Do Manufacturing Companies' Key Performance Indicators Support Circularity?

An Explorative Study on Swedish Manufacturing Companies

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Abstract.

Manufacturing companies today are facing a grand challenge to become more sustainable. One way this can be achieved is through circularity, which can support companies in creating a regenerative system by closing and narrowing loops of material and energy. To strive towards becoming more circular, companies can deploy key performance indicators (KPI:s) that are able to communicate the strategic direction of the company. Although KPI:s have received significant attention related to sustainability, it still remains to be seen how they can be used to support circularity. By analysing the sustainability reports of 20 of the most sustainable companies in Sweden, this paper presents a current state if manufacturing companies' KPI:s support circularity. In total, 469 KPI:s were extracted from the reports, which were then grouped into themes and connected to if they help companies to Reduce, Reuse, or Recycle resources. The analysis showed that a majority of the KPI:s used support Reduce, whereas significantly fewer support Reuse and Recycle. It is further seen that a disconnect between the strategic intent and the KPI:s used within the companies exist, where all companies highlight to different extent that circularity is of importance and something they work with, but the KPI:s presented are not connected to this. The paper further presents some ways forward to help manufacturing companies in their endeavour to become more circular, as well as discusses avenues for future research.

Keywords. Circularity, Circular Economy, Key Performance Indicators, Manufacturing

1. Introduction

One of society's grand challenges today is how to achieve a sustainable future. This challenge, although great, has seen some potential solutions. One such solution can be the adoption of circularity which can be described as resulting in "*a regenerative system in which resource input and waste, emission, and energy leakage are minimized by slow-*

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ing, closing, and narrowing material and energy loops" [11] (p.759). Circularity plays a significant role in achieving sustainability since it can enable companies to limit their impact on the global climate crisis by for instance reducing and reusing resources [12, 25]. This is yet more predominant in manufacturing companies, where potential impact on sustainability can be prominent both in their production as well as their products' usage and end of life [5]. Thus, circularity provides a relevant avenue for manufacturing companies to pursue. However, the question bares: how can this be done? One way for companies to work towards becoming more circular is by deploying key performance indicators (KPI:s) [1]. KPI:s are quantifiable metrics that can be used to steer the direction of companies and to align their employees towards a common goal [3], in this case becoming more circular. As KPI:s create incentive for the employees in companies, they can support necessary ideation that in return supports companies in their circularity endeavour [1]. How KPI:s can be used to support sustainability and circularity has been pointed out as a grand challenge [1, 4], and whereas previous studies have looked into if and how the KPI:s of companies from different sectors and levels of companies support sustainability or not [8, 16, 41], there is still a gap related to if and how KPI:s can support circularity [1]. To ensure alignment towards circularity, it becomes important to first define what KPI:s should be used on a company level to point out the strategic direction of the company [34] which can later be applied throughout the company on lower levels of aggregation [30]. To explore how companies work with sustainability and circularity, recent literature has employed exploratory research approaches utilizing sustainability reports to gain insights into companies' practices [8, 31]. Such an approach can thus be deemed relevant to also explore how manufacturing companies work with KPI:s and if they support circularity or not. The purpose, alike the title, of this paper is therefore to explore if manufacturing companies' KPI:s support circularity.

2. Theoretical Background

2.1. Circularity

Circularity has been acknowledged as an enabler for sustainable development [12, 25]. It is especially significant given the urgent need to tackle the climate crisis which continues to excel [17]. Although numerous descriptions of circularity have been put forward in the past years, attempts at creating a unified definition has been made. For instance, Kirchherr et al. [23] analysed 114 definitions of circularity, and summarized it as an "*economic system that replaces the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes.*" (p.229). Through circularity, lifetime extension of e.g. raw materials and water can thus be achieved, in contrast to the 'end-of-life' concept, i.e. the linear economy, wherein a 'take-make-use-dispose' approach is adopted [22].

Circularity can be reckoned as occurring at three different levels: i) the micro level (e.g. specific products, companies and consumers), ii) the meso level (e.g. industrial symbiosis and eco-industrial parks) and iii) the macro level (city, region, nation) [23]. A way to describe how circularity can be achieved is through numerous strategies, frequently labelled as R's. According to the definition posed above, circularity can be realized through reducing, reusing, recycling and recovering materials, whereas each of these strategies

represents an R. These actions can be elaborated even further, e.g. by describing which types of resources or raw materials such strategies implies. For instance, reusing has been described as not only reusing products between users [29], but also reusing e.g. metals, packaging materials, and water within production [32]. By following the approach of focusing on resource and raw material usage, rather than emphasising solely the products and actions related extending their lifecycles, a more comprehensive perspective can be achieved. Although KPI:s have been used extensively in relation to sustainability [39, 41], their application in relation to circularity remains sparse and challenges remain [1].
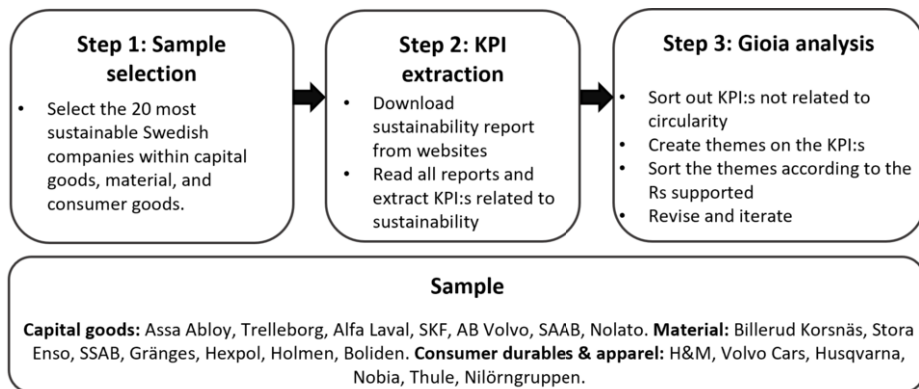
2.2. Key Performance Indicators

KPI:s are quantifiable metrics that can inform companies on how to improve their performance significantly [3, 28]. It is broadly acknowledged that KPI:s drive behaviour in individuals, which means that they can be used to to create alignment towards the strategic objectives of the company [21, 26]. However, to do this, the KPI:s must be tightly connected to the strategy of the company and further be aligned with the key processes and stakeholder values [27]. A further effect of this is that the type of KPI:s used matter. For instance, although KPI:s historically tended to focus solely on economic profitability related to accounting, companies should not only focus on financial KPI:s since they only present a part of the picture [9]. A reason for this is that you "get what you measure", and solely focusing on financial KPI:s may thus result in a deficient understanding of other aspects, resulting in sub-optimization of the company's performance [36].

As explained earlier, an important aspect of KPI:s is to align them towards strategy. However, there is also a need to ensure alignment across the KPI:s used. For instance, when developing and deploying new KPI:s, one must address the role of existing KPI:s [42]. For instance, coming from a linear economy and strategy, the KPI:s used in companies can be tailored accordingly and thus create challenges when striving to becoming more circular [1]. Another important aspect to consider related to sustainability and circularity is to focus not only on a few KPI:s in isolation, but rather understand the connection between them [4, 18]. For instance, sustainability related KPI:s may contain synergies with financially centered KPI:s, and thus provide further incentive for companies to pursue sustainability as a means to get a competitive advantage [4]. Related to this, it is also important to distinguish between the different levels that KPI:s may be, such as macro, meso, or micro, and which of these levels that the KPI support [30]. It has also been argued in the literature that one should focus on a smaller amount of KPI:s that provide the highest amount of importance to companies [21].

3. Methodology

To fulfil the purpose, a document study was carried out in order to explore if manufacturing companies' KPI:s support circularity. Sustainability reports were chosen as the documents to study as they provide detailed insights into a company's sustainability and circularity practices and also contain numerous KPI:s. As sustainability reports are intended for providing stakeholders with information regarding the ongoing and past sustainability actions occurring in the companies, they also provide the possibility for conveying strategic objectives vertically within an organisation. In Sweden, sustainability reporting

Step 1: Sample selection
- Select the 20 most sustainable Swedish companies within capital goods, material, and consumer goods.

Step 2: KPI extraction
- Download sustainability report from websites
- Read all reports and extract KPI:s related to sustainability

Step 3: Gioia analysis
- Sort out KPI:s not related to circularity
- Create themes on the KPI:s
- Sort the themes according to the Rs supported
- Revise and iterate

Sample

Capital goods: Assa Abloy, Trelleborg, Alfa Laval, SKF, AB Volvo, SAAB, Nolato. **Material:** Billerud Korsnäs, Stora Enso, SSAB, Gränges, Hexpol, Holmen, Boliden. **Consumer durables & apparel:** H&M, Volvo Cars, Husqvarna, Nobia, Thule, Nilörngruppen.

Figure 1. Depiction of research process

is a mandatory requirement for Swedish companies that in each of the last two financial years have fulfilled at least one of the following requirements: (i) More than 175 million SEK in total assets (roughly 15 million EUR as of October 2023), (ii) More than 350 million SEK in net sales (roughly 30 million EUR as of October 2023) or (iii) Average of more than 250 employees or more [2]. Although there are limited requirements on specific contents required to be included in the sustainability reports, e.g. which KPI:s to include, they have been studied previously wherein both circularity and KPI:s have been emphasised, thus confirming that they are valid documents to study. For example, sustainability report have been scrutinized in order to explore climate mitigation in terms of CO2 emissions and energy use [20], to explore the adaptation of circularity practices within multi-national companies [6], and to evaluate KPI:s for the ceramic industry [8].

In this research, the sample consisted of 20 Swedish manufacturing companies, see figure 1 below. The sample size was decided based upon a review of previous research wherein sustainability reports were scrutinized (see e.g. [6, 35, 38]). The companies were selected based on being awarded amongst the most sustainable companies in Sweden according to a compilation by researchers from Lund University alongside an expert committee and representatives from various Swedish funding agencies (see [14]). The list followed the Global Industry Classification Standard [37] and given this research's purpose, solely manufacturing companies were selected, i.e. belonging to the material, capital goods, as well as consumer durables and apparel categories. Hence were e.g. companies within consumer services and food, beverage and tobacco categories excluded from this sample. Both companies with a large variety of products, operating on a group level, such as AB Volvo which produces e.g. trucks, buses, and power solutions for marine and industrial applications, as well as companies focusing on single type of product, e.g. SSAB which produces a wide arrange of steel, were included in the sample.

The sustainability reports are publicly available documents and were downloaded from the companies web pages. These were subsequently read, and all sustainability KPI:s were extracted. A Gioia analysis [13] was carried out wherein the KPI:s were filtered based on if they support circularity or not. For example, KPI:s related to social sustainability were not deemed to support circularity and were thus omitted. This selection constituted the 1st level constructs, 2nd order themes were created based on the identified circularity KPI:s based on what they measured. The themes were then linked to if

they aim to Reduce, Reuse, or Recycle, which constituted the aggregate dimension in the analysis; thus implementing an abductive approach, see figure 1. To exemplify, within Reduce, the following themes were identified: Air emissions, Chemicals, CO2 emissions, Water, Waste, Transportation, Material, and Energy. Within each of these themes, numerous KPI:s were identified, thus showcasing how these are being measured and used by the sample companies in relation to both the theme identified, as well as which R it supports. The R's Reduce, Reuse, and Recycle were used in this research due to those being the most commonly used to describe circularity both in research (see e.g. [23, 24]), and in the industry (see e.g. [32]). As a consequence was e.g. Recover not used as it was deemed not resulting in finding sufficient KPI:s to create representative themes for the entire sample.

4. Results and Analysis

In total, 469 KPI:s were extracted from the sustainability reports. From these, 14 themes that were connected to if they support Reduce, Reuse, or Recycle were distinguished. Some of the themes could be connected to all of the R's, and were thus split depending on the character of the KPI. To exemplify, water was measured in different ways, such as either by a pure reduction of water usage (Reduce), or by how much water was recycled (Recycle). Thus, the same theme, Water, was seen to connect to two different R's and were subsequently split as such. When revising the coding, a distinction was made related to energy which could pertain both to the amount of energy used in the production, such as through heat or electricity, but also through fuel usage related to transportation. A summary of the analysis can be seen in figure 2, which depicts the R supported, the underlying themes, and two examples per theme of their underlying KPI:s.

A notable finding from the analysis is that 403 of the KPI:s were seen to support Reduce, whereas only 51 were directed towards Recycle, and a mere 15 to Reuse. This is also evident when looking at the themes, which yielded far more themes related to Reduce, than Reuse, and Recycle. As such, there is a disproportionate focus on reduction of for instance material usage, as opposed to recycling. A reason for this can be that by reducing for instance material usage and energy consumption, companies subsequently also find an economic synergy [4]. Coupled with the strong focus on financial KPI:s the analysed companies present in their reports, this proves a plausible thesis.

Another distinction as to the characteristics of the identified KPI:s is that they in large focus on the production of the product, and not so much towards the use phase or end of life. Related to recycling, several companies did however measure the amount of recycled material used in their products. As such, there seems to be an underlying focus on the internal processes of the companies, where the focus is related to the processes before the customer receives the product. However, ensuring the further reuse and recyclability of the product can be deemed an integral part if the companies wish to become more circular [29]. One reason for this can pertain to the fact that this is not a key process within the companies themselves, but rather something that is expected to be taken care of by other companies. Nevertheless, this is something that is still lacking in terms of the identified KPI:s.

The level of aggregation [30] that the KPI:s were presented varied throughout the companies. All companies presented their CO2 emissions in some way, but some com-
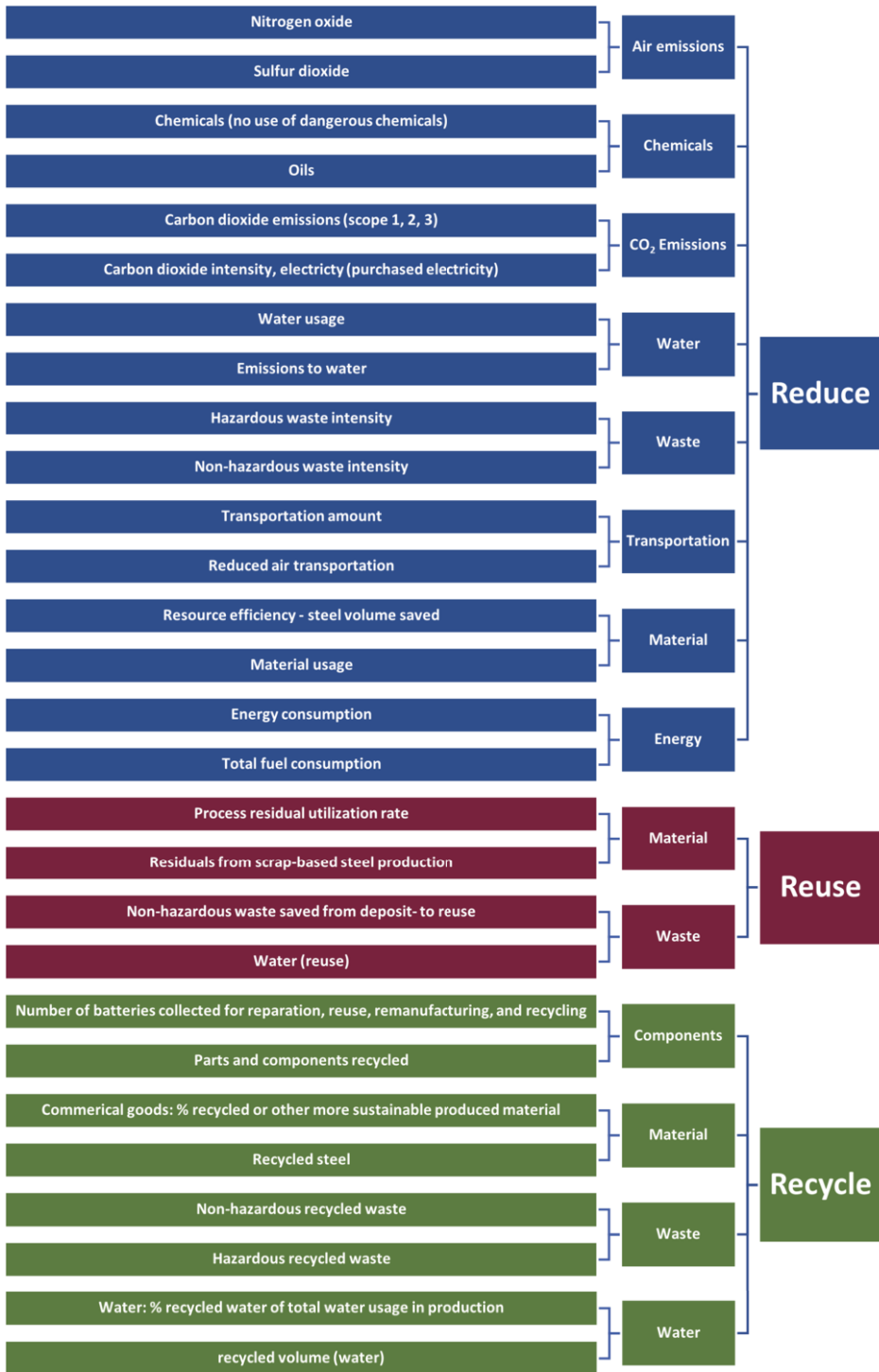
Reduce

- Nitrogen oxide / Sulfur dioxide → Air emissions
- Chemicals (no use of dangerous chemicals) / Oils → Chemicals
- Carbon dioxide emissions (scope 1, 2, 3) / Carbon dioxide intensity, electricty (purchased electricity) → CO_2 Emissions
- Water usage / Emissions to water → Water
- Hazardous waste intensity / Non-hazardous waste intensity → Waste
- Transportation amount / Reduced air transportation → Transportation
- Resource efficiency - steel volume saved / Material usage → Material
- Energy consumption / Total fuel consumption → Energy

Reuse

- Process residual utilization rate / Residuals from scrap-based steel production → Material
- Non-hazardous waste saved from deposit- to reuse / Water (reuse) → Waste

Recycle

- Number of batteries collected for reparation, reuse, remanufacturing, and recycling / Parts and components recycled → Components
- Commerical goods: % recycled or other more sustainable produced material / Recycled steel → Material
- Non-hazardous recycled waste / Hazardous recycled waste → Waste
- Water: % recycled water of total water usage in production / recycled volume (water) → Water

Figure 2. Breakdown of KPI:s, themes, and R supported

panies chose to divide it up depending on if it was Scope 1, 2, or 3 [40], whereas others only presented them summed up together. Another example of aggregation could be seen from Billerud Korsnäs, who presented the amount of water used on an aggregated level, but presented in a footnote that the water used was reused 30-50 times before it went to cleansing. However, this reuse and and recycling of the water used could have proven a usable KPI to report on as well, to not only focus on the reduction of water usage, but also reuse and recycle. Although most KPI:s were presented on a micro-level [30], there is a clear demarcation towards the internal processes of the companies, with an exception of scope 3 emissions in some reports.

Although all companies mentioned circularity as an area of importance to different degrees, there seems to be a discrepancy between what is presented in terms of strategic objectives and the used KPI:s. An example of this is that Husqvarna mentions circularity clearly as a strategically important area and further highlights Reduce, Reuse, Repair, Remanufacture, and Recycle as their R's of focus. However, the KPI:s presented in the report are not connected to these. In a similar fashion, Volvo Cars present a visualisation of their value chain for a circular economy and further highlights two overarching goals related to how this should be achieved: i) cost savings and new revenue streams, and ii) decrease the amount of CO_2 emission. However, one can argue that these goals and KPI:s in fact only focus on mere reduction rather than holistic perspective on circularity, encompassing also Reuse and Recycle. Similarly, the other KPI:s communicated in Volvo Car's report did not support all stages of their visualisation of their value chain for circular economy. Finally, H&M mentions that reuse of their products is a way they work to support circularity. However, there is no support for this in the KPI:s presented in their report. As such, the strategic intent regarding circularity seems to have gone longer than the deployment of KPI:s to actually support these endeavours.

5. Discussion

Although a few companies already have created strategic circularity objectives, there is still a lack of connection between those and relevant KPI:s. This study has shown that such realization is yet to be achieved by companies. Furthermore, succeeding with such effort calls for an evaluation which Rs should be included in the strategic objectives. The results of this study indicates that KPI:s related to Reduce is clearly the most common. However, an issue might be that Reduce can be reckoned too overarching and as a consequence of other R's to properly connect to suitable KPI:s. Instead, novel R's might need to be used and developed which support the alignment in a more efficient way. For instance, Volvo Cars clearly has depicted their circularity strategy within a figure, as previously described. However, a clear connection to suitable KPI:s is currently missing, not solely at Volvo Cars, but in the entire sample. By clearly connecting KPI:s to these summarizing figures, it might be possible to clarify the crucial alignment between strategic objectives and KPI:s. Such attempt would also aid in creating a more evenly distributed set of KPI:s, transitioning from the current heavy emphasis on Reduce, towards more explicit Rs and KPI:s instead.

The lack of equal distribution between the R's might derive from the alignment between circularity practices and economic benefits. Reduce clearly has the potential of also bringing economic benefits to a company, e.g in terms of reducing energy, chemicals,

materials usage. Although it is possible that Reuse and Recycle leads to the same result, they might require additional efforts which potentially 'requires more than it gives'. The same argumentation can be used to explain why other R's have been so scarcely mentioned. To exemplify, although 'Remanufacturing' has been depicted as economically justifiable from a manufacturing perspective [10], consumers might yet not be ready for such behavioural change [15], and therefore might 'Remanufacturing' not yet be commonly carried out. This might consequently lead to a lack of emphasis on 'Remanufacturing' in the strategic objectives and in the KPI:s.

As described previously, there is a lack of KPI:s that support the reuse and recycling of products. Further alluded to, companies could see that it is not a key process to focus on reuse and recycling of their products and rather focus on their internal processes. One avenue for this could be to establish collaborations with external partners to further support the circularity. This in return presents other challenges, as the KPI:s and objectives across organisations might not be aligned [4]. As such, understanding not only the role of the sole company, but also how collaborations on the meso-level [30], such as by utilizing circular business ecosystems [19], can be seen as an important avenue to further support the companies circularity endeavours. However, such approach would complicate matters, as standardization of data collection and analysis needs to be realized in order to achieve proper utilization of KPI:s on a meso level. Given the existing lack of alignment between strategy and KPI:s even within the own company, such endeavour might be reckoned rather distant.

As noted in the literature, it is advantageous to focus on a smaller set of KPI:s that depict the performance and strategic objectives of the company [21]. However, most of the companies presented a large amount of KPI:s in their reports. A subsequent effect of this is that focus, and what is deemed important, may get lost. One way to counteract this can be to present an aggregated dimension on the most important KPI:s and then present breakdowns of these. Thus, the essence of the most important KPI:s is communicated, while still showing transparency on a lower level of aggregation.

Although circularity might not convey the entire picture of sustainability, as it often associated with the environmental aspect [43], it is evident that circularity is a suitable means forward in tackling the global climate crisis [12, 25]. Thus, the importance of also conveying the KPI:s related to the realization of circularity is evident. This study unravels the question whether manufacturing companies' KPI:s support circularity, and acts as complement to previous studies which e.g. studies which circularity practices exist in manufacturing companies [31]. Nevertheless, although numerous KPI:s have been identified in the sustainability reports, it is evident that companies are communicating far more circularity practices than they are actually measuring their progress in terms of circularity realization, at least as mentioned in the sustainability reports. Whether companies actually use a more efficient way of aggregating and using KPI:s internally within the company were not identified within this study. However, it is arguably needed to convey the progression of circularity realization to numerous stakeholders, and thus enable transparency towards the public, and the sustainability report provides such opportunity. Whether this change needs to be driven by the companies themselves, or if more detailed description of requirements, including KPI:s, should be regulated by governments remains to be discovered.

6. Conclusion and Future Research

As seen in this paper, there seems to be a disconnect between the strategic objectives and KPI:s used related to circularity. Thus, the KPI:s cannot at this stage be deemed to support circularity fully. If manufacturing companies wish to support a circular transformation, it becomes imperative to ensure alignment between both the strategic objects and KPI:s, but also their key processes and stakeholder values [27]. Thus, some avenues for future research can be seen. The issue of alignment is pertinent and in need of more empirical studies related to how this can be achieved. Another key issue is that circularity is not something that one actor can achieve by itself, rather it requires collaboration across multiple stakeholders. Thus, investigating the role KPI:s can play in this and function as a form of boundary object to align multiple stakeholders [7, 33] is seen as an interesting avenue for future research. This also connects to the need for case studies within companies, as the sustainability reports might only provide a glimpse of the ongoing strategic objectives and KPI:s used. Although this research has presented a current state and some avenues for future development, the full realisation of circularity in manufacturing companies is still seen as distant.

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