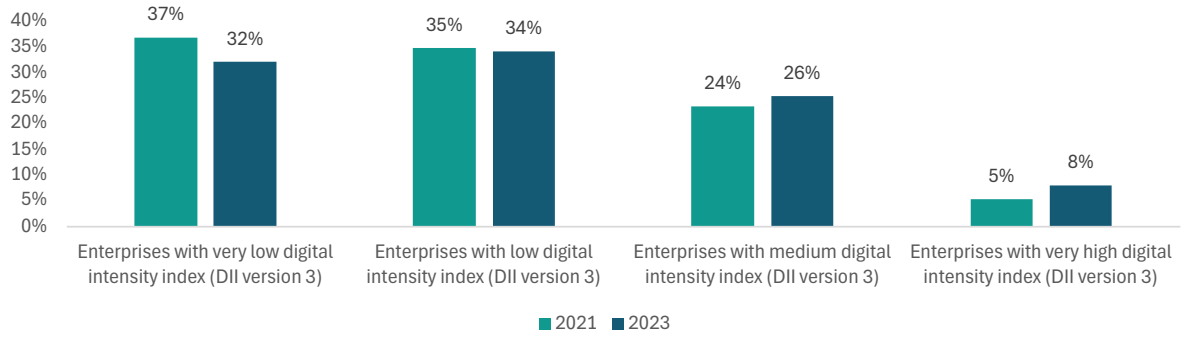
3.1.1. Uptake of digital technologies

The target of the Digital Compass set in relation to digital transformation of businesses are dedicated to help **late digital technology adopters** – more than 90% of SMEs to reach at least a basic level of digital intensity[103]. The majority (66%) of retailers and wholesalers had low or very low digital intensity in 2023. However, progress has been made, as the

[103]The digital intensity index (DII) is a composite indicator, derived from the EU survey on ICT usage and e-commerce in enterprises. The indicator is calculated based on 12 variables, with each of the variables having a score of 1 point. The DII distinguishes 4 levels of digital intensity for each enterprise: 0-3 points: very low; 4-6 points: low; 7-9 points: high; 10-12 points: very high. The indicator measures the use of digital technologies such as such as AI, social media, cloud technologies or having e-commerce sales.

share of retailers with medium to very high digital intensity increased between 2021 and 2023 (see Figure below).

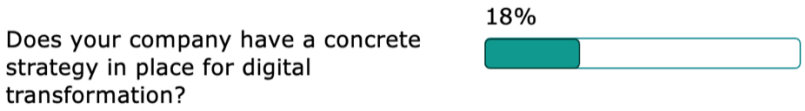
Figure 28: Digital intensity of retail enterprises



Source: Technopolis Group, EUROSTAT. NACE codes used (Retail trade, except of motor vehicles and motorcycles and Wholesale trade, except of motor vehicles and motorcycles)

Similarly, the EMI Enterprise survey found that it is only **18% of companies in the retail industrial ecosystem that have adopted a concrete strategy in place for digital transformation in 2024**.

Figure 29: Share of companies in the retail industrial ecosystem that has adopted a strategy for the digital transformation



Source: EMI Enterprise Survey 2024

When it comes to the adoption of advanced digital technologies, the retail industrial ecosystem has lagged behind other sectors. However, it has shown improvement over the past year, particularly in the areas of the Internet of Things (IoT) and Artificial Intelligence (AI), where usage has notably increased. The three most adopted advanced digital technologies include Cloud, the Internet of Things and Artificial Intelligence technologies.

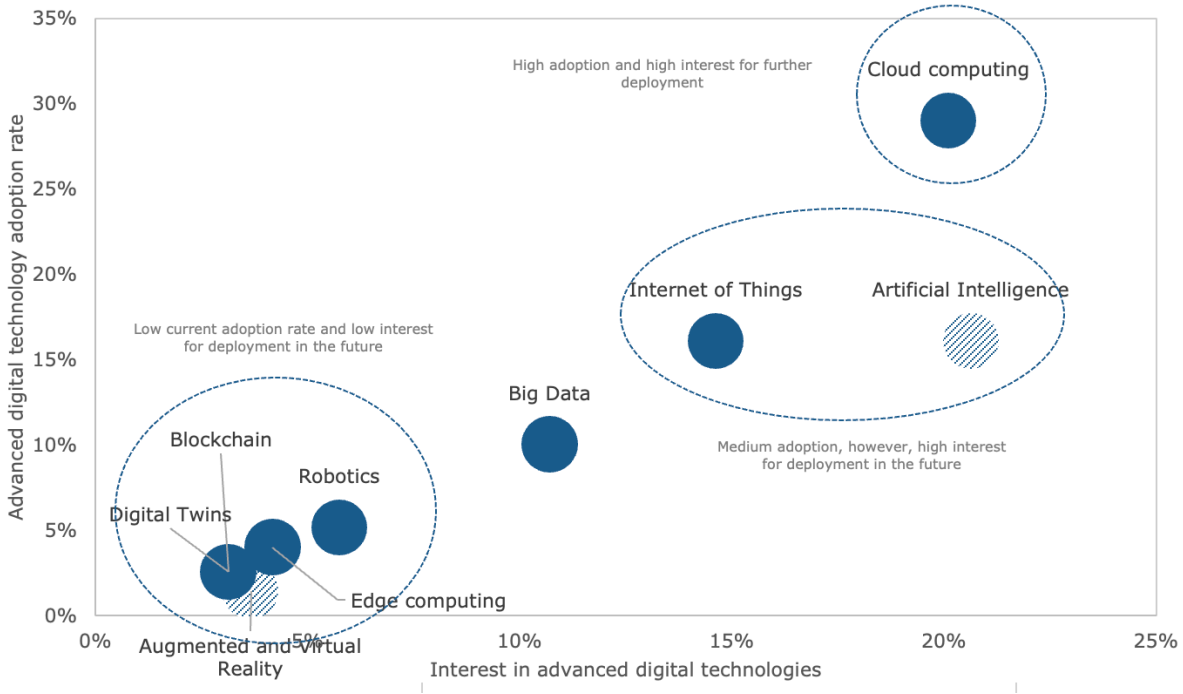
Figure 30: Share of companies in the retail industrial ecosystem that has adopted digital technologies

Digital Technologies	***Share of adoption (2023)***	***Share of adoption (2024)***
Cloud	19%	**30%**
Internet of Things	10.2%	**16.5%**
Artificial Intelligence	6%	16.5%
Big Data	9.7%	10%
Augmented and Virtual Reality	3.3%	1.32%
Robotics	1.9%	5.61%
Blockchain	2%	2.97%
Edge Computing		4.29%

Source: EMI Enterprise Survey 2024

The Figure below displays the current and planned adoption of digital technologies.

Figure 31: Digital technology adoption and technology generation in retail industrial ecosystem.



Source: EMI survey, Note: Advanced digital technology adoption rate is based on the responses to survey question "Which advanced digital technologies does your company use or has your company adopted?" Interest in advanced digital technologies is based on the responses to survey question "Which advanced digital technologies is your company planning to use or adopt".

The light blue lined circles indicates that more than half of the companies have adopted technology less than 3 years ago

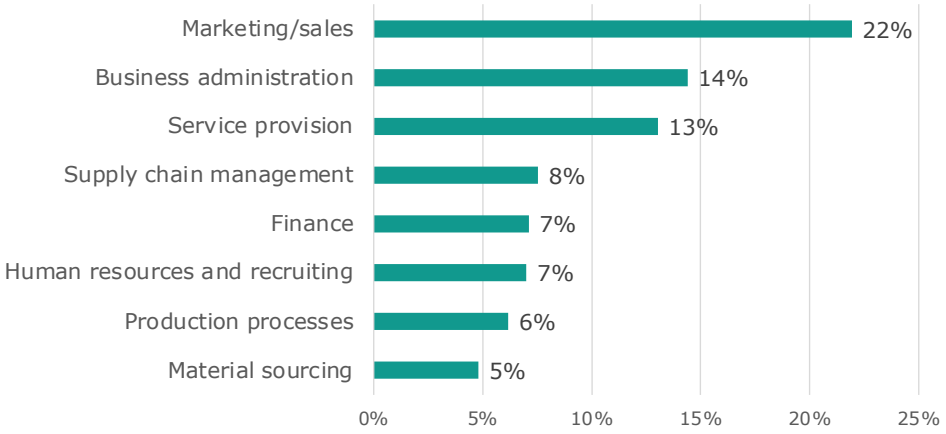
Use of Artificial Intelligence in retail

The EMI Enterprise Survey revealed a significant increase in the adoption of artificial intelligence technologies, with 16.5% of retail companies reporting its use. This marks a substantial difference from last year's findings and Eurostat's 2023 data[104], which indicated that only 6% of companies in the retail industry had adopted AI technology. This sharp rise suggests a growing use of especially open AI technologies, Chat.GPT, OptiMonk among retailers in particular. These technologies are becoming more accessible and cost-effective, enabling retailers to integrate AI-driven solutions such as personalised recommendations and demand forecasting into their operations, thereby enhancing efficiency and customer experience.

The EMI survey of companies within the retail industrial ecosystem shows that the **primary use of AI has been in marketing and sales**, with businesses leveraging AI to personalise customer interactions and optimise campaigns. This is followed by its application in business administration for automating routine tasks, in service provision for enhancing customer support, and in supply chain management for improving inventory tracking, demand forecasting, and logistics efficiency (see Figure below).

104 Retrieved from: https://ec.europa.eu/eurostat/databrowser/view/isoc_eb_ain2__custom_13289598/default/table?lang=en

Figure 32: Main use of AI



Source: EMI Enterprise Survey 2024

These activities are linked to distinct parts of a retail business – supply chain management, marketing, and talent – demonstrating the potential impact that AI might have on retailers.

Some AI use cases include IKEA Kreativ AI-driven digital design experience which offers customers the lifelike, fully integrated way to design and visualise their living spaces, from computers and smartphones[105]. By leveraging big data, Fnac Darty has developed indicators to qualify vendors and products, enhancing transparency and customer trust. AI is now being used to streamline customer service operations, such as identifying optimal solutions for customer inquiries efficiently. Additionally, Fnac Darty is shifting its business model to include recurring revenue from services instead of relying solely on transactions. AI is used to support employees and improve customer relationships.

The EMI survey also revealed that 48% of companies using AI rely on external service providers to implement AI solutions, while 32% depend on their own employees for in-house development. This indicates that a significant portion of businesses prefer outsourcing AI expertise, while others are investing in building internal capabilities to handle their AI needs. In terms of external services providers, surveyed retailers have used services provided by OpenAI (ChatGPT) (36%), followed by Google Cloud AI (16%), Microsoft Azure AI (13%) and Amazon Web Services (AWS) (7%). The majority of the companies also responded that their external service provider was from the same EU Member State.

Internet of Things and its impact on retail

The Internet of Things can significantly improve supply chain management and enhance customer experience. This technology enables the real-time delivery of information about customer behaviour patterns, facilitating more targeted advertising strategies. By analysing data collected from connected devices, retailers can gain valuable insights into customer preferences and purchasing habits, allowing them to tailor their marketing efforts more effectively. Additionally, IoT helps maintain optimal inventory levels through real-time tracking of stock and automated restocking processes. This reduces the risk of overstocking or stockouts, improving overall inventory management efficiency. In terms of operational management, IoT aids in managing energy consumption and predicting equipment maintenance needs, which leads to cost savings and fewer disruptions in operations. Finally, with the added convenience of contactless payment and pickup options,

[105] IKEA launches new AI-powered, digital experience empowering customers to create lifelike room designs. Retrieved from: https://www.ikea.com/us/en/newsroom/corporate-news/ikea-launches-new-ai-powered-digital-experience-empowering-customers-to-create-lifelike-room-designs-pub58c94890

[106] Enrique Martinez, CEO of FNAC DARTY at the Adopt AI Summit – How AI drives a new cycle of innovation and transformation. Retrieved from: https://www.artefact.com/blog/adopt-ai-summit-enrique-martinez-ceo-of-fnac-darty-at-the-adopt-ai-summit/

IoT helps reduce wait times and enhance customer safety, which is particularly important in the post-pandemic retail environment.[107] Due to these benefits, the number of Internet of Things active connections in the retail sector in the European Union (EU) increased and is expected to grow throughout the years. From 1.53 million connections in 2016, to estimated 3.09 million connections by 2025.[108]

Need for big data

The EMI Enterprise Survey found that 6.52% of surveyed retail companies used services of the European Data Spaces in 2024. To underpin both the use of AI and the IoT, the ecosystem has to rely on substantial amounts of customer data that companies can collect and process. Consequently, there is a need for a data space dedicated to the retail ecosystem.[109] For example, one of the surveyed retailers in food and beverage indicated that they use agriculture dataspace for monitoring purposes. In general, retailers use the data spaces mainly for data storage and backups, market analysis, business intelligence, business development. Considering the significant importance of customer data for the retail industrial ecosystem, the data space would provide retail industrial ecosystem with access to information, with an impact on productivity, greening, digitising, innovative business models and upskilling. Additionally, it will enable better alignment of offers to customers' expectations, predicting customer flows, demands, and more efficient resource planning. Similarly to other service-based ecosystems, retail industrial ecosystem data space would closely connect to other sectoral data spaces, such as the data space for tourism, agriculture, mobility or skills.

The role of augmented and virtual reality in the retail industrial ecosystem

VR and AR technologies are still in their nascent phase for use by retailers, and immersive, functional ways to showcase products and services remain a niche. The EMI survey shows that it is a low share, notably around 2-3% of retailers that actively engage with this technology. It has the highest interest among the fashion retailers.[110]

The potential of VR and AR is manyfold. It can enhance the shopping experience and allow customers to interact with products in novel ways. For example, retailers can use VR to create virtual showrooms where customers can explore products in a simulated environment, which is particularly effective for large items like furniture and appliances. Also, VR technologies enable virtual events & live streaming where retailers can connect with customers to promote products. AR applications enable customers to see how products look in their own homes through their smartphones, fostering confidence in online purchases and reducing return rates.

When discussing the role of VR in retail, one has to address the adoption and the impact of the metaverse. It should be noted, however, that research highlights low metaverse adoption rates and a general lack of awareness and prioritisation of metaverse technologies amongst European firms.[111] The metaverse, although at early stages, is allowing users to explore different virtual worlds[112]. More specifically, retailers are exploring virtual worlds to create immersive shopping experiences that blend physical and digital elements. Companies such as Gucci, Moncler, and Zara have invested in the metaverse by launching

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[107] IoT in Retail Industry: Business Benefits and Use Cases. Retrieved from: https://smarttek.solutions/blog/iot-in-retail/
[108] Number of Internet of Things (IoT) active connections in retail in the European Union (EU) in 2016, 2019, 2022 and 2025. Retrieved from: https://www.statista.com/statistics/691865/retail-iot-active-connections-in-the-eu/
[109] A transition pathway for a more resilient, digital and green retail ecosystem. Retrieved from: https://single-market-economy.ec.europa.eu/publications/transition-pathway-more-resilient-digital-and-green-retail-ecosystem_en
[110] Deloitte (2019) Digital Reality changes everything. Retrieved from: https://www2.deloitte.com/content/dam/Deloitte/dk/Documents/Grabngo/Digital%20Reality%20GrabNGo_2019_030419.pdf
[111] LSE Policy Brief (2024). Unleashing European Innovations for the Metaverse. Retrieved from: https://www.lse.ac.uk/business/consulting/assets/documents/Unleashing-European-Innovations-for-the-Metaverse-LSE-Policy-Brief-24-April-2024.pdf
[112] Retail Economics. 40 Future Retail Trends to 2030. Retrieved from: https://www.retaileconomics.co.uk/retail-insights/thought-leadership-reports/40-future-retail-trends-to-2030

virtual stores and interactive experiences where consumers can try products virtually, engage with brands, or purchase virtual goods.[113] For the retail industry, the metaverse is considered as a channel where brands can realise their promotional activities and save cost and time. Additionally, brands direct their marketing activities to the metaverse as it offers possibility to bridge the gap between physical and online channels and offer personalised customer experience[114].

Edge computing in retail

Implementing edge computing in omnichannel retail operations can provide valuable benefits for both retailers and customers, improving efficiency and overall experience. These benefits include faster data processing, better customer service, and smoother operations across multiple sales channels. Quantitatively, edge computing can significantly **improve productivity and efficiency**. For instance, inventory management enabled by edge-connected cameras, Point-of-Sale systems, and data analytics can help reduce inventory shrinkage by up to 20%, according to retail experts[115]. Moreover, **real-time updates on stock levels** can enable retailers to reduce stockouts and improve order accuracy, leading to better inventory turnover and increased customer satisfaction[16].

Following the results of the EMI Enterprise Survey, **4.29% of surveyed retail companies reported relying on edge computing in their business operations.**

There are also **cost saving benefits** by reducing the need for powerful servers and large data centres and reducing data transmission and storage costs. Moreover, processing data locally brings economic savings associated with the transmission costs and reduced energy consumption through the use of efficient edge device.[116] Retailers can benefit from this by deploying cost-effective edge devices in stores to handle tasks such as point-of-sale (POS) transactions and in-store customer analytics without relying heavily on expensive cloud infrastructure.

Qualitatively, the uptake of edge computing can enhance decision-making processes by using real-time data analytics. If not automatically performed, retail managers can make informed decisions on stock replenishment, promotions, and customer service improvements based on the latest data available[117]. This real-time data processing capability also promotes personalised customer interactions and quicker response times, enhancing the overall customer experience. Features such as automated checkout systems and personalised promotions have made the shopping experience more engaging and satisfying, driving customer loyalty.

3.1.2. Retail tech startups

Retail tech startups are pivotal in transforming the ecosystem by driving the adoption of advanced digital technologies. They introduce innovative solutions that streamline operations, enhance customer experience, and enable retailers to remain competitive in a rapidly evolving digital landscape. Through their cutting-edge products and services, these startups not only help modernise retail practices but also challenge the industry to accelerate its digital transformation. This report analyses key trends in retail tech, leveraging data from Crunchbase[118] and Net Zero Insights[119] to provide insights into emerging innovations and the startups leading this transformation. Since 2015, a total of 5,481 retail tech companies have been established in the European Union, with 5,390 still active in 2024, according to the latest data.

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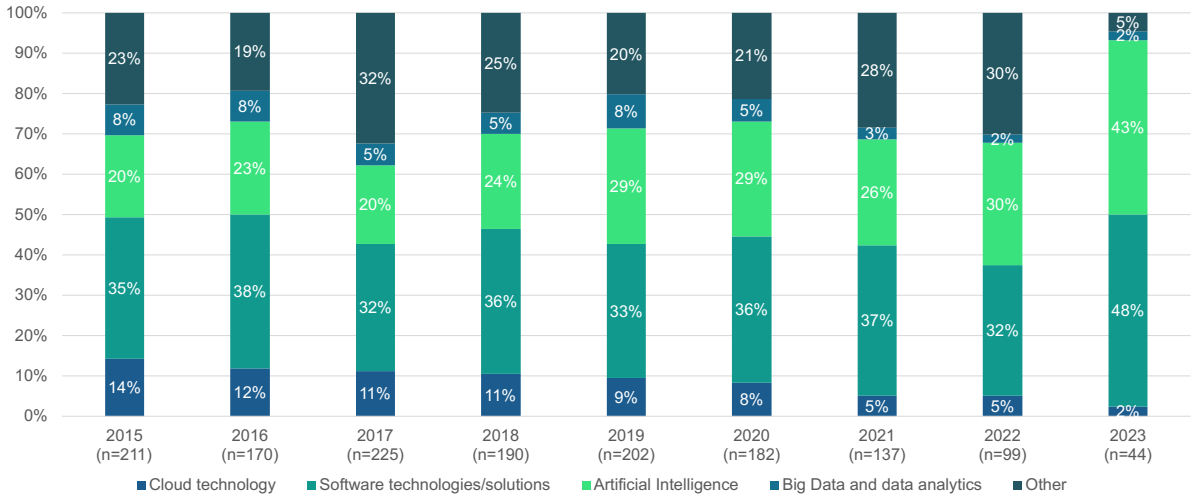
[113] Is the metaverse the future of retail in Europe. Retrieved from: https://www.eurodev.com/blog/is-metaverse-the-future-of-retail#:~:text=Some%20of%20the%20famous%20brands,strong%20demand%20for%20digital%20assets.
[114] Tavman, E. B. (2024). Metaverse Retailing: Opportunities and Challenges. Press Academia Procedia, 19(1), 10-15.
[115] McKinsey retail expert interviews, January 2022
[116] Accenture, 2022
[117] Ibid
[118] https://www.crunchbase.com/home
[119] https://netzeroinsights.com/

Retail tech startups have been rapidly expanding software solutions, playing a crucial role in transforming retail operations. These solutions are streamlining processes such as inventory management, customer relationship management (CRM), payment systems, and data analytics (see Figure below).

The patterns in the type of retail tech startups emerging confirms also the importance of AI as highlighted in the previous section. The analysis reveals that **30% of retail tech startups in 2022 and 43% in 2023 were relying on AI technologies,** highlighting a growing trend. Some examples are presented in the Table below.

Figure 33: Share of startups created, by advanced digital technology between 2015 and 2023. (N is the size of the sample (number of start-ups) created each year.)



Source: Technopolis Group based on Crunchbase and Net Zero Insights

Table 2: Examples of digital retail tech startups scaling up

Software solutions and online marketplace

Ankorstore is a wholesale marketplace that connects independent shop owners and specialist brands with neighborhood retailers. It has raised a total of €365 m in funding over 4 rounds, the latest from a Series C round.

Mobile payment

Klarna, Klarna is a ecommerce payment platform. It has raised a total of €3875M in funding over 20 rounds in a period of 12 years from 2010 to 2022. (Crunchbase)

Artificial Intelligence

RELEX Solutions uses AI for supply chain planning system. It has raised a total of €751M in funding over 5 rounds. Their latest funding was raised on 2022 from a Private equity round. (Crunchbase)

Source: Technopolis Group based on Crunchbase and Net Zero Insights

3.1.3. Industrial investments into digital technologies

Digitalisation strategies in retail naturally require financial investment. The EMI Enterprise Survey has assessed the level of investment into advanced digital technologies by retail companies. The table below indicates that companies invested in general less than 1% of their annual turnover into any advanced digital technology. The share was slightly higher for robotics, with 28% of respondents who adopted this technology indicating that they

invested 6-10% of their annual turnover. This higher investment is largely attributed to the greater capital intensity required for implementing robotics systems.

Figure 34: Investments into advanced digital technologies by retail companies in the EU27 (Over the past year, how much has your company invested on average in digital technologies?)

	Cloud	Robotics	IoT	Big Data	Artificial Intelligence	AVR	Blockchain
Less than 1% of annual turnover	57%	22%	44%	24%	59%	66%	62%
1-5% of annual turnover	34%	28%	24%	14%	7%	33%	12%
6-10% of annual turnover	4%	7%	8%	14	7%		
11-30% of annual turnover	2%				4%		
More than 30% of annual turnover		7%					

Source: EMI Enterprise Survey 2024

As it was also found by a recent report of McKinsey, 3.6% of EU retailers' and wholesalers' revenue is allocated to investment overall and 2.1% goes into IT spending.[120] The report has pointed out that this investment is below the one in North America, where 6.7% of retailers' revenue is allocated to investment overall and 3.3% to IT investment. This discrepancy is particularly relevant when considering that leading online pure players invest 4.5% to 6% in IT expenses.[121] In general, estimates show that retailers need to invest between 0.4 % to 0.6 % of retail's total revenue for the digital transition.[122]

When investigating venture capital and private equity investment into retail tech companies, the trends show that most investments in 2023 were allocated to online platforms/e-commerce solutions (EUR 956 m), followed by software solutions (EUR 294 m) and AI (EUR 69 m). For software solutions, Internet of Things (IoT), and online platforms, there was a significant surge in investments in 2021. This aligns with broader market trends from that period, including pandemic-fuelled growth in the adoption of e-commerce and record venture capital activity. The pandemic accelerated the shift to online shopping and digital retail solutions, prompting investors to focus on scalable technologies. Additionally, 2021 was a peak year for venture capital funding globally[123].

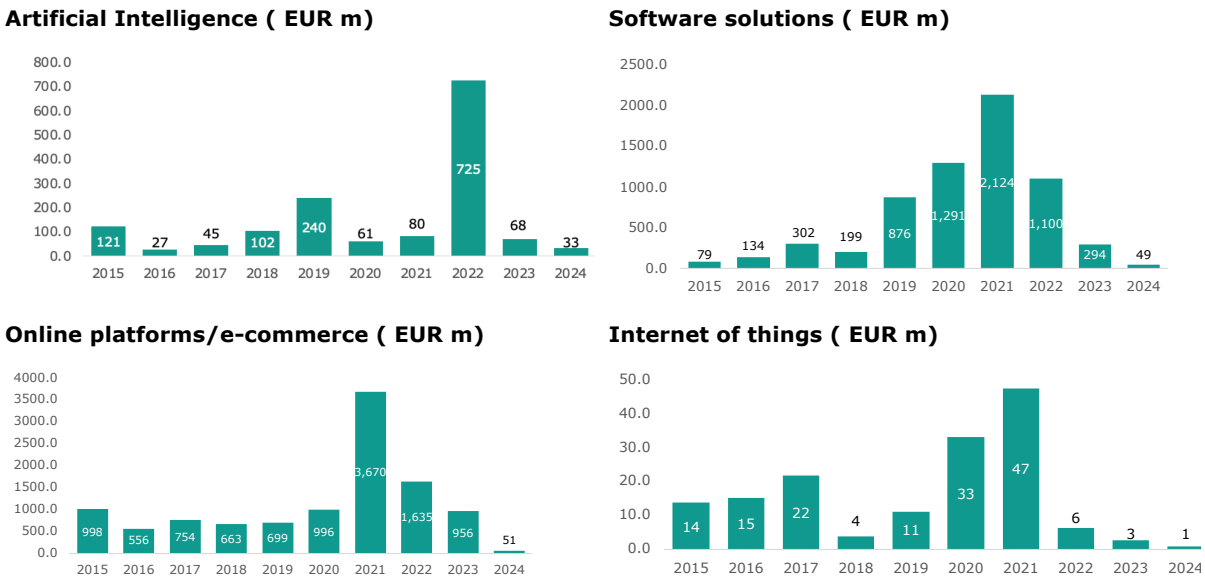
[120] McKinsey & Company, (2022), Transforming the EU retail and wholesale sector. https://www.mckinsey.com/industries/retail/our-insights/transforming-the-eu-retail-and-wholesale-sector

[121] McKinsey & Company, (2022), Transforming the EU retail and wholesale sector. https://www.mckinsey.com/industries/retail/our-insights/transforming-the-eu-retail-and-wholesale-sector

[122] A transition pathway for a more resilient, digital and green retail ecosystem. Retrieved from: https://single-market-economy.ec.europa.eu/publications/transition-pathway-more-resilient-digital-and-green-retail-ecosystem_en

[123] https://dealroom.co/guides/europe#:~:text=European%20VC%20investment%20peaked%20in,from%205%25%2020%20years%20ago.

Figure 35: Investments in startups by advanced digital technology over the period from 2015 and 2024 in the EU27[124]

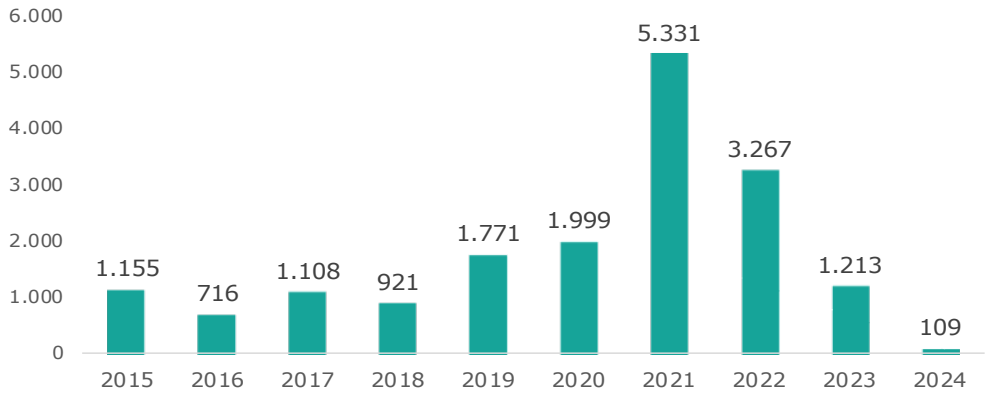


Source: Technopolis Group based on Crunchbase and Net Zero Insights

In a global context, venture capital investment into retail tech has been the highest in the USA and much less deals are closed within the European Union. It is an estimated 20% of the total amount of deals that are linked to retail tech companies headquartered in the EU27.[125] The Figure below provides an overview of the venture capital and private equity investments in retail tech companies. It must be noted that investments in retail tech decreased in 2022. This decline, which may be evident across the entire global venture ecosystem, is attributed to high interest rates, high inflation and uncertain economic conditions.[126] Additionally, it should be acknowledged that the 2022 decrease is a correction of the substantial investments made in 2021 to address the realities of the COVID-19 crisis.

[124] Data for 2024 should be interpreted with caution and regarded as partial, as the data collection was conducted in March 2024, limiting the inclusion of developments later in the year.
[125] European Commission (2023). Staff Working Document on Co-creation of a transition pathway for a more resilient, digital and green retail ecosystem, Brussels, 27.7.2023, SWD (2023) 283 final
[126] For example, The European VC market faced several challenges in 2023, with funding to European startups reaching $52 billion, down 39% year over year from 2022. The first nine months of 2023 saw European VC deal value at EUR 43.6 billion, a decrease of 49.1% compared to the same period in 2022. https://www.daacap.com/european-venture-capital-in-2024-embracing-change-and-opportunity/#:~:text=The%20European%20VC%20market%20faced,the%20same%20period%20in%202022.

Figure 36: Venture capital and private equity investment into digital retail technologies over the period from 2015 to 2024 in the EU27[127]



Source: Technopolis Group, Crunchbase and Net Zero Insights

3.2. Framework conditions – assessment of the broader ecosystem supporting the digital transition

To what extent do framework conditions such as public financing and skills support the digital transition?

- The European Regional Development Fund (ERDF) plays a vital role in the digital transition of retail. Over the period 2014-2020, **10% of all retail ERDF projects are related to the digital transition, accounting for 16% of the funding (EUR 370 m).** Advanced digital technologies accounted for 22% of the ERDF funding dedicated to the digital transition of retail, with Artificial Intelligence being the most commonly supported advanced technology.

- In 2024, **4% of professionals registered on LinkedIn and employed within the retail industrial ecosystem possessed advanced digital skills and 20% possessed other more moderate digital skills, marking an increase from the levels observed in 2022**. The most prevalent advanced digital skills are Artificial Intelligence, Augmented and Virtual Reality and Cloud technologies. However, the overall percentages remain modest, and while there has been some increase, it is not substantial.

- **Requirements both for moderate and advanced digital skills listed on online job advertisements within the retail industrial ecosystem have been growing steadily** over the period from 2021-2023. In 2023, **13% of online job advertisements in the EU27 required moderate digital skills and 5% advanced digital skills**.

- Specific skill needs of the industry relevant to the digital transition include **digital literacy**, **use of AI** and **e-commerce-related skills**.

- **Consumer preferences are rapidly shifting retail from a supply-driven to a demand-driven, personalised experience**. Key trends include the **rise of mobile commerce,** enabling fast, efficient, and convenient shopping and str**ong demand for an omnichannel shopping experience**, blending online and offline touchpoints seamlessly. Also, there is a growing emphasis on **data privacy and digital security**, reflecting heightened consumer concerns in the digital era.

[127] Data for 2024 should be interpreted with caution and regarded as partial, as the data collection was conducted in March 2024, limiting the inclusion of developments later in the year.

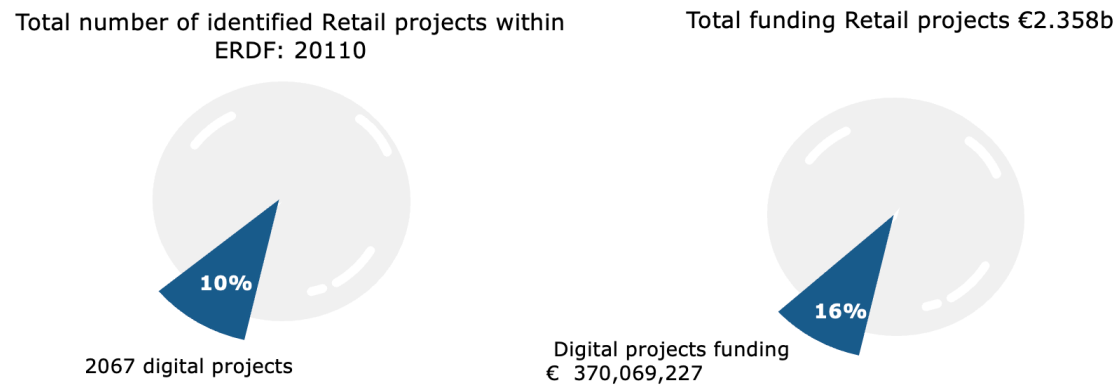
3.2.1. Public investments via the European Regional Development Fund

This section analyses the investments made in digital transition through the European Regional Development Fund similarly to the section on public investments as part of the green transition chapter above.

To implement digital transformation, retailers will have to rely on a robust technological infrastructure, including a reliable and trustworthy Wi-Fi network. This infrastructure will establish the link between the digital and physical experience, powering all the business operations from warehouse management to customer pick-up. The further deployment of 5G will enable a smooth functioning of this infrastructure, including through enabling the Internet of Things. Additionally, it is important to be aware of the existent asymmetries between rural and urban areas, as well as different geographical parts of the EU. The different population density rates, the access to technological infrastructure, or the availability and quality of communication routes are critical factors that can lead to different infrastructure and technological solutions to be implemented.[128]

A recent OECD analysis shows that while targeted support to SME digitalisation increased in absolute value, it **decreased as a share of total investment in digitalisation**, from around 23% for rescue packages (immediate help) to 8% in recovery measures (long-term plans)[129]. Consequently, the role of public intervention is to continue investing in infrastructure upgrades and incentivising companies to adopt digital technologies. Data from ERDF funding supports this statement, with projects with a digital component accounting for 10% of all funded projects and receiving 16% of the total funding (see Figure below).

Figure 37: Total number and total funding of retail projects co-financed by the ERDF



Source: Technopolis Group based on Kohesio data

Secondly, total share of funding into advanced digital tech funded within projects with a digital component is 22% (so 3.52% of all funding directed into Retail ERDF projects). The remaining EUR 228m are invested in basic digital technologies and transition enabling infrastructure.

[128] Presentation of a project on the twin transition and the future of retail SMEs in urban and rural areas (OECD). Retrieved from: https://ec.europa.eu/docsroom/documents/58896

[129] OECD (2022), Assessing National Digital Strategies and Their Governance, OECD Digital Economy Papers, No. 324

Figure 38: Examples of projects co-funded by the ERDF

ERDF projects support advanced digital technologies in retail

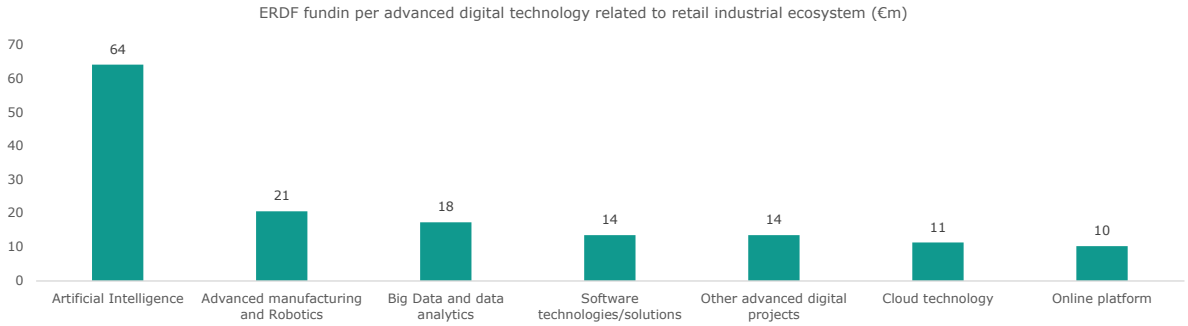
Examples:

- AI-enabled software for the automation of visual content on e-commerce platforms (AI.LT)
- Creation of a model of functioning of an intelligent and automated grocery store based on innovative technology of automatic retail sale with modular structure.
- Development of an online platform integrated with online stores and Foundations thanks to which in an easy, convenient and pleasant way customers will be able to return unnecessary, homemade items, and half of the profit from their sales will go to the foundation indicated by the client.

Source: Technopolis Group based on Kohesio data

In terms of specific technologies, the ERDF funding has been mainly allocated to artificial intelligence (EUR 64 m) and advanced manufacturing (EUR 21 m).

Figure 39: ERDF funding per advanced digital technology



Source: Technopolis Group, Kohesio

In terms of national and regional public programmes, there are typically general national business digitalisation programmes in which retailers can participate. These programmes include components of both basic and advanced digital technologies.

The overview of the **Recovery and Resilience Plans** shows that the 20% target for digital investments has been exceeded, reaching 26% as shown by the recovery and resilience scoreboard. Within this, the digitalisation of businesses is the second-largest intervention area, accounting for 20% of the funds dedicated to digital investments. The investments and reforms aimed at business digitalisation take various forms, such as tax incentives, voucher schemes, and the establishment of digitalisation funds. For instance, Greece has taken the initiative to invest in the development and delivery of digital tools to Greek SMEs in the areas of electronic payments and sales, industrial data platforms and cash registers and point of sale ecosystem upgrade[130]. Similarly, Cyprus is setting up a grant scheme to

[130] European Commission (2022). Digitalisation of Businesses in National Recovery and Resilience Plans (NRRPs). Retrieved from: https://digital-strategy.ec.europa.eu/en/library/digitalisation-businesses-national-recovery-and-resilience-plans-nrrps

increase the share of present and future SMEs using information and communication technologies, including e-commerce, and to promote digital entrepreneurship[131].

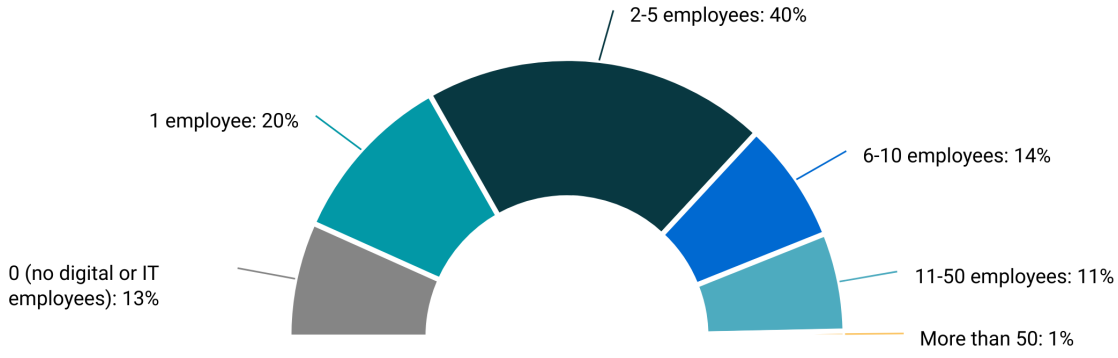
The EU plays a significant role in supporting retail digitalisation. Starting in 2024, the European Union will introduce a new regulation requiring nearly all products sold in the EU to include a Digital Product Passport (DPP). This initiative, part of the Ecodesign for Sustainable Products Regulation, is aimed at increasing transparency across product value chains by providing detailed information about a product's origin, materials, environmental impact, and disposal instructions. The DPP is designed to bridge the gap between growing consumer demand for transparency and the current lack of reliable product data, helping consumers make informed choices and promoting sustainability.[132] The DPP will include essential details such as a unique product identifier, compliance documentation, and information on substances of concern. It will also provide user manuals, safety instructions, and guidance on product disposal. By offering a detailed digital record of a product's lifecycle, the DPP will enhance supply chain management, ensure regulatory compliance, and help retailers identify and mitigate risks related to authenticity and environmental impact.[133]

3.2.2. Skills underpinning the digital transition

This section analyses the demand and supply side of the labour market in terms of skills relevant for the digital transition. The skills needed for retailers to succeed in the future will be different from those that were required for success in the past. As highlighted by a report of McKinsey, more than 50% of all activities in retail can be automated with technology. Moreover, customer needs and preferences for how they interact with retail are continually changing. They are seeking more personalised experiences, seamless interactions across multiple channels, and faster, more convenient services, which in turn requires new types of skills.

According to the results of the EMI Enterprise Survey in 2024, 87% of the retail companies surveyed have at least one full-time employee in jobs directly relevant for the digital transition of the company (see Figure below). 40% of the respondents said they employ between 2-5 people in digital roles.

Figure 40: Share of full-time employees working in jobs relevant for the digital transition of the company



Source: EMI Enterprise Survey 2024

[131] European Commission (2022). Digitalisation of Businesses in National Recovery and Resilience Plans (NRRPs). Retrieved from: https://digital-strategy.ec.europa.eu/en/library/digitalisation-businesses-national-recovery-and-resilience-plans-nrrps https://digital-strategy.ec.europa.eu/en/library/digitalisation-businesses-national-recovery-and-resilience-plans-nrrps and https://www.fundingprogrammesportal.gov.cy/en/call/scheme-for-the-digital-upgrade-of-enterprises/

[132] Retrieved from: https://data.europa.eu/en/news-events/news/eus-digital-product-passport-advancing-transparency-and-sustainability

[133] Retrieved from: https://data.europa.eu/en/news-events/news/eus-digital-product-passport-advancing-transparency-and-sustainability

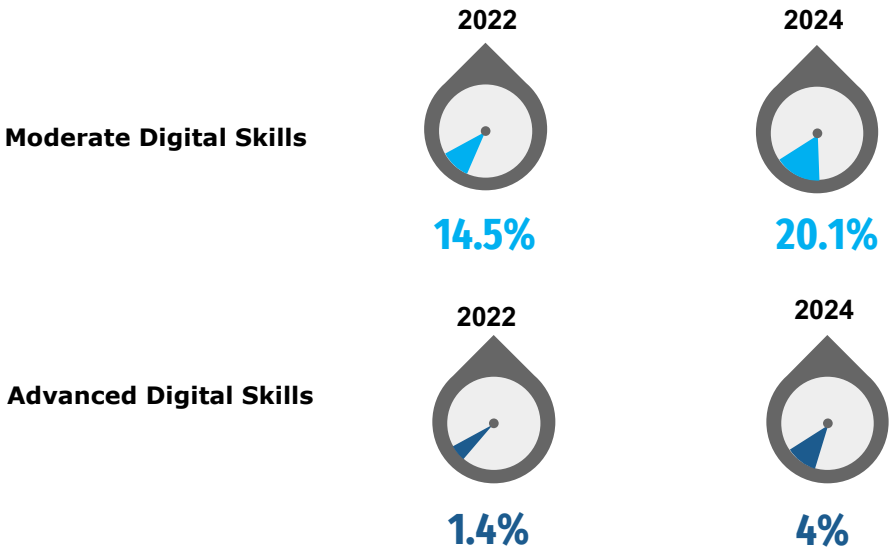
In order to analyse trends in the skills of professionals working in the retail industrial ecosystem, data from LinkedIn has been used. LinkedIn data provides a proxy about self-reported supply of digital skills including moderate and advanced digital skills.

Moderate digital skills have been defined following Cedefop[134] notably including "*five types of skills under the digital skills umbrella such as information processing (e.g. using a search engine and storing information and data); communication (including teleconferencing and application sharing); content creation (such as producing text and tables, and multimedia content); security (e.g. using a password and encrypting files); and, problem solving (e.g. finding IT assistance and using software tools to solve problems)"*. (The list of keywords that have been used to track LinkedIn is included in Appendix B).

Advanced digital skills have been defined as a specific group of digital skills in the context of the main digital technologies captured in this project notably in artificial intelligence, cloud computing, connectivity, robotics, Internet of Things, augmented and virtual reality and blockchain (the list of keywords that have been used and are possible to track with the algorithm of LinkedIn is included in Appendix B). LinkedIn data have to be interpreted in the light of its representativeness for retail and across the EU. An analysis of representativeness is provided in Appendix B and in the related methodological report.

The results indicate that both the share of professionals with moderate and advanced digital skills - including artificial intelligence, big data, cloud technologies, augmented and virtual reality, Internet of Things, robotics – **have increased between 2022 and 2024.** (see Figure below).

Figure 41 Share of professionals with advanced digital skills in retail



Source: Technopolis Group based on the analysis of LinkedIn data

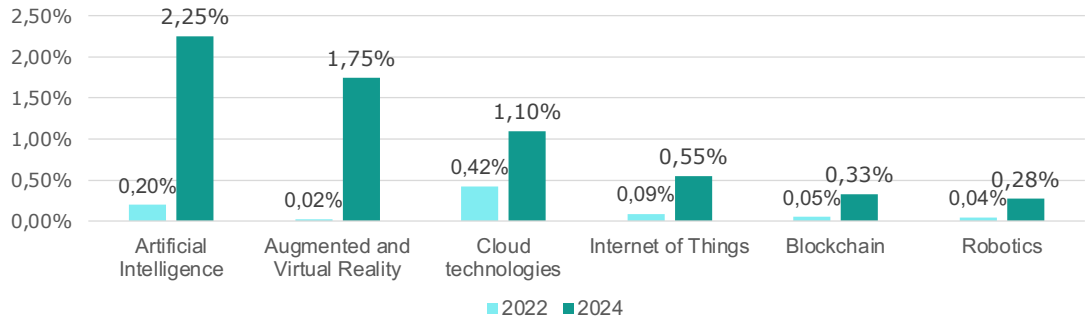
Advanced digital skills were more common among retail professionals in fashion followed by retail in electronics.

The most relevant advanced digital skill in retail in 2024 has become artificial intelligence, as professionals have increasingly listed these skills on their profiles. As AI applications continue to grow and prove their value, professionals have increasingly highlighted AI skills to remain competitive and meet the growing demand for digital expertise in the retail sector. AI skills are followed by augmented reality (AR) and

[134] Available online at: https://www.cedefop.europa.eu/en/data-insights/digital-skills-challenges-and-opportunities

virtual reality (VR) because, while still in the early stages of adoption, these technologies hold great potential for transforming the retail experience in particular in e-commerce. AR and VR can create immersive shopping environments, allowing customers to visualise items in real-world settings. Although these technologies are not yet as widespread as AI, their future potential is driving demand for professionals with AR/VR expertise. Skills related to blockchain, and robotics have been the lowest.

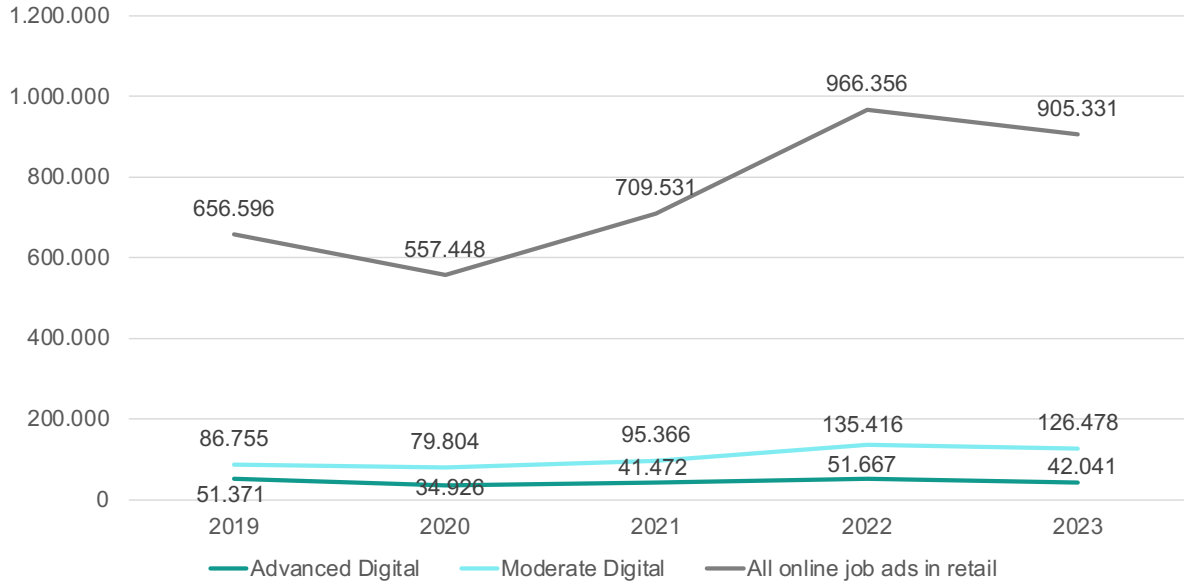
Figure 42: Share of professionals with specific advanced digital skills in retail in 2022 and 2024



Source: Technopolis Group based on the analysis of LinkedIn data

On the demand side, the requirements for digital skills listed on online job advertisements within retail have been growing over the period from 2019-2022, as shown by the data from Cedefop Skills-OVATE. The total number of online job advertisements in retail amounted to 905 331 in 2023 in the EU27. The results of the data analysis show that 5% of the job ads included a requirement of advanced digital skill such as AI, big data, augmented and virtual reality, cloud. A higher share, notably 13% of the job ads, required moderate digital skills (more than simple Microsoft or web skills but not necessarily artificial intelligence). Sweden has the highest share of online job ads with a digital skill in retail, followed by France and Germany.

Figure 43: Share of online job advertisements with a requirement for digital skills

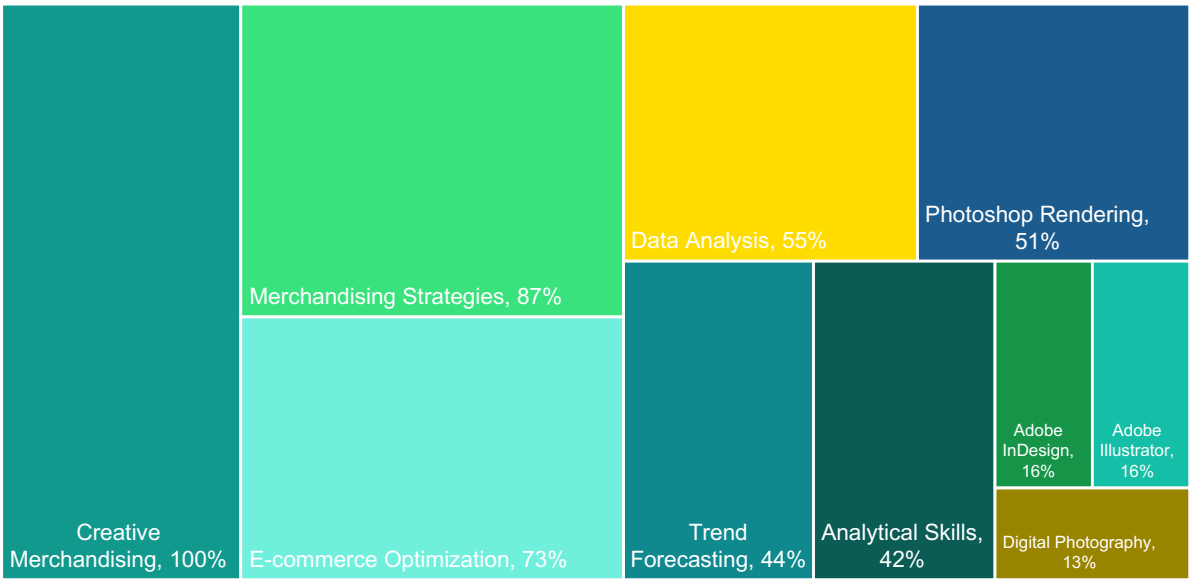


Source: Technopolis Group based on the analysis of Cedefop data

The retail industrial ecosystem faces several digital skill gaps. As identified by the Skills4Retail initiative, the main needs are in digital literacy, collaboration and productivity

software, artificial intelligence and big data, spatial thinking, data mining, cybersecurity and application security, computer hardware and networking[135]. Moreover, following the ESCO profiles mapping and prioritisation, e-commerce specialist and customer experience manager are among top 10 emerging occupational digital profiles in retail.[136] User experience specialists, digital marketing specialists, social media specialists, data specialists and AI specialist are other emerging profiles. Similarly, the analysis of LinkedIn shows that the fastest growing and most sought-after skills include creative digital merchandising, e-commerce strategies, data analysis, trends forecasting and analytical skills.

Figure 44: Fastest growing skills in retail as captured by LinkedIn



Source: Technopolis Group based on analysis of LinkedIn data

Specific skill needs of the industry relevant for the digital transition include:[137]

- **Digital literacy:** includes use of a computer, mobile and tablet devices; use of commonly used software (Microsoft Word/Excel); responsible use of internet browsers and social media; cybersecurity and data protection fundamentals.
- **GenAI**: emerging key skill for almost all staff for 2030. This includes responsible use of large language models, virtual assistants and chatbots with practical demos of retail specific use cases.
- **E-commerce**: Includes knowledge on how to set up and manage online sales; how to use social media to develop a brand presence; how to manage multi-channel customer experiences; how to use commonly used software (for instance, CRM software), and how to interpret and integrate data with sales.

To address the digital skill gaps, companies have implemented skill development programmes. Following the OECD D4SME survey results, 23% of companies organise workplace mutual learnings, 10% offer informal learning and training through online course platforms. 6 % of companies rely on internal and/or external trainings.[138]

[135] Skills4Retail (2024). Occupational Profiles & Needs Analysis. Retrieved from: https://skills4retail.eu/wp-content/uploads/2024/07/S4R_WP2_D2.1_Occupational-Profiles-Training-Needs-Analysis_20240604.pdf
[136] Skills4Retail (2024). Occupational Profiles & Needs Analysis. Retrieved from: https://skills4retail.eu/wp-content/uploads/2024/07/S4R_WP2_D2.1_Occupational-Profiles-Training-Needs-Analysis_20240604.pdf
[137] Skills4Retail (2024). Occupational Profiles & Needs Analysis. Retrieved from: https://skills4retail.eu/wp-content/uploads/2024/07/S4R_WP2_D2.1_Occupational-Profiles-Training-Needs-Analysis_20240604.pdf
[138] OECD (2023), "SMEs in the era of hybrid retail: Evidence from an OECD D4SME survey", OECD SME and Entrepreneurship Papers, No. 41, OECD Publishing, Paris, https://doi.org/10.1787/882f30b0-en.

3.2.3. Consumer demand for digital services in retail

This section analyses consumer demand for digital services in retail, including technology acceptance and user expectations, which determine the further roll-out and success of digitalisation in retail operations. The analysis relies on an in-depth literature review and desk research.

First, consumers are buying a broader variety of goods online, a trend that has been accelerated by the Covid-19 crisis and has resulted particularly in a crisis for the smaller and non-grocery retailers.[139] The **number of consumers engaging in e-commerce has increased significantly over the past years**. In 2019, before the coronavirus pandemic, the figure stood at an estimated 235 million, which has now risen to approximately 326 million in 2024. According to Digital Market Insights, forecasts suggest that the number of e-commerce users in Europe will reach 446 million by 2029.[140] Additionally, the penetration rate in the e-commerce market in Europe was forecast to continuously increase between 2024 and 2029 by in total 9.9 percentage points and reach 55.8%.[141]

Second, **rising food prices, utilities expenses, and the threat of an economic downturn continue to be the main factors weighing on consumers' decisions**[142]. Moreover, inflation continues to have a compounding impact in the EU, even though price increases have slowed. Therefore, affordability and price are almost always the baseline factors shaping consumer decision making in 2024. In this context, online shopping often enables consumers to easily compare prices across different retailers, maximising their budget. Moreover, digital platforms not only offer competitive pricing but also make it easier to access promotions, discounts, and bulk buying options.

In terms of specific consumer demand for digital services in retail, consumers are driving the industry to consider shifting its paradigm from mass to micro, or from supply-driven to demand-driven, personalised retail. As a consequence, there is a demand for marketing, promotions, and processes that are more targeted and personalised. For this, for example, the transitory metaverse might show a potential in combining retail and personalised marketing based on online shared 3D space, digital avatars, and digital objects. Nevertheless, the uptake of transitory metaverse and large-scale studies on the impact of this technology is limited.[143] In general, personalisation of retail entails creating personalised experiences for customers and service modes in channels. This shift addresses consumer expectation that assortments, provided in a combination of digital and in-store experiences, will match their individual needs. The focus on personalisation also necessitates the blend of digital and physical, delivery and in-store niche offerings that are available in high volume and configured around different consumers' priorities (e.g., quality, value, choice, convenience, etc.). In this evolution, technology plays a crucial role.

On average, consumers are willing to pay a 5% premium for convenient, fast and efficient shopping experience, with younger and more affluent consumers willing to pay even more[144]. This growing demand for efficient, convenient and fast shopping experiences has implications for physical and digital commerce. First, brick-and-mortar

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[139] Retrieved from: https://ivi.ie/project_category/digital-retail/

[140] STATISTA data Number of B2C e-commerce users in Europe from 2017 to 2029. Retrieved from: https://www.statista.com/forecasts/715683/e-commerce-users-in-europe

[141] STATISTA data Penetration rate of the e-commerce market in Europe from 2020 to 2029. Retrieved from: https://www.statista.com/forecasts/891317/digital-buyer-penetration-in-europe#:~:text=The%20penetration%20rate%20in%20the,a%20new%20peak%20in%202029.

[142] Retrieved from: https://nielseniq.com/wp-content/uploads/sites/4/2024/09/NIQ-Guide-to-2025-Mid-Year-Consumer-Outlook-Full-Report_90de1a.pdf

[143] Ki, C. W. C., Chong, S. M., Aw, E. C. X., Lam, M. M. L., & Wong, C. W. (2025). Metaverse consumer behavior: Investigating factors driving consumer participation in the transitory metaverse, avatar personalization, and digital fashion adoption. *Journal of Retailing and Consumer Services*, *82*, 104094.

[144] https://alphabridge.co/featured/everything-on-demand-the-growth-of-the-convenience-economy/

shops will need to evolve to meet these new demands. This consumer demand requires expanding product ranges, improving store layouts, and integrating digital technologies. These changes are crucial to staying relevant in a competitive market. Convenience stores for example are no longer just for quick snacks or emergency items. They are becoming essential stops for fresh produce, ready-to-eat meals, and even household goods.[145] In the attempt to bring the storage and distribution of goods closer to end consumers and shortening the time it takes to deliver products ordered online, the number of automated micro-fulfilment centres is expected to expand significantly. In the next five years, e-commerce sales will almost surely witness a strong emphasis on quick delivery, with 64% expected to be fulfilled on the next day or on the same day.[146]

This consumer demand for convenient, fast and efficient shopping is closely related to consumer use of in-store devices. In-store devices, for example, include interactive kiosks for self-checkout and providing information. It should be noted that these devices are no longer a novelty as only 9% of consumers have never used any form of technology designed to improve their shopping experience[147]. In addition, the retail sector is witnessing a significant transition as Retail Service Robots (RSRs) become more widely deployed[148]. One of the most visible applications of robotics in the retail sector is the deployment of robotic informational guides. These robots, often equipped with friendly human-like features or appealing designs, roam store aisles, ready to assist customers. They leverage advanced natural language processing and voice recognition technologies to understand and respond to customer queries. By providing information on product location, details, promotions, and even personalised recommendations based on shopping habits, these robots are elevating the customer experience[149]. However, not all in-store devices are leading to increased consumer satisfaction and enable convenient, fast and efficient shopping. Despite the anticipation about what the store of the future might look like, there seems to be more frustration from consumers today regarding devices used in-store and how these devices are being managed, maintained and secured.[150] For example, self-serve checkouts are an interesting case study, as it has been the most normalised in-store tech in recent years. Yet, 45% of surveyed consumers indicated that the shopping experience had been made neither better nor worse by its introduction.[151] Moreover, 24% of surveyed consumers in Sweden and France indicate that tablets for ordering goods and shopping are making the shopping experience worse.[152] Also, lack of in-store staff that can support with the use of self-services checkout or kiosks were among the main customer dissatisfaction reasons of instore devices.

Mobile commerce is another key component of convenient, fast and efficient shopping. Sales through mobile commerce in Western Europe are on the rise. In 2023, transactions via mobile devices amounted to nearly EUR 257 billion. Forecasts suggest that this figure will surpass EUR 327 bn by 2027[153]. This trend is closely related to growth of commerce on social media channels. Recent statistics show expectations that the global social commerce market size will continue growing over the next few years. Social commerce is expected to increase by 30.8% in 2024 to reach around EUR 1.5 trillion. That is expected to rise to EUR 1.9 trillion in 2025 and EUR 2.7 trillion in 2026. However, many

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[145] Retrieved from: https://quaysidewholesale.co.uk/blog/how-convenience-stores-are-adapting-to-changing-consumer-preferences/

[146] Deloitte (2024). Global Retail Outlook 2024 Retrieved from: https://www.deloitte.com/global/en/Industries/consumer/analysis/global-retail-outlook.html

[147] Soti (2024). Techspectations: Consumer Demand For Digital Transformation In Retail. Retrieved from: https://soti.net/media/upcptgmb/soti-industry-report-techspectations-consumer-demand-for-digital-transformation-in-retail-english-web.pdf

[148] Vinoi, N., Shankar, A., Agarwal, R., & Alghafes, R. (2025). Revolutionizing retail: The transformative power of service robots on shopping dynamics. *Journal of Retailing and Consumer Services*, *82*, 104085.

[149] Retrieved from: https://www.agritechfuture.com/wp-content/uploads/2024/02/The-Rise-of-Retail-Robotics.pdf

[150] Soti (2024). Techspectations: Consumer Demand For Digital Transformation In Retail. Retrieved from: https://soti.net/media/upcptgmb/soti-industry-report-techspectations-consumer-demand-for-digital-transformation-in-retail-english-web.pdf

[151] Ibid.

[152] Ibid.

[153] Retrieved from https://www.statista.com/statistics/281260/mobile-commerce-sales-europe/

retailers are plagued with slow-loading pages or a clunky user interface on mobile devices, which can frustrate shoppers and lead to higher bounce rates, as well as lower conversion rates. If customers have difficulty navigating mobile site or experience delays in loading product pages or checkout processes, they are more likely to abandon their carts without completing a purchase.

Nearly 90% of consumers expressed a need for an **omnichannel shopping experience**[154]. This shows a decision-making for shopping that considers channels, searching for information, receiving shipments or making returns both online and offline[155]. For example, consumers are migrating between channels as they are looking for discounts that has become the key motivation for research online-purchase offline or reverse purchase offline- research online shopping[156]. This bridging of the physical and online experiences, also called phygital, refers to integrating digital technology into physical retail spaces to create fluid customer journeys. As shoppers continue to flock to brick-and-mortar stores, blending online and offline experiences is a natural evolution for retailers that explore seamless omnichannel commerce.[157]

Health and wellness are growing consumer trends, as a result of more conscious behaviours and a greater attention to health[158]. Eight in ten consumers declare to seek foods that offer nutritional profiles personalised to their needs[159]. Also, spending for health and wellness digital goods and services, such as apps for telehealth and fitness tracking, is an emerging spending category according to Deloitte Global's Consumer Signals. Roughly one in ten consumers spent on products and services in this category over the last month, with young consumers (18-34 years old) being the heaviest spenders across generations[160]. As a result, retailers can expect an increase in consumers' use of wearables to monitor their health and integrate personalised nutrition into their shopping selections. This might be an opportunity for retailers to invest in digital functionalities to help consumers make healthier choices.[161]

Finally, one of the main digital consumerism trends to take into account is the focus on data and digital security. In the 2023 survey, 59% of consumers said a bad experience with data security while shopping online would destroy trusting a brand. Heading into 2024, only 24% of consumers had no concern at all about entering personal details either online in-store devices.[162] More than three quarters worry to some extent about using in-store devices because of retailer mistrust. Over one quarter of consumers (26%) are worried about the next user of the device seeing their personal details. Considering that one in eight retailers faced a cyber-attack over the past 12 months, according to data from Grant Thornton's International Business Report, retailers will need to invest in digital security technologies.[163] The digital technologies therefore play a key role in supporting the security of customer data. This can be done for example, by enhancing payment processing by using encryption and tokenization thus providing a

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[154] Retrieved from: https://www.bigcommerce.com/articles/omnichannel-retail/

[155] It should be recognised that consumers make different decisions on where to buy online or where to buy in person. Therefore, retailers are increasingly looking at leveraging the strengths of each approach (e.g. offering physical locations can enable them to offer additional services, which are not possible online. Offering online, can offer an ease that may not be available in person) not necessarily focusing only on omnichannel approach.

[156] Retrieved from: https://ecommercegermany.com/blog/omnichannel-in-europe

[157] Retrieved from: https://ok.commercetools.com/hubfs/Statamic/Files/2024-WP-Reimagine-Retail.pdf

[158] Retrieved from: https://www.mckinsey.com/industries/consumer-packaged-goods/our-insights/state-of-consumer

[159] Deloitte (2024). Global Retail Outlook 2024 Retrieved from: https://www.deloitte.com/global/en/Industries/consumer/analysis/global-retail-outlook.html

[160] Deloitte (2024). Global Retail Outlook 2024 Retrieved from: https://www.deloitte.com/global/en/Industries/consumer/analysis/global-retail-outlook.html

[161] Deloitte (2024). Global Retail Outlook 2024 Retrieved from: https://www.deloitte.com/global/en/Industries/consumer/analysis/global-retail-outlook.html

[162] Soti (2024). Techspectations: Consumer Demand For Digital Transformation In Retail. Retrieved from: https://soti.net/media/upcptgmb/soti-industry-report-techspectations-consumer-demand-for-digital-transformation-in-retail-english-web.pdf

[163] Ibid.https://www.grantthornton.ie/globalassets/1.-member-firms/ireland/insights/factsheets/grant-thornton---cyber-security-concerns---retail.pdf

shield for customer payment data and guaranteeing that sensitive information remains confidential throughout the entire transaction process.[164]

3.3. Impact of digital technologies on industrial competitiveness

What is the impact of digital technologies on competitiveness?

- The retailers have become more digital, mobile and personalised affecting the retail ecosystem across three dimensions: **1) supporting internationalisation and entering new markets; 2) improving shopping experience; 3) improving productivity**

- The survey of retail companies indicates **that on average the adoption of advanced digital technologies increased productivity by 16.5%** as proxied by the output per hour worked. The technology that respondents identified as having the greatest impact on increasing productivity was artificial intelligence, followed by cloud computing.

- The largest share of respondents witnessed an **increase in productivity as a result of AI followed by Cloud technologies.**

This section analyses the extent to which companies perceive digital technologies as enhancing their competitiveness, both for their business and the industry. It also explores the reasons why investing in digital technologies is worthwhile and identifies which ones are particularly advantageous for the retail sector.

In recent years, digitalisation has been a key driver of economic transformation in the EU and globally, fostering innovation across value chains, reshaping how products are manufactured, how services are delivered, and altering the way we work and consume. Moreover, the Digital Decade Communication sets the target of more than 90% of SMEs reaching at least a basic level of digital intensity by 2030[165]. In 2021, only 56% of SMEs have reached the target, which includes elements such as fast internet connection, a minimum share of e-commerce or web sales in turnover, use of social media, etc.

These changes have been particularly significant in the retail ecosystem as they have not only encompassed the introduction of digital technologies into retail operations but led to a fundamental change in the relationship between businesses and consumers. It should be noted that retailers adopt digital and advanced digital technologies. While both categories of technologies foster digital transformation, their adoption, benefits and limitation differ.

Figure 45: Definitions of basic and advanced digital technologies

Basic digital technologies	Advanced digital technologies
These are foundational tools and platforms that enable retailers to establish an online presence and improve their operational efficiency. Some examples include e-commerce platforms (e.g., websites and online marketplaces that facilitate online transactions), social media (e.g. use of platforms like Facebook, Instagram, and Twitter for marketing and customer engagement), Point	Advanced technologies involve cutting-edge innovations that offer more sophisticated solutions for optimising operations, enhancing customer experiences, and gaining a competitive advantage in the digital marketplace. Examples include artificial intelligence (AI) and Machine Learning (ML),

[164] Retrieved from: https://ok.commercetools.com/hubfs/Statamic/Files/2024-WP-Reimagine-Retail.pdf
[165] Europe's Digital Decade: digital targets for 2030. Retrieved from: https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/europes-digital-decade-digital-targets-2030_en

of Sale (POS) systems, Customer Relationship Management (CRM) systems.	Internet of Things (IoT), big data, augmented and virtual reality (VR), blockchain, etc.

Source: Technopolis Group

As the transition pathway for a more resilient, digital and green retail ecosystem[166] highlighted, the share of online retail trade in the EU has been increasing since 2014. Its value in the EU has doubled between 2015 and 2020. E-commerce represents 10-15% of retail sales in the EU. The share grew on average 13.4% annually between 2016 and 2019 with a sharp increase to 24.4% annually between 2019-2021, illustrating the effects of the COVID crisis and the resulting shift from physical to online sales. Additionally, more and more retailers aim to provide consumers with an omni-channel shopping experience, combining physical and online sales.

Digitalisation does not only modernise or speed up operations, but leads to a complete change of paradigm, shifting sales entirely or partially from the physical to the digital sphere. New digital technologies, including robotics, monitoring systems, the Internet of Things (IoT), online platforms and artificial intelligence (AI), hold immense potential to foster the twin transition in the ecosystem. Physical shops of the future could take on the role of showrooms, offer tailor-made solutions, provide additional services and advice from trained staff, turning shopping into a unique experience. Retailers use innovative in-store technologies to offer this experience to customers. This may include technologies such as contactless payment systems, digital screens that offer in-store shoppers certain features of online shopping, and augmented reality (AR) systems for trying on clothing or testing products.

The EMI survey of retail companies conducted in the framework of this project indicates that on average the adoption of advanced digital technologies increased productivity by 16.5% as proxied by the output per hour worked. The technology that respondents identified as having the greatest impact on increasing productivity (see figure below) was artificial intelligence, followed by cloud computing. Interestingly, some respondents noted that robotics actually decreased productivity. This is largely due to the significant upfront investment required for both equipment and training, as well as the complexity of integrating robots into existing workflows, which can result in an initial drop in productivity.

Table 3: The impact on productivity of advanced digital technologies as expressed by the share of respondents

	Increased	No change	Decreased
Artificial Intelligence	81.40%	18.60%	
Cloud computing	76.47%	22.35%	1.18%
Robotics	71.43%	21.43%	7.14%
Big Data	60.71%	39.29%	
Internet of Things	57.78%	40.00%	2.22%
Blockchain	14.29%	85.71%	
Augmented and Virtual Reality		100.00%	

Source: EMI Enterprise Survey 2024

[166] European Commission (2023). Co-creation of a transition pathway for a more resilient, digital and green retail ecosystem, Brussels, 27.7.2023 SWD(2023) 283 final

Note: the surveyed companies were asked has the adoption of specific technology increased your productivity? Productivity is proxied by the output per hour worked.

In terms of other impacts, digital transformation supports internationalisation and entering new markets. In this case, the online platforms play a substantial role in supporting the competitiveness of small online retailers by helping them enter new global markets and deal with often fragmented legislation across the EU. In a recent OECD survey of retail SMEs selling on e-commerce platforms, 90% of surveyed companies agreed that their online activity has allowed them to increase domestic sales and 85% that it helped them reach new customer groups[167]. In other words, the impact of digitalisation is not limited only to shift in sales channels, but also to sales creation.

In general, these results are closely related to the main digitalisation goals captured by the survey data from the OECD Digital for SMEs Global Initiative (D4SME) 2023 report. The top 5 objectives are: 1) Increase domestic sales – nearly half of businesses (47%) aim to boost sales within their own country through digitalisation; 2) Broaden customer base – around 43% see digitalisation as a way to expand their reach to more customers; 3) Automate processes – approximately 42% want to automate tasks for greater efficiency; 4) Lower inventory and supply chain costs – about 35% focus on reducing costs associated with inventory and supply chains Explore new sources of revenue – roughly 32% are looking for digital opportunities to create new revenue streams.

Another important element of digitalisation is its capacity to enable the green transformation. In particular the use of data and data analytics (on product flows, consumer purchasing habits etc.) can be useful for mitigating some environmentally relevant issues such as reducing packaging. Also, just-in-time production and deliveries help minimise the cost and the environmental impact of excessive warehousing and prevent waste. Digital tools adopted by retailers are likely to facilitate the uptake of green solutions by consumers. They can provide communication channels through websites, apps, QR-codes etc., which enable consumers to discover the sustainable offers of retailers. They can also allow consumers to track their consumption and make more sustainable choices. Finally, the growth of e-commerce also represents an opportunity to develop reuse, repair, upcycling, or DIY markets contributing to the circular economy[168].

The increased energy consumption associated with the use of digital technologies can drive up energy costs for businesses and pollute the environment. **It is important therefore for retailers to ensure that digital technologies consume less energy than they save**. As digitalisation expands, including the use of data centres, cloud computing, and automation, energy demand rises significantly. This has become a pressing issue for competitiveness and sustaining digital transformation efforts especially with fluctuating and rising energy prices. Therefore, there is a growing need for businesses to transition towards renewable energy sources (RES). Embracing RES not only addresses the environmental concerns tied to digitalisation but also helps in stabilising long-term operational costs.

[167] OECD (2023), "SMEs in the era of hybrid retail: Evidence from an OECD D4SME survey", OECD SME and Entrepreneurship Papers, No. 41, OECD Publishing, Paris, https://doi.org/10.1787/882f30b0-en.
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Appendix B: Methodological notes

Startup data and venture capital data analysis

Crunchbase and Net Zero Insights

Codes used include Retail, Retail Technology, E-commerce, E-commerce Platforms, Marketplace, Shopping, Point of Sale, Wholesale, Warehousing and Mobile Payments (including retail and customer within their description) and additional search in the business descriptions.

LinkedIn data analysis

Table 4: Concordance between NACE and LinkedIn

NACE		LinkedIn categories used
G47	Retail trade, except of motor vehicles and motorcycles	Retail
G46	Wholesale trade, except of motor vehicles and motorcycles	Wholesale

Source: Technopolis Group based on LinkedIn

Green skills – keywords used: Cleantech, Sustainability, Sustainable Development, Sustainable Business, Energy Efficiency, Clean Energy Technologies, Renewable Energy, Wind Energy, Biomass, Biomass Conversion, Solar Energy, Solar Power, Urban Forestry, Forest Ecology, Sustainable Communities, Organic Farming, Organic Gardening, Urban Agriculture, Organic Food, Waste Management, Waste Reduction, Recycling, Water Treatment, Water Resource Management, Water Purification, Green Marketing, Green Printing, Environmental Biotechnology, Environmental Science, Environmental Engineering, Environmental Management Systems, Environmental Protection, Wastewater Treatment, Ecology, Circular Economy, Zero Waste, Waste to Energy, Plastics Recycling, E-Waste, Carbon Reduction Strategies, Carbon Footprinting, Carbon Neutral, Energy Retrofits, Biodiversity, Biodiversity Conservation, Nature Conservation, Advanced Materials, Nanomaterials, Biomaterials, Reuse, Separation Process, Sorting, Equipment Repair, Natural Resource Management, Sustainability Reporting, Green Development, Sustainable Cities, Energy Conservation, Energy Management, Environmental Awareness, Environmental Impact Assessment, Environmental Compliance, Leadership in Energy and Environmental Design (LEED), Environmental Policy, Green Technology, Sustainable Design, Sustainable Architecture, Environmental Consulting, Maintenance and Repair, Solar PV, Solar Cells, Wind Turbines, Wind Turbine Design, Carbon Capture, Low Carbon Technologies, Low Carbon, Renewable Fuels, Renewable Energy Systems, Renewable Resources, Integrated Water Resources Management, Natural Resources, Biodiesel, Bioplastics, Waste Treatment, Waste Water Treatment Plants, Electric Vehicles, Hybrid Electric Vehicles, Multi-modal Transportation, Energy Efficiency Consulting, Recycled Water, Adaptive Reuse, Ecodesign, Life Cycle Assessment, Energy Optimisation, Alternative Fuels, Green Building, Green Infrastructure, Green Purchasing, Biodegradable Products, ISO 14001, EMAS, Environmental Standards

Digital skills – keywords used: data analytics, online platforms, digital payment, online ticketing, Cybersecurity, Intrusion Detection, Malware Detection, Cloud Security, Cybercrime Investigation, Cyber Threat Intelligence (CTI), Cryptography, DLP, Malware Analysis, IDP; Vulnerability Assessment, Certified Information Security Manager (CISM), Computer Forensics, Cloud Infrastructure, Cloud Services, Google Cloud Platform (GCP), SAP Cloud Platform, SAP HANA, Everything as a Service (XaaS), Software as a Service (SaaS), Platform as a Service (PAAS), Infrastructure as a Service (IaaS), Private Clouds, Hybrid Cloud, Cloud Computing, Edge Computing, High Performance Computing (HPC), Serverless Computing, Robotics, Robot, Robotic Surgery, Human-robot Interaction, Drones, Connected Devices, Internet of Things (IoT), Robotic Process Automation (RPA), Wireless Sensor Networks, Embedded Systems, Cyber-Physical Systems, Smart Cities, Artificial Intelligence (AI), Biometrics, Cognitive Computing, Computer Vision, Deep Learning, Machine Learning, Natural Language Processing (NLP), Natural Language Understanding, Natural Language Generation, Reinforcement Learning, Speech Recognition, Supervised Learning, Unsupervised Learning, Big Data Analytics, Hadoop, Real-time Data, Yarn, Teradata Data Warehouse, Blockchain, Ethereum, Bitcoin, Cryptocurrency, Crypto, Distributed Ledger Technology (DLT), Hyperledger, Augmented Reality (AR), Virtual Reality (VR), Mixed Reality, Computer-Generated

Imagery (CGI), Connectivity, M2M, 5G, SD-WAN, Home Automation, Flexible Manufacturing Systems (FMS), Smart Manufacturing, Smart Materials, Quantum Computing, Smart Devices, Intelligent Systems, Big Data, Computer-Aided Design (CAD), Computer Science, MATLAB, C (Programming Language), Python (Programming Language), Digital Strategy, Digital Printing, Digital Marketing, Online Journalism, Revit, Building Information Modeling (BIM), JavaCard, R (Programming Language), Digital Imaging, Digital Media, C++, Collaborative Robotics, Industrial Robotics, Medical Robotics, Mobile Robotics, AutoCAD, Automation, Autodesk 3ds Max, Lumion, Data Analysis, Data Mining, 5G Core, Integrated Security Systems, Cloud Applications, Cloud Computing IaaS, Cryptocurrency Mining, CryptoAPI, Automated Machine Learning (AutoML), Machine Learning Algorithms, Virtual Reality Development, Virtual Data Rooms, Intelligence Systems, Robot Programming, Predictive Analytics, Data Lakes, Blockchain Analysis, Digital Publishing, Enterprise Software, Software Development, SAS (Software), SAP Products, SAP ERP, Online Payment, Online Payment Solutions; Online Travel, Online Marketing, Online Business Management, Online Advertising, Online Gaming, Web Services, Mobile Applications, Mobile Marketing, Java Database Connectivity (JDBC), Data Warehousing, Statistical Data Analysis, Data Modeling, Databases; Electronic Data Capture (EDC), Data Centres, Oracle Database, SAP Solution Architecture Data Entry, Data Management, Data Mapping, Web Applications, GIS Applications, Oracle Applications, Visual Basic for Applications (VBA), Computer Hardware, Computer Maintenance, Computer Network Operations, Computer Networking, Computer Graphics, Online Communications, Social Media Marketing, Digital Direct Marketing, Digital Illustration, Digital Video, Digital Photography, Xero, GPS Applications, GPS Devices, GPS Tracking, GPS Navigation, Microsoft Power Apps, Social Networking Apps, Google Apps Script, Social Media, E-Commerce, Data Intelligence, Online Platforms, Mobile Payments

To perform a representativeness analysis of LinkedIn, the available industry-specific dataset has been compared to Eurostat figures regarding the active population. Nevertheless, there are several limitations in conducting a robust representativeness analysis since the two datasets have different origins, classification systems and hence there are mismatches in the definition of some categories[169]. There are 149 industries available on the LinkedIn platform and categories are allocated according to the individual choice of the user or the affiliation to a company registered on LinkedIn as a company profile.

Regarding the country profiles, there is an important heterogeneity in the national use of LinkedIn among EU Member States. The largest users are Netherlands, Denmark, and Ireland where LinkedIn is the most popular, with more than 75% of the active population registered. In other EU countries, the number of LinkedIn users is marginal such as in Hungary, Slovakia, Bulgaria, and Poland that display the lowest use of LinkedIn, with less than 20% of the population registered on the platform.

Keeping the above in mind, overall, it can be estimated that approximately 30% of retail industry professionals have a profile on LinkedIn. Countries where a highest share of retail professionals are present in LinkedIn are Belgium, France, and the Netherlands (see figure above). As it was the case in the overall users of LinkedIn, Slovakia, Hungary and Bulgaria have the lowest rates of retail professionals present in LinkedIn.

Exiobase

Exiobase is a time series of environmentally extended multi-regional input-output (EE MRIO) tables. Its coverage is by country and industry from 1995 to 2021 and has EU and extra rest of the world coverage. Source: Stadler, Konstantin, Wood, Richard, Bulavskaya, Tatyana, Södersten, Carl-Johan, Simas, Moana, Schmidt, Sarah, Usubiaga, Arkaitz, Acosta-Fernández, José, Kuenen, Jeroen, Bruckner, Martin, Giljum, Stefan, Lutter, Stephan, Merciai, Stefano, Schmidt, Jannick H, Theurl, Michaela C, Plutzar, Christoph, Kastner, Thomas, Eisenmenger, Nina, Erb, Karl-Heinz, … Tukker, Arnold. (2021). EXIOBASE 3 (3.8.2) [Data set]. Zenodo. https://doi.org/10.5281/zenodo.5589597

[169] See more in detail ATI Methodological report: https://ati.ec.europa.eu/reports/eu-reports/advanced-technologies-industry-methodological-report

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EA-01-25-083-EN-N

Publications Office
of the European Union

ISBN: 978-92-9412-158-5