Study of standardization points based on a survey on the transition to a circular economy and its international standardization

H-AIST CE Lab.

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Abstract

To accelerate the transition from a linear economy to a circular economy, National Institute of Advanced Industrial Science and Technology (AIST) and Hitachi, Ltd. launched the Hitachi-AIST Circular Economy Collaborative Research Laboratory in 2022. As part of the activities of this laboratory, we commissioned Yordas Group to conduct a survey using questionnaires and interviews in order to understand the need for international standardization and rule-making. After analyzing the results of the survey, we understand the need for the "performance indicator" we proposed to visualize the efforts of companies in the CE industry, as well as the "grading" that visualizes the value of recycled products in the recovery value chain. Furthermore, in order to perform the grading, we found that data must be connected in a value network that connects between both production and recovery side, and we have extraced following requirements for that data :
1) requirements such as transparency ; 2) information on substances that impede circulation and CFP; and
3) information/data linkage in the value network, such as the supply chain or value chain.

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1. Introduction

In order to share and effectively utilize the limited resources that exist within planetary boundaries, the global economy is currently undergoing a major transition from a linear economy, based on the premise of mass production, mass consumption, and mass disposal, to a circular economy (CE). In Japan, in particular, there are resource shortages and waste problems, and the transition to circular society that implements a CE is an urgent need. In this situation, National Institute of Advanced Industrial Science and Technology (AIST) and Hitachi, Ltd. launched the Hitachi-AIST Circular Economy Collaborative Research Laboratory (H-AIST CE Lab.) in October 2022. The laboratory has established the following three working groups (WGs) to work on following three research themes..

- Theme1: Formulation of a grand design for a CE society. (WG1)
- Theme2: Development of digital solutions for the CE. (WG2)
- Theme3: Development of standardization strategies and promotion of measures that contribute to the transition to CE. (WG3)

This paper reports on the activities of WG3.

One way to encourage the major behavioral changes needed for the transition to a circular society, as mentioned above, is to create rules through international standardization. WG3 is surveying standardization trends related to CE, preparing a preliminary standardization strategy, and conducting activities to refine the standardization strategy and its implementation in cooperation with academia, government, and other companies.

To understand the need for standardization and rulemaking, WG3 conducted a survey of the current state of CE activities in various companies and organizations, including Value Networks (VNs). This survey was conducted by outsourcing the work to Yordas Group (Yordas), a major consulting firm in this field (www.yordasgroup.com). The survey was conducted primarily in the UK/EU and North America, with an effort to incorporate the perspectives of developing countries wherever feasible.

Meanwhile, in WG3, we have been analyzing the architecture of the value chain (VC) in CE, in parallel with the above survey. As a result, we formulated the hypothesis that "visualizing value" for stakeholders on the VC would promote the transition to CE in industry.[1][2] In particular, we constructed the following two hypotheses regarding "visualizing value" as key points for international standardization. [3]

- Performance inducator that show stakeholders, such as investors, the value of a company or organization's contribution to CE.
- In recovery VC, "Grading" makes the value of end-of-life products, materials, etc. visible between adjacent players.

In this report, in order to verify and further specify the above hypothesis, we have tried to extract suggestions and insights about its importance and requirements from the results of the Yordas survey.

2. Research Methodology

We commissioned Yordas to conduct a survey using questionnaires via the internet and short interviews. We received responses to the questionnaire from 38 organizations, including those in the industrial sector. We also conducted short interviews with all 38 organizations. Details of these survey methods are provided in Appendix 1. The main stakeholders surveyed are the groups shown in Table 2.1. As shown here, we aimed to elicit a wide range of opinions by reaching out to many of the stakeholders in the circular economy field.

Table 2.1 Stakeholder groups relevant to this project

Stakeholder Group	Details
National and International Standards Organisations, Committee members, and other organisations with standards remits	Representatives from SCC (Canada), ISO (International), CEN-CENELEC (EU), SIS (Sweden), NIST (US)
Industry	Included both large organisations and SMEs. Industries include auto, chemical or plastics manufacturers, construction, electronics, recyclers and consultants
Industry Associations/ Action Group	Include auto, metals, household and consumer products
Government	Offices responsible for CE strategies and waste/recycling
Inter/Non-Govermental Organizations	Inter-Govermental Organizations or Non-Govermental Organizations (NGOs) with CE or Sustainability remits, trade, manufacturing, research or policy
Others	Academic/Research Institute, Consultancy, and so on.

SCC: Standards Council of Canada
ISO: International Organization for Standardization
CEN: European Committee for Standardization
CENELEC: European Committee for Electrotechnical Standardization
SIS: Swedish Institute for Standards
NIST: National Institute of Standards and Technology
SME: Small and Medium-sized Enterprise

3. Results and Discussion

3.1 Quantitive questionnaire survey

The questionnaire is designed so that you can answer each question by selecting an option, so that quantitative analysis can be carried out. Below we will examine the results of the responses to each question in the survey and the implications that can be drawn from them.（"Q+number" is the question number in the questionnaire）

Q1：what are the most important factors in implementing CE practices? (You can select up to 5.)
Figures 3.1 and 3.2 are bar grapfs showing the number of times each option was selected. Figure 3.1 shows the result of respondents from industry (including Industry Association / Action Group) only, and Figure 3.2 shows the results of respondents from non-industry (Academic/Research Institute, Consultancy, Government, and Inter/Non-Governmental Organization).

Figure 3.1   Q1: The most important factors in implementing CE practices (industry)
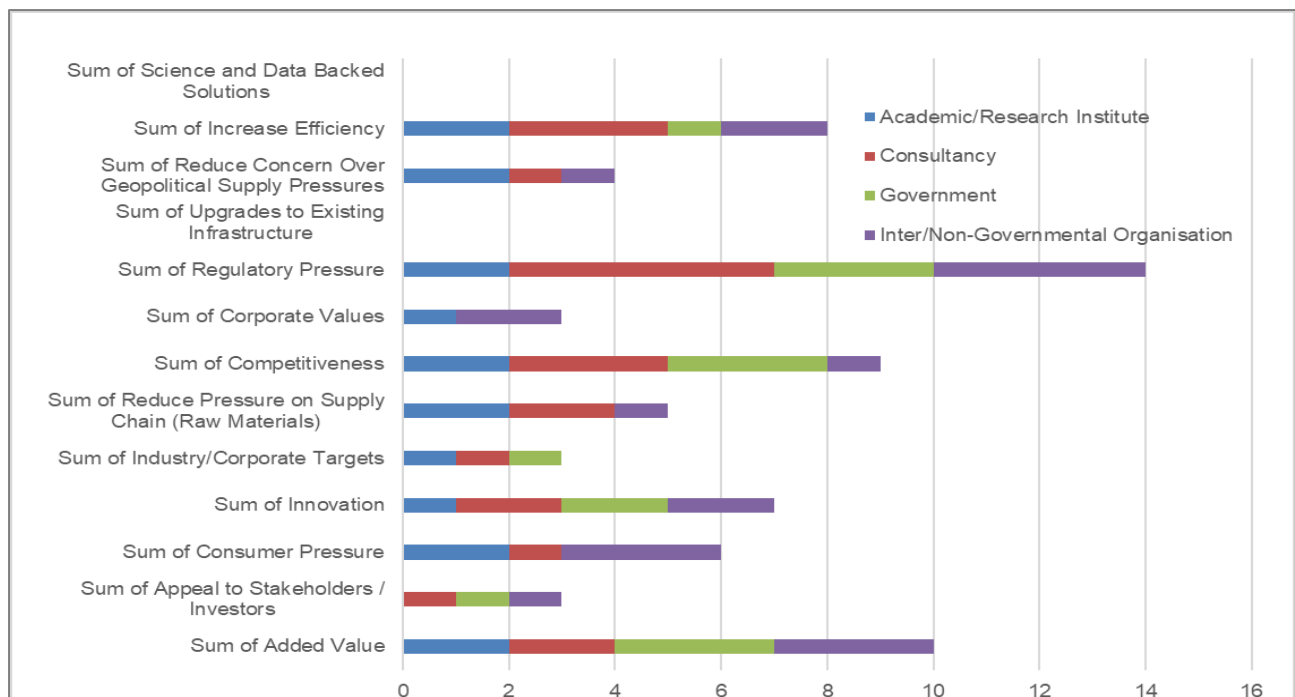

Figure 3.2   Q1: The most important factors in implementing CE practices (non-industry)

The top three responses for each graph were: for industry, competitiveness (10), corporate value (10), added value (9), and appeal to stakeholders/investors (9).

Looking at cases of non-industry in the same way, the most common reasons are legal pressure (14), added value (10), and competitiveness (9). (The numbers in parentheses indicate the number of times the option was selected. The same applies below.)

The results above show that, in particular, industry places importance on competitiveness, added value and corporate value when implementing CE. By demonstrating these values to stakeholders and investors, industry has the potential to show its contribution to CE.

The following questions are analyzed in the same way as Q1.

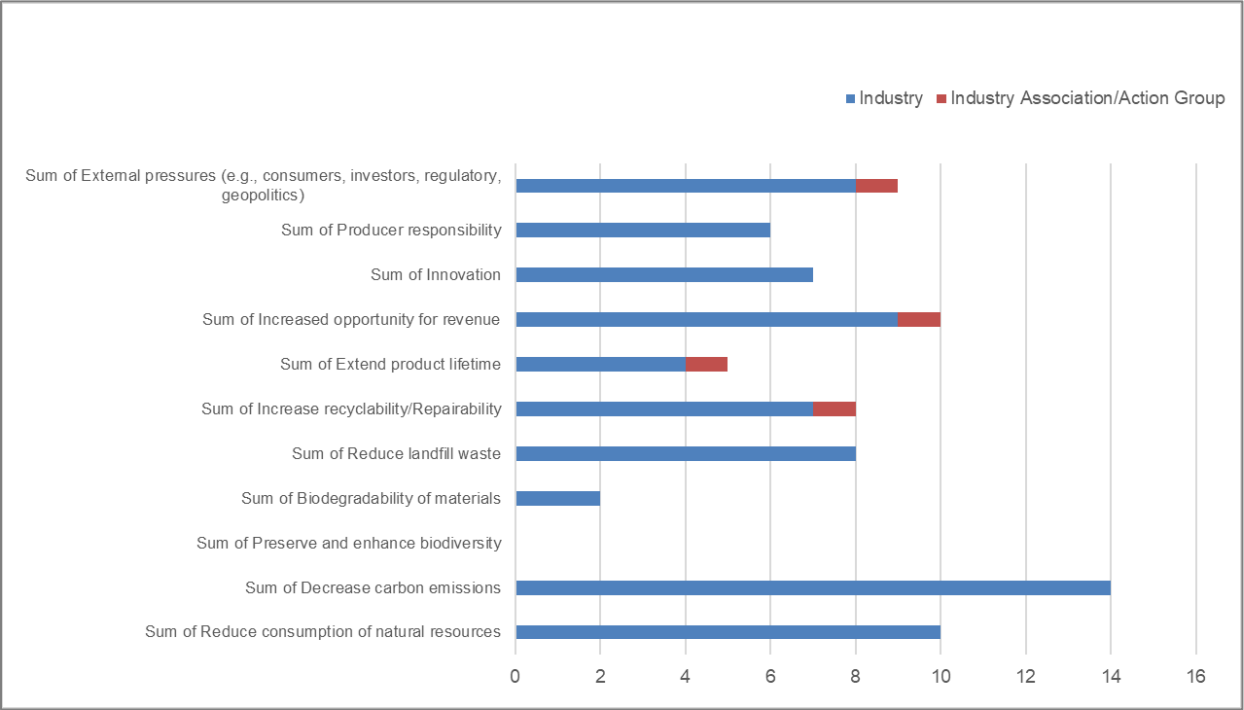Q2: Top motivations for implementing CE principles. (You can select up to 5.)

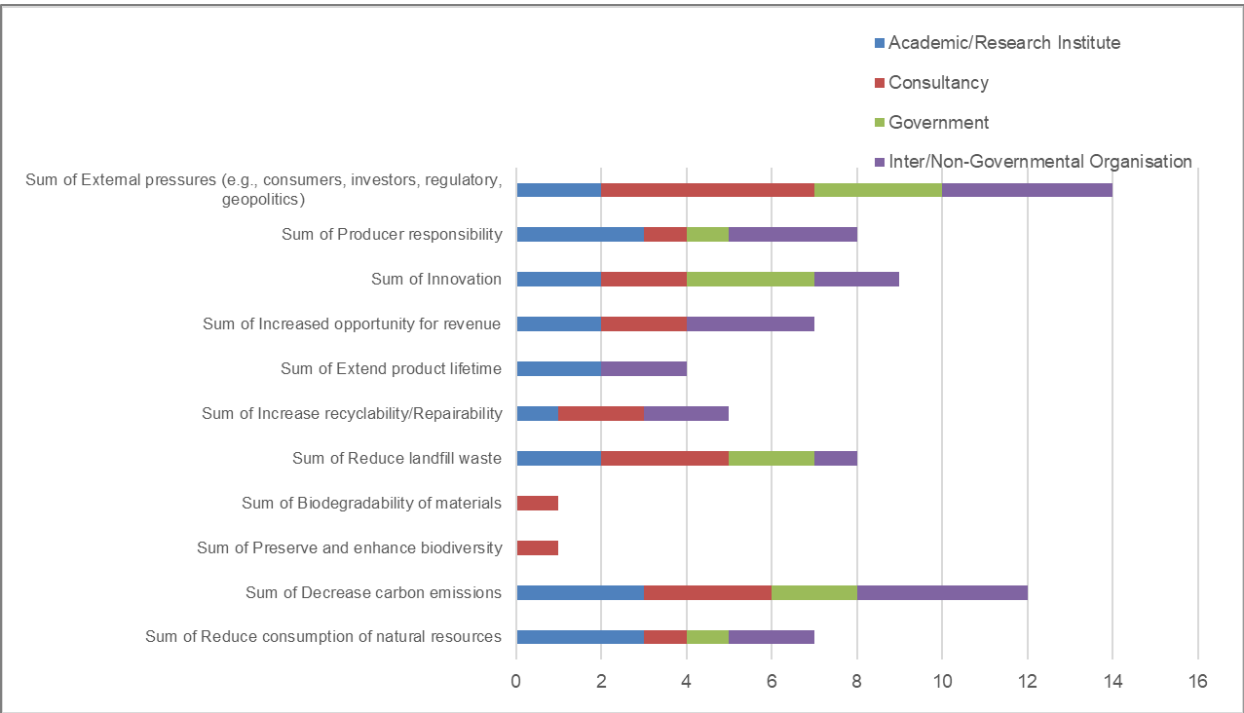Figure 3.3   Q2: Top motivations for implementing CE principles (industry)

Figure 3.4   Q2: Top motivations for implementing CE principles (non-industry)

The top three items with the most responses, both in industry and non-industry, are as follows:

Industry (Figure 3.3): decrease carbon emmissions (14), reduce consumption of natural resources (10), increased opportunity for revenue (10)
Non-industry (Figure 3.4): external pressures (14), decrease carbon emmissions (12), Innovation (9)

From the above, we can see that in addition to the motivation of decarbonization and reduction of natural resources, there are many in industry who see CE as an opportunity for profit. In addition, innovation is the third most common response from non-industry. This shows that many non-industry see CE as an opportunity for innovation.

Q3: What CE initiatives does your organisation undertake? Select all that apply.
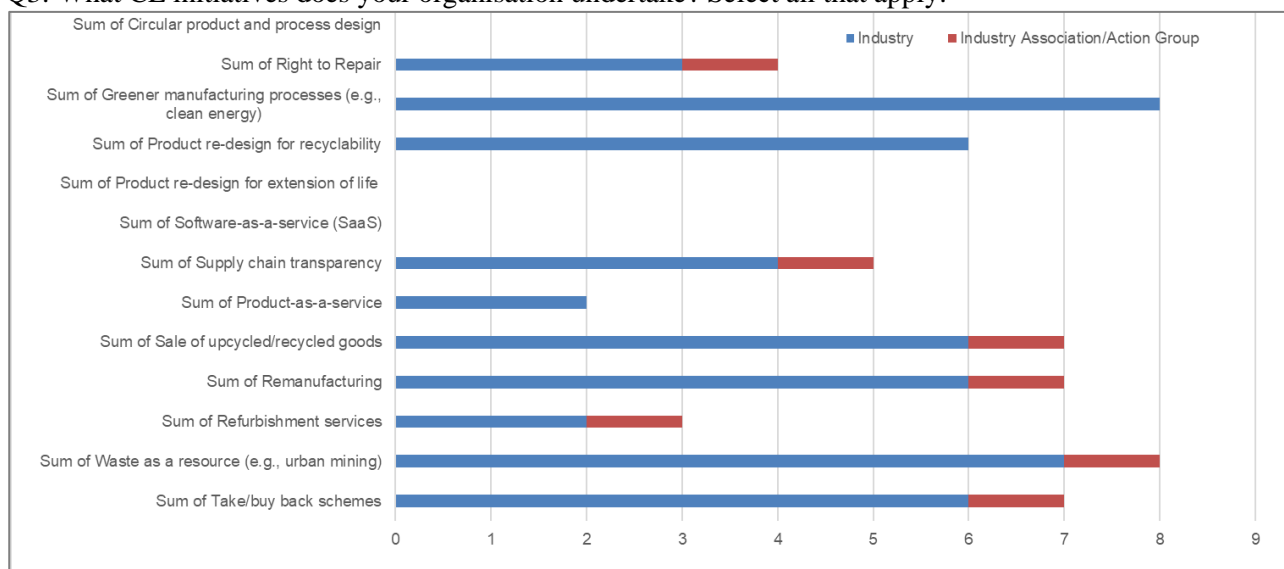

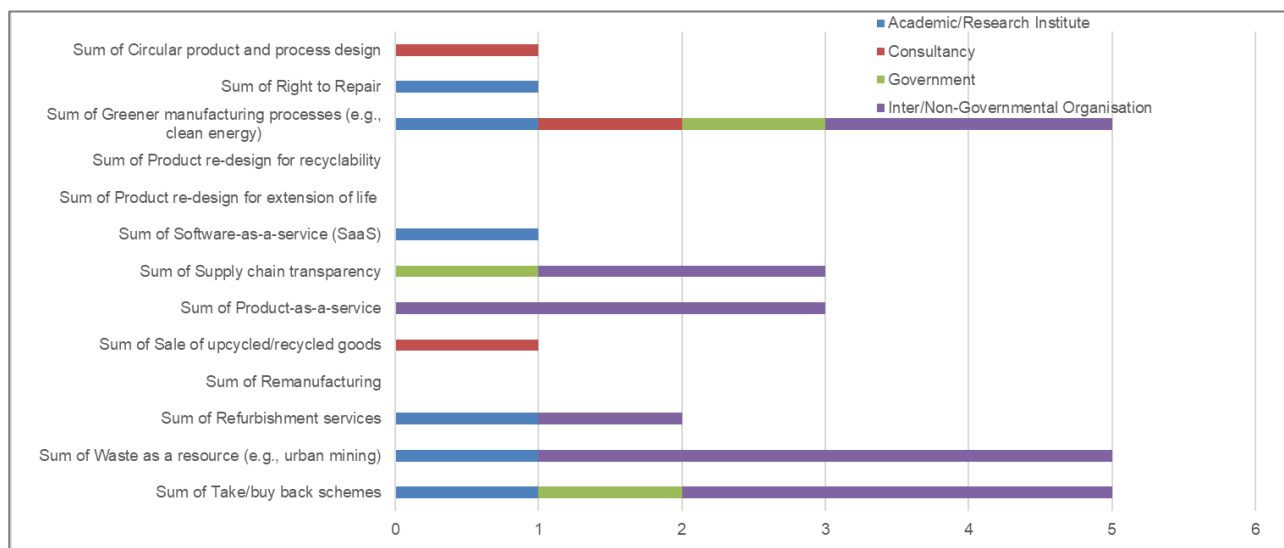Figure 3.5   Q3: What CE initiatives does your organisation undertake?   (industry)

Figure 3.6   Q3: What CE initiatives does your organisation undertake? (non-industry)

The top items with the most responses, both in industry and non-industry, are as follows:

Industry (Figure 3.5) : Greener manufacturing processes (8), Waste as a resouce (8), Take/buy back schemes (7), Remanufacturing (7), Sale of upcycled/recycled goods (7)
Non-industry (Figure 3.6) : Greener manufacturing processes (5), Waste as a resouce (5). Take/buy back schemes (5)

All of these initiatives contribute greatly to CE, and if the performance of such initiatives can be measured and visualized, there is the potential to guide corporate efforts.

Q4: Does your organisation undertake any of the following assessments? Select all that apply.
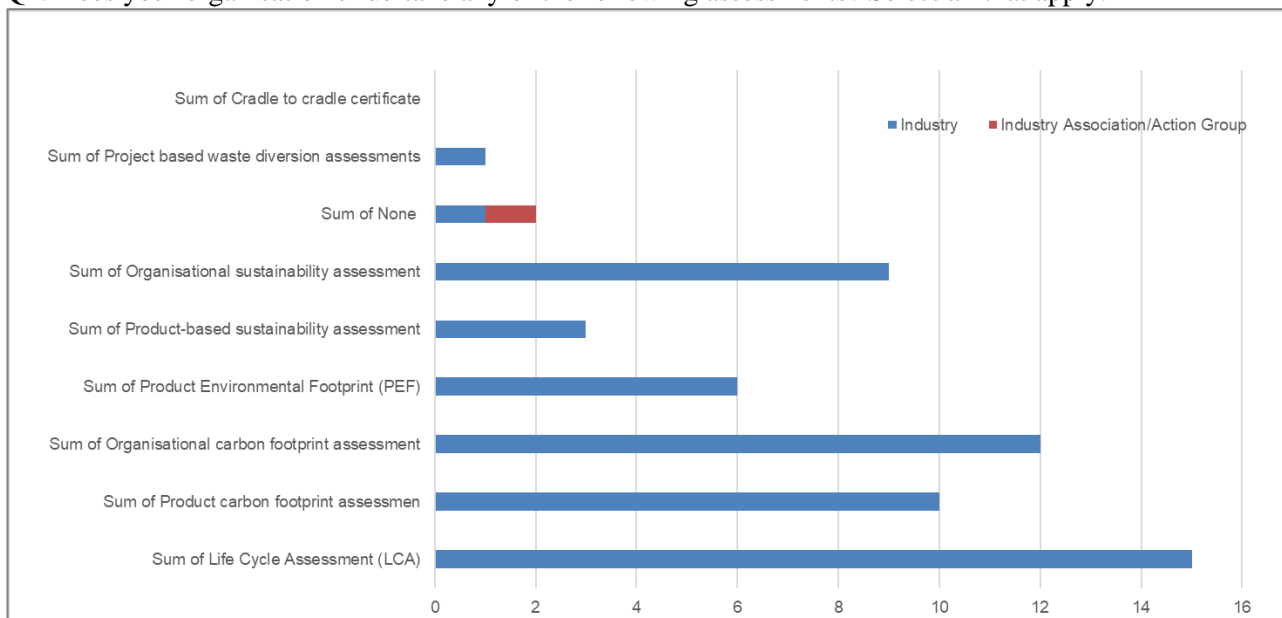

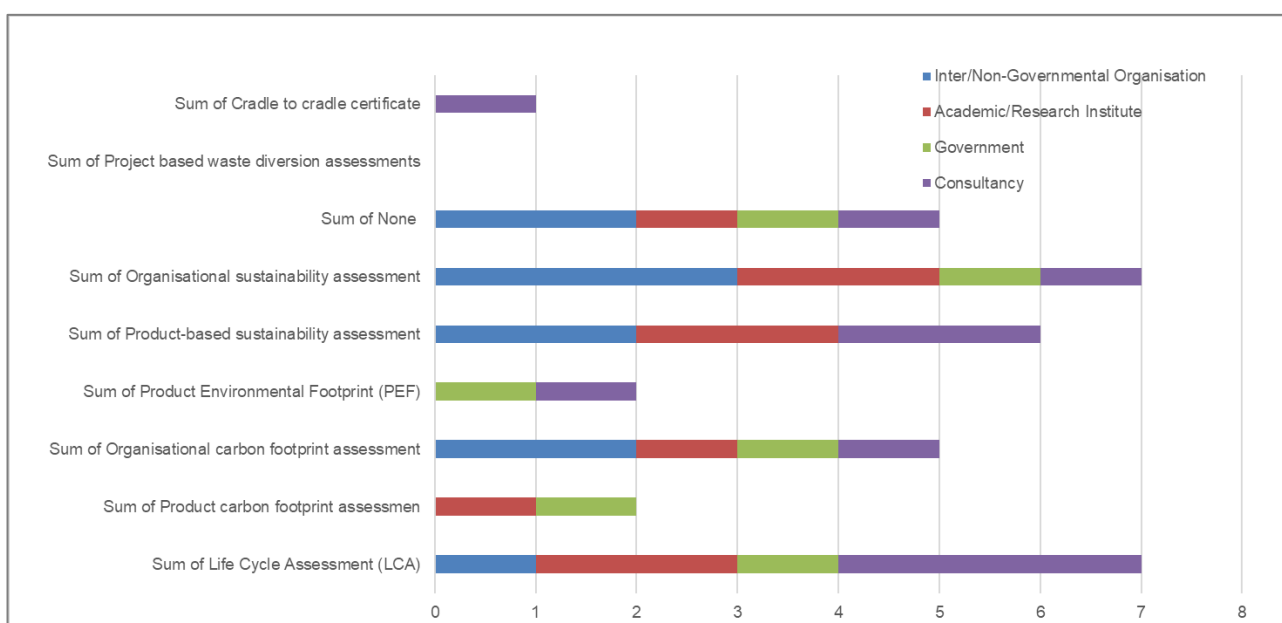Figure 3.7   Q4: Does your organisation undertake any of the following assessments? (industry)

Figure 3.8   Q4: Does your organisation undertake any of the following assessments? (non-industry)

The top items with the most responses, both in industry and non-industry, are as follows:

Industry (Figure 3.7) : Life Cycle Assessment (LCA) (7), Ordganizational carbon footprint (CFP) assessment (12), Product CFP assessment(10)

Non-industry (Figure 3.8)   : LCA (7), Ordganizational CFP assessment(7), Organizational sustainability assessment (6)

Regarding the evaluation of CE, many respondents indicated that they assess LCA and CFP. LCA and Product CFP assessment are thought to be factors that affect the value of recycled products/materials, and Organizational CFP and sustainability assessments are thought to be factors that affect corporate value.

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Q5: What challenges do you find with standardising circular economy practices in your organisation? Select all that apply.
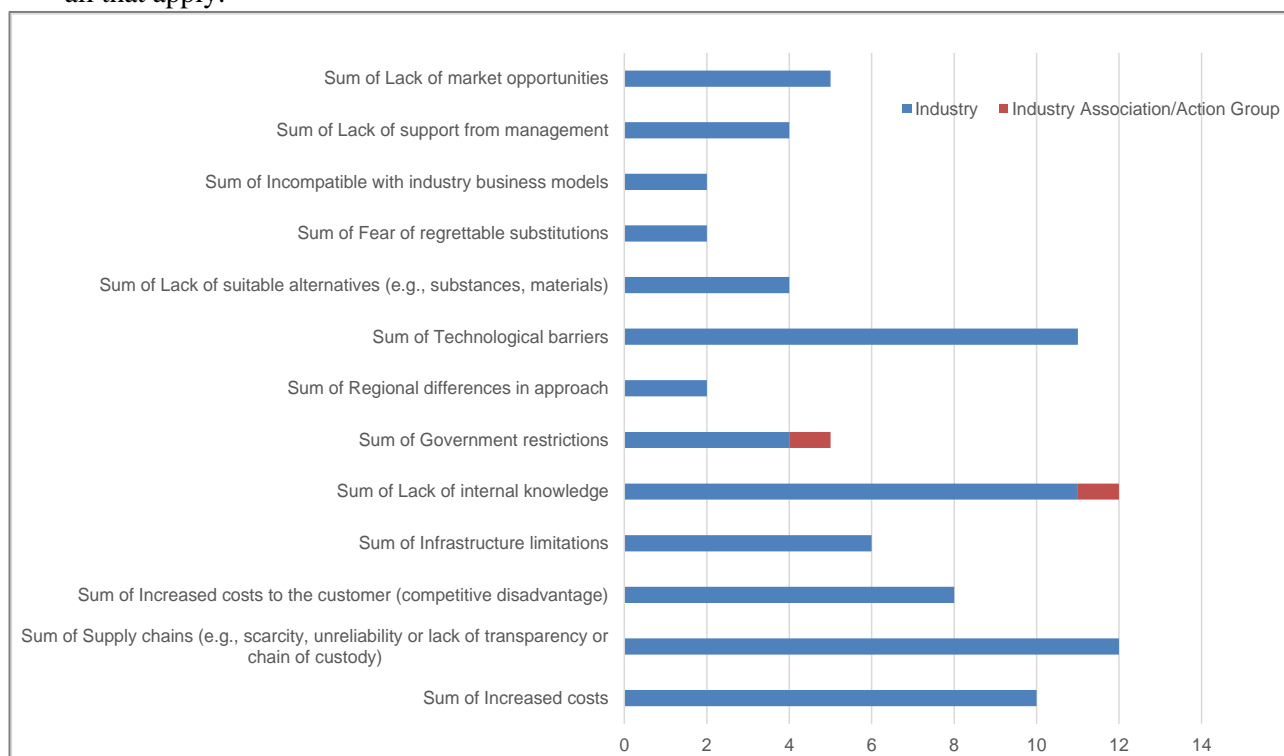
Figure 3.9   Q5: What challenges do you find with standardising circular economy practices in your organisation?   (industry)
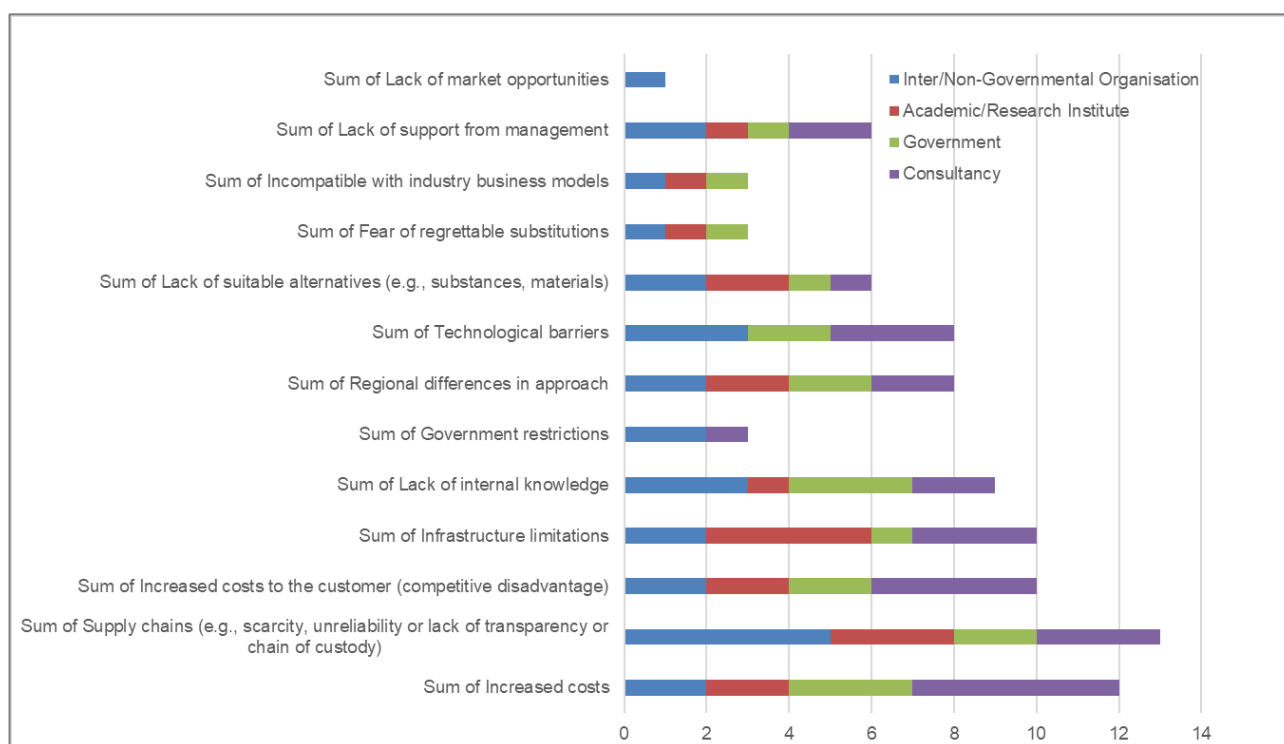
Figure 3.10   Q5: What challenges do you find with standardising circular economy practices in your organisation?   (non-industry)

The top items with the most responses, both in industry and non-industry, are as follows:

Industry (Figure 3.9) : Lack of internal knowredge(12), Supply chains (SC) (e.g., scarcity, unrelaiability orlack of transparency or chain of custody (CoC))(12), Technologucal barriers (11), Increased cost to the customer (10)

Non-industry (Figure 3.10)： SC(e.g., scarcity, unrelaiability orlack of transparency or CoC) (13), Increased

cost (12), Increased cost to the customer (10), Infrastructure limitations (10)

In terms of issues in the CE, both in industry and non-industry, "SC(e.g., scarcity, unrelaiability orlack of transparency or CoC)" is frequently selected. In other words, it is an issue of ensuring the quantity, reliability, transparency and Chain of Custody in SC. In order to achieve grading that makes values visible, it is thought that it will be necessary to utilize information and data on the SC that takes these issues into account.

Q6: What areas of the circular economy offer the best opportunities for revenue? Select up to 5.

Figure 3.11   Q6: What areas of the circular economy offer the best opportunities for revenue? (Industry)
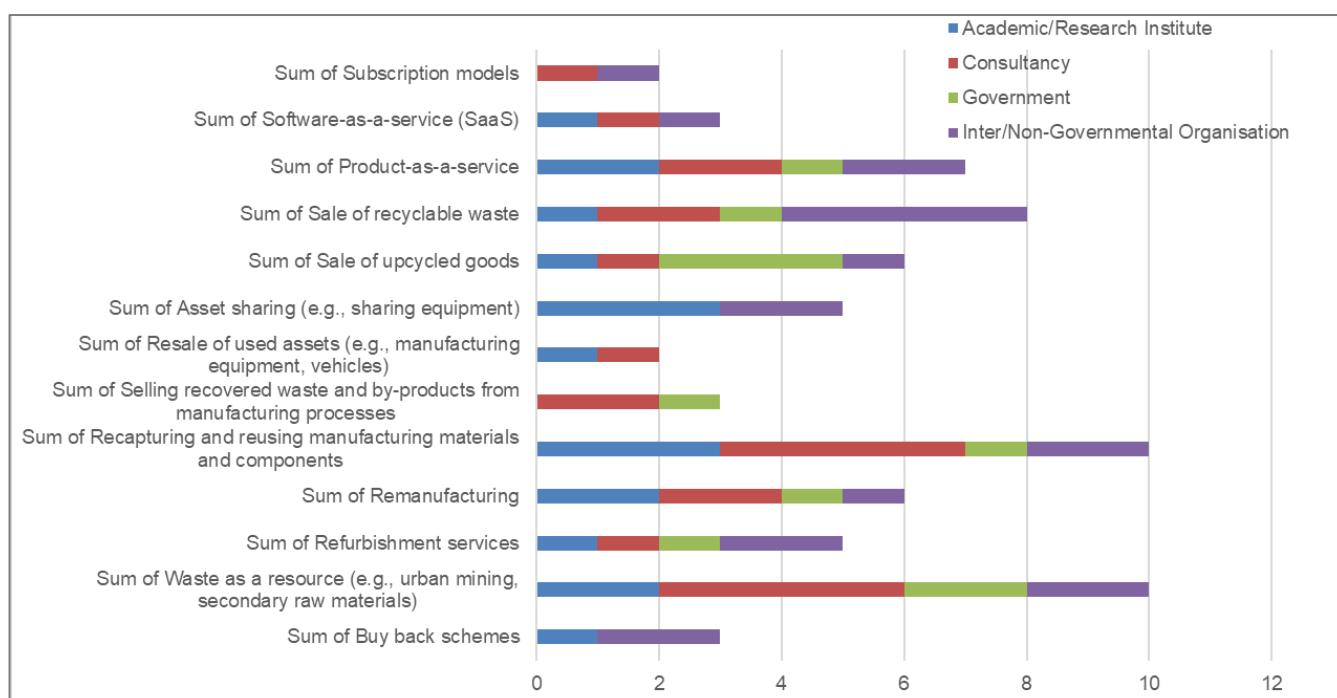
Figure 3.12   Q6: What areas of the circular economy offer the best opportunities for revenue? (non-industry)

The top items with the most responses, both in industry and non-industry, are as follows:

Industry (Figure 3.11) : Waste as a resource (10), Remanufacturing (7), Recapturing and reusing manufacturing materials and components (6), Selling recovered waste and by-products from manufacturing processes (6)

Non-industry (Figure 3.12): Waste as a resource (10), Recapturing and reusing manufacturing materials and

components (10), Sale of recyclable waste (8)

These activities are seen as opportunities to generate revenue, and if a small investment can generate a large return, it will encourage the transition to CE. In other words, it is important to show the return on investment of CE, and we believe that making such indicators visible will encourage the transition to CE. In addition, we believe that value-added activities such as these will lead to increased transactions through the "visualization of value" through grading.

Q7: How much of an impact do you think circular economy regulations will have on businesses, globally?

Figure 3.13   How much of an impact do you think circular economy regulations will have on businesses, globally? (industry)

As Q7 was about the business impact of the CE regulations, there were no responses from outside the industry, but 15 out of 20 organizations (75%) in the industry felt that the CE regulations had some sort of positive impact.

Q8: Which of the following are the most useful in the standardisation of the circular economy for your organisation? Select up to 5.
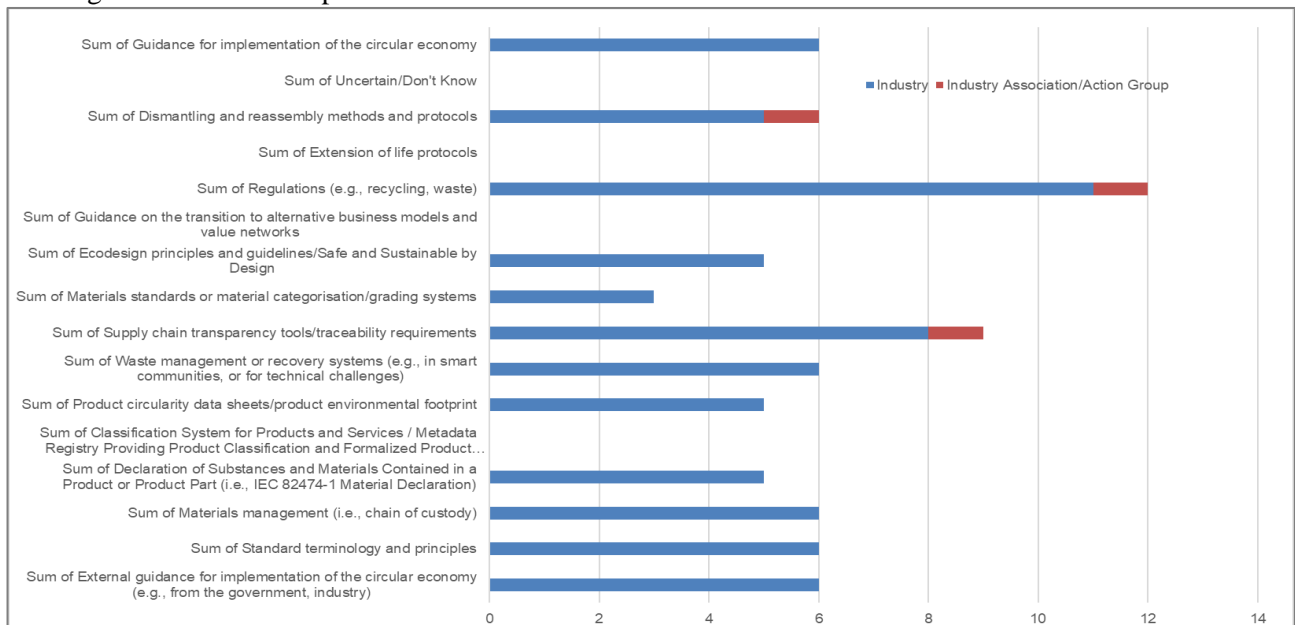
Figure 3.14   Q8: Which of the following are the most useful in the standardisation of the circular economy for your organisation? (industry)
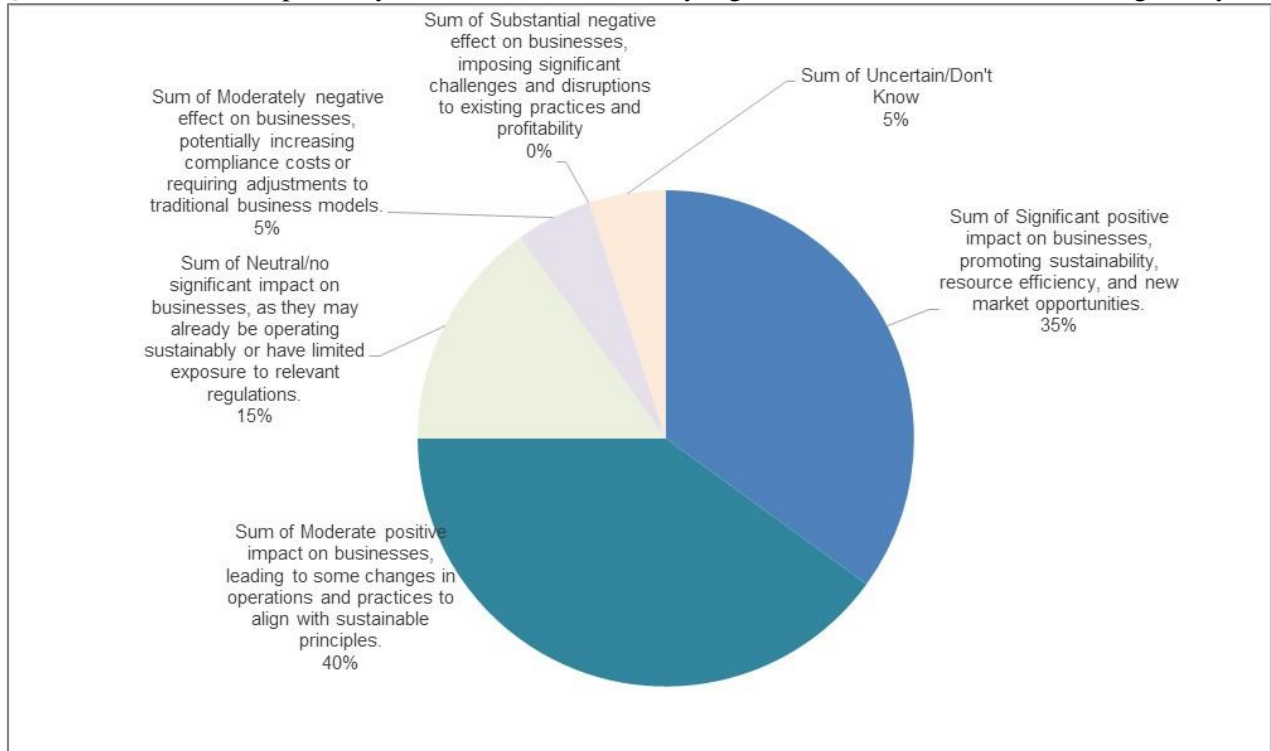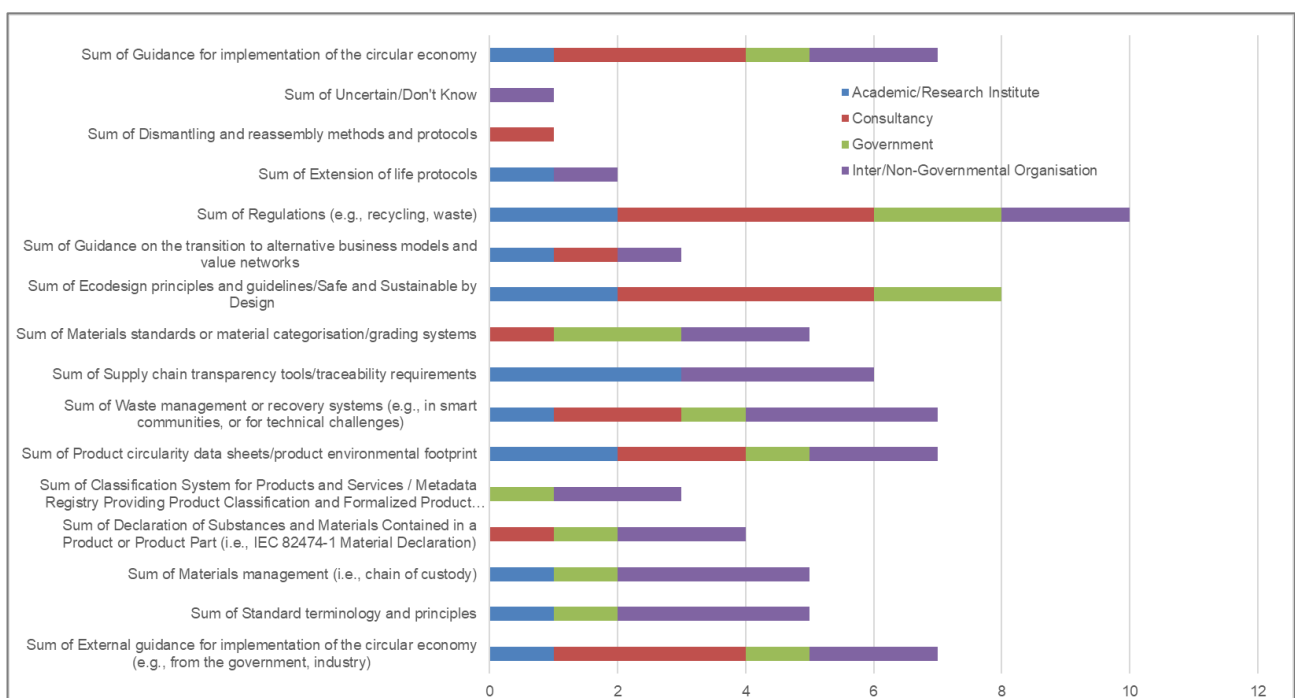

Figure 3.15   Q8: Which of the following are the most useful in the standardisation of the circular economy for your organisation? (non-industry)

The top items with the most responses, both in industry and non-industry, are as follows:

Industry (Figure 3.14): Regulations (e.g., recycling, waste) (12), SC transparency tools/traceability requirements (9)

Non-industry (Figure 3.15): Regulations (e.g., recycling, waste) (10), Ecodesign principles and guidelines/Safe and Sustainable by Design (8)

The second most common item in the industry is "SC transparency tools/traceability requirements". These data are elements that determine the "value of the thing". It is regarded that "value of the thing" will expected to be more visible.

Q9: Which materials or components are of most concern to your organisation in the successful implementation of the circular economy? Select up to 5.

Figure 3.16   Q9: Which materials or components are of most concern to your organisation in the successful implementation of the circular economy? (industry)

Figure 3.17   Q9: Which materials or components are of most concern to your organisation in the successful implementation of the circular economy? (non-industry)

The top items with the most responses, both in industry and non-industry, are as follows:

Industry (Figure 3.16): Plastics (10), Critical raw materials(CRM) (9), Batteries (6)

12

Non-industry (Figure 3.17): Plastics (15), Microprastics (11), Batteries (10)
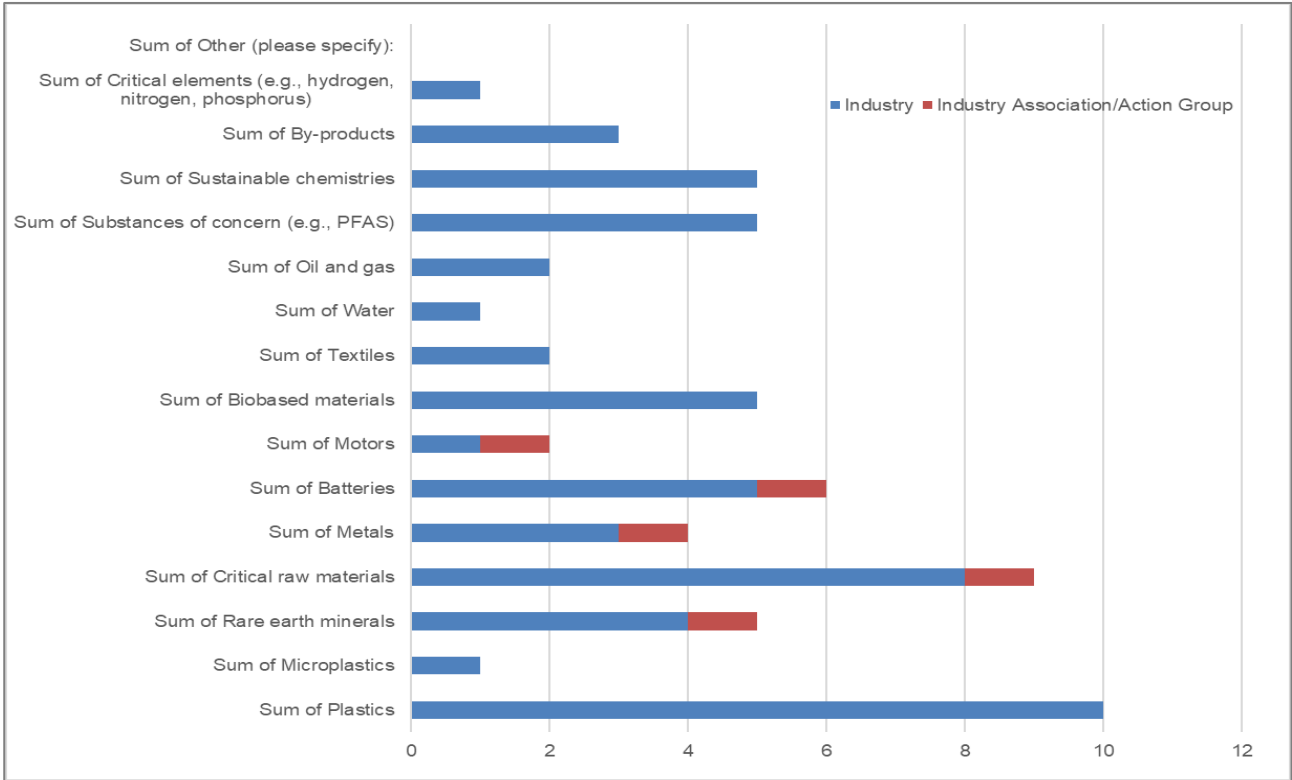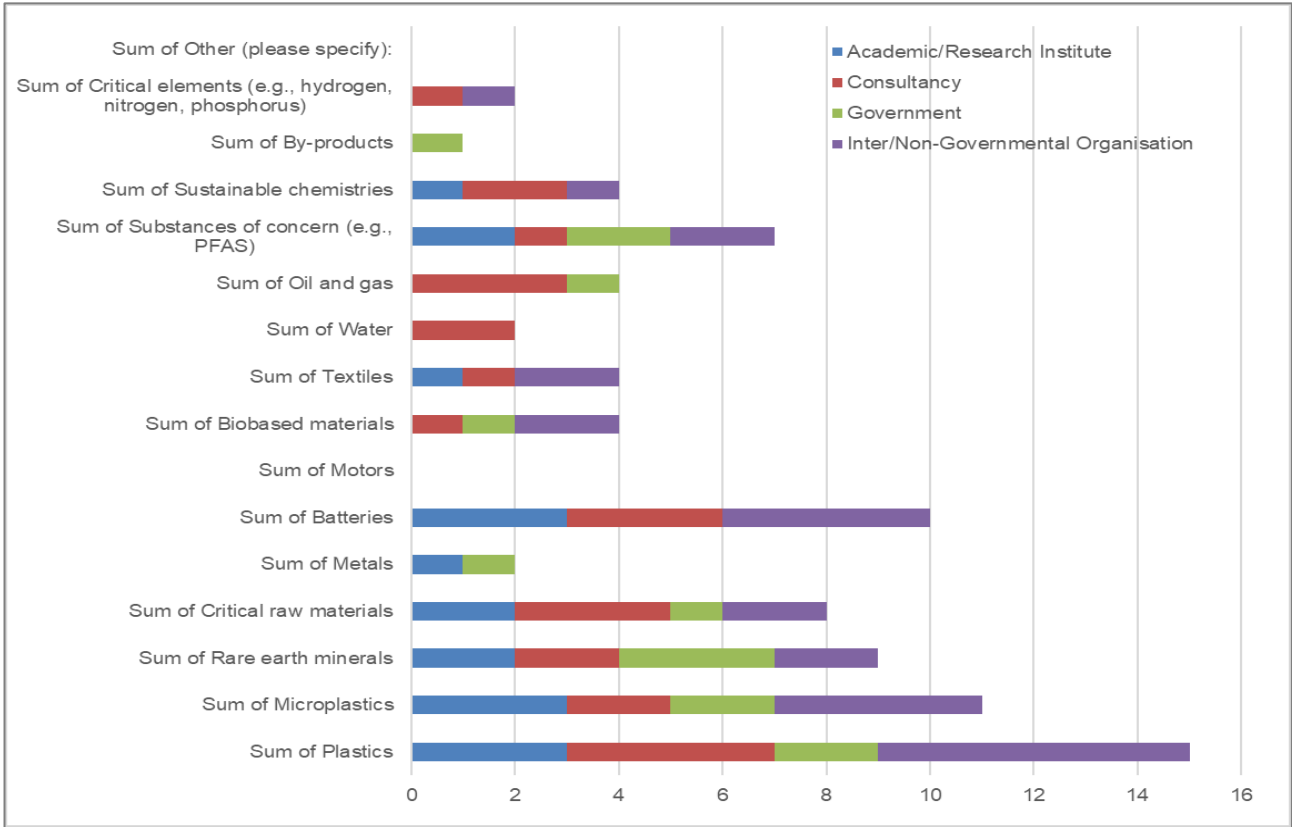
Plastics, CRM and batteries are the products, parts and materials that are of concern in both industry and non-industry. In particular, the demand for recycled plastics is increasing due to regulations, and CRM and batteries are important from an economic security perspective, so there is a possibility that their value will increase through recycling. The need for grading is apparent.

Q10. Eco or sustainable design is being prioritised by some regulators. If your organisation is undertaking ecodesign, what areas are you targeting? Select up to 5.
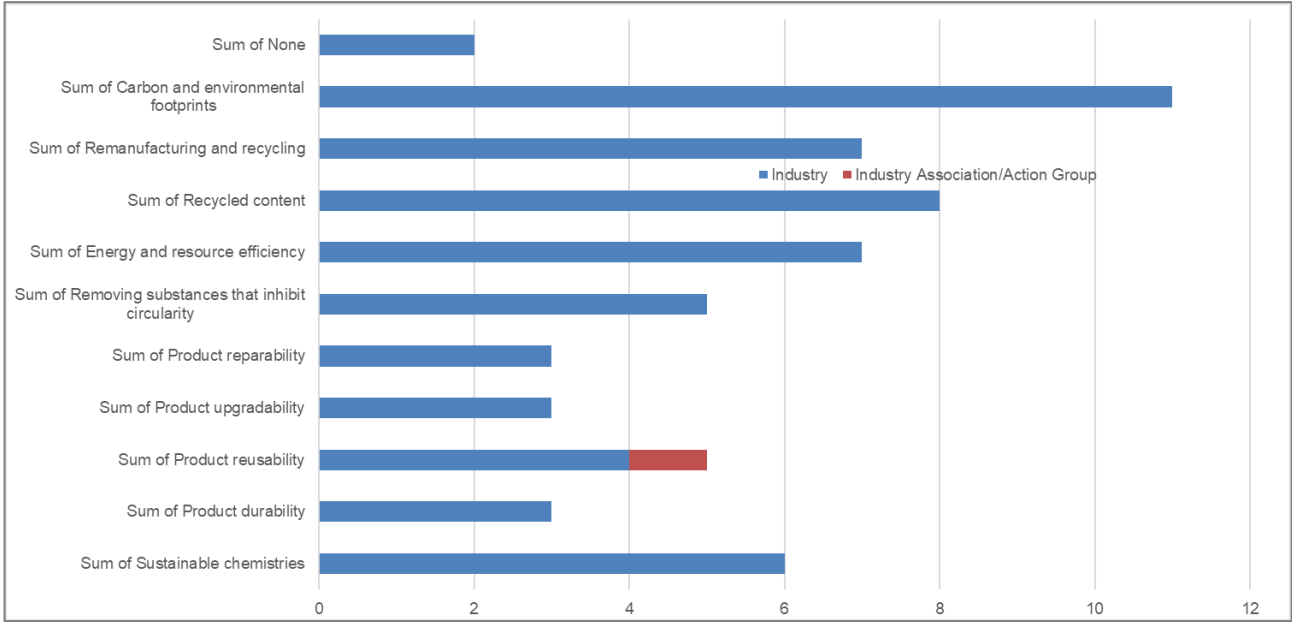
Figure 3.18   Q10: Eco or sustainable design is being prioritised by some regulators. If your organisation is undertaking ecodesign, what areas are you targeting? (industry)
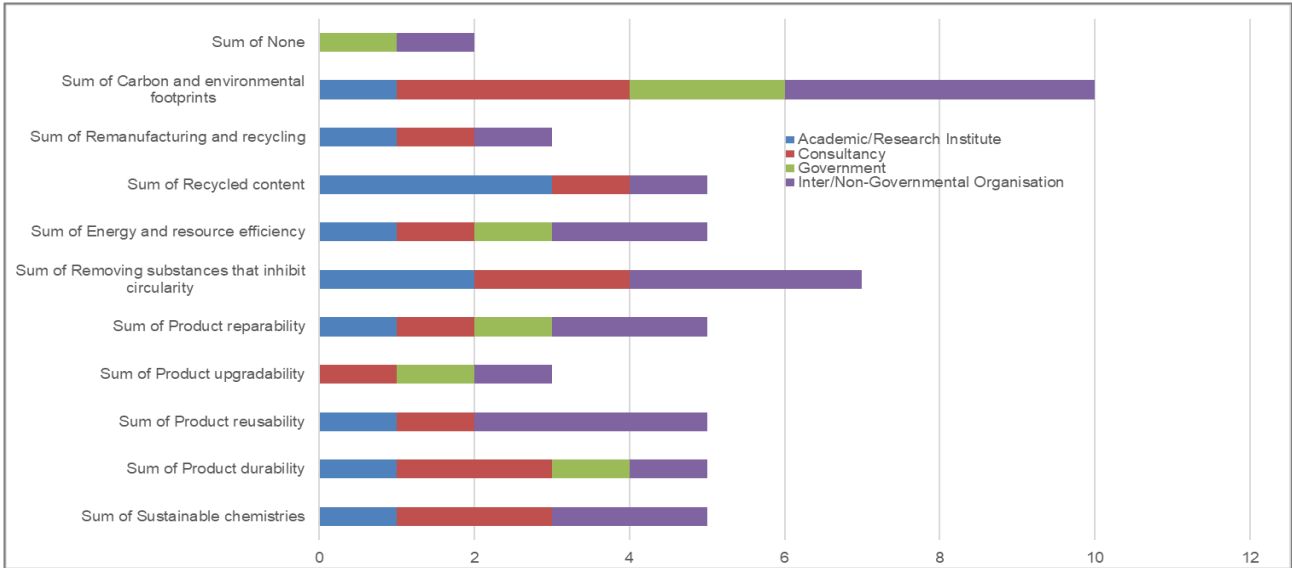
Figure 3.19   Q10: Eco or sustainable design is being prioritised by some regulators. If your organisation is undertaking ecodesign, what areas are you targeting?   (non-industry)

The top items with the most responses, both in industry and non-industry, are as follows:

Industry (Figure 3.18): Carbon and environmental footprints (11), Recycled content (9), Remanufacturing and recycling (8), Energy and resource efficiency (8)

Non-industry (Figure 3.19): Carbon and environmental footprints (10), Removing substances that inhibit circularity (7)

The above items are considered to be the information necessary to indicate the value (grade) of recycled products and materials.

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Q11: Are you aware of any of the following initiatives to support industry transition to the circular economy? Select all that apply.
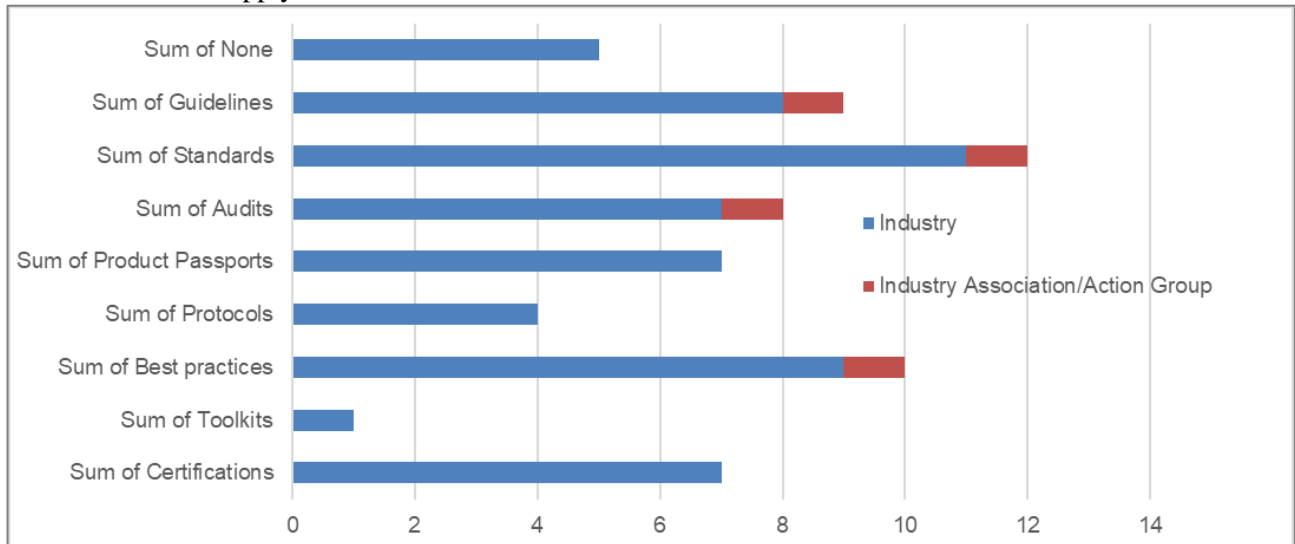
Figure 3.20   Q11: Awareness of initiatives to support industry transition to the circular economy (industry)
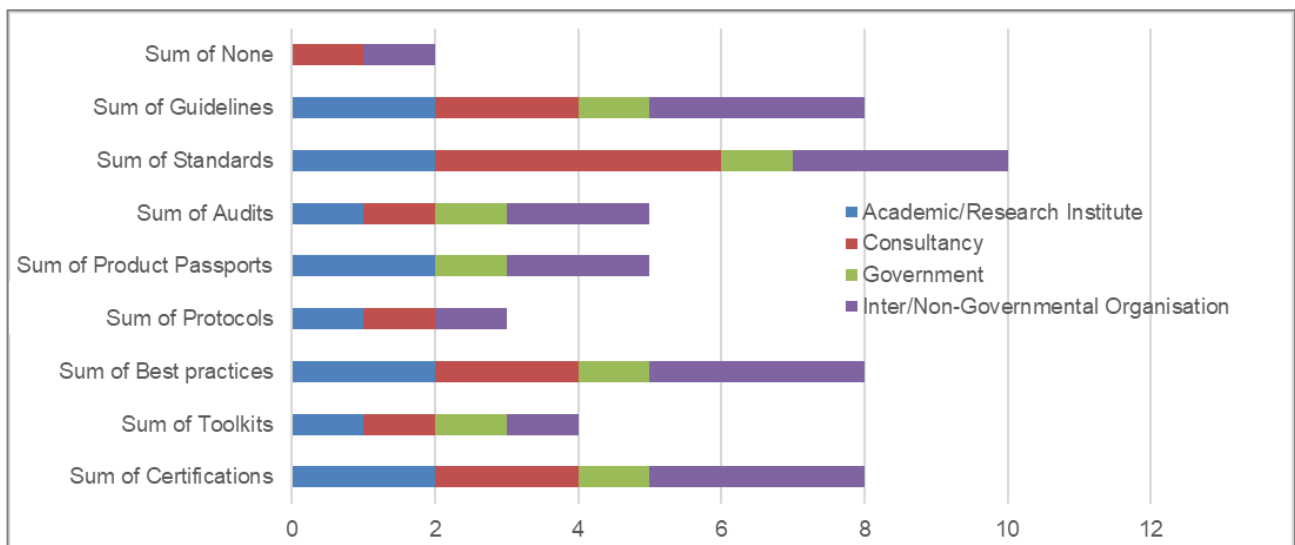
Figure 3.21   Q11: Awareness of initiatives to support industry transition to the circular economy (non-industry)

The top items with the most responses, both in industry and non-industry, are as follows:

Industry (Figure 3.20): Standards (12), Best practices (10), Guidelines(9)
Non-industry (Figure 3.21): Standards (10), Guidelines (8), Best practices (8). Certifications (8)

Many in industry and non-industry insisted that standards and best practices would help to promote the transition to CE.

Q12: . Is your organisation collaborating with any external partners to help achieve circular economy goals? Select all that apply.
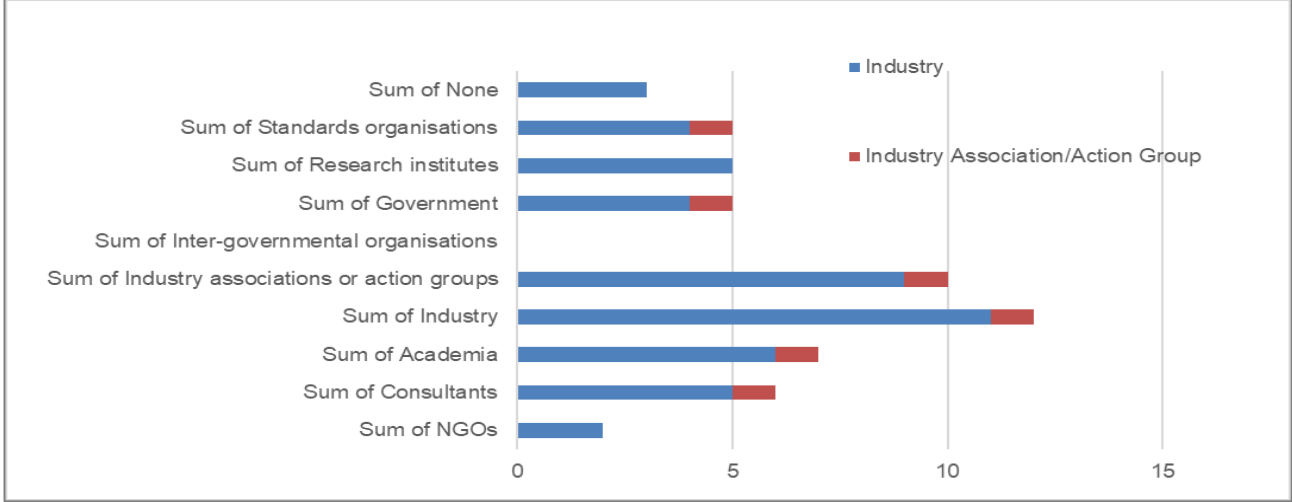
Figure 3.22 Q12: Collaboration with external partners to help achieve circular economy goals. (industry)
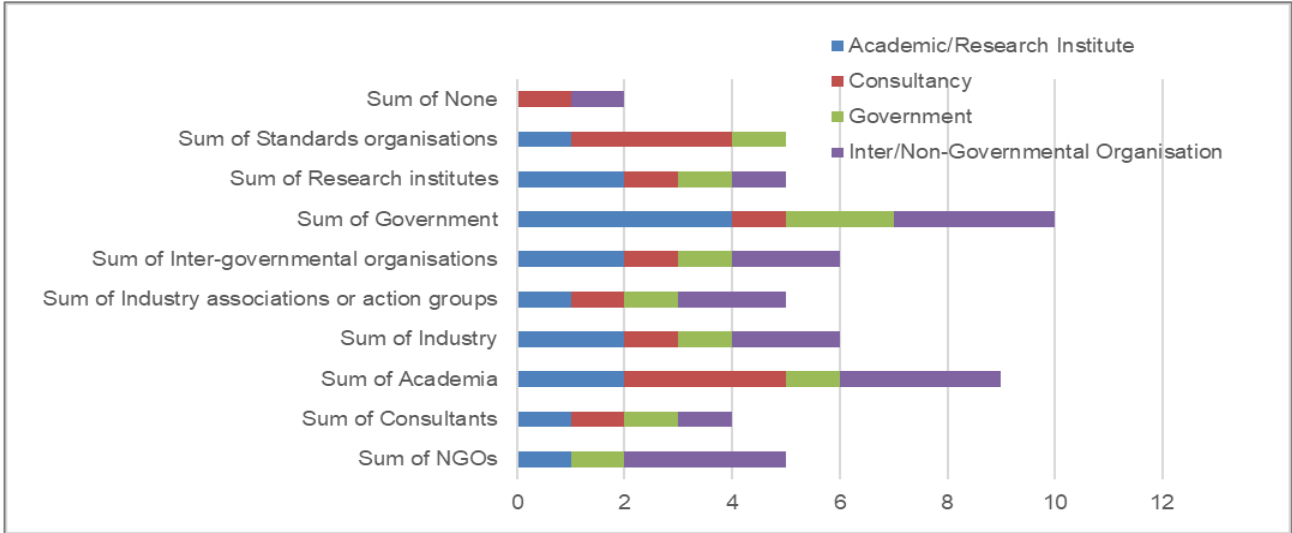
Figure 3.23 Q12: Collaboration with external partners to help achieve circular economy goals. (non-industry)

The top items with the most responses, both in industry and non-industry, are as follows:

Industry (Figure 3.22): Industry (12), Industry associations or action groups (10), Academia (7)
Non-industry (Figure 3.23): Government (10), Academia (9), Inter-governmental organisations (8), Industry (8)

In industry, CE is often driven by collaboration between companies. On the other hand, non-industry, there is no bias toward government, universities, intergovernmental organizations, or specific organizations.

Q13: How far along is your organisation in adopting circular economy principles? (industry)
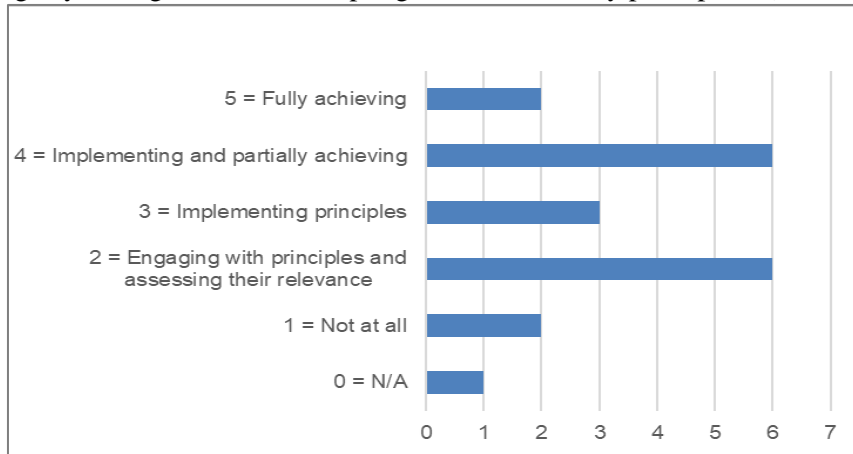
Figure 3.24   Q13: How far along is your organisation in adopting circular economy principles? (industry)

Q14: How motivated is your organisation to implement circular economy practices? (industry)
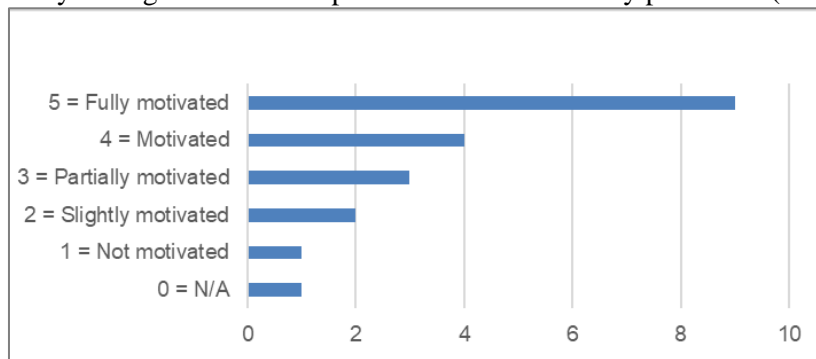
Figure 3.25   Q14: How motivated is your organisation to implement circular economy practices? (industry)

Q15: How motivated do you think your supply chain is to implement circular economy practices? (industry)
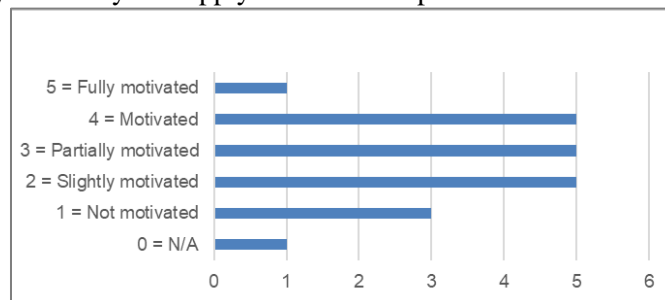
Figure 3.26   Q15: How motivated is your organisation to implement circular economy practices? (industry)

The results of the above can be summarized as follows.

（1） Regarding performance indicators
- In implementing CE, the industry puts emphasis on competitiveness, added value and corporate value, and it is also important to show these things to stakeholders, investors, etc. Therefore, it is necessary to have indicators on competitiveness, added value and corporate value to appeal to them. (From the results of Q1)
- In industry, many organizations see CE as an opportunity for profit, so Key Performance Indicators (KPIs) that show profit are desirable. (From the results of Q2)
- Many of the initiatives in CE are related to green manufacturing and the use of urban mines, so it would be good to have an indicator that could be used to show the results of these initiatives as contributions to CE. (From the results of Q3)
- Revenue opportunities in CE include the use of urban mines and remanufacturing, and if large profits can be made with a small investment, the attractiveness of CE will increase and lead to the transition. We

believe that the transition to CE can be encouraged by making the return on investment in CE more visible. (From the results of Q6)
- CFP and sustainability assessments are being used to evaluate organizations and are expected to have an impact on shareholder value. These assessment items can also be considered to be essences of performance indicators. (From the results of Q4)

（2） Regarding Grading
- Regarding the need for grading
  - ➢ Revenue opportunities in the CE include the use of urban mines and remanufacturing. These activities have the potential to generate high value. Visualizing this high value has the potential to revitalize transactions between or among recovery businesses. By making high value visible, there is the possibility of revitalizing transactions between or among recovery businesses. (From the results of Q6) It is also suggested that grading is necessary as a means of "visualizing value".
  - ➢ When asked "Which materials or components are of most concern to your organisation in the successful implementation of the circular economy?" (Q9), many respondents answered plastics, CRM and batteries. As transactions in these areas are expected to increase in the future, there is a high level of expectation for the "visualization of value" through grading in order to facilitate the transactions.
- Information/data required for "grading"
  - ➢ As for evaluations of CE, many respondents answered that they were evaluating LCA and CFP. These factors affect the value of recycled products and materials, and the evaluation results can be considered as information that can be used for "grading". (From the results of Q4)
  - ➢ One of the most common issues raised in relation to standardization in the implementation of CE was "SC(e.g., scarcity, unrelaiability orlack of transparency or CoC)". (Q5) In paticular, information such as laiability, transparency or CoC affects the value of goods in transactions in reverce SC. We believe that this kind of information is necessary for "grading" to visualize the value of things in reverce SC.
  - ➢ When asked "Which of the following are the most useful in the standardisation of the circular economy for your organisation?" (Q8), many in industry responded with "SC transparency tools/traceability requirements". The transparency and traceability of SC are considered to be requirements for "grading".
  - ➢ Q10 is a question about the area that is the target of eco-design, and the answers given are "Carbon and environmental footprints", "Recycled content", "Remanufacturing and recycling", "Energy and resource efficiency", and "Removing substances that inhibit circularity". This information is considered necessary for "grading" showing the value (grade) of recycled products and materials.
- The need for data linkage in SC
  As mentioned above, the results of Q5 and Q8 show the importance of obtaining information/data on SC. The same is true for LCA and CFP, which are mentioned in the results of Q4 and Q10. Based on these responses, data linkage is required at the SC. "Grading" requires data to be obtained from the upstream side of each player's SC, as each player on the recovery VC, including recyclers, needs to be able to visualize the value.
  ISO 59010 [4] specifies the construction of a network (Value Network (VN)) that connects players between production and recovery.

（3） Other insights
- Expectations for International Standardization
  There was a high level of awareness about standardization as an initiative to support the transition to CE. It is thought that there are high expectations for standardization. (From result of Q11)

(4) Summary of the quantitive questionnaire analysis
The above analysis has revealed the need for "performance indicator" and "grading".
In addition, it was understood that the following three key points are necessary for "grading".
① Requirements such as transparency and traceability
② Information on substances that inhibit circularity (hazardous materials) and CFP
③ Information/data collaboration in VN, such as SC and VC

In the next section, we will further explore these themes based on the results of the short interviews.

3.2 Short Interview
The results of the short interviews conducted with 38 organisations are summarised in

Appendix 2. In Appendix 2, in addition to the "performance indicators" and the "grading" (visualisation of value), there are columns for each of the keywords mentioned in the previous section (4) ①~③, "Transparency", "Traceability", "Substances that inhibit circularity (Hazardous Materials)", "CFP", "VN" and "Data Utilisation", and a circle is placed in the relevant column for those mentioned. In addition, we include ESG (environment, social, governance) in our CFP with the aim of contributing to the SDGs. There were also many references to 'confidentiality', so we have also included a column for this.

The following is a discussion of the "paformance indicator" and "grading" using Appendix 2, result of the short interview.

(1) About the "Performance Indicator"
In the results of short interviews with 38 organisations, there were 8 organisations that mentioned the indicators. The main comments are as follows. The main comments are as follows. The numbers in parentheses (# + number) are the interview IDs.
- The value is concentrated on material recycling, which is only a part of the actors. Therefore, we do not want to focus on the target of the recycling rate. (#2)
- Researching CE evaluation. (#10)
- We are taking on the role of establishing best practices for communicating the performance of a circular business model to investors. Stakeholder incentives are needed. (#14)
- The issue is that there is no appropriate indicator for measuring CE, and there is a concern that misleading opinion will be made. Clear and realistic specifications are needed based on accurate measurements. Economic value is needed. (#16)
- Quantitative indicators are extremely difficult to obtain. CE is extremely complex, with no single indicator that can be tracked. (#17)
- Aircraft are used for a long time and are repaired and recycled many times. Product as a Service is the prescribed business model. (#18)
- Focuses on the efficiency of energy, water and waste recovery related to CE and urban mining. (#23)
- We are trying to define the company's KPIs based on 9R. (#27)

As many of the comments show, there are needs for the indicators, but there are also many issues. As for "best practices for communicating the performance of a circular business model to investors" in"14, we think that the "CE Added Value Productivity Index" [3] proposed by WG3 is available. In addition, #16 mentions the need for an indicator of economic value. From #18 we can see that there is a desire for indicators that can evaluate CE contributions other than those that reduce linear resources, such as product life extension and product as a service. #23 focuses on efficiency, suggesting the importance of indicators of efficiency.

(2) About the "Grading"
There were 9 organizations that made reference to "grading" (visualizing value). The main comments are as follows.
- Assessing the condition and remaining life of parts. (#1)
- Plastic needs to be "graded". (#6)
- The quality of recycled plastic is a concern. It is necessary to know the technical characteristics. Labeling is also necessary. (#13)
- Data sharing can be used to evaluate value. (#24)
- If we can maintain the quality of our separation, our value will increase and our competitiveness will also increase. (#26)
- Better guidance is needed on determining the quality of materials. (#28)
- We need something that brings the circularity of textiles closer to the circularity of automobiles, and there are different sectors under that. The risk is that each of them has a different definition, etc. We need confidence in the value. It's about certification. (#33)

From the above, we can see that "grading" is required for plastics. We can also see that quality is an important piece of information for "grading".

From the keywords in the majour comments, it can be seen that the following are the requirements for "grading".

- All of these keywords are mentioned by multiple organizations, and it seems that there is a lot of interest in them. (Figure 3.1)
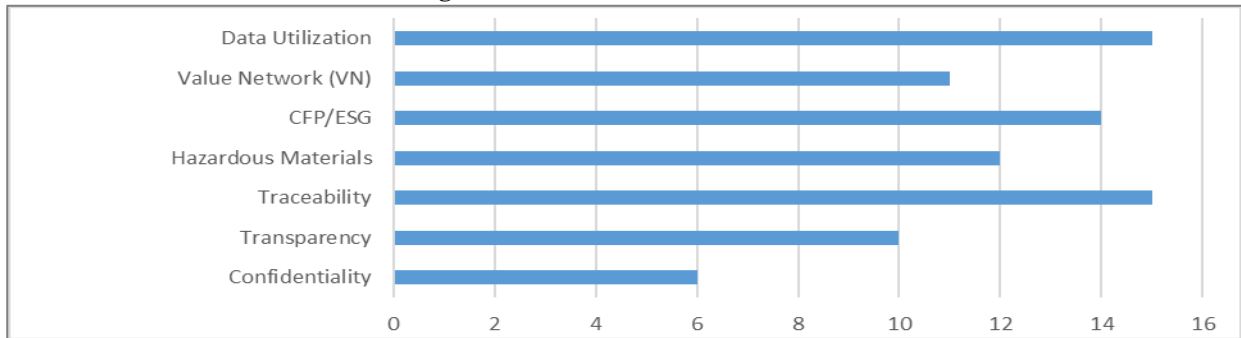
Figure 3.1 Number of comments for each keyword

- Both the references to confidentiality and transparency were indicative of their importance and necessity.There were also comments that the use of DPP was helpful. (#24)。
- Although there were many comments indicating the need for traceability, there were also comments like the following.
  - ➢ Voluntary information sharing is necessary, and this is an issue for the CoC. (#2)
  - ➢ There are also those who point out the existence of the gray market and informal sector. (#5, #14, #23)
  - ➢ There was an example of a local government in the UK that was receiving reports from the private contractor for waste services. (#22)
  - ➢ There are also cases of providing information that contributes to traceability. (#24, #26)
- There were also many comments indicating the necessity and importance of substances that inhibit circularity (Hazardous Materials) and CFP/ESG.
- Many comments regarding the need for network construction were made regarding VN and data utilization. In the automotive industry, there were also comments that some players were working together and sharing data. (#5, #6, #24)。

(3) Summary of Short Interview

The short interview also provided comments supporting the need for "performance indicators" and "grading" and their requirements, which were derived from the analysis of the questionnaire in section 3.1 (4) above.

4. Conclusion

4.1 Summary

In order to understand the need for standardization and rule-making, we conducted a survey of the current situation regarding the value network of the circular economy in companies and organizations. This survey was conducted through questionnaires and short interviews, and the subjects were people involved in CE-related industries and government, as well as experts and other knowledgeable individuals. This survey was conducted by outsourcing the work to Yordas, a major consulting firm in the relevant field.

The following was ascertained from the quantitive questionnaire survey.

- The need for performance indicators and grading
- The following key points are required for grading.
  1) Requirements such as transparency and traceability
  2) Information on substances that interfere with circulation and CFP
  3) Information/data collaboration in VN

Many of the comments we received in the short interviews also aligned with the results of the above questionnare survey.

4.2 To the next step

Based on the results of this survey, we will work to make the path to standardization more concrete. To

implement the roadmap, we will consult with experts and stakeholders in the relevant fields and plan to develop the "performance indicators" and "grading" identified in this survey, as well as standards for data models and other specifications that will enable "grading".

5. References

[1] Hoshino, Osamu,et al. Hitachi-AIST Cooperative Research on Circular Economy - Planning Standardization Strategies and their Implementation, *Proceedings of EcoDesign 2023 International Symposium*

[2] Hoshino, Osamu, Kamigaki, Koshi et al. Activities towards "the formation of rules that link things and information", The first open forum of Hitachi-AIST Circular Economy Collaborative Research Laboratory, (https://unit.aist.go.jp/hitachi-cecrl/news/2024/pdf/240205_05.pdf)

[3] Hoshino, Osamu, International Standardization toward Digital CE Transition, *International Symposium on Standardization to Promote Transition to Circular Economy*, Hitachi-AIST Circular Economy Collaborative Research Lab. (https://unit.aist.go.jp/hitachi-cecrl/news/2024/pdf/240423_01.pdf)

[4] ISO 59010 : 2024 Circular economy — Guidance on the transition of business models and value networks, International Organization for Standardization

6. Appendix

Appendix 1 : Details of Survey Methodology by Yordas
Appendix 2 : Short Interview Log (summary)

Appendix 1
Details of Survey Methodology by Yordas

6.1 Quantitive Questionnaire Survey

The quantitive questionnaire survey was prepared based on our understanding of the key issues associated with the transition to a circular economy, and particularly with its regulation and standardisation. This questionnaire is designed so that you can answer by selecting an option for each topic so that quantitative analysis can be performed. The survey was piloted by the project team, using Yordas's staff members not working on the stakeholder engagement (See Chapter 2 of the main text.), but who are familiar with the circular economy.

(1)   Survey structure (refer to 6.3   below)
The survey began with an introduction to the study, the purpose of the consultation, and a set of instructions for completion.   We included contact details of the study team for any questions and logistical requests.

The survey was divided into three parts:
1.   Background information on participants' organisation, job role, region
2.   Technical questions on the circular economy, including those focused on business models, assessments, regulations and standards, materials and components, design, tools and certifications, collaborations
3.   Circular economy leadership according to region and organisation.

The survey was configured to adapt the questions visible to a respondent depending on whether they were an industry or a non-industry respondent. The survey took approximately 20 minutes to complete, and respondents were able to edit their responses until they submitted the survey.

All data collected in this survey was handled in compliance with the European Union's General Data Protection Regulation (GDPR). The survey data is reported only in anonymised aggregate form or in a manner that does not allow individual responses to be identified.

(2)   Survey response rate
While the survey was initially conceived to gain a broad understanding of the challenges and opportunities associated with the transition to the CE across the world, the overall response rate for the survey communication activities was low.
According to Yordas, in general, low internet survey response rates are not uncommon and do not necessarily indicate that results are invalid.[1]   They say, the risk to validity largely depends on whether respondents were not representative of the surveyed population in some way. For example, if there were not a broad sampling of different types of industry or geographies, or if the survey only had highly divergent responses.

Yordas insists, there are a number of reasons why we might have anticipated a low response rate.   External surveys (i.e., surveying participants from outside of one's own organisation--in this case, AIST or Hitachi) tend to have lower response rates. It is also well-known that internet surveys tend to have lower response rates with little information about non-respondents.[2] Furthermore, issue relevance has been found to have a strong correlation with response rate, where relevance is defined as timeliness and importance of a topic. Researchers observed that if a person has low interest in the topic of the survey, they are unlikely to respond.[2] Thus we can assume that individuals with a high interest in the circular economy have responded to the survey. There is also significant survey fatigue in the population in general due to a sharp rise in surveying during the Covid-19 pandemic.[3]   In fact, survey response rates overall have declined significantly in recent years, in some cases

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[1] See van Mol, C., 2007. 'Improving web survey efficiency', *International Journal of Social Research Methodology*, 20(4): 317-327; Bose, J., 2001. 'Non-response Bias Analysis at the National Center for Education Statistics', *Proceedings of Statistics Canada Symposium 2001, Achieving Data Quality in a Statistical Agency;* Berg, Nathan, 2005. 'Non-response bias' in *Encyclopedia of Social Measurement*, 865-873; Alvarez, R. M., Van Beslaere, C., 2005. 'Web-based Survey' in Encyclopedia of Social Measurement, 955-962.

[2] Sheehan, K.B., 2001. 'Email survey response rates: a review', *Journal of Computer-Mediated Communication*. 6: 2; Sheehan, K.B. and McMillan, S.J., 1999. 'Response variation in email surveys, an exploration', *Journal of Advertising Research*, 39: 45-54.

[3] De Koning, R., Egiz, A., Kotecha, J., Ciuculete, A. C., Ooi, S. Z. Y., Bankole, N. D. A., ... & Kanmounye, U. S.,

by as much as 40 percent. This trend can be observed across different types of surveyors (academic, NGO, private) and subject matter.[4]

Conversely, it is known that there are methods to maximise response rate, but these are not always possible. For example, providing an incentive to respondents to complete a survey generally elicits a higher response rate. Incentives can range from some kind of compensation (payment, a voucher, a discount), to less tangible incentives, for example when respondents feel their input will result in a positive impact on their everyday life (e.g., an internal survey of employees about a change to working practices). In this case, respondents may have felt that there was little incentive for them to complete the survey because they were not compensated for their time, and/or because they were not confident that their input would have an impact.

Other well-known low response rate factors, such as demographics affected by access to the internet, lower education rates, or class differences, are not significant to this set of stakeholders. However, time pressure and how often a particular group has been previously surveyed are significant factors in response rate. Surveys of populations who are busy people, or who have previously been surveyed, tend to have much lower response rates.

Yordas has stated that there is no bias in the response rate. Yordas says it has received responses from all stakeholder groups in a wide range of regions and situations, and that the opinions it has received are also very diverse. Furthermore, the results of the survey were deemed to be valid because similar opinions were also expressed in the interviews that were conducted afterwards. As all respondents are experts in the field of circular economy, it is assumed that they recognise the validity of the results of this survey.

6.2 Short Interviews

The purpose of conducting short interviews was to deepen the analysis and to further elaborate on topics from the survey. The survey included a question about people's willingness to participate in a follow-up interview, which helped to generate a list of respondents. Interviewees were also selected from participants at relevant events, conferences, online research, and professional associations. WG3 also made recommendations, and a "snowballing" method — where participants introduce the researchers to further contacts — was used to reach out to new participants. It is worth noting here that not all interviewees have completed the survey.

When selecting interviewees it was important to ensure a representative sample of circular economy stakeholders, in collaboration with the Research Lab. Yordas tried to cover a wide geographical range when selecting interview participants, and other criteria considered were a range of industry representation, years of experience, and subject matter expertise. The range of expertise included product design, regulatory compliance, materials engineering, supply chain management, critical minerals and mining, and polymer chemistry. Most respondents were non-industry stakeholders such as professional associations and research institutions, and they outnumbered industry respondents by approximately two to one. There was an equal number of North American and UK/EU respondents, while one in six respondents were from developing nations.

The interview was structured in three parts: questions were developed for each of the introductory, technical and concluding sections. An interview proforma, which included a note-taking template (one for industry and a second for non-industry stakeholders) was also developed to help guide the interview and note-taking. Both templates were structured as follows:
- Introduction (opening questions for all respondents)
- Circular economy status and plans
- Standards, best practices and regulations
- Challenges and barriers
- Circular economy business models

2021. 'Survey Fatigue During the COVID-19 Pandemic: An Analysis of Neurosurgery Survey Response Rates', *Frontiers in Surgery*, 326.

[4] Dillman, D. A., Smyth, J. D., & Christian, L. M., 2014. *Internet, phone, mail, and mixed-mode surveys: the tailored design method, 4th edition*. Hoboken, NJ: John Wiley & Sons; Tourangeau, R., T.J. Plewes, eds., 2013. *Nonresponse in social science surveys: A research agenda*. Washington, DC: National Academies Press.; De Koning, R., et. al., 2021, as above.; Field, A., 2020. 'Survey fatigue and the tragedy of the commons', *Evaluation Matters,* 6: 1-11; Galea, S., Tracy, M., 2007. 'Participation Rates in Epidemiological Studies', *Ann Epidemiol*, 17: 643-53.

- Conclusion (closing questions for all respondents)

As participants had a wide range of different backgrounds, expertise, and specialties, the questions were tailored to ensure that they were relevant to the discussion, with additional questions asked for clarity as needed. This flexibility meant that interviews were less structured than they might have been if we had interviewed respondents from only one stakeholder group. Guidance was provided to each interviewer and any note takers to ensure that interviews were conducted consistently. To achieve optimum use of interview time, interview proforma were used to ensure comprehensive coverage of interview questions and to keep the interview focused on the relevant topics (see 1.4 Interview Proforma). The interviews were semi-structured, meaning that while we had a set of prepared questions, interviewees could speak at length and follow-up questions were determined by their previous responses. The aim was to elicit considered and detailed responses in a relatively informal, conversational manner.

The interviews were recorded, where permitted. Where not permitted or if circumstances did not allow, detailed notes were taken. Interviews ranged in length from 30 minutes to one hour, with the vast majority one hour long. A total of 42 interviews (38 organizations) were conducted, resulting in a combined total of almost 2000 minutes of recorded dialogue.

6.3 Survey questions

Introduction
The Japanese National Institute of Advanced Industrial Science and Technology Circular Economy Research Lab (hereafter referred to as the "Research Lab") has launched research aimed at gaining a comprehensive understanding of organisational efforts worldwide in the move to the circular economy. This collaborative initiative aims to shape future discussions and foster best practices for implementing and standardising circular economy principles. Yordas Group has partnered with the Research Lab to conduct stakeholder engagement, seeking insights from expert stakeholders regarding their perspectives on circular economy trends and standardisation efforts. We sincerely invite you to participate by completing this short survey. Your valuable insights will greatly contribute to the project's outcomes and help to shape the future of circular economy practices. The survey will ask a series of questions depending on your role as a stakeholder in the circular economy. The survey should **only take 15 to 20 minutes to complete**. Respondents may complete the survey as individuals or members of a specific organisation. You can only take the survey once, but you can edit your responses until the survey is submitted. This survey is based on the following definition of circular economy as defined by ISO/DIS 59004(en): an "economic system that uses a systemic approach to maintain a circular flow of resources, by recovering, retaining or adding to their value while contributing to sustainable development". All data collected in this survey will be handled in compliance with the General Data Protection Regulation (GDPR). The survey data will be reported only in anonymised aggregate form or in a manner that does not allow individual responses to be identified and will be presented to The Research Lab for the stated purpose of the survey in accordance with GDPR and other data sharing laws. You can find our full Privacy Policy here. If you have any questions about the survey, please contact us at sustainability@yordasgroup.com.
Part 1. Background Information
1. Please select the most suitable description of your organisation: a. Industry

        i.   Construction
        ii.   Textiles
        iii.   Agriculture
        iv.   Health care
        v.   Food
        vi.   Mining
        vii.   Retail
        viii. Transportation
        ix.   Manufacturing
        x.   Automotive
        xi.   Aerospace
        xii.   Electronics
        xiii. Information technology
        xiv. Other (please specify):

b. Industry Association/Action Group
c. Standards Organisation
d. Consultancy
e. Inter/Non-Governmental Organisation
f. Government
        i.   Municipal
        ii.   State/provincial
        iii.   Federal/member state
        iv.   Continental union

- Please specify the type of government organisation (e.g., chemical regulator, waste management, etc.): [write in]

g. Academic/Research Institute

2. What is your job title?
    a. [write in]

3. Where are you located?
    a. [country list]

4. How did you find out about this survey?
    a. Email
    b. Social media
    c. Newsletter
    d. Word of mouth

    e.   Event/conference
    f.   Other (please specify):

Part 2. Technical Questions

Part 2A. Industry and Industry Association/Action Groups	Part 2B. Government and Standards Organisations, Consultancies, Inter/Non-Governmental Organisations, Academic/Research Institutes

Part 2A.

1. In your industry, what are the most important factors to your organisation in implementing circular economy practices? Select up to 5.
   a. Added value
   b. Appeal to stakeholders / investors
   c. Consumer pressure
   d. Regulatory pressure
   e. To access new markets
   f. Innovation
   g. Corporate values
   h. Industry/corporate targets
   i. Reduce pressure on supply chain (raw materials)
   j. Reduce concern over geopolitical supply pressures
   k. Competitiveness
   l. Increase efficiency
   m. Upgrades to existing infrastructure
   n. Other (please specify):

2. In your industry, what are the top motivations for implementing circular economy principles? Select up to 5.
   a. Reduce consumption of natural resources
   b. Decrease carbon emissions
   c. Preserve and enhance biodiversity
   d. Biodegradability of materials
   e. Reduce landfill waste
   f. Increase recyclability/repairability
   g. Extend product lifetime
   h. Improve water security

Part 2B.

1. In your opinion, what are the most important factors to an organisation in implementing circular economy practices? Select up to 5.
   a. Added value
   b. Appeal to stakeholders / investors
   c. Consumer pressure
   d. Regulatory pressure
   e. To access new markets
   f. Innovation
   g. Corporate values
   h. Industry/corporate targets
   i. Reduce pressure on supply chain (raw materials)
   j. Reduce concern over geopolitical supply pressures
   k. Competitiveness
   l. Increase efficiency
   m. Upgrades to existing infrastructure
   n. Other (please specify):

2. In your opinion, what are the top motivations for organisations to implement circular economy principles? Select up to 5.
   a. Reduce consumption of natural resources
   b. Decrease carbon emissions
   c. Preserve and enhance biodiversity
   d. Biodegradability of materials
   e. Reduce landfill waste
   f. Increase recyclability/repairability
   g. Extend product lifetime
   h. Improve water security
   i. Innovation

i. Innovation
j. Increased opportunity for revenue
k. Producer responsibility
l. External pressures (e.g., consumers, investors, regulatory, geopolitics)
m. Other (please specify):

3. What circular economy initiatives does your organisation undertake? Select all that apply.
   a. Take/buy back schemes
   b. Waste as a resource (e.g., urban mining)
   c. Refurbishment services
   d. Remanufacturing
   e. Sale of upcycled/recycled goods
   f. Product-as-a-service
   g. Supply chain transparency
   h. Software-as-a-service (SaaS)
   i. Product re-design for extension of life
   j. Product re-design for recyclability
   k. Greener manufacturing processes (e.g., clean energy)
   l. Right to Repair
   m. None
   n. Other (please specify):

4. Does your organisation undertake any of the following assessments? Select all that apply.
   a. Product carbon footprint assessment
   b. Organisational carbon footprint assessment
   c. Life Cycle Assessment (LCA)
   d. Product Environmental Footprint (PEF)
   e. Product-based sustainability assessment
   f. Organisational sustainability assessment
   g. None
   h. Other (please specify)

5. What challenges do you find with standardising circular economy practices in your organisation? Select all that apply.

j. Increased opportunity for revenue
k. Producer responsibility
l. External pressures (e.g., consumers, investors, regulatory, geopolitics)
m. Other (please specify):

3. Is your organisation involved in any of the following circular economy initiatives? Select all that apply.
   a. Take/buy back schemes
   b. Waste as a resource (e.g., urban mining)
   c. Refurbishment services
   d. Remanufacturing
   e. Sale of upcycled/recycled goods
   f. Product-as-a-service
   g. Supply chain transparency
   h. Software-as-a-service (SaaS)
   i. Product re-design for extension of life
   j. Product re-design for recyclability
   k. Greener manufacturing processes (e.g., clean energy)
   l. Right to Repair
   m. None
   n. Other (please specify):

4. Is your organisation involved in any of the following assessments? Select all that apply.
   a. Product carbon footprint assessment
   b. Organisational carbon footprint assessment
   c. Life Cycle Assessment (LCA)
   d. Product Environmental Footprint (PEF)
   e. Product-based sustainability assessment
   f. Organisational sustainability assessment
   g. None
   h. Other (please specify)

5. In your opinion, what challenges will industry face as they standardise circular economy practices? Select all that apply.
   a. Increased costs

a. Increased costs
b. Supply chains (e.g., scarcity, unreliability or lack of transparency or chain of custody)
c. Increased costs to the customer (competitive disadvantage)
d. Infrastructure limitations
e. Lack of internal knowledge
f. Government restrictions
g. Regional differences in approach
h. Technological barriers
i. Lack of suitable alternatives (e.g., substances, materials)
j. Fear of regrettable substitutions
k. Incompatible with industry business models
l. Lack of support from management
m. Lack of industry standards
n. Lack of government standards
o. Lack of industry best practices
p. Lack of market opportunities
q. Other (please specify):

6. What areas of the circular economy offer the best opportunities for revenue? Select up to 5.
   a. Buy back schemes
   b. Waste as a resource (e.g., urban mining, secondary raw materials)
   c. Refurbishment services
   d. Remanufacturing
   e. Recapturing and reusing manufacturing materials and components
   f. Selling recovered waste and by-products from manufacturing processes
   g. Resale of used assets (e.g., manufacturing equipment, vehicles)
   h. Asset sharing (e.g., sharing equipment)
   i. Sale of upcycled goods
   j. Sale of recyclable waste
   k. Product-as-a-service
   l. Software-as-a-service (SaaS)

b. Supply chains (e.g., scarcity, unreliability or lack of transparency or chain of custody)
c. Increased costs to the customer (competitive disadvantage)
d. Infrastructure limitations
e. Lack of internal knowledge
f. Government restrictions
g. Regional differences in approach
h. Technological barriers
i. Lack of suitable alternatives (e.g., substances, materials)
j. Fear of regrettable substitutions
k. Incompatible with industry business models
l. Lack of support from management
m. Lack of industry standards
n. Lack of government standards
o. Lack of industry best practices
p. Lack of market opportunities
q. Other (please specify):

6. In your opinion, what areas of the circular economy offer the best revenue opportunities? Select up to 5.
   a. Buy back schemes
   b. Waste as a resource (e.g., urban mining, secondary raw materials)
   c. Refurbishment services
   d. Remanufacturing
   e. Recapturing and reusing manufacturing materials and components
   f. Selling recovered waste and by-products from manufacturing processes
   g. Resale of used assets (e.g., manufacturing equipment, vehicles)
   h. Asset sharing (e.g., sharing equipment)
   i. Sale of upcycled goods
   j. Sale of recyclable waste
   k. Product-as-a-service
   l. Software-as-a-service (SaaS)
   m. Subscription models
   n. Other (please specify):

m. Subscription models
n. Other (please specify):

7. How much of an impact do you think circular economy regulations will have on businesses, globally?
   a. Significant positive impact on businesses, promoting sustainability, resource efficiency, and new market opportunities.
   b. Moderate positive impact on businesses, leading to some changes in operations and practices to align with sustainable principles.
   c. Neutral/no significant impact on businesses, as they may already be operating sustainably or have limited exposure to relevant regulations.
   d. Moderately negative effect on businesses, potentially increasing compliance costs or requiring adjustments to traditional business models.
   e. Substantial negative effect on businesses, imposing significant challenges and disruptions to existing practices and profitability.
   f. Uncertain/Don't Know

8. Which of the following are the most useful in the standardisation of the circular economy for your organisation? Select up to 5.
   a. External guidance for implementation of the circular economy (e.g., from the government, industry)
   b. Standard terminology and principles
   c. Materials management (i.e., chain of custody)
   d. Declaration of Substances and Materials Contained in a Product or Product Part (i.e., IEC 82474-1 Material Declaration)
   e. Classification System for Products and Services / Metadata Registry Providing Product Classification and Formalized Product Information (i.e., ECLASS/IEC CDD)
   f. Measurement and assessment tools for circular economy
   g. Product circularity data sheets/product environmental

7. How much of an impact do you think circular economy regulations will have on businesses, globally?
   a. Significant positive impact on businesses, promoting sustainability, resource efficiency, and new market opportunities.
   b. Moderate positive impact on businesses, leading to some changes in operations and practices to align with sustainable principles.
   c. Neutral/no significant impact on businesses, as they may already be operating sustainably or have limited exposure to relevant regulations.
   d. Moderately negative effect on businesses, potentially increasing compliance costs or requiring adjustments to traditional business models.
   e. Substantial negative effect on businesses, imposing significant challenges and disruptions to existing practices and profitability.
   f. Uncertain/Don't Know

8. Which of the following are the most useful in the standardisation of the circular economy? Select up to 5.
   a. Guidance for implementation of the circular economy
   b. Standard terminology and principles
   c. Materials management (i.e., chain of custody)
   d. Declaration of Substances and Materials Contained in a Product or Product Part (i.e., IEC 82474-1 Material Declaration)
   e. Classification System for Products and Services / Metadata Registry Providing Product Classification and Formalized Product Information (i.e., ECLASS/IEC CDD)
   f. Measurement and assessment tools for circular economy
   g. Product circularity data sheets/product environmental footprint
   h. Waste management or recovery systems (i.e., in smart communities)
   i. Supply chain transparency tools/traceability requirements
   j. Materials standards or material categorisation/grading systems

footprint
h. Waste management or recovery systems (e.g., in smart communities, or for technical challenges)
i. Supply chain transparency tools/traceability requirements
j. Materials standards or material categorisation/grading systems
k. Ecodesign principles and guidelines/Safe and Sustainable by Design
l. Guidance on the transition to alternative business models and value networks
m. Regulations (e.g., recycling, waste)
n. Extension of life protocols
o. Dismantling and reassembly methods and protocols
p. Uncertain/Don't Know

9. Which materials or components are of most concern to your organisation in the successful implementation of the circular economy? Select up to 5.
    a. Plastics
    b. Microplastics
    c. Rare earth minerals
    d. Critical raw materials
    e. Metals
    f. Batteries
    g. Motors
    h. Biobased materials
    i. Textiles
    j. Water
    k. Oil and gas
    l. Substances of concern (e.g., PFAS)
    m. Sustainable chemistries
    n. By-products
    o. Critical elements (e.g., hydrogen, nitrogen, phosphorus)
    p. Other (please specify):

10. Eco or sustainable design is being prioritised by some regulators. If your organisation is undertaking ecodesign, what areas are you

k. Ecodesign principles and guidelines/Safe and Sustainable by Design
l. Guidance on the transition to alternative business models and value networks
m. Regulations (e.g., recycling, waste)
n. Extension of life protocols
o. Dismantling and reassembly methods and protocols
p. Uncertain/Don't Know

9. In your opinion, which materials or components are of most concern to the implementation of the circular economy? Select up to 5.
    a. Plastics
    b. Microplastics
    c. Rare Earth minerals
    d. Critical raw materials
    e. Metals
    f. Batteries
    g. Motors
    h. Biobased materials
    i. Textiles
    j. Water
    k. Oil and gas
    l. Substances of concern (e.g., PFAS)
    m. Sustainable chemistries
    n. By-products
    o. Critical elements (e.g., hydrogen, nitrogen, phosphorus)
    p. Other (please specify):

10. Eco or sustainable design is being prioritised by some regulators. If your organisation is undertaking ecodesign, what areas are you targeting? Select up to 5.
    a. Sustainable chemistries

targeting? Select up to 5.
   a. Sustainable chemistries
   b. Product durability
   c. Product reusability
   d. Product upgradability
   e. Product reparability
   f. Removing substances that inhibit circularity
   g. Energy and resource efficiency
   h. Recycled content
   i. Remanufacturing and recycling
   j. Carbon and environmental footprints
   k. Other (please specify):

11. In your industry, are you aware of any of the following initiatives to support industry transition to the circular economy? Select all that apply.
   a. Certifications
   b. Toolkits
   c. Best practices
   d. Protocols
   e. Product Passports
   f. Audits
   g. Standards
   h. Guidelines
   i. None

11b. Please give an example of the initiative(s):

12. Is your organisation collaborating with any external partners to help achieve circular economy goals? Select all that apply.
   a. NGOs
   b. Consultants
   c. Academia
   d. Industry
   e. Industry associations or action groups
   f. Inter-governmental organisations
   g. Government
   h. Research institutes

   b. Product durability
   c. Product reusability
   d. Product upgradability
   e. Product reparability
   f. Removing substances that inhibit circularity
   g. Energy and resource efficiency
   h. Recycled content
   i. Remanufacturing and recycling
   j. Carbon and environmental footprints
   k. Other (please specify):

11. Are you aware of any of the following initiatives to support industry transition to the circular economy? Select all that apply.
   a. Certifications
   b. Toolkits
   c. Best practices
   d. Protocols
   e. Product Passports
   f. Audits
   g. Standards
   h. Guidelines
   i. None

11b. Please give an example of the initiative(s):

12. Is your organisation collaborating with any external partners to help achieve circular economy goals? Select all that apply.
   a. NGOs
   b. Consultants
   c. Academia
   d. Industry
   e. Industry associations or action groups
   f. Inter-governmental organisations
   g. Government
   h. Research institutes
   i. Standards organisations
   j. None

| Left Column | Right Column |

Left column:

     i.   Standards organisations
     j.   None

12b. Please name the organisation(s):

13. How far along is your organisation in adopting circular economy principles?
    a. 0
        1 = not at all
        2 = engaging with principles and assessing their relevance
        3 = implementing principles
        4 = implementing and partially achieving
        5 = fully achieving

14. How motivated is your organisation to implement circular economy practices?
    a. 0,1-5. 1 = no motivation, 5 = fully motivated

15. How motivated do you think your supply chain is to implement circular economy practices?
    a. 0,1-5. 1 = no motivation, 5 = fully motivated

Right column:

12b. Please name the organisation(s):

13. How important to your organisation is engaging with circular economy issues and challenges?
    a.   0, 1 = not at all, 5 = extremely important

Part 3. Circular Economy Leaders

Part 3A. Industry and Industry Association/Action Group	Part 3B. Government and Standards Organisations, Consultancies, Inter/Non-Governmental Organisations, Academic/Research Institute

The following section aims to explore your individual perspective on innovators and leaders in the circular economy.

1. Select the top 3 leading regions in circular economy:
    a. Europe
    b. North America (Canada, US, Mexico)
    c. Central America and the Caribbean
    d. South America
    e. Asia

(Right column, Part 3B)

The following section aims to explore your individual perspective on innovators and leaders in the circular economy.

1. Select the top 3 leading regions in circular economy:
    a. Europe
    b. North America (Canada, US, Mexico)
    c. Central America and the Caribbean
    d. South America
    e. Asia

i.   Central Asia
ii.   Eastern Asia
iii.   South-eastern Asia
iv.   Southern Asia
v.   Western Asia
   f.   Africa
   g.   Oceania
      i.   Australia and New Zealand
      ii.   Melanesia
      iii.   Micronesia
      iv.   Polynesia
 	
2.   Please specify any cities you identify as circular economy innovation hubs: [write in]
 	
3.   Please identify one organisation in each category that is engaged in circular economy innovation: [write in]
    a.   Standards Organisation:
    b.   Government:
    c.   NGO:
    d.   Industry:
    e.   Research Institute:
    f.   Academia:
    g.   Intergovernmental Organisation:
    h.   Industry Action Group/Association:
    i.   Thought Leader:
	i. Central Asia
	ii. Eastern Asia
	iii. South-eastern Asia
	iv. Southern Asia
	v. Western Asia
	   f. Africa
	   g. Oceania
	      i. Australia and New Zealand
	      ii. Melanesia
	      iii. Micronesia
	      iv. Polynesia
	
	2. Please specify any cities you identify as circular economy innovation hubs: [write in]
	
	3. Please identify one organisation in each category that is engaged in circular economy innovation: [write in]
	    a. Standards Organisation:
	    b. Government:
	    c. NGO:
	    d. Industry:
	    e. Research Institute:
	    f. Academia:
	    g. Intergovernmental Organisation:
	    h. Industry Action Group/Association:
	    i. Thought Leader:

Part 4. Closing Message

We are also conducting short interviews (30 minutes to 1 hour) as a part of this research project. If you are interested in being contacted for an interview, please provide your name and email below.

[Name]
[Email]

Thank you for participating in this survey. Your input in this study is valuable to help improve the understanding of the trends in standardisation of the

circular economy.

6.4 Interview proforma

Introduction and Oral Consent Script

The Japanese National Institute of Advanced Industrial Science and Technology Circular Economy Research Lab (hereafter referred to as the "Research Lab") has launched research aimed at gaining a comprehensive understanding of organisational efforts worldwide in the move to the circular economy. This collaborative initiative aims to shape future discussions and foster best practices for implementing and standardising circular economy principles. Yordas Group has partnered with the Research Lab to conduct stakeholder engagement, seeking insights from expert stakeholders regarding their perspectives on circular economy trends and standardisation efforts. We sincerely invite you to participate by completing this short interview. Your valuable insights will greatly contribute to the project's outcomes and help to shape the future of circular economy practices.

Are you still interested in participating in the interview? *[Await confirmation]*

Now, I would like to confirm some of the details of this interview to make sure you understand your role:
- The interview data will be reported only in anonymised aggregate form or in a manner that does not allow individual responses to be identified and will be presented for the stated purpose of compliance with the General Data Protection Regulation (GDPR) and other data sharing laws.
- We may use some brief anonymous quotes from your interview in the study.
- You do not have to answer any questions that you do not want to answer and you can stop the interview at any time, without giving a reason.
- The interview will last approximately 30 minutes to one hour.
- To ensure better data quality we would like to ask you for permission to record our talk, which will allow us to further analyse the information you give us. *(participants can decide if they want your camera on or off)*
- All of your data will be stored in secure files. All identifiable data will be destroyed at the end of the study.

Are you still happy to take part in the interview? *[Await confirmation]*

Are you happy for us to record the interview? You can leave your camera off or on whichever you prefer.   *[Await confirmation]*

Thank you, let's start the interview. *[start recording]*

Part 1. Introduction	
1. How are you involved with the circular economy?	
Part 2. Technical Questions **Industry/Industry-Associations**	**Part 2. Technical Questions** **Non-Industry**

Current Circular Economy Status and Plans

1. **How does your organisation address circularity?**
   a. Do you have a detailed CE strategy and specific sustainability goals for the organisation? Can you comment on these (e.g., short-term and longer-term goals)?
   b. In the survey you responded that the top motivation for implementing circular economy in your organisation comes from [insert survey Technical Q2 answers]. Can you please elaborate?
   c. Has your organisation partnered or collaborated with others to develop CE practices/tools/projects? If so, who and what did you do?
   d. In the survey, you stated your organisation does the following initiatives and assessments [insert survey answer from Technical Q3]. Please elaborate on this.
   e. Do you have measurable circular economy targets? If so, please elaborate.

Standards, Best Practices and Regulations

2. **Best practices, standards and regulations aim to support industry in implementing the circular economy. Are you aware of or follow any circular economy standards or best practices?**
   a. Is your organisation helping to develop any best practices or standards? If so, what?
3. **Are you aware of current or upcoming regulations? If so, what? Please elaborate.** If they ask for examples: sustainable manufacturing standard by the American Society for Testing and Materials (ASTM)
   a. Are the current circular economy standards and regulations adequate? Where do you find gaps in these

Current Circular Economy Status and Plans

1. **What aspects of CE does your organisation focus on?**
   a. In the survey you responded that the top motivation for implementing circular economy in your organisation comes from [insert survey Technical Q2 answers]. Can you please elaborate?
   b. Has your organisation partnered or collaborated with others to develop CE practices/tools/projects? If so, who and what did you do?
   c. In the survey, you stated your organisation is involved in the following initiatives and assessments [insert survey answer from Technical Q3]. Please elaborate on this.
   d. If you are involved in implementing smart communities, what are your biggest challenges and priorities? Are these geographically focused? How do you measure smart community infrastructure?

Standards, Best Practices and Regulations

2. **A part of having measurable circular economy targets is putting in place the best practices, standards and regulations that support them. Has your organisation developed any best practices to support industry? Are you involved in discussions regarding standards?**
   a. Are the current circular economy standards and regulations adequate? Where do you find gaps in these standards/regulations? What else do you think is needed? Please elaborate.

standards/regulations? What else do you think is needed? Please elaborate.

4. **Are you planning to implement or are you currently implementing circularity across your product life cycle phases and/or business units? Please elaborate.**

   a. Design

      i. Does your company intentionally design products according to circular economy principles — e.g. design for the environment, design for disassembly, design for recycling, etc.? If not, does your organisation plan to? Why or why not? (If not again, note their industry and product format (e.g., personal care, multi-layer packaging) - is this a technical challenge? Or is it because it is not economically viable?)

      ii. Do you see new opportunities brought about by incorporating circular economy principles into product design?

      iii. Do you consider sustainable chemistries (e.g., sustainable feedstocks) during product development? How will shifts in sustainable chemistries affect your products/industry? What are the challenges for you in using sustainable feedstocks? (E.g., keeping their inherent chemical complexities)

   b. Production Operations

      i. When your facility manufactures a product do you consider alternative manufacturing approaches based

Circular Economy Across Production

3. **Are you involved in any projects to implement circularity across product life cycle phases and/or business units? Please elaborate.**

   a. Design

Is your organisation undertaking any projects to support industry around design for the circular economy?

      i. Are you supporting companies to intentionally design products according to circular economy principles — e.g. design for the environment, design for disassembly, design for recycling, etc.? If not, do you plan to? Why or why not? (If not again, note the industry and product format (e.g., personal care, multi-layer packaging) - is this a technical challenge? Or is it because it is not economically viable?

      ii. Do you see new opportunities brought about by incorporating circular economy principles into product design?

      iii. Are you helping organisations consider sustainable chemistries (e.g., sustainable feedstocks) during product development? How will shifts in sustainable chemistries affect products/industry? What are the challenges in using sustainable feedstocks? (E.g., keeping their inherent chemical complexities)

   b. Production Operations

Is your organisation undertaking any projects to support industry around production operations?

on environmental impacts beyond those that are regulated? If so, how (e.g., LCA)?

ii. How do you manage by-products from your primary production processes?

iii. What is your organisation doing to cycle critical elements? (e.g., carbon, hydrogen, nitrogen, phosphorus)

iv. How will you manage the data generated in the shift to circular production practices?

c. Supply Chain Management

i. How do you embed circularity principles throughout the value chain within your industry and how can you make it more effective?

ii. Do you collect circularity data from your suppliers? If so, what types of data do you ask for?

iii. How do you manage data on circularity from your suppliers?

d. Waste-to-Resource

i. Do you have specific recovery, recycling and/or reuse goals for the organisation?

ii. What challenges do you find with the use of recycled materials? How do you sort, grade, and ensure they meet quality standards, for example? How do you assess their value?

iii. Do you monitor and measure the percentage of waste materials you divert to recycling?

iv. What kind of quality of secondary raw materials does your organisation need?

v. How do you plan on increasing the use of secondary raw materials?

i. Do organisations consider alternative manufacturing approaches based on environmental impacts beyond those that are regulated? If so, how (e.g., LCA)?

ii. What do organisations do with by-products of primary production processes?

iii. Are you helping organisations consider cycling of other critical elements? (e.g., carbon, hydrogen, nitrogen, and phosphorous)

c. Supply Chain Management

Is your organisation undertaking any projects that support industry with circular supply chain management?

i. How do organisations embed circularity principles throughout the value chain within their industry and how do they make it more effective?

ii. Do you help industry collect circularity data from suppliers? If so, what types of data do you ask for?

iii. How will companies/industry/government manage data on circularity in the supply chain?

d. Waste-to-Resource

Is your organisation undertaking any projects to help industry in the area of waste-to-resource?

i. How do you support manufacturing operations in addressing the use of recycled materials?

ii. Are you involved in projects to monitor and measure the percentage of waste materials diverted to recycling?

iii. Are you involved in projects focused on secondary raw materials? Including their quality, increasing their use, etc.

iv. Who do you think most benefits from secondary raw materials?

vi. How are you considering resource management and recovery for indirect materials? Are potentially valuable materials recovered and sold?

vii. What do you do when there are mixed feeds, impurities or SVHCs in the recycling steam? Are you aware of any projects/innovations to address this?

viii. Does your company up-cycle or sell up-cycled products?

ix. How does your facility handle used packaging materials?

x. Who do you think most benefits from secondary raw materials?

v. Are you involved in projects considering resource management and recovery for indirect materials? Are potentially valuable materials recovered and sold?

vi. Are you involved in projects addressing mixed feeds, impurities or SVHCs in the recycling steam?

vii. Are you involved in projects focused on up-cycling?

viii. Are you involved in projects supporting the circularity of packaging materials?

Challenges/Barriers

5. **In our survey, we asked you about the challenges of implementing the circular economy. Would you like to expand here? Are there industry, organisational or geographic specific challenges?**
   a. What technological barriers does your organisation encounter when implementing the circular economy?
   b. Some circular processes require substantial amounts of time, energy, or other resources. Where do you see the challenges here and do you see any solutions?
   c. In your experience, does a company that decides to adopt circular economy principles need new staff and/or expertise?

Circular Economy Business Models

Challenges/Barriers

4. **In our survey, we asked about the challenges of implementing the circular economy. Would you like to expand here? Are there industry or organisational or geographic specific challenges?**
   a. What technological barriers do you see in implementing the circular economy?
   b. Some circular processes require substantial amounts of time, energy, or other resources. Where do you see the challenges here and do you see any solutions?
   c. Does a company that decides to adopt circular economy principles need new staff and/or expertise?
   d. Have you had any funding to help implement Circular Economy projects? If so, where does your funding come from? (e.g., government funding, private, etc.)

Circular Economy Business Models

5. **Has your business considered circular economy business models for industry/companies?**

6. Has your business considered the best circular economy business model for your organisation? Do you have an economic strategy?
   a. Are you considering a service model for any of your products?
   b. What are the biggest opportunities for your organisation or industry as we move to implementing the circular economy? Are there some that are geographically specific? (internal note: we want to know about tech opportunities, but also about revenue streams)

   a. Are you supporting industry/companies in developing service models?
   b. Where do you see the opportunities for revenue as we move to implement the circular economy? Are there some that are geographically specific? (internal note: we want to know about tech opportunities, but also about revenue streams)

Part 3. Closing

1. Is there anything we've not asked you about, that you would like to share?
2. Do you have any recommendations for other organisations to interview?
3. Do you have any recommendations for circular economy "city hubs" we could focus on for our research?

Appendix 2
Short Interview Log (Summary)

ID	Organization Type	Region	Majour Notable Topics and Challenges	Index	Grading/ Visibility of Value	Confident-iality	Trans-parency	Traceability	Hazardous Materials	CFP/ESG	Value Network (VN)	Data Utilization
1	Research institute for remanufacturing and Sustainability	NA	・Manufacturers have difficulty working with reverse supply chains. ・It is necessary to assess the condition and remaining life of parts.		O						O	O
2	International alminium trade association	UK-Based	・Industry standards that take ESG into account have been established. ・Information sharing is voluntary, and CoC is an issue. ・The value is concentrated on material recycling, which is only one of the actors, and we do not want to focus on the target recycling rate. ・It is almost impossible to investigate the data of recycling companies.	O			O	O		O	O	O
3	Consumer product industry association	NA	・There are many issues with reducing packaging materials and plastics. ・Consumer safety also needs to be ensured.						O			
4	Natinal government department	EU	・Behavioral change in society is necessary. International cooperation and standardization are necessary.									
5	Automotive recycling association	NA	・Data from collisions is used for the reuse of parts. ・Data is shared between recyclers. The reuse rate is high. ・The dismantling and remanufacturing industries are integrated. ・There are still issues with data interoperability. ・There is also a gray market.					O			O	O
6	Automotive industry association	NA	・We are also cooperating with other industry groups. ・Transporting waste batteries is a problem. ・We are working with recycling companies, repair shops and auction companies. ・The collection infrastructure is immature, and this is causing an imbalance between supply and demand. ・LCA is not easy. ・The industry needs to unite. ・Plastics need to be graded.		O					O	O	O
7	Governmental research organization	NA	・Maintains a public database of impurities and additives. ・Access to data requires step-by-step management ・Data harmonization is required			O	O	O	O		O	O
8	National standards organization	NA	・The definition of tracking methods is necessary. ・It is necessary to harmonize best practices between different sectors.					O			O	
9	Regional CE Agency	South America	Interaction with industry through local recycling/upcycling									
10	University researcher	South America	・Researching the evaluation of CE.	O								
11	Global research institute, partnered with other NGOs focused on CE	NA	・It is important to create standards for "responsible mining". ・The mass balance approach requires that the source of supply be clarified. Traceability is an issue.					O		O		

ID	Organization Type	Region	Majour Notable Topics and Challenges	Index	Grading/ Visibility of Value	Confident- iality	Trans- parency	Traceability	Hazardous Materials	CFP/ESG	Value Network (VN)	Data Utilization
12	Electronics	NA	・Focus on traceability to ensure high purity. ・In many cases, plastics are mixed with metals, etc., so they are removed at the product level. ・High-tech companies are sensitive about confidential information. They are afraid of cooperating with rivals or pooling data ・DPP is great, but the communication method in SC/VC is an issue ・Data on substances of very high concern (SVHC) is necessary. Complete transparency is necessary			○	○	○	○			
13	International electronics waste NGO	EU	・Involved in the development of standards for batteries containing mercury. ・Investigated the impact of external damage to printers on resale value ・Developed tools related to CO2 ・The quality of recycled plastic is of the utmost concern. It is necessary to know its technical characteristics. Labeling is also necessary. It is important to visualize substances of concern.		○				○	○		
14	International electronics NGO	EU	・The length and complexity of the value chain in this industry is a major issue. It is difficult to grasp the origins. ・In high-tech, confidentiality is important, but it is gradually being opened up. ・CE's vision is to maximize value and ensure safe working practices. Balancing environmental and economic value ・The informal sector needs to be taken into account ・Our role in developing standardized measurement methods is to establish best practices. For example, establishing best practices for communicating the performance of circular business models to investors. Incentives are needed for stakeholders ・CRM is an important trend. If the impact of decarbonization can also be communicated, it will create opportunities	○		○	○	○		○	○	
15	Personal care with long history in specialty materials/chemicals company	NA	・Trade secrets need to be protected ・It is difficult to find out where products have leaked to ・Information on labeling and safe use is essential.			○		○	○			
16	Electronics industry consultant	NA	・There is no appropriate indicator for measuring CE, and there is a concern that misleading claims will be made. Clear and realistic specifications based on solid measurement are needed. ・Economic value is needed ・Environmental value is also needed to reduce the mining of non-renewable resources ・Hazardous substances affect quality ・Extending the lifespan is important ・Recycling companies need access to information about the materials contained in products	○					○	○		○

2

ID	Organization Type	Region	Majour Notable Topics and Challenges	Index	Grading/ Visibility of Value	Confident-iality	Trans-parency	Traceability	Hazardous Materials	CFP/ESG	Value Network (VN)	Data Utilization
17	International CE NGO	EU	・Quantitative indicators are very difficult to obtain. There is no single indicator that can be tracked in CE, and it is very complicated ・It is difficult to pursue responsible procurement. The cost is also a concern ・Aside from regulations, incentives are also needed	○			○			○		
18	Aerospace	UK	Aircraft are used for a long time and are repaired and recycled many times This industry is required to reduce CO2 emissions Product as a Service is a prescribed business model It is important to avoid the release of substances of high concern at the design stage	○						○		
19	CE Author, Consultant and NGO	EU	・It is important to introduce full producer responsibility so that producers bear all the costs of Cradle to Cradle.									
20	Recycling	India	・LCA is carried out in response to customer requests. Focus on CFP ・Traceability is important for understanding the origins of products ・Non-petroleum-derived materials are emphasized as recycled raw materials. There are brokers who support this.					○		○	○	
21	CE Consultant - industry design bachground, especially consumer products	UK	・There is a danger that if you pursue perfection, you will make acceptable trade-offs your enemy. A harmonized and standardized approach is needed.									
22	Minicipality	UK	・Set a net zero target ・CE is important for bidding. Sustainable supply chains are weighted. ・It is difficult to measure progress in CE. I don't think anyone has figured it out. ・We outsource waste services to the private sector, but we have KPIs and receive reports. ・We rely on other organizations to ensure regulatory compliance. ・The market for reuse is not clear. ・Legacy chemicals are an issue. We need to cooperate with companies that handle materials.				○	○	○	○	○	
23	Governmental research institute	SouthAmerica	・Has experience in waste traceability. Mapping of urban mining hotspots and route adjustments are being carried out.・Focus on the efficiency of energy, water and waste recovery related to CE and urban mining.・Consideration for supporting the livelihoods of informal operators is an issue・Somewhat skeptical about the value of LCA・Zinc recovery from batteries is profitable and decarbonizing.・The quality of polymers is important	○	○			○		○		○

ID	Organization Type	Region	Majour Notable Topics and Challenges	Index	Grading/ Visibility of Value	Confident- iality	Trans- parency	Traceability	Hazardous Materials	CFP/ESG	Value Network (VN)	Data Utilization
24	CE Consultancy	EU	・DPP should help to provide transparency for product designers ・Automobile manufacturers associations have developed recommendations for data that product designers should provide further down the supply chain to enable effective repair and end-of-life management ・The aftermarket is important for the industry. Most manufacturers do not make money from selling cars, but from services during the use phase of the vehicle (service network, repairs, etc.). Aftermarket services are always incorporated into product design. ・Data sharing is an issue, and how do you make a business case for data sharing? It can be used to assess value.		○		○	○			○	○
25	Construction industry	NA	・Measures against controlled substances are important						○			
26	Recycling industry	NA	If we can maintain the quality of separation, the value will increase and competitiveness will also increase. We are investing in this. We are conducting follow-up surveys on legacy chemicals.		○			○	○			
27	Automotive industry	EU	・Focusing on CFP, chemical substances, and recycling initiatives ・Trying to define the company's KPIs based on the 9Rs	○					○	○		
28	US HQ specialty chemicals company	Japan	・Industry is reluctant to share the information necessary to make the supply chain more circular ・Better guidance is needed on determining material quality		○		○					
29	NGO pressure group for environment friendly policies, regulations and standards	EU but inter-national	・The role is to ensure that no harmful substances are included ・Waste disposal companies also need to know whether prohibited chemical substances are present or not ・Confidentiality is also a concern, but transparency and information sharing are necessary				○		○			○
30	Electrics/electronics industry	NA	・Implemented Scope 1 to 3. Published environmental profile							○		
31	Government sustainability certification programme for consumer products	NA	・Implement product safety certification ・Collaborate with NGOs that have green material lists ・Concern about legacy chemicals and impurities in recycled materials						○			
32	Government industry association	South America	・After consumers are hardly tracked. ・Illegal sources are a major concern. ・Trust is an issue in collaborative networks. Data is important.					○			○	○

ID	Organization Type	Region	Majour Notable Topics and Challenges	Index	Grading/ Visibility of Value	Confident-iality	Trans-parency	Traceability	Hazardous Materials	CFP/ESG	Value Network (VN)	Data Utilization
33	Researcher	EU	・DPP is purely technical, so there are problems with information sharing, for example. So we need to consider the content of information sharing. There is no law. Extended producer responsibility is also related to information sharing. How do we define these things? There are international standards for terminology and frameworks, but they need to be fleshed out ・We need something that brings the circularity of textiles closer to the circularity of automobiles, and there are various sectors underneath that. The risk is that each of these has a different definition. ・The issue is how to maintain value. ・DPP will not solve the problem. Consumer behavior change is also necessary. ・We are implementing LCA to prevent costs from rising. We are introducing social LCA. ・There is also the issue of confidentiality. ・We need to have trust in value. It is a certification issue.		○	○				○		○
34	Researcher	EU	・Greater transparency is greatly needed, and regulations including the start of DPP in Europe will help to promote data sharing activities.				○					○
35	Consultant	Central America	・DX is important for achieving CE.									○
36	National standards organization	EU	・For CE, interoperability, authentication and reliability, APIs, searchability, linking physical and digital representations, and access control are important ・DPPs flow outside the EU and affect everyone. It is difficult for other countries to have a say in the formulation of these laws and standards ・At present, the only two flows of used textile products are car seats and cleaning rags.			○						○
37	Digital servive provider	EU	・The need for information management in this field is huge. If we can track the actual lifespan, we can unravel use cases such as recycling design, warranties, and which parts will fail when. ・Consumers have usage data, but it is not recorded. Consumers also want to know how to repair their products. ・Especially for small companies, data is often too complicated to use. It needs to be simple and easy to manage. It is also necessary to obtain more data by linking it, such as which parts break when, how difficult it is to get to those parts, and whether parts for repair are available. ・The current recycling method is cruel. It only involves crushing the parts and removing the dangerous or valuable CRM. Many aspects of design will be divided between recycling and durability, repair and regeneration. However, the recycling industry is powerless.					○				○
38	Environmental standards organization (ISO standard expert)	EU	・Infrastructure systems related to quality are important, especially in developing countries.		○							
				8	9	6	10	15	12	14	11	15