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Gabrielle Gentric, François Cluzel, V Boccara, Hakim Boudaoud, Julien Gonzalo

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## MULTI-INTERNAL ACTORS DIAGNOSIS OF CIRCULAR ECONOMY IN AN INDUSTRIAL SME

**Gentric, Gabrielle (1,2);**  
**Cluzel, François (1);**  
**Boccara, Vincent (3);**  
**Boudaoud, Hakim (4);**  
**Gonzalo, Julien (2)**

1: Laboratoire Genie Industriel, CentraleSupélec, Université Paris-Saclay;  
2: Style & Design;  
3: Laboratoire Interdisciplinaire des Sciences du Numérique (LISN), Université Paris-Saclay;  
4: Equipe de Recherche sur les Processus Innovatifs (ERPI), Université de Lorraine

### ABSTRACT

In big companies, Circular Economy (CE) is being explored and implemented. However, Small and Medium-sized Enterprises (SMEs) struggle to follow because of specific barriers and a lack of practical guides. Here, we use a French manufacturing SME as a case study to explore how SMEs can perform a successful CE integration. This article proposes to start with a multi-internal actor circularity diagnosis. It focuses on building an inclusive, co-constructed and tailored CE integration plan for SMEs, which is lacking today in the existing literature. We conduct and analyse 42 semi-structured interviews, covering 70% of the company's employees. We capture the view of the current and desired situation and identify CE barriers unique to each interviewed worker. As a result, we find 6 new CE barriers compared to the literature that highlights the need to consider the social aspects of CE. We connect with each worker, involving all of them in the CE deployment from the start. The final goal is to assemble this worker-oriented diagnosis with quantitative diagnosis, like Life Cycle Analysis of the products and Material Flow Analysis of the factory, to completely diagnose an SME's circularity.

**Keywords:** Circular economy, Diagnosis, SME, Collaborative design, Participatory design

### Contact:

Gentric, Gabrielle  
CentraleSupélec  
France  
gabrielle.gentric@centralesupelec.fr

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# 1 INTRODUCTION: CONTEXT AND OBJECTIVES

Circular Economy (CE) principles, take, make, use, re-use, (instead of the linear take, make, dispose) have been identified as a relevant leverage for sustainable development by the European Commission, which included it in most of their sustainability policies since 2015 (European Commission, 2015). There have been multiple follow-ups in directives, incentives, and declarations with the most recent update in 2020 (European Commission, 2020), making CE a popular trend.

According to ADEME (the French governmental agency for the ecological transition), a circular economy is an economical system of exchange and production which, for each product (goods and services) life cycle's steps, aims at increasing the efficiency of the usage of resources and to diminish their environmental impacts while developing individual's well-being (ADEME, 2016). Despite its popularity and EU financial support, CE remains in its infancy, with less than 9% of the global economy being circular today (CGRI, 2021). A lot of research is still to be done on CE as even its exact definition is still under discussion (Nobre and Tavares, 2021).

A way to implement CE would be through SMEs, in fact, the EU has identified SMEs' transition towards CE as a key element of its CE Action plan, granting them considerable financial support (Directorate-General for Research and Innovation (European Commission), 2019). The definition of SME is mostly based on headcount: small (medium-sized) companies have 10–50 (50–250) employees (European Commission, 2003). SMEs account for more than 99.7% of all Non-Financial Business Sector (NFBS) companies in the European Union (EU). They represent close to two-thirds of total NFBS employment (65.0%) in the EU (Executive Agency for Small and Medium sized Enterprises. et al., 2021), they shape the core of economies in the EU (Miller, Varma and Williams, 2011). SMEs collectively represent around 60% to 70% of all industrial pollution in the EU (Miller, Varma and Williams, 2011) and are therefore relevant subjects for CE transition.

SMEs are facing particular issues compared to bigger companies in their implementation of CE (Takacs, Brunner and Frankenberger, 2022). Most of the research focuses on identifying the company's CE maturity, barriers, enablers, and opportunities thanks to questionnaires or interviews with the company's top management (Lobo et al., 2022). Such diagnoses appear to be incomplete by not considering all stakeholders (suppliers, clients, company workers other than top-management, etc), thus missing potentially important aspects.

Our hypothesis is that a more complete diagnosis, including all company internal workers specifically, could improve CE implementation in SMEs. By including all company-internal actors (meaning management, support, and production workers) in the CE implementation from the start, the diagnosis is rich of each worker's point of view and expertise, highlighting new aspects that are not detected by existing diagnosis. It also co-constructs the whole CE implementation process with the workers from the start, therefore enabling its effective, well-accepted, and persistent realization.

We aim to address the gap of tin existing literature with a larger, multi-internal actors CE diagnosis for industrial SMEs. Thanks to this enhanced diagnosis of their business, industrial SMEs will be able to design an adapted, inclusive, action plan to perform a durable CE implementation, allowing them to create value and gain a competitive advantage in the market.

To perform the multi-internal actors' diagnosis, we propose to use mainly observations, interviews, and document analysis. In this article, an emphasis is made on the interview part. In the interviews, we propose to evaluate the current situation (company internal and external, including current CE barriers) and the targeted situation with CE successful integration, from each company-internal actor's point of view. To do so, we used semi-structured interviews, analyzed with a combination of qualitative and quantitative tools and methods.

The paper is structured as followed: First, the case study is described. Second, the multi-internal actor's diagnosis strategy is presented. Third, a focus is made on its interview part. Fourth, the first results of the study are presented. Finally, we discuss the limits and challenges faced and conclude on the generalization potential of our methods to other SMEs.

## 2 METHODOLOGY

### 2.1 Case study

Style & Design is a French industrial SME of around 150 employees, that specializes in vehicle prototyping, for the European rail, aviation, and defense industry, but mostly the automotive industry.

The prototypes are used at various stages of vehicle development to complement the virtual 3D model with a physical, real-life size mock-up version, thus providing a more realistic perspective on the vehicle. The company is willing to transform itself and its prototyping products from linear (take, make, dispose) to circular (take, make, use, re-use) from the ground up and is, as a result, a relevant candidate for CE. The particularity of Style & Design is that the CEO and most of the top management are already convinced of the utility of CE and are willing to start the transition towards it. On top of that, contrary to most SMEs, this company can recover (after use) and reuse some of the products which they manufactured. As a matter of fact, some products are already coming back to the plant today but are being destroyed. The clear CE opportunity that is laying here, together with other CE opportunities, have been identified but Style & Design was unable so far to make it a reality. Thus, a Ph.D. student has been hired to analyze the situation and help carry out the CE implementation.

The researcher that conducted this study has total and long-term access to all the company's workshops and data. In line with this context, we chose action research. It allows to include the company actors as collaborators in the research project and allows to generate concrete solutions and actions answering the company's needs while acquiring and generating new scientific knowledge for academic universal purposes. The four steps of our action research process are the following: 1. Field diagnosis 2. Identification of scientific questions and reviewing the state-of-the-art 3. Generation of solutions 4. Experimentation and validation (Yannou and Petiot, 2011). Our research project is currently at the first step; therefore, the rest of this article will be about the field diagnosis we conducted as part of our action research plan.

## 2.2 Field diagnosis

Inspired by Design Research Methodology (DRM) (Blessing and Chakrabarti, 2009), the field diagnosis aims to seek out from our case study, the "Reference Model", a complete picture of the current situation, and the "Impact Model", a complete picture of the targeted, desired situation (here circular business and product). Particular attention is given to the "CE" dimension, which embeds CE maturity (existing CE measures, material flow closed loop, knowledge, competencies, and ability), CE barriers, opportunities, and enablers.

This article focuses on the multi-internal actors' part of this field diagnosis. In this part, an exploratory mixed methods approach is chosen combined with descriptive mixed methods. In the first phase, exploratory research is conducted, in which the Reference Model and CE dimensions are explored by the researcher, via direct field observations of each actor at Style & Design. At the same time, interviews of each company actor are performed, in which participant views of the Reference and Impact Model and CE dimensions of Style & Design are explored. The first exploratory step allows performing a large but not exhaustive screening of the company actor's "reality", providing new insights and detecting points of interest needing further investigation. The aim is not to derive definite evidence but rather to serve as a basis for further research (Mayer, 2015). Therefore, we need to complete this exploratory phase in a later stage with an exhaustive descriptive phase targeting the detected points of interest. To seize the remaining unexplored points of interest, a combination of three methods will be used: document analysis, observation, and interview. For example, using document analysis, we will analyze the regulatory framework of each profession at Style & Design.

In our research project, the exploratory step has been conducted and the descriptive step is in preparation. The rest of this paper will focus on the interviews conducted for the first exploratory diagnosis step.

## 2.3 Interview campaign objectives

Our goal is to capture a complete Reference and Impact Model with a focus on CE dimensions from the perspective of all the company workers, and not only from the top-management perspective as it is usually done in the literature. The Impact Model, as a wish for a future, enhanced, the situation at Style & Design with CE, only exists as an idea in the workers' minds. Hence interviews seemed to be the best way to collect it. For the sake of durable CE implementation, we chose to include all workers in the co-construction of our CE implementation from the start, in the diagnosis step.

The type of interview selected is semi-structured, the interview guideline served as orientation, but it also allowed participants to adapt to the dynamics of the discussion, enabling the interviewee to speak freely (Cassell and Symon, 2004).

The target subjects about CE are: current knowledge and beliefs on CE of each profession and hierarchical level, existing CE measures in Style & Design, CE opportunities, enablers and barriers, CE sensibilization, and training needs. The target subjects of the Impact and Reference Model are: a description of the current situation and wishes for the future situation from each point of view (each profession and hierarchical level).

For the next step of our action research plan, it is also required to identify points of interest that need further investigation and future key collaborators. The interviews were also identified as a privileged opportunity for the researcher to present himself, his research project, and CE principles, to open a dialog with each worker, and spread CE awareness.

## 2.4 Interviewee selection

The aim is to collect the point of view of each Style & Design actor, to make sure to assess completely the Reference Model, Impact Model, and CE dimensions of the company. It was not possible to interview each actor, because of a lack of time and resources. The aim was to create the largest possible sample to ensure theoretical saturation when processing the data while making sure to capture all the types of points of view and keeping the interview campaign in a reasonable amount of resources and time inside the project (under 6 months for a three years project). It was decided that the interview corpus should feature at least one interview of each profession and hierarchical level, assuming that inside a profession, the points of view wouldn't differ too much.

Therefore, we employed judgmental (purposeful) sampling as opposed to randomized sampling (Coleman and Briggs, 2002). We first conducted semi-structured interviews with the CEO, Director of Human Resources, and other top-management representatives to build the interviewee list. Interviewees were also selected according to availability and/or because they were the only ones in a profession category or hierarchical level. Additional interviewees were then selected during the data-gathering process using snowball sampling (Noy, 2008).

We obtained a list of 37 different professions containing all actors in Style & Design. Thanks to this list, we planned on interviewing 70% of Style & Design identified actors with at least one person per profession and position. We planned 45 interviews, contacted 50 workers, and conducted 42 interviews between May 2022 and November 2022 on 37 different professions, with a 90% acceptance rate.

## 2.5 Data collection

An interview lasted, on average 65 minutes, we conducted around 45h of interviews. The interviews were all conducted in French and inside Style & Design buildings. Maximum efforts were made to keep a compassionate neutrality and make the interviewee comfortable and encourage him to speak freely: the interviews were individual, in a closed space, with chairs and table, with no audio records, only handwritten notes. The study employed semi-structured interviews (Blanchet, Gotman and Singly, 2007). Most of the exchanges were free, exploratory, and non-scripted, but several questions and presentations were scripted and identical in all interviews. The structure of the interview has evolved along the interviews, mostly more scripted questions were added to ensure that key subjects were discussed. The interviews were globally structured in three steps: contextualization of the interview, Development of Reference Model and CE dimensions, Development of Impact Model and CE dimensions. Each step theme was launched by a scripted question given by the interviewer. For example, "I would like to hear about your point of view about CE. How do you see CE in general?", "How do you see CE at S&D?", or "How do you see the future of S&D?".

With this process, we interviewed 70% of Style & Design prototyping actors with at least one person per profession and position, creating a corpus of raw data presented as handwritten notes of each interview, in French covering around 5 paper notebooks (96 pages, 21X29,7cm).

A first processing was made on the raw data: as the interviews were not recorded, they were manually transcribed from handwritten notes to a digital text file on a computer. The transcription was made using a set of rules, to ensure consistency with the original oral exchanges of the interviews but also to ensure the text's readability. A transcribed corpus text of 112 334 words has been produced with this method.

## 2.6 Data analysis

A second processing was made on the transcribed corpus. For the construction of the Reference and Impact Model, we evaluate the interviews in detail (coding and classification), semi-ignorant of prior studies as advised for inductive research (Gioia, Corley and Hamilton, 2013). First, the coding of the complete transcribed corpus is done using data-based open coding on the software MaxQDA, which generates numerous codes (Saldaña, 2013). Each idea or subject is given its own category. Then, to reduce the number of codes and reach a higher level of understanding, we aggregated the codes to form themes. Without deleting any codes, we analyzed the similarities and differences between the codes to create the themes. Finally, for this article, a selection and additional aggregation of themes have been made to generate a summarized view of the Impact Model. Themes discussed by less than 6 interviewees have been ignored, and all the other themes have been aggregated by similarity as much as possible for the sake of readability. However, as we aim to highlight the diversity of points of view among the company workers, some similar themes have been kept separated when the interviewees discussing them were from different profession categories.

To analyze the CE barriers, a comparison with the literature seemed fit to highlight the benefit of including all workers in the interview and not only the top management. Thus a first set of themes was extracted from the literature, mainly from Araujo Galvão et al., 2018; Lobo et al., 2022; Takacs, Brunner and Frankenberger, 2022. Then the complete transcribed corpus was coded according to these already identified themes. In addition, data-based open coding was performed when the CE barriers identified didn't fit in any existing themes. The aim was to identify in our case study the CE barriers in common with the literature, the CE barriers in the literature missing from our interview corpus, and the new CE barriers found in our interviews but not in the literature. As for the Impact Model, the codes were then aggregated without suppressing anything and then a selection and additional aggregation of themes has been made to generate a summarized view of the CE barriers for the sake of readability. The method was the same as for the Impact Model but with the additional rule to prioritize the highlight of newly found CE barriers compared to the literature.

As a result, we obtained coded and categorized text segments from the transcribed text of each interview and a list of corresponding themes. In the last processing step, we combined qualitative data with quantitative data for the Impact Model and CE barriers in two visual diagrams, showing the differences and similarities between each worker's point of view. The qualitative data provide meaning and understanding while the quantitative data provides rigor and strength to the answer we find. A final processing of the data would bring an additional visual representation of all the results. The final goal is to build a complete "mind map" of the Reference and Impact Model and CE dimensions featuring all the aspects discussed during the interview.

## 3 FINDINGS

### 3.1 Impact model

The interviews are aggregated into three categories: Direction, Support, and Production. In the Direction (or strategic) category we grouped the interview of the CEO, top management, and management. In the Support category, we grouped the interviews of professions not directly linked to the production: engineers, salesman, designers, project leaders, and their team leaders. In the Production (or operation) category we grouped the interviews of professions directly linked to the production: textile, metal, plastic, electrical, electronical, painting workers, etc, and their team leaders. As a result, among the 42 interviews, we have 15 direction workers interviews, 12 support workers interviews, and 15 production workers interviews. In Figure 1, a radar chart with three summits, one for each worker category, is presented. The position of the circles indicates how many interviewees of each category talked about the subject of the circle. The closer a circle is from a summit, the more interviewees from the corresponding category talked about the circle subject. For example, 7 interviewees from the production category, one from the support category, and zero from the direction category, talked about "Invest in durable production equipment, tools", at the bottom right of Figure 1. Each circle represents a theme from the analysis, each theme being an aggregate of wishes for the future of the company that the interviewee expressed during the interview. The size of a circle indicates how many interviewees in total, talked at least once about the circle subject. The wishes in the circles are not mutually exclusive, meaning that the wishes could all be present together in the wished future without contradiction.

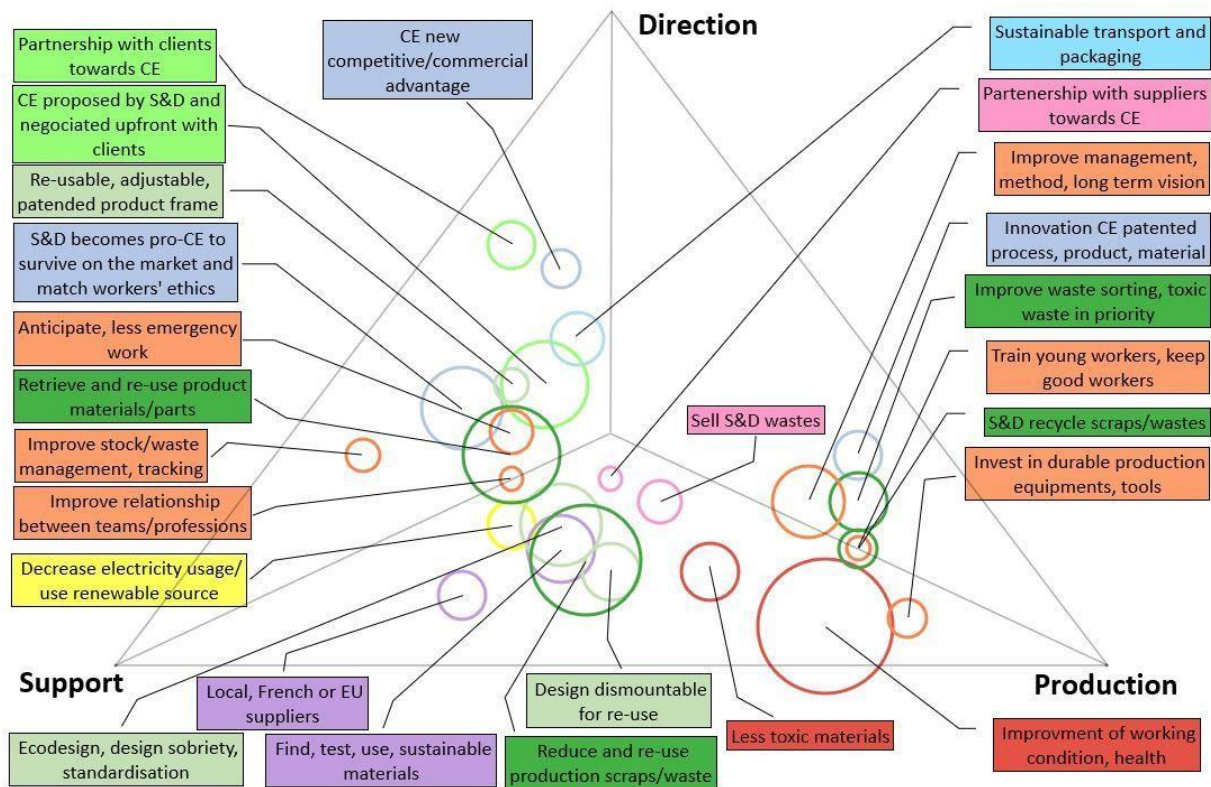


Figure 1. Summarized impact model per worker category

|   |                                 |                                   |
|---|---------------------------------|-----------------------------------|
| CE transition strategy at S&D               | Industrial ecology with clients | Industrial ecology with suppliers |
| Sustainable working condition in production | Sustainable production          | Sustainable purchasing            |
| Eco-design                                  | Sustainable End-of-life, 4R     | Sustainable transport             |
| Strategic and operational management        |                                 |                                   |

Figure 2. Colour code for summarized impact model

The color of the circle subject description indicates a category of theme, as described in Figure 2.

The "Improvement of working conditions, health" is the wish for the future the most discussed during the interview, and mostly by production workers and a little by support workers. Even if Style & Design is following the required health and safety legislation, there is a wish for further improvement clearly expressed by a total of 28/42 interviewees (66%). This wish aggregates multiple "smaller" wishes regarding working conditions, like for example the reduction of dust or better air cleaning for the plastic workshop. Production workers expressed that their working condition concern takes priority over environmental concerns. Therefore, our CE deployment plan must include, from the start, an improvement in working conditions as a priority. The "Reduce and reuse production scraps/wastes" is the second most discussed wish (23 interviewees) and is discussed nearly as much by support and production workers. In fact, support and production workers expressed deep frustration about the significant amount of production waste and proposed, during the interviews, numerous solutions to reduce or reuse them. The third most discussed wish is "Retrieve and re-use product materials/parts" (20 interviewees), discussed mostly by support workers and a little by direction workers. This wish highlights the identified possibility for Style & Design to retrieve its products after use, dismantle them, and re-use at least some of the parts or materials for an updated version of the same product or for new products. The fourth most discussed wish is "CE proposed by S&D and negotiated upfront with the clients" (18 interviewees), discussed mostly by support and direction workers. This wish expresses the desire of Style & Design employees to be a source of proposals (CE proposals in particular), for its clients and not only execute what the clients are asking. Interviewees also expressed frustration as they cannot negotiate CE elements with the clients once the contract has already been settled without them. Interviewees expressed the desire for the pre-sale teams to take care of this matter with the clients, from the early stages of the project, where CE design choices can still be made. The fifth most discussed wish is "S&D becomes pro-CE to survive on the market and match workers' ethics" (17 interviewees), discussed mostly by support and direction workers. Most of the direction workers expressed their belief

that if Style & Design does not deploy CE in the 5 coming years, it will lose market shares by failing to address its clients' needs for CE and getting behind its competitors on the matter. Some direction but mostly support and production workers expressed a personal and professional interest in CE and expressed frustration about the current situation at Style & Design not being circular enough. Some also expressed their belief that CE will become inevitable or compulsory in the future, so Style & Design should anticipate it. These five elements take an important place in the worker's desired future; therefore, they should be integrated in priority and implemented as early as possible in the CE deployment plan.

In the literature, in CE diagnosis, only direction workers are interviewed (Lobo et al., 2022; Takacs, Brunner and Frankenberger, 2022), thus missing the support and production workers' point of view. This means that only the wishes on the top part of Figure 1 are considered and that the entire bottom part (below the zero at the junction of the three branches of the radar) of the chart is ignored, thus missing the 19/26 most discussed wishes here. At Style & Design, the direction workers are willing to deploy CE, they wish to see the results of its implementation already, as they are accountable for the company's financial results (CE is a new competitive/commercial advantage) and client satisfaction (Partnership with clients towards CE, CE proposed by S&D and negotiated upfront with the client, S&D becomes pro-CE to survive on the market). Production workers, more focused on their day-to-day job, have different wishes, addressing their capability, tools, and equipment to actually perform the new CE tasks (Improvement of working conditions, health, invest in durable production equipment and tools). This difference of interest, highlighted by our interviews, is the basis of change management (Hiatt and Creasey, 2003), yet it is currently being ignored in nowadays CE diagnosis and deployment. CE deployment is a complex change management task in which considering what every actor wants is important, not considering some of the most expressed wishes for change (here the wish for working condition improvement in particular) could turn out to be a barrier for CE deployment.

### 3.2 CE barriers

The CE barriers detected during the interviews are summarized in Figure 3, just like the Impact model, it is a radar chart with three summits, one for each worker category. Each circle represents a CE barrier discussed at least once by at least 6 interviewees. The size of the circle indicates how many interviewees in total discussed the circle CE barrier.

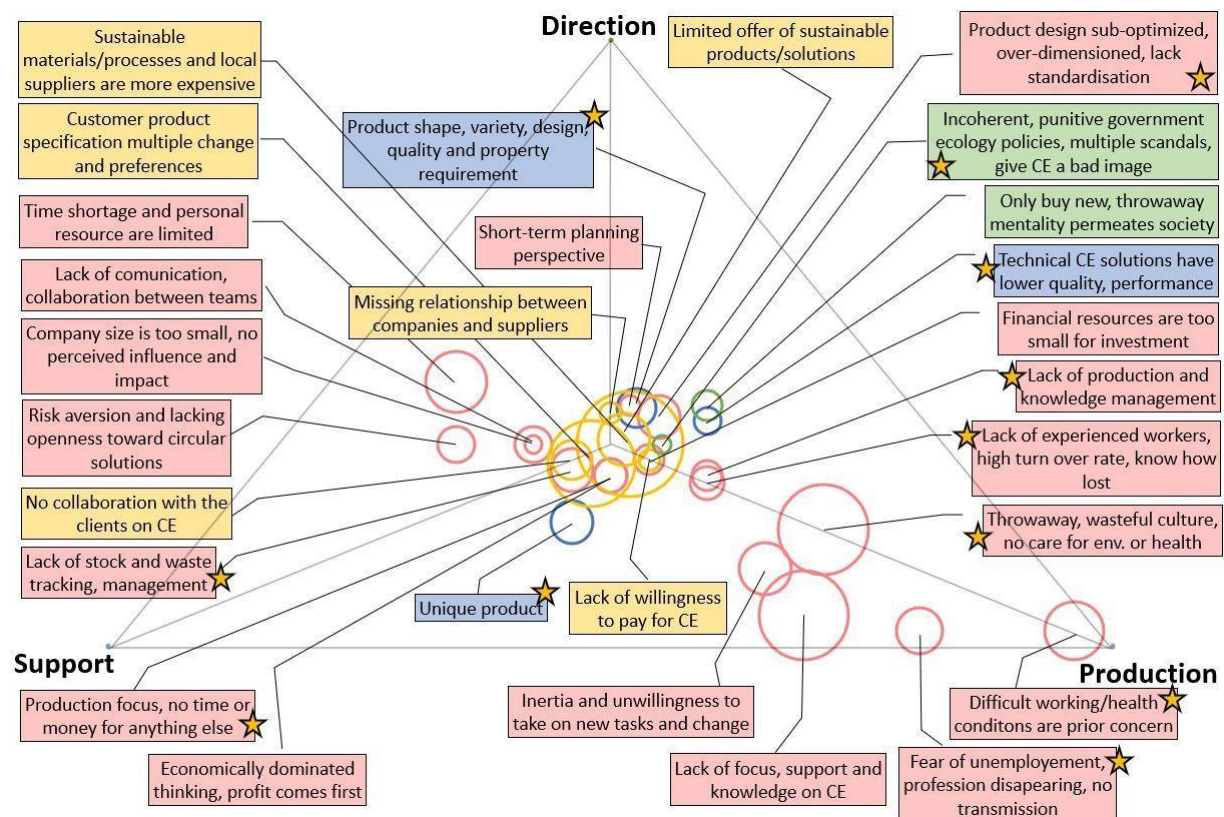


Figure 3. Summarized CE barriers per worker category



The colors indicate the CE barrier theme: pink for company's internal barriers, yellow for market barriers, blue for technological, and green for societal barriers. The circle descriptions with a yellow star indicate CE barriers that are not presented in the CE barriers literature and that are newly found SME CE barriers or CE barriers specific to Style & Design. The fact that 15 out of 28 CE barrier and 8 out of 12 new CE barriers are from the bottom part of the chart, highlight the benefit of our method, as interviews of only direction workers wouldn't have revealed them. The chart summarizes the most discussed CE barriers but not all the ones that have been identified in our interviews. Most of the CE barriers of SMEs listed by (Takacs, Brunner and Frankengerger, 2022) have been found in our interviews. "Sustainable materials and processes, and local suppliers, are more expensive than ordinary" (the most addressed CE barrier, by 34 interviewees out of 42), "Lack of focus, support, and knowledge of CE" (29 interviewees, mostly production workers) and "Time shortage and personal resources limited" (20 interviewees, mostly support workers) being the most addressed. However, legislative barriers were not at all addressed in our interviews, as Style & Design business has fewer legislative constraints than the food or clothing industry, the main source of information for Takacs, Brunner and Frankengerger, 2022. Other CE barriers like " Price pressure through e-commerce or greenwashing competitors" or " Requirements of up and downstream companies restricting CE" or " Quantity of eco-labels increases complexity, confusion, costs", also do not concern Style & Design business. In general, Style & Design seems to have fewer external CE barriers and more company internal barriers (17/28), which should be seen as a great opportunity.

The most discussed new CE barrier is the "Throwaway, wasteful culture with no care for the environment or health" (29 interviewees). In the literature, this barrier is addressed as the general state of society, but here the interviewees seemed to think that it was more severe in Style & Design than in other companies and society in general. This CE barrier aggregates lots of CE barriers mostly addressed by production workers. The CE barrier "Difficult working and health condition are a prior concern" (19 interviewees), "Fear of unemployment, profession disappearing, no transmission of know-how" (15 interviewees), "Production focus, no time or money for anything else" (11 interviews), highlights the production workers priorities and lack of openness to CE. These are new compared to the CE barrier literature but not to the change management literature (Hiatt and Creasey, 2003). Together with the difficult working conditions and "Inertia and unwillingness to change" barriers, they form the very basis of individual change management. However, Style & Design seems to be facing a few unique technical and internal CE barriers. On the technical side, the fact that the company's products are unique products, one-off pieces of craft that will never be repeated, limits their circular potential. On top of that, the products have irregular shapes, with a wide range of variety, which limits the re-use potential of parts in between products. The quality and property requirements can also be a challenge, as the product has strong resistance and visual requirements and sometimes must be fire-proof, water-proof, and resistant to exposition to the sun, heat, or cold. This leads to the last new CE technical barriers: most environmentally friendly or CE solutions that Style & Design could use, have lower quality or performance, and do not match the requirements. These three CE barriers are new but could be placed in the general theme of "Technological barriers" identified in the literature. Another new CE barrier identified is "Incoherent, punitive government ecology policies, multiple scandals, that gives CE a bad image". Interviewees expressed that government decisions regarding ecology seemed bad and incoherent, directed by the financial and industrial lobby's interest, and always led to punitive measures like taxes and restrictions for them. Together with the multiple scandals, like the Qatar football world cup or the future COP 28 in Dubai held by oil businessmen, it results in a bad image of ecology and by extension, of CE. As a result, interviewees struggle to believe that CE could be beneficial to them. This thought could be particularly present in Style & Design because of its close link to the transport industry, targeted by questionable ecology policies in the last few years. Style & Design, as most SMEs undertaking drastic change, is also facing internal management issue that becomes CE barriers, like "Lack of experienced workers, high turnover rate and know-how being lost", "Lack of production and knowledge management" (for example lack of practical feedback after a project) and "Lack of stock and waste tracking and management". These new CE barriers could be placed in the general theme of "Management" identified in the literature. Style & Design is already currently working on improving these aspects and will go further in this work with the CE deployment plan. The last new CE barrier identified here is "Product design sub-optimized, over-dimensioned, with a lack of standardization" (14 interviewees). This CE barrier highlights the fact that CE should be integrated at the design stage, as the workers that intervene after that are blocked in their CE application because of it.

## 4 DISCUSSION

### 4.1 Limits and challenges

Preliminary high-level results are presented here; more detailed results and analysis will follow in a next article. The results are summarized and aggregated for readability and space optimization, we chose to focus on certain aspects and put aside some others, therefore some elements might be hidden from this article but will be discussed in future articles. The interview sample covers 70% of the identified actors, 100% could have been useful as we have seen that theoretical saturation was not reached as with each new interviewee, new wishes for the Impact Model and CE barriers were discovered. But the resources and time constraints have prevented covering more than 70%. The interview structure has evolved during the interview campaign; therefore, the interviews are not uniform, and some elements are not as thoroughly discussed in some of the early interviews compared to the later ones. The hand-written notes were transcribed manually with a set of rules, instead of audio recording with automatic transcription. This could have affected the quality and consistency of the text with the original speech, but the research was using strict rules to prevent it as much as possible. To prove the benefit of our method, testing it in other SMEs would be valuable, but is not doable in this research study. For the Impact Model chart, the wishes have been aggregated and given short titles as descriptions, which hides the nuances the interviewees expressed, for example, to "Improve the management" doesn't mean the same thing for every interviewee. For the analysis of CE barriers, proving that some are "new" compared to the literature is difficult, as the literature uses too general themes or too precise examples. The diagnosis faced several challenges in its implementation, e.g., employee turnover and limited interview candidates' availability for a one-hour-long interview, which delayed the interviews.

### 4.2 Lesson learned and perspectives

From the interviews, we have confirmed that the comfort of the interviewee is essential to the quality of the data collected. For example: not recording, using only handwritten notes, and performing interviews directly in their office or break room instead of in a separated unfamiliar meeting room. Also doing single-person interviews freed the interviewees from the social pressure of co-workers or team leaders, isolated, each worker had a chance to express their very own unfiltered point of view.

More than that, the interviews opened a dialog on CE with the company's workers, after the interview and even months after, the workers have been coming back to the researcher with newly identified CE barriers, opportunities, and solutions, proving the success of this interview campaign on this objective. Interviews have proven to be a key tool to create collaboration and gather even more data, which highlights its benefits compared to the literature questionnaire or CEO-only interviews.

The complete results of the observation and interview step or the multi-internal actor diagnosis will be presented in a future article. The diagnosis will be completed with descriptive methods as described in our methodology. In addition, quantitative analysis like LCA on the product, and MFA on the factory, will be performed to complete the diagnosis with quantitative data. The proposed diagnosis could be the first part of a complete guide for industrial SMEs CE implementation. The reproducibility of the study and its generalizability to other SMEs will be studied and documented in a next article.

## 5 CONCLUSION

We have presented in this paper the first step and the first results of a methodology to perform a multi-internal actor diagnosis of Circular Economy in an SME. Thanks to our 42 interviews, the point of view on the Reference Model (current situation) and Impact Model (desired situation) have been explored, with a focus on CE dimensions, from the point of view of 70% of the prototyping actors at Style & Design. The preliminary results highlight the difference and similarities between each worker's point of view and confirm the benefits of our approach as each profession category provided unique insights and answers. The successful opening of the dialog on CE, with interviewees coming back to the researcher with additional unique perspectives and ideas, also confirms the first benefits of our workers-inclusive diagnosis technique compared to the literature one. This first exploratory step of our diagnosis method will be completed with additional descriptive and quantitative methods. Our final goal for this CE diagnosis is to generate a complete picture of the Reference and Impact Model and CE dimensions, rich of all the workers' insights. Thanks to this enhanced diagnosis of their business, industrial SMEs will be able to design an adapted, inclusive, action plan to perform a durable

CE implementation, allowing them to create value and gain a competitive advantage in the market. SMEs are key players in the EU economy, and a practical and adapted guide for CE implementation in SMEs would be of significant help in reaching a circular economy.

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