

Circular Economy: An International Needs Analysis for Vocational Learning in Small and Medium-Sized Enterprises

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Abstract

Context: Extensive theory-based research on academic and vocational education has long explored the connections between emotions, motivation, and learning as drivers of behavioral change in occupational contexts. Emotions and motivations play a crucial role in shaping how individuals and organizations adopt new practices, yet their role in fostering larger-scale shifts, such as the transition to a circular economy, has received limited attention. Meanwhile, the global shift toward a circular economy has gained increasing priority, with governments, industries, and international organizations promoting various initiatives aimed at encouraging companies, particularly small and medium-sized enterprises (SMEs), to adopt sustainable, resource-efficient, and circular practices. These initiatives predominantly emphasize the cognitive and practical dimensions of circular-economy strategies, focusing on actionable knowledge and technical skills. However, the emotional drivers—such as enthusiasm, apprehension, or resistance—of such transformative changes are often overlooked. Sentiments, which significantly influence individual and collective behaviors, could be critical to understanding how ready SMEs are to embrace circular-economy principles. Despite their importance, the role of sentiments in shaping organizational and behavioral responses to circular-economy transitions remains underexplored and warrants further investigation.

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Approach: Grounded in the multiple R framework and Plutchik's multifactor-analytic theory of emotion, this study sought to address this gap by analyzing the sentiments expressed by SME members. We conducted a sentiment analysis on statements from employers and employees across 100 SMEs in Germany, Italy, and Poland.

Findings: The results indicate that the overall sentiment among SME members was predominantly positive, suggesting that these companies are largely optimistic and supportive of transitioning to circular-economy practices. This positive outlook implies that emotional attitudes are not the primary barriers to adopting circular-economy principles. Instead, systemic challenges—such as regulatory, infrastructural, and financial barriers—appear to be the main obstacles impeding SMEs' progress toward circular practices.

Conclusions: Our findings underscore the need for more comprehensive systemic vocational education on circular-economy practices to better equip SMEs for this transition. Understanding this need provides valuable insight into the real-world challenges faced by SMEs and emphasizes the importance of addressing structural barriers to facilitate this critical transformation. By considering both cognitive and emotional dimensions, this study sheds light on key factors influencing the adoption of circular economy practices in SMEs, ultimately supporting policymakers and business leaders in devising more effective strategies for sustainable development and economic resilience.

Keywords: Green Economy, Needs Assessment, Small and Medium Enterprises, Employers, Continuing Vocational Education and Training, VET

1 Introduction

The transition to a circular economy (CE) is part of the sustainability goals globally (Geisendorf & Pietrulla, 2018; Morsetto, 2020), with numerous approaches (Ghisetti & Montresor, 2020; Nikoloudakis & Rangossi, 2024; Rizo et al., 2016) being discussed to stimulate changes within companies, including SMEs (Alivojvodic & Kokalj, 2024). These approaches typically focus on cognitive (Hökkä et al., 2023; Leiß & Rausch, 2023), reasoning (DeCock-Caspell & Vasseur, 2021; McCrudden et al., 2017; Rainear & Christensen, 2017), and action competencies (Otieno et al., 2014; Thiengkamol, 2011) of CE practices. In other words, the approaches often emphasize the importance of concrete actions and strategic thinking. However, there is a significant gap in the scientific understanding of the underlying sentiments expressed by employers and employees regarding these changes. It is well-established that emotional states significantly influence motivation and human behavior (Leiß & Rausch, 2023). Yet this dimension remains underexplored in the context of the CE.

Understanding the sentiments (i.e., emotional states reflected in statements) of stakeholders within SMEs can provide critical insights into their information status and attitudes towards CE initiatives and resulting vocational educational (VE) needs. Positive sentiments may reflect an ongoing transition toward circular practices (Hökkä et al., 2023; Loy & Spence, 2020), indicating SME members' supportive and optimistic attitudes regarding circular practices. Conversely, negative sentiments (Loy & Spence, 2020) can be related to barriers and challenges that hinder the adoption of CE principles, offering valuable information on the emotional and motivational factors at play.

This study provides internationally relevant insights into the challenges and opportunities SMEs face in adopting CE practices across different regulatory and economic contexts. By comparing Germany, Italy, and Poland—three countries with distinct legislative CE frameworks and vocational education systems—our findings offer transferable lessons for policymakers, industry leaders, and educators worldwide. This research contributes to the global CE transition by identifying strategies that can support SMEs in overcoming financial, regulatory, and skill-related barriers, aligning international sustainability initiatives such as the EU Green Deal and the UN Sustainable Development Goals (Sachs et al., 2019). In the current study, we aimed to analyze the statements from SME members about CE practices in their companies in Germany, Italy, and Poland. By examining these sentiments, we aimed to disclose individual emotional factors underlying the CE transition and identify factors that may either facilitate or impede this transformation into a CE.¹

However, the successful implementation of national policies relies heavily on the readiness and capabilities of businesses and their employees. Vocational training may equip employers and employees with the necessary competencies to implement CE principles in their workplace. vocational educational training ensures they understand and comply with regulatory requirements, such as Extended Producer Responsibility (EPR) policies and deposit-refund systems (Pouikli, 2020). Furthermore, vocational educational activities facilitate the adoption of sustainable practices by addressing fundamental barriers to the CE. By prioritizing cost reduction and resource efficiency, companies can overcome challenges related to short-term price prioritization and insufficient business environment development. Vocational learning fosters innovation and competitiveness by promoting national cross-sector cooperation and knowledge sharing (e.g., Maslak, 2022; Pouikli, 2020). A fundamental question for designing high-quality vocational training is the theoretical basis addressing actions and characteristics of (the change to) a CE. The multiple-Rs framework provides such a theoretical foundation.

¹ Supplement 1a presents sample legislative frameworks in Europe. Supplements are available at: https://osf.io/m4rw6/?view_only=463aebc22d1b4f279bfa4f6e9bfeef41

1.1 Multiple R Framework to a Circular Economy and Emotional Associations

Potting et al. (2017) introduced the 9R Framework as a comprehensive guide for transitioning to a circular value chain, aiming to minimize natural resource consumption and reduce waste generation. The framework presents three main categories of strategies, each targeting different stages of the product lifecycle:

(A) Smarter product use and manufacturing (R0-R2) can be reached by reducing the need for new raw materials and optimizing product efficiency: R0 includes Refuse, making a product redundant by abandoning its function or offering the same function with a different product. R1 includes Rethink as intensifying the use of a product, such as through sharing. R2 is assigned to Reduce and increase the efficiency of product manufacture or use by consuming fewer natural resources and materials.

(B) Extended lifespan of the product and its parts (R3-R7) summarizes strategies to keep materials in circulation after a product is disposed of, emphasizing reuse and repurposing. R3 is Reuse, utilizing discarded products that are still in good condition and maintain their original function. R4 includes Repairing by restoring a defective product to its original function through maintenance. R5 includes Refurbish by updating an old product to bring it to the current state of technology. R6 means Remanufacture, incorporating parts of discarded products into new ones with the same function. R7 is Repurpose and uses parts of discarded products in new ones with different functions.

(C) Materials can usefully be applied (R8-R9) as strategies involve processing materials to obtain the same or lower quality for further use or recovering energy from waste: R8 is Recycle – processing materials to obtain the same (high grade) or lower (lower grade) quality. R9 includes Recover by incinerating material with energy recovery, although this strategy is often excluded due to its lower level of circularity than others. The 9R Framework (Mast et al., 2022; Potting et al., 2017) serves as a valuable tool for vocational companies on their CE transformation (see Wolgast et al., 2022, for an illustration). Providing a structured approach to circular strategies helps companies better understand the topic and plan their processes accordingly. Additionally, the framework facilitates reflection on current practices and encourages the adoption of CE principles. Other researchers extended the framework with further action words, for example, Recover, which involves incineration of materials with energy recovery, highlighting the necessity to use resources that cannot be otherwise reutilized in a more circular way (Bag et al., 2021).

Although CE and sustainability are emotionally discussed topics in our society (de la Torre et al., 2021; Garcia et al., 2021; Scalabrino et al., 2022; Wolgast et al., 2022). Research on these expressed emotions in both contexts is still rare. Extensive research findings suggest the four basic bipolar emotion dimensions: Joy–sadness, anger–fear; trust–disgust; and surprise–anticipation (Khare et al., 2024; Lee & Kim, 2023; Plutchik, 1960). Researchers

employed these dimensions in sentiment analyses to identify expressed emotions in various text materials (Barbosa & Marín-Suelves, 2024; Okoye et al., 2020; Yantseva, 2020).

Sentiment analysis involves extracting semantical subjective information that is often related to ideas, feelings, or emotions expressed in writing from natural language texts (Guzsvinecz & Szűcs, 2023; Liu & Zhang, 2012). It is widely applied in various fields such as reviews, marketing, customer service, medical applications, and social media (Al-Samarraie et al., 2023; Buder et al., 2021; Carneros-Prado et al., 2023; Stine, 2019; Wankhade et al., 2022). The process entails building a classifier from text using methods such as counting words from an emotional terms dictionary and natural language algorithms (Stine, 2019; Wankhade et al., 2022).

Since the multiple Rs framework proposes concrete actions, we speculated that these actions might be weakly associated with statements about CE evoking surprise, highly with statements about CE evoking trust, and moderately with statements about CE evoking anticipation. Instead of speculating further, we asked whether these emotional dimensions can be identified in interview responses concerning CE from SME's employers or employees.

1.2 Existing Vocational Learning Tools on Circular Economy

Vocational educational learning tools and resources are available online, focusing on the CE. The CE Club (2024) Toolkit provides valuable guides, case studies, and practical tools for educational purposes (Schröder et al., 2019). For manufacturers, the University of Cambridge's CE Toolkit (Evans & Bocken, 2014) offers practical resources to help implement effective circular strategies. Furthermore, the European Institute of Innovation and Technology (EIT) and Climate Innovation Agency and Community (KIC, Klapper et al., 2024) support vocational educational activities with programs focused on developing and applying sustainable practices. These tools provide a robust foundation for learners and professionals, significantly advancing the adoption of CE principles across various industries. However, research on employers' and employees' expressed emotions and needs for tailored educational online training focusing on CE in SMEs remains scarce.

2 The Current Research

The current study was based on the multiple R framework (Mast et al., 2022; Potting et al., 2017), Plutchik's multifactor-analytic theory of emotion (1960), and previous research on CE (de la Torre et al., 2021; Garcia et al., 2021; Scalabrino et al., 2022). Based on the 9R Framework, the multifactor-analytic theory of emotion, and the conceptual framework, our research questions (RQs) were:

(RQ1) What emotions are reflected in the respondents' answers? (RQ2) Are the year of foundation and the hierarchical level of the interviewee related to the amount of information on the status of the CE in their SME, controlling for the country and the sector (goods or services)? The intention was to answer both RQs by statistical methods, RQ1 by sentiment analysis, and RQ2 by generalized linear modeling as detailed next.

3 Method

SMEs from the regional practice partnerships and the project's newsletter distribution network received an invitation to participate in the current study. We made sure that different companies were represented in the invitations. Aligned with the CE Action Plan (Johansson, 2021), industries and services with the potential for circular innovation and environmental impact were prioritized. Only interviewees from SMEs were selected because, unlike larger corporations, SMEs often encounter numerous uncertainties, a lack of expertise, and limited resources, complicating their change towards circularity. When we selected the SMEs, we sought to interview companies with practical experience with this topic and those that had no experience with this topic.

3.1 Participants and Procedures

In total, 68 employers and 32 employees of $N = 100$ SMEs participated in the current study, $n = 33$ from Germany, $n = 39$ from Poland, and $n = 28$ from Italy. These SMEs were non-profit and profit organizations (40% mainly producing goods, 60% offering services) with 1 to 500 employees (foundation years ranging from 1867 to 2023). Their answers included $n = 573$ responses to CE questions we analyzed to determine the expressed sentiment.

These countries were selected due to their distinct legislative frameworks for CE¹, varying economic structures, and differences in vocational learning and training systems (Cedefop, 2025). In Germany, the CE Initiative, backed by the Federal Ministry of Education and Research (BMBF), promotes CE adoption through policy recommendations, industry roadmaps, and product design strategies that enhance repairability. Despite this structured approach, SMEs—critical to the German economy—face challenges such as limited financial support, technological constraints, and a shortage of environmental management professionals. These barriers, coupled with the complexity of regulatory requirements, may contribute to negative sentiments toward CE implementation. To address this, Vocational educational programs tailored to employers, HR managers, and employees are important in facilitating knowledge transfer and practice-oriented CE adoption. In Italy, Vocational education supports CE transitions, as recognized within national legislative frameworks¹. However, regional disparities and sector-specific challenges require tailored vocational educational initiatives to ensure

effective implementation. Poland operates within an evolving CE regulatory framework largely influenced by EU legislation¹. Policies such as the CE Action Plan and the Roadmap for Transformation towards a CE provide a structured approach to sustainability efforts, with vocational training as a crucial mediator between policy regulations, employer strategies, and employee actions. By focusing on these three countries, this study captures the diversity of sentiment toward CE adoption across different regulatory and economic contexts, highlighting the role of vocational education in fostering social interactions, cooperation, and knowledge-sharing necessary for sustainable business transformation.

3.2 Background Information and Circular Economy Questions

Our structured interview questionnaire was based on Van Langen et al. (2021) and adapted to the current study. We assessed the role of the interviewee in the company, country, (non-) profit type of company, the main goods or services produced, and their year of establishment in the first part of the interview, followed by questions about the CE. The questions about the CE are depicted in Table 1¹.

Table 1: Structured Interview Questions About Circular Economy Experiences in SMEs

1	Have you ever heard about the circular economy? (briefly describe any knowledge found) Have you adopted / Do you currently adopt any circular economy practices in your organization? (if yes, skip to question n.4)
2	If not, what prevents you from adopting circular economy practices in your organization? Which skills, knowledge, and competencies have helped you in implementing such practices?
3	How have the values and changes in favor of the circular economy been promoted within your organization?
4	Which difficulties do you face in implementing circular practices in your organization? (e.g., concerning staff, lack of knowledge, costs, legal issues)
5	What helped you overcome these difficulties? (e.g., tools used, any changes made, costs incurred, improvements achieved)
6	If no action has yet been taken in a circular direction, what knowledge do you think is essential to develop to turn your organization into a circular one?
7	If no action has yet been taken in a circular direction, which skills do you think are essential to develop to turn your organization into a circular one? (Focus both on hard and soft skills)
8	What do you expect to learn from a short-learning program about circular economy targeting SME leaders?
9	Looking at companies active in your sector, what do you think could stimulate a process of change towards a circular economy?
10	Do you think a circular economy can provide you with competitive advantages in the market?

3.3 Data Analyses

In this study, we conducted a sentiment analysis based on Plutchik's multifactor-analytic theory of emotion and the multiple R framework to examine the emotional content of SME members' statements. We applied sentiment analysis to understand the underlying emotional expressions in the statements of employers and employees regarding the transition to

a CE. Sentiment analysis is a method used to identify and extract subjective information from textual data, often employed to determine the sentiment expressed in a piece of text (Guzsvinecz & Szűcs, 2023; Liu & Zhang, 2012). We used the R package *syuzhet* (Jockers, 2020) for the sentiment analysis because it is designed to identify and score emotion-related words within text material. These emotional associations are divided into four antagonistic pairs anger–fear, sadness–joy, surprise–anticipation, and trust–disgust (Yantseva, 2020). Sentiment polarity (positive versus negative) can also be determined (Jockers, 2020). Further R packages we used were *apaTables* (Stanley & Spence, 2018), *car* (Fox & Weisberg, 2019), and *psych* (Revelle, 2019) for descriptive statistics, correlation, and generalized linear modeling².

4 Results

The research questions (RQs) were: (RQ1) What emotions are reflected in the respondents' answers? (RQ2) Are the year of foundation and the hierarchical level of the interviewee related to the amount of information on the status of the CE in their SME, controlling for the country and the sector (goods or services)?

4.1 The Sentiment Analysis

The sentiment expressed in the statements from the 100 SMEs was predominantly positive (see Table 2 for details). A single response may contain different emotional associations expressed. Consequently, each emotional expression is identified on a separate scale from 1 to 100% (as with multiple-response questions). The sentiment analysis mainly suggested trust expressed in 45% of $n = 573$ responses, followed by anticipation in 20% of $n = 573$ responses, joy in 15% of $n = 573$, and surprise in 7% of $n = 573$ responses. Furthermore, the participants' responses mainly expressed fear in 13% of $n = 573$, followed by sadness in 10% of $n = 573$, anger in 6% of $n = 573$, and disgust in 6% of $n = 573$ responses. The overall evaluation yielded a negative sentiment in 25% of $n = 573$ and a positive sentiment in 87% of the $n = 573$ responses.

² The R codes are detailed in Supplement 1c and the data in Supplement 1d.

Table 2: Sentiment Analysis Results – Relative Frequencies (in %)

IQS	Anger	Anticip.	Disgust	Fear	Joy	Sadness	Surprise	Trust	Negat.	Posit.
1	7	19	7	26	30	11	7	56	37	93
2	0	3	6	3	1	1	0	15	6	59
3	7	26	6	4	25	6	13	49	22	91
4	7	17	7	24	13	25	4	48	68	89
5	1	21	4	17	16	13	9	39	26	77
6	8	29	6	12	21	8	6	71	15	98
7	4	20	4	9	13	7	4	44	9	99
8	10	16	9	11	11	7	10	41	22	84
9	6	28	5	13	19	5	9	54	17	83

Note. IQS = interview question for sentiment analysis, Anticip. = anticipation. A single response may contain different emotional associations expressed. Consequently, each emotional expression is identified on a separate scale from 1 to 100% (as with multiple-response questions).

Sentiment analysis results per question are: (a) The sentiment analysis of statements about *barriers to adopting CE* practices revealed a mix of emotional expressions (trust 56% and anticipation 19% of $n = 573$ responses, see Table 2 for details). The participants highlighted concerns, for example, regulatory barriers, resource limitations, and lack of knowledge, reflecting negative emotions like anger, fear, and sadness. However, there were also positive sentiments, indicating anticipation, trust, and joy when considering the potential for CE practices. For example, some respondents showed optimism about ongoing research and process optimizations, while others expressed frustration over the lack of supplier cooperation and strategic support. A positive sample statement is: "The topic is implemented within the framework of various process optimizations, as well as being taken into account in new product developments, insofar as technology permits". A negative sample statement is "A CE involves several parties, but unfortunately, my suppliers very rarely take back the packaging".

(b) The sentiment analysis of the statements concerning *skills, knowledge, and competencies that helped implement CE practices* suggested predominantly neutral or positive emotional expressions (trust 15% and anticipation 3% of $n = 573$ responses, see Table 2 for details on the identified emotions). The respondents highlighted various skills and competencies such as technical knowledge, collaboration with universities and research institutes, understanding of CE principles, practical experience, networking, and resourcefulness. A sample response is "Collaboration with universities, research institutes, internal technicians, and ad hoc courses".

(c) *Practical experience and the ability to apply skills in real-world contexts* were valued (trust 49% and anticipation 26% of $n = 573$ responses, see Table 2). Employers and employees emphasized the importance of long-term experience in their fields and the need to be adaptable and resourceful in implementing sustainable practices. They also mentioned individual

motivation and willingness as important conditions to adopt circular and sustainable behaviors through continuous learning through courses, seminars, and workshops. According to their further responses, institutional support and the regulatory environment influenced the implementation of CE practices. Some responses indicated that low regulations facilitated their CE efforts. Other companies that had integrated CE principles into their core operations early on found it easier to implement such practices. A sample response is "Leadership commitment, collaboration with suppliers and partners to implement circular practices".

(d) The sentiment analysis of *how values and changes for the CE have been promoted within the organizations* yielded mostly positive sentiments (trust 48% and anticipation 17% of $n = 573$ responses). Many organizations reported fostering these values through training, discussions, and collaborations. Some use specific strategies like social media, websites, and client communications. A few statements reflected a lack of fostering due to individual initiatives or organizational norms. A sample response is "engaging and convincing the team as a whole in change processes, expertise in specific technical areas, and acquisition costs".

(e) The SMEs faced several *challenges in adopting CE practices* reflected in the corresponding negative sentiment, besides positive expressions identified (trust 39% and anticipation 21% of $n = 573$ responses). One major issue is that many products are not designed for multiple life cycles. Convincing the entire team to embrace new processes and expertise was also difficult. Technical restrictions, high costs, and limitations in product scalability further complicated implementation. Sourcing sustainable suppliers and training employees on circular practices were additional hurdles. Legal and regulatory barriers add to the complexity, alongside customer demands for cheaper parts and reluctance to adopt new methods. Finding recyclable materials and dealing with packaging issues also pose problems. High implementation costs and a lack of public funding make the transition even harder. Furthermore, the SMEs struggled with cooperation, information gaps, and tracking progress. Changing long-standing practices and company structures presents cultural and structural barriers. A sample response is "a period of experimentation that lasted several months to years".

(f) Perseverance based on a high amount of underlying trust has been crucial for *overcoming obstacles in CE initiatives* (trust 71% and anticipation 29% of $n = 573$ responses). Engaging in conversations and open discussions about new approaches, receiving public funding, and enhancing the company image have all been beneficial. Many companies are involved in the process of educating customers and optimizing production to reduce costs. A sample response is "In order to convince staff, a low-threshold guide to action would be very helpful, accompanied by very useful proposals for action".

(g) The interviewees emphasized the importance of *understanding CE principles and their implications, including the advantages* and applications across different sectors (trust 44% and anticipation 20% of $n = 573$ responses). Legal and regulatory knowledge is crucial, particularly regarding waste management and recycling practices. There is a notable focus on

sustainable packaging and material management, with an interest in both eco-friendly packaging options and strategies for reusing leftover materials.

Respondents seek information on technology solutions and logistics to support circular operations, including new technologies for energy efficiency. Practical implementation strategies are also highlighted, with a need for case studies, practicable examples, and cost-effective methods to start the transition. Financial and operational considerations are important: Skills in applying for funding and finding cost-neutral options for circular practices. Additionally, sector-specific insights are valued, particularly for applying circular principles to construction, medical fields, and transportation. A sample response is "Creativity, discussing with partners, stakeholders".

(h) The sentiment analysis yielded no notable positive or negative expressions focusing on the *factual aspects of CE implementation*. However, there is a moderate level of trust, reflecting optimism about the potential benefits and opportunities associated with CE practices (trust 41% and anticipation 16% of $n = 573$ responses). Some responses also expressed anticipation for future developments, indicating a hopeful outlook on the effectiveness of the CE strategies. Furthermore, respondents emphasized the need for understanding the CE process, time management, and resource-saving practices. Skills in writing funding applications and packing projects ecologically were also noted. There was a strong emphasis on openness to new ideas, creativity, and strategic thinking, alongside critical consideration of new trends. Personal attributes such as goal orientation, innovation, and leadership skills are deemed important for the interviewees. Networking, partnership-building, and the ability to adapt to new demands and environmental impacts are also highlighted. A sample response is "the importance of building a solid professional network".

(i) The sentiment analysis of the responses revealed differential perspectives on *what SME leaders expect to gain from a short-learning program about the CE* with a moderate amount of trust (trust 54% and anticipation 28% of $n = 573$ responses). This amount of trust indicates that respondents have had high expectations and were hopeful for specific learnings and improvements from the short learning online program. Many respondents highlighted the need for broad communication and education about the CE's benefits, such as its potential to enhance community traditions, improve environmental sustainability, and offer a competitive edge. They emphasized integrating circular practices into business strategies and leveraging regulatory support, financial incentives, and practical examples. On the other hand, challenges such as economic constraints, the need for innovative solutions, and overcoming entrenched business philosophies are noted. A sample response is "Saving resources and time. Ultimately, it helps if expenses are reduced and unnecessary processes are saved".

4.2 Background Information and Amount of Information on the Status of the Circular Economy

Table 3 presents means, standard deviations, Spearman's correlation coefficients, and beta weights with confidence intervals for the response lengths and the country variable (ranked after the country's geographic area). Significant and weak relationships existed between the amount of information on the status of the CE in their SME and the country variable. Generalized linear modeling indicated that the year of establishment did not significantly determine the amount of information on the status of the CE in their SME. However, the *interviewee's role in the organization* significantly predicted the amount of information on the status of the CE in their SME, as well as the control variables, *country*, and *SME's focus on goods or services* (see Table 3 for details).

Table 2: Means, Standard Deviations, Spearman Correlation Coefficients, and Standardized Regression Coefficients With Confidence Intervals

Number of characters in the response	M	SD	1	2	3	4	5	6	7
1. If_not	26.37	46.38							
2. Which_skills	76.40	117.37	-.14 [-.34, .08]						
3. How_have	71.52	88.87	-.21* [-.41, -.00]	.67** [.53, .77]					
4. If_no_act	54.62	89.63	.29** [.08, .47]	.05 [-.16, .26]	.08 [-.14, .28]				
5. If_skills	37.01	63.23	.31** [.10, .49]	-.12 [-.32, .10]	-.03 [-.24, .19]	.58** [.43, .71]			
6. What_expect	91.09	81.24	.05 [-.16, .26]	.33** [.12, .50]	.58** [.42, .70]	.34** [.14, .52]	.21* [.00, .41]		
7. Looking	80.90	84.55	.13 [-.09, .33]	.46** [.27, .61]	.51** [.34, .65]	.41** [.22, .57]	.27* [.07, .46]	.54** [.37, .68]	
8. Country	0.86	0.71	.20 [-.02, .39]	-.26* [-.44, -.05]	-.23* [-.42, -.02]	.16 [-.06, .36]	.18 [-.04, .37]	-.12 [-.32, .10]	-.15 [-.35, .07]
Number of characters in the response regressed on				β	SE	z	p	CI _{2.5}	CI _{97.5}
Year of establishment				-0.057	0.086	-0.658	0.511	-0.226	0.112
Interviewee's role in the organization				0.031	0.110	0.280	0.780	-0.185	0.247

Country	-0.064	0.115	-0.554	0.579	-0.290	0.162
SME's focus on goods or services	0.137	0.119	1.154	0.248	-0.096	0.370

Note. 1.–7. See Table 1 for the respective questions. M and SD are used to represent mean and standard deviation, respectively. Values in square brackets indicate the 95% confidence interval for each correlation. The confidence interval is a plausible range of population correlations that could have caused the sample correlation (Cumming, 2014). * indicates $p < .05$. ** indicates $p < .01$.

5 Discussion

This study aimed to answer two research questions (RQs) using different data analysis methods. The theoretical foundation was the conceptual framework based on the 9R Framework (Mast et al., 2022; Potting et al., 2017) and the multifactor-analytic theory of emotion. We intended to answer RQ1 by sentiment analysis, and RQ2 by generalized linear modeling. According to the results, the research questions can be answered as follows.

5.1 What Emotions are Reflected in the Respondents' Answers? (RQ1)

The sentiment analysis suggested different emotional expressions, with moderate amounts of "trust" and "positive" being more prevalent than others like "anger" and "disgust." The predominantly positive sentiment in the interview sentences suggests that individual attitudes toward the CE in the current sample are favorable. This result supports the view that the CE is a promising approach to sustainable development (Sachs et al., 2019). This finding contrasts with prior assumptions that resistance to change is primarily psychological. Instead, the interviewees' responses suggest systemic challenges—such as financial and regulatory barriers—appear to be the main obstacles preventing broader implementation. This observation extends the applicability of the 9R framework by introducing an additional dimension:

While the 9R model categorizes CE strategies at different levels, our findings imply that SME members' sentiment can influence the likelihood of SMEs engaging with higher-order CE strategies (e.g., rethink and redesign). Companies with optimistic change communication practices might be more willing to explore transformative CE practices. Thus, those facing systemic constraints would remain confined to lower-order strategies (e.g., recycle and recover). The employers and employees also reported system-related barriers hindering the transition to a CE. These barriers included regulatory, financial, or infrastructural challenges rather than a lack of willingness or negative attitudes among employees and cooperating employers, in line with other studies (Bening et al., 2021; Sahajwalla & Hossain, 2023). Together with the positive sentiment, these responses imply that systemic barriers, rather than individual attitudes, are the main obstacles hindering the adoption of CE practices. This insight can guide how to deal with these barriers and support SMEs in their journey towards greater sustainability, also through vocational educational training (Rizos et al., 2016). This

implication for vocational educational training is also supported by the results, suggesting trust toward CE practices, with little to no negative emotion associated with the skills and knowledge required for the practices' implementation.

Collaboration and networking emerged as key themes, with many respondents mentioning their work with universities, research institutes, and external experts. Networking and participation in working groups were also highlighted as important for gaining insights and support. In terms of knowledge and technical skills, specific areas such as fashion, textile design, and power electronics were frequently noted. Thus, a collaboratively shared understanding of CE principles and knowledge in sustainability (Alivojvodic & Kokalj, 2024), recycling, and waste management was valuable for SMEs. Some responses expressed challenges and external pressures; the sentiment suggested a commitment to integrating CE principles, highlighting the importance of collaboration, networking, leadership, intrinsic motivation, and practical implementations. Challenges and external pressures are also discussed by other researchers (e.g., Maslak, 2022; Pouikli, 2020). The main challenges in our study revolved around costs, legal issues, knowledge gaps, a lack of cooperation partners to work together on circular change, and cooperation partners and employees with resistance to change. Some of these challenges are already known from previous research (e.g., Alivojvodic & Kokalj, 2024; Bening et al., 2021).

On their way to a CE, inspections, rethinking, and training, along with financial support, have also played important roles according to the interviewees – in line with the R Framework (Bag et al., 2021; Mast et al., 2022; Potting et al., 2017). Creativity, brainstorming sessions, and combining complementary skills with colleagues have driven progress. Regulatory support and customer demands have further influenced sustainability efforts, although challenges remain in areas like plastic recycling and managing high production costs. The commitment to community well-being and creating jobs has provided additional motivation, supporting and extending previous research on a CE (de la Torre et al., 2021; Garcia et al., 2021; Scalabrino et al., 2022).

Essential knowledge described and sentiments found: The analysis of essential knowledge for transitioning an organization to a CE revealed a wide range of needs and sentiments. The sentiment analysis of responses suggested positive sentiments with an underlying optimism about the potential for positive change. Occasional mentions of anger and fear reflected experienced barriers and the change of necessary practical skills.

The short learning program anticipation may reflect their interest or motivation to engage with and benefit from the training. The notable amount of negative sentiment suggests that while there is enthusiasm for the learning opportunity, there are underlying concerns and system-related dissatisfaction that need to be addressed. Since the legal requirements and system are given, strategies to deal with it and transit the way to circularity despite it seems to be promising. Such strategies and system-related knowledge might be included in a short

learning curriculum on SME's transition to a CE. Thus, while employers or employees are generally positive about the potential of the short learning program on SME's transition to a CE, they also have concerns that need to be addressed. To maximize the effectiveness of the program, it is crucial to focus on practical solutions and examples that tackle common challenges. Ensuring that the program meets or exceeds participants' expectations and continuously improving based on feedback will be essential to addressing the anger, fear, dissatisfaction, or concerns identified in the analysis. The analysis of the mentioned essential skills needed for transitioning an organization to a CE highlights both professional competences and social-emotional competencies crucial for this shift. Key areas of focus include a willingness for change and the ability to grasp and apply new technologies.

There was clear recognition that initiating this transition involves a multifaceted approach. Thus, effective change starts with leadership, both within companies and from external authorities. The increased awareness and understanding among consumers, combined with stronger regulatory frameworks and financial support, may support the adoption of CE principles. More information, training, and networking opportunities may help SMEs navigate this transition. Achieving a successful transition towards a CE requires a collaborative effort that includes improved public relations, financial backing, regulatory support, and a shift in mindset both within companies and among consumers. These sentiments behind the responses extend published findings on CE experiences and practices (de la Torre et al., 2021; Garcia et al., 2021; Scalabrino et al., 2022).

Thus, our study bridges a critical gap between psychological and systemic perspectives in CE transitions by integrating sentiment analysis as a complementary methodological tool for assessing CE adoption potential. This approach adds an emotional-cognitive layer to the existing 9R model (Mast et al., 2022; Potting et al., 2017), providing policymakers and business leaders with new insights into how CE strategies may be more effectively implemented within SMEs.

5.2 Are the Year of Foundation and the Hierarchical Level of the Interviewee Related to the Amount of Information on the Status of the Circular Economy in Their SME, Controlling for the Country and the Sector (Goods or Services)? (RQ2)

The generalized linear modeling suggested that the background variables did not have a significant impact on the amount of information on the status of the CE in the SMEs included in this study. This result implies that other factors might influence the amount of information on the status of the CE in the SMEs included that are not assessed in the current study. However, the sentiments behind these responses highlighted relevant factors that support or impede the adoption of CE practices in SMEs (e.g., strategies to change and fulfill complex

legal requirements, and strategies to find cooperation partners who are also on their way to an increasing number of circular practices. The positive sentiments indicate a readiness and enthusiasm for change, training, and tools that address the systemic barriers, and strategies to solve and facilitate a smoother transition to a CE. Such strategies are often associated with the verbs – the action words – of the 9R framework, according to previous and current results (Mast et al., 2022; Potting et al., 2017).

Our results suggest that systemic barriers, including regulatory, financial, and infrastructural challenges, are the primary obstacles hindering SMEs in their transition to a CE. However, our sentiment analysis reveals that despite these challenges, SMEs express predominantly positive emotions toward CE adoption. This positive sentiment could be a valuable asset in overcoming systemic barriers, as positive sentiments are associated with higher motivation, protective factors in terms of resilience, and openness to change (Barbosa & Marín-Suelves, 2024; Okoye et al., 2020; Yantseva, 2020). While sentiments alone may not remove structural obstacles, they can facilitate engagement with training programs, policy initiatives, and innovative solutions aimed at navigating regulatory and financial constraints. Further research might examine how emotional attitudes interact with external barriers and whether fostering positive sentiments through targeted interventions could enhance SMEs' capacity for circular transformation.

5.3 Limitations and Implications for Research and Practice

The current study has several limitations that should be acknowledged. The sample from three countries and the sectoral distribution limit the generalizability of our findings. SMEs in other European countries or industries might exhibit different sentiments toward CE transitions. Future research might expand the geographical scope and sectoral representation to provide a more comprehensive understanding of SME perspectives on CE adoption.

Additionally, sentiment analysis may only partly capture the respondents' emotions and attitudes. Another limitation is the potential lack of sector-specific insights, which could limit the applicability of the findings across different SME sectors (e.g., Alivojvodic & Kolkaj, 2024; Bening et al., 2021; Di Foggia & Beccarello, 2022; European Commission, 2014). Furthermore, the reliance on self-reported data could introduce bias, as respondents might present more favorable views or underreport challenges.

Our study focused on sentiments in SME members' statements regarding CE adoption. However, we acknowledge the potential for self-reporting bias, as respondents may have overemphasized positive sentiments or underreported challenges due to social desirability effects. While we took measures to mitigate this bias—such as ensuring participant anonymity and using open-ended responses to allow more nuanced expressions—this remains an inherent limitation. Future research might consider triangulating self-reported emotions

with observational data, external assessments, or longitudinal studies to validate findings and provide a more comprehensive picture of SME members' emotions and attitudes toward CE transitions. Lastly, the rapidly changing economic and regulatory environments could impact the relevance of the findings over time.

This study applied sentiment analysis to examine SME members' sentiment toward CE adoption. While this approach allows for the systematic analysis of large-scale textual data, it has limitations in capturing the full complexity of SME perspectives. The inclusion of additional qualitative methods, such as focus groups, in-depth interviews, or ethnographic observations, could provide a richer understanding of the contextual and experiential dimensions of CE adoption. Additionally, detailed case studies of SMEs that have successfully implemented CE practices could provide practical insights and actionable strategies for others.

For future research, several directions could be beneficial. Including a larger and more diverse sample of SMEs across various sectors would enhance the degree of validity of the findings. Longitudinal studies could provide deeper insights into the long-term impact of CE practices and the evolving challenges faced by SMEs. Furthermore, our findings indicate that SMEs require broader systemic vocational training on CE practices to support their transition. However, training needs may differ significantly across sectors due to industry-specific challenges. For example, in manufacturing, vocational training could focus on material efficiency, waste reduction, and product lifecycle management, whereas in the hospitality sector, emphasis may be placed on sustainable procurement, food waste reduction, and energy-efficient operations. Given these variations, sector-specific training modules might be developed to align with industry demands. Future research might further investigate how CE challenges and training needs vary across different sectors, ensuring that educational interventions are both relevant and actionable.

In terms of practical implications, several steps can be taken to support SMEs in their transition to a CE. Developing training programs that address specific regulatory, financial, and infrastructural barriers identified by SMEs is crucial. These programs might include practical solutions, case studies, and actionable strategies. Facilitating platforms for collaboration and networking among SMEs, universities, research institutes, and industry experts can help share knowledge and best practices. Emphasizing the importance of leadership and change management skills in training programs can help SMEs navigate the transition effectively. Additionally, advocating for increased regulatory and financial support from policymakers can reduce barriers and incentivize the adoption of CE practices.

Finally, developing campaigns to raise consumer awareness and demand for products and services that adhere to CE principles can drive market-driven sustainability. By addressing these limitations and implications, future research and practical initiatives can better support SMEs in their journey toward sustainable development and the adoption of CE practices. To support SMEs in overcoming key financial and regulatory barriers to CE adoption, a

combination of financial incentives, regulatory support, and vocational training is essential. Beyond financial and regulatory aspects, vocational training and capacity building play a key role in supporting SMEs on their CE journey. Developing sector-specific training programs in collaboration with industry stakeholders would ensure that the unique challenges of different fields are effectively addressed. Digital learning platforms and mentorship networks would offer additional opportunities for continuous knowledge transfer, allowing SMEs to stay up to date with evolving best practices. By integrating financial support, regulatory advocacy, and tailored vocational education, SMEs can be better equipped to implement circular strategies successfully and contribute to a more sustainable economy.

6 Conclusion

The main finding of this study is that many SMEs need effective support in transitioning to a CE. A short online program might focus on addressing the key challenges and needs identified in this study. SMEs require practical solutions and examples to overcome systemic barriers such as regulatory, financial, and infrastructural challenges. An effective short online program might emphasize the importance of collaboration, networking, and technical knowledge. Essential components of the program might include professional and social-emotional competencies, with a strong emphasis on leadership, regulatory support, and increasing consumer awareness. Training might guide SMEs on how to navigate complex legal requirements and develop strategies for finding cooperative partners.

Moreover, the program might be designed to foster a positive attitude and associated emotional expressions towards change, providing tools and strategies to facilitate a smoother transition to circular practices. By focusing on these aspects, the online program can equip SMEs with the necessary knowledge and action competences to achieve greater sustainability and effectively integrate CE principles into their operations.

Our findings highlight the importance of integrating CE principles into vocational training to ensure sustained adoption among SMEs. Beyond addressing immediate barriers, targeted long-term support mechanisms—such as ongoing upskilling, financial incentives, and industry-specific regulatory guidance—can facilitate lasting change. Furthermore, maintaining positive emotional engagement through leadership initiatives and peer networks may help SMEs remain motivated in their transition. Future research might explore longitudinal effects of such interventions, assessing their impact on the scalability of CE practices across industries.

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Ethics Statement

The study complies with the requirements of the Helsinki Declaration, and all steps of the study followed international ethical standards (AERA et al., 2014). The ethical committee of the University of Applied Sciences FHM approved the study concept, including the questionnaire. Informed consent was obtained from all individual participants included in the study.

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