



The working future: An analysis of skills needed by circular startups

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ABSTRACT

Aside from potential environmental benefits, the implementation of circular economy principles in businesses can have merits for the labour market. The current unemployment in several regions of Europe and the qualitative mismatch between supply and demand could be countered by reskilling the labour force to adjust supply and demand to one another for increased reuse, repair, or recycling, among others. This study uses interviews to increase the focus of the research question and uses survey data to perform an ordered probit regression analysis to sketch the current and future landscape of startups' skills in Flanders (Belgium), and to analyse the relationship between circular strategies and different types of skills. The results show that design to lower material use increases the need for transport and logistics skills, digitalisation increases the need for R&D and IT skills, and the recuperation of waste requires technical knowledge. Furthermore, gender, age, and experience of the entrepreneur influence the needed skills. The paper probed for policy recommendations for the uptake of circular strategies and recommendations for future research. The most asked policy measures by the respondents are innovation and collaboration support (subsidies), fiscal measures that support circular goods and services, and public procurement for circular goods and services. This research is of relevance for several stakeholders, such as startup ecosystems, sector organisations, policy makers in innovation policy and labour market policy, and educational institutions.

1. Introduction

Improving resource efficiency and environmental benefits are often mentioned as drivers for the transition to a circular economy. Furthermore, several authors mention benefits for the labour market in terms of increased net creation of jobs by the shift from mining and manufacturing to services, and thus a shift from more material-intensive to more labour-intensive activities (ILO, 2022; Laubinger et al., 2020). The European Commission aspires this creation of jobs in its Circular Economy Action Plan (European Commission, 2020), as already 4 million jobs were linked to the circular economy in 2018.

The circular economy (CE), a well-contested concept, is defined by Kirchherr et al. (2017) after analysing 114 definitions in scientific literature and positing an all-encompassing definition in their frequently cited paper: "A circular economy describes an economic system that is based on business models which replace the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes, thus operating at the micro level (products, companies, consumers), meso level

(eco-industrial parks) and macro level (city, region, nation and beyond), with the aim to accomplish sustainable development, which implies creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations."

According to the Circular Economy Action Plan, especially the reuse, repair, remanufacturing, and refurbishment sectors are labour intensive and the size of these sectors will grow with benefits for all skill levels (European Commission, 2015; Willeghems and Bachus, 2018). Several estimations exist to date on the move to a more circular economy and the effect on employment. Cambridge Econometrics (2018) estimated, using a moderate and an ambitious CE scenario in their econometric model E3ME, that the circular economy would generate 700,000 extra jobs by 2030 in Europe on the already 4 million jobs in 2018 (Cambridge Econometrics et al., 2018; European Commission, 2020). Wijkman and Skånberg (2015) calculated the employment effects in an Input-Output (IO) model for Spain, France, Sweden, the Netherlands, and Finland. They found that a doubling of resource efficiency, combined with substituting half of virgin materials with recycled materials and doubling the lifetime of consumer goods, results in 50,000 extra jobs in

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Finland and Sweden, 100,000 in the Netherlands, 200,000 in Spain, and 300,000 in France. However, they also found that sectors offering raw materials will lose demand in favour of other sectors. In Flanders, the northern region of Belgium, [Dubois and Christis \(2014\)](#) estimated using IO calculations that a circular economy would create 26,573 jobs, which is more than 1% of the total Flemish employment.

We argue that the estimations are often too aggregated, generalizing the results over all the sectors or several countries. Furthermore, previous studies are often too focused on the net effects, and it is not clear which types of jobs the increase in employment will entail. In this paper, the focus is not on the net employment creation, but on the qualitative match between labour supply and labour demand. Furthermore, in this paper, we argue that the implementation of circular strategies in business models requires different types of jobs, or the same jobs with a different skill set. These skills are, according to the [European Parliament Council \(2008\)](#), defined as “the ability to apply knowledge and use know-how to complete tasks and solve problems. (...) skills are described as cognitive (involving the use of logical, intuitive, and creative thinking) or practical (involving manual dexterity and the use of methods, materials, tools, and instruments)”. The interesting perspective of skills instead of occupations is the core of this paper.

In this paper, we address the scarce literature concerning skills in the circular economy as an important research gap and focus on startups in Flanders, their implementation of several specific circular strategies, and their needs for skills. Our research question is “Which sets of skills will startups increasingly need, depending on the circular strategies they implement?”. To our knowledge, this is the first paper exploring and providing empirical proof of the necessary skills for circular startups. This is done by means of interviews and a survey analysis covering 165 startup entrepreneurs in the region of Flanders (Belgium). Flanders has a high share of SMEs of which a large part (28%) are younger than 5 years ([Deman and Tchinda, 2021](#)). Therefore, we argue that Flanders is an interesting case study for this research question. The paper contributes to the literature on estimations for net employment changes and provides the necessary insights for involved stakeholders, such as startup ecosystems, sector organisations, policy makers with different authorizations such as the labour market and educational institutions, and private investors.

The focus in this paper is placed on a specific business context, namely, that of startups. Startups are defined as “new” (i.e. typically operating for four to six years) and ‘independent’ entrepreneurial ventures designed to effectively develop and validate a scalable, repeatable, and at least break-even business model” ([Henry et al., 2020](#)). Startups are an interesting case study as they can adopt a (new) business model from scratch while established companies tend to make incremental changes of their business operations and implementation of circular strategies before they can do more radical changes ([Neligan et al., 2022](#)). Furthermore, startups disrupt existing institutions, and for that reason are pivotal in a transition towards a circular economy and the creation of new institutions. [Närvänen et al. \(2021\)](#) similarly argue that startups will contribute to changing the pillars upon which institutions were built in the transition towards the CE. Finally, startups are an interesting case study for their role in the labour market. [Fritsch and Noseleit \(2013\)](#) find that the number of startups that survive the first 4 years have a positive relation with employment growth in incumbent companies due to a consequential growth of the sector.

In the remainder of the paper, the literature review will first be presented (section 2). Next, the method and model will be described (section 3). Finally, the results will be discussed, and policy recommendations will be provided (section 4), as well as limitations of this research and suggestions for further research (section 5).

2. Literature review

2.1. Skills

We follow the approach of [Burger et al. \(2019\)](#) who argue that occupations “do not fully capture the breadth and depth of task complexities within a sector, nor do they capture the associated knowledge base that is needed to adequately perform a job.” Also, education levels, often expressed in low-, medium-, and high-skilled employees do not capture the capacity of a person to perform a job. Therefore, the analysis in this paper will be focused on skills. We approach skills as the specific set of knowledge and know-how people need to fulfil the tasks of their jobs, according to the definition of the [European Parliament Council \(2008\)](#).

In previous research, several distinctions of skills were made, such as soft skills versus hard skills ([Balcar, 2014](#); [Padhi, 2014](#)), basic skills, complex problem-solving skills, social skills, technical skills, resource management skills, or systems skills ([Burger et al., 2019](#)), the distinction between social skills, process skills, complex problem solving skills and content skills ([Brunello and Wruuck, 2019](#)), or the distinction between 9 circular skills ([Sumter et al., 2021](#)). Specifically for Belgium, [Janssens et al. \(2021\)](#) defined a list of skills based on literature review and a focus group with experts to define the sets of skills which would become relevant in the circular economy. These skills were put in three categories: technical, valorisation, and transversal skills.

2.2. CE strategies

The above-mentioned definition of the circular economy implicitly covers several of the so-called R strategies which are the building blocks of the CE. Over time, multiple R frameworks were developed, depending on the level of detail of interest. These frameworks share the common view that a previous R-strategy is to be preferred over the next strategy as they contain a certain hierarchy ([Kirchherr et al., 2017](#)). The most concise framework, the 3R-framework consists of reuse, reduce and recycle ([Ghisellini et al., 2016](#); [King et al., 2006](#)). The most detailed and widely adopted framework from [Potting et al. \(2017\)](#) consists of 10 strategies and is called the 9R-framework, including: R0 refuse, R1 rethink, R2 reduce, R3 reuse, R4 repair, R5 refurbish, R6 remanufacture, R7 repurpose, R8 recycle, and R9 recover.

The adaptation of these R strategies to the specific business context requires circular business models (CBMs). CBMs have a focus on materials, with the ultimate goal to reduce dependency on virgin materials, shift from a carbon-based energy system to a renewable one, increase the adoption of sustainable production practices, and adjust their value chain strategies ([Urbinati et al., 2017](#)). This way, resource loops can be closed, slowed down or narrowed ([Bocken et al., 2016](#)). The practice of closing loops can be achieved by minimising waste through end-of-life sorting and recycling, slowing loops indicates reuse, repair, and remanufacture services to extend the lifetime of the product, and narrowing the loops aims at using less materials in the first place by, for example, efficient product design.

2.3. Skills and CE strategies

The exact nature and content of occupations may change because of global effects such as digitalisation, technological improvement, or the move to a CE ([Brunello and Wruuck, 2019](#)). Therefore, we argue that a change to a CE may shift both the skills demand and the skills supply due to changes in consumption patterns and production processes. To date, little is known about employment in the CE although few papers have tried to quantify the effects of several circular strategies on the workforce ([Burger et al., 2019](#)) or more specifically on the social economy ([Van Opstal and Borms, 2022](#)). [Laubinger et al. \(2020\)](#) analysed that there will be four directions of effects on employment: there will be job creation for those sectors and activities that are stimulated in the

development of new circular business models and increased resource efficiency. There will be job substitution where some activities will be replaced by others, e.g. from landfilling and waste incineration to recycling. Third, there will be job destruction when occupations disappear without replacement by other jobs, e.g. because of banned activities. Finally, job redefinition occurs when existing jobs continue but the content of the work changes, requiring a different skillset. Furthermore, the authors expect job substitutions from material-intensive industries to services sectors, along with job destruction in the former and job creation in the latter.

As we pointed out before that the current theories of the interrelation between the CE and employment are too broad because previous research is focused on the aggregated CE or labour market level, more research is needed on specific, disaggregated, CE strategies and skills. It should be noted that different circular strategies entail different tasks and thus require different skills, hence the heterogeneity of circular skills (Burger et al., 2019; Laubinger et al., 2020). This heterogeneity enforces the need for less broad and more focused research. We narrow down on four types of skills that will become especially important in a more circular economy according to experts we interviewed in semi-structured interviews (see method section). We expect a positive relation of CE strategies on these four skills which are: transport and logistics, R&D, IT, and technical skills. We are interested in which CE strategies cause a higher need for these skills.

3. Materials and methods

In this paper, we follow the method of Burger et al. (2019) to create our measures of skills. They applied their research and analysis to the case of the United States. The database they use is O*NET which provides information on occupational requirements and worker attributes, thereby classifying all the occupations based on skills. Furthermore, their dataset contains information on the occurrence of the occupations in every sector and the education level. Ultimately, their dataset contains 35 skills categories which are grouped into six categories: basic skills, complex problem solving skills, resource management skills, social skills, systems skills, technical skills. Finally, this information is linked to seven CE strategies as they identified 28 of 329 industries as belonging to one of the seven CE strategy categories. This complete dataset allowed the authors to perform Ordinary Least Squares (OLS) regression analyses of the link between CE strategies and skills.

The novelty of our study compared with Burger et al. (2019) is the focus on the business-level context such as the translation of circular strategies to business models, the applicability to the Flemish context with an institutionalized labour market, the inclusion of control variables, and the use of survey research. Fig. 1 provides an overview of our method. We used the internal dataset of the Public Employment Service of Flanders (VDAB) that identified 31,701 individual skills grouped into 27 categories. We aggregated these categories into 9 groups by grouping similar categories together to improve the readability of the survey: (i) Sales, trade, and marketing, (ii) Crafts, (iii) Construction, (iv) IT and digital communication, (v) Environment and green technology (vi) Research and development, (vii) Production, (viii) Technical skills, (ix) Transport and logistics. Based on the interviews (see below), we selected four sets of skills and their relationships with 10 CE strategies as the focus of our analysis. In this section, we explain the format of the interviews and the survey.

The choice to apply this study to the Flemish region is because of its characteristics as summarized in Fig. 2. Flanders is a small, open, and industrialized economy with a high degree of urbanization and a highly regulated labour market. Furthermore, Flanders has a high share of small and medium-sized enterprises (SMEs) of which 28% are younger than 5 years (Demant and Tchinda, 2021). This relatively large share of startups and its other characteristics make Flanders an adequate case study for this research.

3.1. Interviews

In June and July 2022, eight semi-structured interviews were performed with labour market and circular economy experts in Flanders. The experts were selected by reaching out to several important institutions in Flanders in the circular economy and labour market field. These institutions are all active in supporting circular companies or circular startups and are thus well aware of the problems they face. Of each institution, one expert was recruited by contacting them one on one. An overview of the experts, their functions, the organisations they work for, and the transcribed passages of interest for this research can be found in Annex A. One question which was asked to all the experts, was what the future of work and skills would look like in a more circular economy. The experts were free to respond from their own experience of the organisations they worked with and did not have to respond according to a format. Their responses were similar and were focused around four types of skills: logistics and transport, research and development, IT, and technical skills. Recordings of the interviews are used to complement the analysis and transcribe certain passages. An overview of the most important findings can be read in Annex A, which justifies the choices of the authors to sharpen our research to the Flemish context by narrowing the scope to four skills categories: IT and digital communication, research and development, technical, and transport and logistics.

3.2. Survey design

In order to gather perspectives, opinions and characteristics of startups and their entrepreneurs in Flanders, we organised a survey in close collaboration with the most relevant organisations that are active in the circular startup ecosystem in Flanders, including Circular Flanders¹ and Start it @ KBC.² To avoid selection bias, we included questions on the ambition levels of startups on a set of ten circular strategies and deliberately urged our partners to spread the survey to startups that are not active in circular economy activities as well. In order to prevent success bias, we included perspectives of startups that stopped their activity already. Annex B contains a description of our partner organisations

Between September 30th, 2021 and February 2nd, 2022, our survey received full responses of 165 entrepreneurs in SurveyMonkey with a response rate of 58.51%. A general and detailed presentation of this survey is reported in Van Opstal and Borms (2023), that describes profile differences, barriers, and enablers for circular startups. Nevertheless, we briefly report the most relevant methodological aspects of our approach.

The questionnaire of this survey has been constructed based on existing literature on successful and failed startups (Cantamessa et al., 2018; Chhatwani et al., 2022; Marom and Lussier, 2014; Pisoni et al., 2021; Rizos et al., 2016; Skawińska and Zalewski, 2020), on earlier research on circular companies in Flanders (Borms et al., 2023), and on the input of partner organisations (Annex B) that were willing to reach out to startups within their network. The questionnaire provided separate answer pathways for startups that did not establish their company yet, for startups that are active, and for enterprises that stopped their activities. While the questionnaire was compiled in Dutch, a translated version is included in Annex C.

3.3. Measures for the dependent, independent, and control variables

At the beginning of the survey, the concept of the CE was explained to all the respondents. The dependent variables of types of skills are estimated based on the following obligatory question in the survey: "To

¹ Circular Flanders is a partnership of governments, companies, non-profits, and knowledge institutions for the circular economy in Flanders.

² Start it @ KBC is a startup accelerator that supports startups in their entrepreneurship.

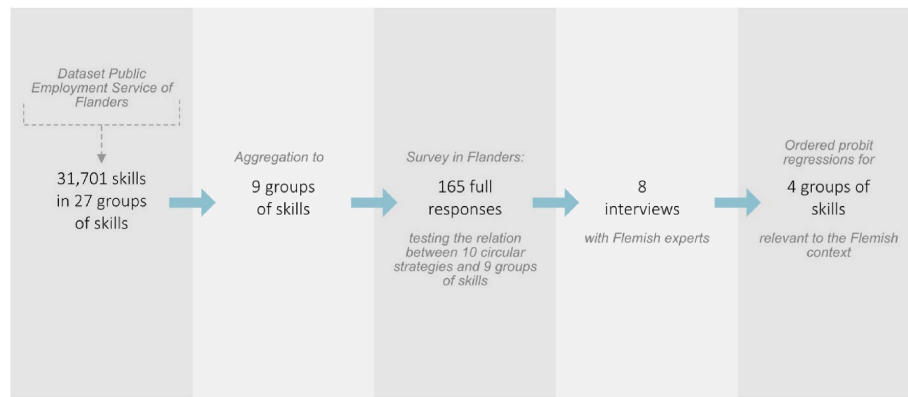


Fig. 1. Flowchart of the method used in this paper.

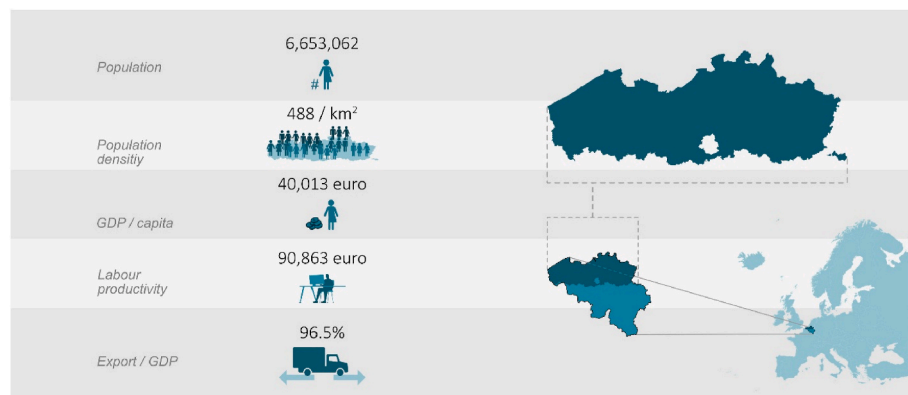


Fig. 2. Key figures on Flanders (Belgium) in 2021. Source: <https://www.vlaanderen.be/en/statistics-flanders>.

what extend do you think you will be needing the following skills in a more circular economy?" The answer options are: (i) sales, trade, and marketing, (ii) crafts, (iii) construction, (iv) IT and digital communication, (v) environment and green technology (vi) research and development, (vii) production, (viii) technical skills, (ix) transport and logistics. These answer options were based on the classification of the Public Employment Service of Flanders (VDAB, internal dataset). For each of these answer options, the respondents could indicate on a 4-point ordinal scale to which extent they think they will be needing these skills in a more circular economy: certainly not (1), probably not (2), probably (3), certainly (4), don't know (0). Consequently, we are able to calculate a score on an interval scale from 1 to 4 which reflects the necessity of every skill for the startups. The responses "don't know" were omitted during the estimations, which were between 30 and 45 omitted responses for every skill set.

As explained earlier, based on the insights of the interviews with experts (see Annex A – Interviews), we chose to focus the scope of the research to the following four skills categories as a subset of the dataset from the Public Employment Service of Flanders as dependent variables: research and development (R&D), IT and digital communication, technical skills, and transport and logistics.

For the independent variables of circular strategies, we used another question from the survey, namely: "To what extent does you startup implement the following strategies?" The answer options are based on the R-framework of Potting et al. (2017) and adapted to the business (micro) context based on Kishna et al. (2019) to come to ten circular strategies, as done before by Borms et al. (2023). The 9R-framework allows us to capture the most detailed level of circular strategies and provides the opportunity for the startups to correctly select the strategies that they implement. The answer options consequently are: (i) Product design to use less materials, (ii) Product design for lifetime extension,

(iii) Product design with modular parts (in function of repair, recycle, ...), (iv) Using renewable materials, (v) Sharing production means, (vi) Circular business models (e.g. as-a-service models or servitisation), (vii) Offering maintenance and repair, (viii) Recuperation of waste, residuals and/or by-products, (ix) Take-back system for refurbishment and recycling, (x) Support services which reinforce circularity (e.g. software). For each of these strategies, respondents could indicate to which extent they implement them on a 3 point likert scale: not (1), limited (2), extensive (3), not applicable (0), which was treated as "not". This resulted in an interval variable, varying from 1 (not) to 3 (extensive).

As control variables, we include characteristics of the entrepreneur to ensure that these characteristics do not correlate with the demand for specific skills. These characteristics are age, gender, years of experience as entrepreneur, as manager, or in the sector of the startup, and a migration background. Van Opstal and Borms (2023) found that people with a migration background have a more optimistic view of starting a profitable circular business. Furthermore, we include some business-specific characteristics such as the turnover, the number of full-time equivalents (FTE), the sector, and the type of the startup (production, services, IT/software, or commerce/retail). While 2020 was not an ideal year because of the COVID-19 pandemic, it was too early to ask for figures from 2021 (suffering from the same pandemic conditions) for their turnover and FTE, and it was too far away to ask startups for figures from 2019. However, we included a question on the estimated impact of COVID-19 on turnover figures.

As described in Van Opstal and Borms (2023), in order to prevent collinearity problems between the years of experience in management, in the sector of the startups, or as an entrepreneur, we did not include these as ratio variables but included dummy variables instead. Furthermore, we saved degrees of freedom by including a dummy variable for startups who are active in the secondary sector (manufacturing,

construction, and energy), based on the NACE nomenclature we applied in our questionnaire and included a dummy for a manufacturing activity.

3.4. Data analysis

Following a descriptive analysis of the urgency of the startups to take action to find the necessary skills, we will estimate four regression models. Each regression model will be estimated using an ordered probit regression.

For our first regression, the estimated model is the following:

$$SK_{TL,i} = \beta_0 + \beta_1 CS_i + \beta_2 PC_i + \beta_3 BC_i + e_i \tag{1}$$

Where $SK_{TL,i}$ refers to the skills required of transport and logistics of company i ; CS_i refers to the vector for circular strategies; and PC_i , and BC_i refer to the vectors of the personal characteristics (age, gender, experience, migration background) and business-specific characteristics (turnover, full-time equivalents, production activity, secondary sector), respectively.

For the second regression, the estimated model is the following:

$$SK_{R\&D,i} = \beta_0 + \beta_1 CS_i + \beta_2 PC_i + \beta_3 BC_i + e_i \tag{2}$$

Where $SK_{R\&D,i}$ refers to R&D skills. The third regression is tested using the following model:

$$SK_{IT,i} = \beta_0 + \beta_1 CS_i + \beta_2 PC_i + \beta_3 BC_i + e_i \tag{3}$$

Where $SK_{IT,i}$ stands for the skills related to IT and digital communication. For the last regression, the following model is used:

$$SK_{tech,i} = \beta_0 + \beta_1 CS_i + \beta_2 PC_i + \beta_3 BC_i + e_i \tag{4}$$

Where SK_{tech} stands for technological skills.

4. Results and discussion

4.1. Descriptive results

In [Table 1](#) we depict the descriptive analysis on skills in the form of a contingency table. In the columns, we can see the percentage of respondents who consider the current skills set of their startup to be a barrier or an asset, or neutral. This was based on the question: “Are the elements below considered as enablers or barriers in your company: skills (a barrier, rather a barrier, neutral, rather an enabler, an enabler)”, where ‘a barrier’ and ‘rather a barrier’ were aggregated in one category as well as ‘rather an enabler’ and ‘an enabler’. In the rows we see their average need for the nine types of skills in the future in a more circular economy, with an average score of lower than three considered as a low score and an average score of three or higher considered as a high score.

We see that most startups consider the current skills in their team to be an asset (72.54%). However, a large part of them (57.84% of total) predict that they will need additional or a different set of skills in the future in a more circular economy. There is a reasonable group who consider the current skills in their team to be a barrier or neutral, and

Table 1
Contingency table (N = 103) of the average score for the need on future skills in the rows and the consideration of the current skills as barriers or assets in the rows.

	Skills are a barrier	Neutral	Skills are an asset	Total
Low average score on needed skills	3.92%	7.84%	14.70%	26.46%
High average score on needed skills	3.92%	11.76%	57.84%	73.52%
Total	7.84%	19.60%	72.54%	100%

who predict to need additional or a different set of skills in the future (3.92% and 11.76% respectively). There is also a group that do not foresee any problems for the future and who find their current skills are an asset (14.70%) or neutral (7.84%). A small part considers their skills to be a barrier at this moment, but do not expect to need a different set of skills in the future (3.92%).

[Centobelli et al. \(2017\)](#) find varying gaps in literature for a lack of knowledge management in startups, which are environmental and socio-political factors, the lack of a comprehensive taxonomy of knowledge management systems, a gap in the alignment between startup’s strategies and technologies adopted, and a gap of the relation between knowledge management and economic, financial, market, technical, technological, organizational, human, and relational performance. [Brandt et al. \(2019\)](#) performed interviews with six Finnish startups who took part in the Startup World Cup 2019. Their results suggest that finding the right people and skills is considered as one of the most important aspects for the startup entrepreneurs. When asked what would be important for the future skills of the entrepreneurs, they also pointed to onboarding the right people. [Kaiser and Müller \(2015\)](#) found, though their data is from 1998 to 2001, that startups in Denmark have a relatively homogeneous skills base in order to protect them from discrimination between the workers in terms of education, age, and wages. Furthermore, they categorised firms in knowledge-intensive and non-knowledge-intensive sector and found that startups from knowledge-intensive sectors have a relatively more heterogeneous team in terms of education compared to non-knowledge-intensive sectors.

4.2. Regression results

To get a better view on the exact nature of the needed skills, we estimate four ordered probit regressions ([Table 2](#)). The independent variables are the ten circular strategies as interval variables of one to three, and the personal characteristics and business characteristics as control variables. The dependent variables are the four sets of skills as interval variables of one to four. These regressions estimate the need for four types of skills based on the circular strategies they implement, their profile characteristics and business characteristics. The number of observations for every regression is lower than the number of completed surveys as the questions were not mandatory. We included the (comparable) results of ordered logit regressions in [Annex D](#).

In [Table 2](#), ‘cut’, ‘cut2’, and ‘cut3’ represent the thresholds of the latent or underlying variable for which the dependent variable changes. There are three cut points as the dependent variables can increase three times: from score 1 to 2, score 2 to 3, and score 3 to 4. Furthermore, we checked for multicollinearity by calculating the Variance Inflation Factors (VIF) and found no high multicollinearity.

4.2.1. Transport and logistic skills

The first regression shows a positive significant relation between developing a design to lower material use and the need for transport and logistics skills. This can be explained by the narrative that reusing materials requires a more complicated logistics system as waste should be reused, separated, reimplemented, and thus transported to separation facilities and back to the producer ([Bing et al., 2014](#)). Similarly, there is a positive significant effect between the CE strategy of maintenance and repair, and the reported need for transport and logistic skills. [De los Rios and Charnley \(2017\)](#) have similar results from case studies, where “understand logistics and distribution processes” and “understand processes for reverse and re-manufacturing” are mentioned as some of the capabilities necessary to leverage product design. Surprisingly, take-back systems do not have a significant relation with the demand for transport skills even though take-back systems require transport back to the producer as well. [Mallick et al. \(2023\)](#) found in their systematic literature review that companies lack the necessary skills for reverse logistics, however, we find that they do not report a higher need for these skills. This can be explained by the outsourcing of transport to

Table 2
Coefficients of the ordered probit regressions: the need for skills.

	Transport and logistics	R&D	IT	Technical
N	105	108	110	102
Pseudo R ²	0.1852	0.2360	0.1365	0.1397
p-value LR test $\chi^2(21)$	0.0002	0.0004	0.0943	0.0117
Design to lower material use	0.425 (0.177)**	0.272 (0.222)	-0.004 (0.198)	0.120 (0.176)
Design for longer product use	-0.067 (0.161)	0.344 (0.205)*	0.068 (0.188)	0.183 (0.165)
Design for additive manufacturing	-0.124 (0.181)	-0.152 (0.205)	-0.107 (0.188)	0.027 (0.168)
Use of renewable materials	0.111 (0.175)	-0.239 (0.214)	-0.257 (0.185)	-0.286 (0.190)
Sharing of means of production	-0.028 (0.137)	-0.578 (0.198)***	-0.124 (0.152)	-0.056 (0.145)
Circular business models	0.124 (0.131)	0.292 (0.163)*	0.330 (0.147)**	-0.050 (0.131)
Maintenance and repair	0.323 (0.137)**	-0.005 (0.163)	-0.090 (0.155)	0.099 (0.135)
Recuperation of waste	-0.001 (0.167)	-0.182 (0.204)	-0.057 (0.175)	0.387 (0.176)**
Take-back systems for refurbishment or recycling	0.093 (0.162)	0.317 (0.188)*	0.256 (0.183)	0.198 (0.164)
Supporting services for circular entrepreneurship	-0.040 (0.116)	0.399 (0.142)***	-0.003 (0.129)	-0.031 (0.113)
Female	0.846 (0.303)***	0.136 (0.340)	0.355 (0.312)	-0.162 (0.284)
Age	0.002 (0.013)	-0.044 (0.014)***	-0.030 (0.013)***	-0.011 (0.013)
Migrant	-0.452 (0.379)	0.049 (0.415)	0.482 (0.410)	-0.265 (0.358)
≥5 years industry experience	-0.487 (0.278)*	-0.635 (0.321)**	-0.077 (0.311)	0.042 (0.287)
≥5 years management	-0.175 (0.368)	-0.528 (0.407)	-1.091 (0.353)***	0.853 (0.406)**
≥5 years entrepreneurial experience	-0.047 (0.342)	0.528 (0.407)	0.471 (0.380)	-0.298 (0.359)
Production activity	0.148 (0.335)	0.140 (0.387)	0.397 (0.361)	-0.014 (0.339)
Secondary sector	0.095 (0.316)	0.178 (0.363)	-0.075 (0.332)	-0.067 (0.324)
Turnover	0.026 (0.075)	-0.033 (0.094)	0.087 (0.087)	0.078 (0.082)
FTE employed	0.007 (0.031)	0.007 (0.036)	-0.022 (0.034)	-0.020 (0.034)
Trump or barrier	-0.113 (0.149)	-0.220 (0.173)	-0.065 (0.147)	-0.002 (0.146)
/cut	0.7476 (0.7803)	-3.2193 (0.9271)	-2.6070 (0.8355)	-0.2043 (0.7602)
/cut2	1.3275 (0.7903)	-2.6287 (0.9016)	-2.2258 (0.8230)	0.5197 (0.7691)
/cut3	2.3792 (0.8050)	-1.3436 (0.8739)	-1.1840 (0.8040)	1.4815 (0.7730)

Note: Significance levels: * at the 10% level, ** at the 5% level, *** at the 1% level. The standard errors are in brackets.

other parties which increases the collaboration with third party waste collectors as explained by [Uhrenholt et al. \(2022\)](#).

Furthermore, there is a positive significant relation between being a female entrepreneur and asking transport and logistics skills. In [Van Opstal and Borms \(2023\)](#) the results of statistical analyses combined with interviews suggest that women are more risk averse and thus they might overestimate the difficulty of organising a qualitative infrastructure and organisation in a more circular economy. On top of this, an extensive amount of literature can be found on the male-dominance in the transport and logistics sector ([Edirisinghe et al., 2017](#); [MacNeil and Ghosh, 2017](#); [Mejia-Dorantes, 2019](#)). [Mejia-Dorantes \(2019\)](#) found that only 22% of transport workers are women while in maritime industry this is only 2% ([MacNeil and Ghosh, 2017](#)). In our dataset, we see that 7

male entrepreneurs of startups are active in the transport and logistics sector compared to zero female entrepreneurs. This unfamiliarity of women with the sector might increase the demand for these skills.

4.2.2. Research and development skills

The second regression shows a positive significant relation between supporting services for circular entrepreneurship (e.g. software) and circular business models such as servitisation and the need for R&D skills. This can be explained by the rather recent development of these concepts which still require a lot of R&D for further development. [Rizos et al. \(2016\)](#) support this finding and explain that larger companies such as multinationals have the means to invest in R&D for technologies while SMEs depend on the availability in the market.

Furthermore, sharing means of production has a strong negative relation with the need for R&D skills. [Bimonte et al. \(2021\)](#) for example argue that firms limit their investments in R&D when their knowledge might spillover to the competitors. We argue that when sharing resource means, also knowledge and technical specifications are shared, generating external economies of scale that benefit the startups. Furthermore, sharing resources requires a different business structure where the focus is less on R&D than in businesses who do not share resource means. [Rizos et al. \(2016\)](#) support this finding and argue that competition legislation is a barrier for collaboration which hinders knowledge creation and development.

Some personal characteristics have a negative relation with R&D skills, namely the age and the experience in the sector of the startup. We argue that these entrepreneurs are more confident about knowing where to find the necessary skills due to their experience. [Fernandes and Ferreira \(2013\)](#) found, using a statistical analysis based on a survey with 500 companies, that firms of older entrepreneurs have a higher rate of product and service innovations.

4.2.3. IT skills

Next, the third regression shows a positive significant relation between circular business models and the need for IT skills. This can be explained by the necessary knowledge of software to develop servitisation business models, as a close contact with the customer is necessary to be able to push notifications about the status of the products and to ease the return of the product at the end of contract. Several authors have analysed this relation via literature review ([Grubic, 2014](#); [Lerch and Gotsch, 2015](#); [Paschou et al., 2020](#)). They claim that digital technologies are necessary for servitisation in several ways; it can enable new business models, help (co)creating value, generate knowledge from data, and improve the business' performance by a competitive advantage for operational performance ([Paschou et al., 2020](#)). It provides benefits for consumers through remote diagnosis and repair of products, through replacement of personal services, reducing costs, and improving access, among others. There are also benefits for the provider through the creation of value in terms of a better customer experience and a better customer's perception of the firm, and through less unplanned maintenance due to more efficient remote detection and diagnosis of problems.

In terms of skills, [Brunello and Wruuck \(2019\)](#) argue that in a linear economy there is also an increasing demand for skills related to ICT, mainly driven by increased technological progress, and leading to a skills shortage. [Lerch and Gotsch \(2015\)](#) argue that one of the major barriers to the digitalisation of services is the lack of skilled employees. The employees need to increase their knowledge of engineering, mechatronics, and IT. Therefore, they need profiles with more complex, abstract, and problem-solving skills through training. These ICT skills in turn drive innovation, especially in young businesses and startups ([Alam et al., 2022](#)). [Willeghems and Bachus \(2018\)](#) found, after a literature review, that servitisation will need IT skills, as well as customer support and sales, engineering and servicing, and leadership roles.

Furthermore, there is a strong negative relation between age and having management experience, and IT skills. A possible explanation is

comparable to before; these entrepreneurs are confident about knowing where to find the necessary skills due to their experience, or they do not equally appreciate the added value of IT (Millán et al., 2021; Robert et al., 2009).

4.2.4. Technical skills

Lastly, the fourth regression shows a positive significant relation between waste recuperation and management experience and technical skills. Recuperation of waste requires profiles with knowledge on the composition of materials, and of machines and processes to reuse or recycle these materials. Experienced managers might know that these skills are always needed and are essential for a circular economy.

The last regression on technical skills is a much-discussed topic in a broad range of literature. Specifically for the CE, Guyot Phung (2019) and Schroeder et al. (2019) argue that new jobs will be created for technicians in the waste sector, the remanufacturing and repair sectors. However, Guyot Phung (2019) notes that this will not compensate the loss of jobs due to the current automatisations. Burger et al. (2019) regressed several CE strategies on several skills with data for the U.S. They found that the CE strategies “Preserve and extend what’s already made”, “Use waste as a resource”, and “Prioritise regenerative resources” all have a positive significant relation with having technical skills. Under “Preserve and extend what’s already made”, they define all repair and maintenance jobs. Under “Use waste as a resource”, they identify all sorting, separating, and recycling of waste activities, and they argue that this includes physical labour and machine handling. With “Prioritise regenerative resources”, they categorise all activities related to renewable energy and materials. However, we could only find proof of the positive relation with waste recuperation.

4.3. Policy measures

To translate these results to policy measures, we asked the respondents which policy measures they would like to see implemented in order to enhance circularity. In Borms et al. (2023) a list of policy measures was formulated based on some well known policy documents such as the Circular Economy Action Plan and a policy document by the OECD (European Commission, 2020; McCarthy et al., 2018). The final list was brainstormed by a group of experts in several sessions. In this paper, we use this list of policy measures and adapt where we could improve the readability for the participants. In the survey, the respondents could then indicate, without ranking, a maximum of

Table 3
Overview of the most asked policy measures along skills needs.

	Transport and logistics	R&D	IT	Technical
N	128	134	135	126
Measures against unfair international competition	20.31%	26.86%	24.44%	21.42%
Bank guarantees for investments	14.06%	17.16%	17.03%	11.90%
Removing regulatory barriers	20.31%	29.85%	28.14%	19.84%
Innovation and collaboration support (subsidies)	43.75%	62.68%	57.77%	42.06%
Education and training for new and polyvalent skills	5.46%	7.46%	6.66%	7.14%
Improved access to information and expertise	14.06%	20.89%	20.00%	15.87%
Liquidity support or subordinated loans	24.21%	29.85%	28.14%	24.60%
Enhance export opportunities and international knowledge transfers	13.28%	21.64%	20.00%	12.69%
Fiscal measures that support circular goods and services	48.43%	55.97%	54.81%	42.85%
Public procurement for circular goods and services	25.78%	32.08%	29.62%	26.19%

five measures which reflects the priority of the entrepreneurs. In a next step, a crosstable was produced of the counts of the responses. Table 3 shows the shares of the demanded skills and the asked policy measures in a more circular economy. The columns represent the respondents with a score of 3 or higher for the demanded skills. For example, of all the entrepreneurs who have a high need for transport and logistics skills, 20.18% include ‘Measures against unfair international competition’ in their top 5 of most asked policy measures.

We see that the results are comparable across the four types of skills. The most asked measures are innovation and collaboration support: of all the respondents who report a high average need for transport and logistics, 43.75% ask this type of support, for R&D skills this is 62.68%, for IT skills 57.77% and 42.06% for technical skills. Other most asked measures are fiscal measures that support circular goods and services (between 43 and 56%), followed by public procurement for circular goods and services (between 26% and 32%).

The least asked policy measure is education and training for new and polyvalent skills (between 5% and 7%). Thus, although the experts during the interviews report these types of skills will become essential and the entrepreneurs report to have a high need for these four types of skills, they are least interested in education and training to obtain these skills. This might indicate that organisations are more concerned with their day-to-day business operations and receiving (mostly monetary) measures, while the skills-dilemma is postponed to the future. In other words, our results suggest that (CE) startup entrepreneurs are myopic with respect to a more structural transition that is needed at the labour market and in education. Colombelli et al. (2020) found similar results for Young Innovative Companies (YIC) that labour market policy instruments are associated to the more popular financial policy instruments. (Belitski et al., 2020) calculated, for the United Kingdom, that the positive returns to training are lower for startups than for incumbents.

Another possible explanation is that the current education and training institutions are insufficient to provide the startups with these necessary skills, and therefore the entrepreneurs are not interested in their employees following an education. Janssens et al. (2021) see a role for the higher institutions for education for the circular economy. The authors organised a focus group with experts in Belgium who believed there is a lack of attention towards ‘skills related to product design’ and ‘knowledge about the principles of a circular economy’ in the current education. On the other hand, while STE(A)M-skills receive a lot of attention (Science, Technology, Engineering, Arts, Mathematics), this attention is not focused enough on sustainability.

In order to inform, inspire, and engage the wider population on the potential of the circular economy in general, and of circular business models in particular, a wide array of educational tools exist. Examples include Serious Games (Manshoven and Gillabel, 2021; Roba et al., 2021; Whalen et al., 2018), Hackatons (Puttonen et al., 2022), and Massive Open Online Courses (MOOCs) (Peck et al., 2020). An example is given by Kirchherr and Piscicelli (2019) who describe a course given to undergraduates to introduce the CE concept. The course was given to the most ambitious bachelor students at the Faculty of Geosciences at Utrecht University. The course was considered a success by the students, however, no conclusions were drawn on the importance of this course for their future working environment.

5. Conclusions, limitations and future research

In this paper we presented results from the first survey on startups that allows for multivariate statistical analyses, analysing the implementation of 10 circular strategies and its relations with four types of skills (transport and logistics, R&D, IT, and technique) while controlling for personal and company characteristics.

With respect to transport and logistics, we find that design to lower material use, and being a female entrepreneur has a positive relation with the need for transport and logistic skills. Furthermore, we find a

strong link between digitalisation and the need for R&D and IT skills while having an older age and more experience suggests a reduced reported need for these skills. With respect to technical skills, we find that the recuperation of waste requires more knowledge of technical specifications, which is supported by experienced managers.

Finally, the paper analysed the most and least asked policy measures, depending on the need for skills. We found that the most asked measures are monetary incentives, namely subsidies and fiscal measures. Although there is a considerable group of startups that considers the set of skills in their team to be a barrier or neutral, the least asked policy measure is education and training for new and polyvalent skills.

This research faces several limitations. First, our cross-sectional dataset does not allow to construct a time series, making it increasingly difficult to observe a trend over time which would be interesting to evaluate the progress of startups in their search for the right skills. Furthermore, the specific timing of the survey coincides with the coronavirus crisis such that this event could influence the implementation of circular strategies, the number of employees, and the turnover. These two limitations can be solved by repeating the survey on a regular basis, or by including specific control variables for the pandemic. However, as we defined startups as typically operating between 4 and 6 years, we argue that the survey is repeated with new respondents in with comparable characteristics as the survey from this paper. Next, our method consists of both interviews and a quantitative analysis using a survey. However, the problem of common method variance states that the values for the variables in the quantitative analysis are obtained through one question only. In future research, it would be beneficial to couple this to multiple data sources. For example, making the survey non-anonymous and coupling it with public corporate data such as the trend in turnover or FTE.

Future research could benefit from including the so-called soft skills in the analysis, as these skills are often recurring in literature. Furthermore, future research can mimic this paper's approach to further assess the robustness of the drawn conclusions and it can test the hypotheses for different scopes, regions, and types of skills, among others. Finally, future research can look into the role of potential moderators, such as investments in human capital, financial means, feasibility of the product, the growth path of the company, the scale, and the capacity to innovate.

CRedit authorship contribution statement

Lize Borms: Conceptualization, Methodology, Formal analysis, Investigation, Resources, Data curation, Writing – original draft, Writing – review & editing. **Wim Van Opstal:** Validation, Resources, Writing – review & editing. **Jan Brusselsaers:** Writing – review & editing. **Steven Van Passel:** Writing – review & editing. All authors have read and agreed to the published version of the manuscript.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.jclepro.2023.137261>.

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