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A conceptual framework for identifying relevant features when realizing collaborative circular business models

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Abstract

Towards a sustainable future, looking beyond the system boundaries of a single manufacturing company is necessary to promote meaningful collaborations in terms of circular economy principles. In this context digital data processing technologies to connect the potential collaborators are seen as enablers to make use of proven collaborative circular business models (CCBMs). Since most of such data processing technologies rely on features to describe the entities involved, it is essential to provide guidance for identifying and selecting the relevant and most appropriate ones. Defining critical success factors (CSFs) is considered a suitable instrument to describe the decisive factors. A systematic literature review (SLR), followed by a qualitative synthesis is investigating two scientific fields of work, namely (1) the general relevant features of CCBMs and, (2) methodologies for determining CSFs. This results in the development of a conceptual framework which provides guidance for digital applications that perform further digital processing based on the relevant CSFs relating to the specific CCBM.

Keywords: Circular economy; Digital transformation; Collaborative business model; Critical success factor; Business model investigation

1. Introduction

Our intention to move away from today's resource-intensive linear economy has given rise to the concept of the Circular Economy (CE) [1]. Part manufacturers, product manufacturers, service providers and customers are at the very core of all the biological and technical cycles that need to be encouraged to rethink their established processes and methods. Scholars agree that better results can be achieved when one strives for collaborations and establishes practices together with other entities [2]. Such practices are referred to in the following as collaborative circular business models (CCBMs). In this paper, a CCBM is defined as a cross-chain or cross-sector collaboration between independent organizational units in the manner of a strategic alliance with shared investments, rewards and goals that are subject to a sustainable concept of resource use and further processing in accordance with the principles of CE.

Digitization is considered to play an empowering role in the CE context, be it by building of a collaboration platform [3], reshaping of practices in the local and global value chain [4], or fostering disruptive product service-systems [5]. These approaches have one paradigm in common: Digital support is only meaningful if the data adequately reflects reality and if certain data quality criteria are met. However, the question of how data integrity may be ensured seems to be neglected in current research [6]. In this context, the transformation of CCBMs into the digital space will certainly play a role. To benefit from the experiences gained from successful CCBMs, it is necessary to examine what has influenced their success. The objective of this study is thus to assess a path towards a digital representation of a CCBM in terms of the associated critical success factors (CSFs), which are defined as 'characteristics, conditions, or variables that when properly sustained, maintained, or managed can have a significant impact on the success' [7]. A conceptual framework will combine established concepts to provide a comprehensive understanding of the

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phenomenon of how to develop the most comprehensive yet high quality digital image possible [8].

2. Research design

Table 1. The scientific fields of work.

#	Scientific field of work	Subject
SF1	General CSFs within collaborative (CE) approaches	Business
SF2	Methodologies for determining CSFs	Multidisciplinary

To ascertain the state of the art in the two scientific fields (SF1 & SF2), which are assessed as a decisive basis for the development of the framework, a systematic literature review (SLR) is carried out. This approach is in line with the renowned Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) reporting guidelines, which form the basis for the summary flowchart (Figure 1) [9]. These types of secondary studies aim to reflect relevant aspects as comprehensively as possible and to generate evidence through the synthesis of best quality scientific studies, thus creating a solid knowledge foundation based on methodological rigour for further development [10].

Table 2. Databases and their inclusion, based on a subject-based adapted selection proposed by Gusenbauer and Haddaway [11].

#	Database	Subject
DB1	ProQuest	Business
DB2	ScienceDirect	Multidisciplinary
DB3	Scopus	Multidisciplinary
DB4	Web of Science (Core Collection)	Multidisciplinary

A trial search was carried out by means of a superficial initial search within the research fields to identify the relevant databases (see Table 2). Search terms using boolean operators were combined to look at abstract, title and keywords (Appendix A), specifically excluding publications before 2015. By using the SLR to create a foundation rather than recording all relevant works ever written, topicality and completeness are balanced. Assessment of the study quality goes beyond merely selecting it based on the metadata. In other words, a full-text check is conducted before deciding whether the focus of the study is as expected and if it is of sufficient quality and value to be used as a foundation that can be built upon. Exclusion criteria apply, as shown in Table 3. The data synthesis, which builds upon the data extraction as described above, is conducted in the manner of a qualitative synthesis.

Table 3. Exclusion criteria in the full-text eligibility check.

#	Exclusion criteria
EC1	Not relevant in terms of subject matter or content, which means: SF1: No focus on CSF identification SF2: No single- or multi-case-study investigation or no adequate methodological description
EC2	Not peer-reviewed and published in journals, conference proceedings, or working papers, or book chapters, or form of an abstract, tutorial, or lecture
EC3	Full text not available

3. Systematic literature review

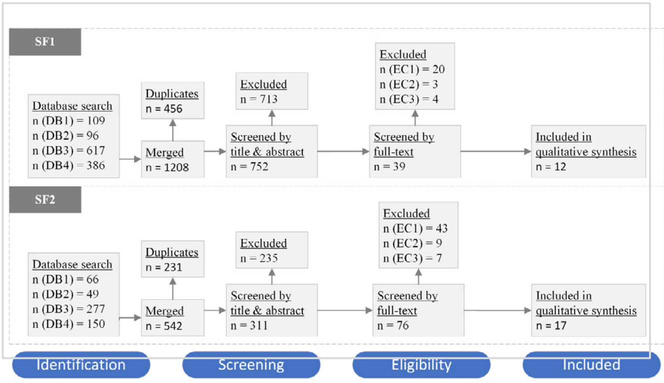

Fig. 1. Quantitative documentation of the PRISMA process.

1.6% (SF1) and 3.1% (SF2) of the studies identified in the SLR were considered eligible for inclusion in the data extraction and subsequent qualitative synthesis, which is presented in the following two subsections.

3.1. Data extraction and synthesis: General CSFs within collaborative (CE) approaches

According to the process conducted as described in Section 2 above, the number of studies that deal with CCBM-specific objects of consideration in SF1 is limited and they are subject to a case-specific bias. Solely considering these would thus not lead to a comprehensive, differentiated picture. Therefore, additional studies were considered, namely, studies that address the CSFs within collaborative approaches in general, as well as approaches dealing with the CSFs of CE. In addition, certain limiting factors, e.g. the limiting factor of a 'limited strategic openness' is interpreted as a CSF in the sense of a 'strategic openness' [12].

Subsequent to the data extraction explained above, the identified studies were sorted into meaningful clusters, as documented in Table 4. Not all studies focus solely on the partners involved. Some studies [6, 13, 14] place parts of their observations at the level relevant to our subject matter, and provide important insights on the operational level, while also dealing with overarching factors, referred to as 'global' in the following. These include, for example, the generally expressed practice of the reverse logistics [13] or the public and consumers awareness of the CE [6, 14]. Since the contribution to a comprehensive and precise picture of the CSFs relevant to the collaborators is limited, 'global' factors are left out of further consideration. Besides the global factors and those, which can be directly addressed by the entities involved, e.g., their 'technology in use', we introduce a categorization in 'cross-linking' CSFs. These factors are more dependent on the strategic alliance than on the organisational units themselves and are difficult to predict before forming the collaboration. This clustering contributes to a differentiated view on collaborations and their CSFs in the scientific community, as CSFs that cannot be directly assigned to the companies involved are to some extent merged with partner characteristics (e.g. [15] introducing 'strategic fit' and 'complementarity' as two of their nine key partner characteristics).

Table 4. Clustered CSFs regarding collaborations in the CE context.
A threshold for once-off sightings applies in this table for clarity.

Cross-linking cluster	
CSF	References
Engagement & Commitment	[15-21]
Trust	[16-22]
Openness, such as open communication	[15, 16, 18-20, 22]
Constructive coordination	[12, 13, 16, 20, 21]
Clear expectation	[12, 16, 17]
Conflict management	[16, 18, 21]
Contract agreement	[16, 19]
Organizational compatibility	[15, 22]
Shared goals	[15, 18]
Individual entity cluster	
CSF	References
Management commitment	[12-14, 20]
The expertise of key people regarding the respective fields	[13, 14, 18, 20]
Facilities and infrastructure	[13, 18, 23]
Ability to innovate	[14, 18]
Partnering attitude	[12, 17]
Technical know-how and skill development	[14, 20]
Technological resources for CE implementation	[6, 14]

It is striking that the factor of trust is included in seven out of eight sightings, as the trust that exists between the partners in the manner of a cross-functional factor. It would be tempting to lump these findings together with the individual factor of 'trustworthiness of the individual entities' (once-off sighting) [15]. However, this factor, which exists within the cluster of the individual entities, should rather be classified as a conditional prerequisite that contributes to a trustworthy relationship. This is also argued by Meieret al. [24], who, in their study, identify eight trust-building factors in strategic alliances, which suggests that the concept of trust hides a complex structure of subordinate factors. Using these exemplary CSFs, caution is required when abstracting from cross-linking factors to individual factors, and non-evidence-based conclusions should be avoided. With regard to the interdependencies of CSFs, it is also notable that, in research such as that of Ehlenet al. [18], the mere existence of a certain infrastructure represents a CSF, but for Lilianiet al. [16], the will to share it also plays a role (once-off sighting). The complementary identification of the factor of commitment [18], leaves it open whether both parties perhaps do not mean the same thing, and highlights the interdependence of the individual factors on each other. This is quantitatively proven by examining the causal relationships of CSFs [20].

3.2. Data extraction and synthesis: Methodology to investigate CSF

There are three types of methods involved, which are presented in Table 5: (1) to detect and collect the CSFs, (2) to perform qualitative data analysis, and (3) to conduct an in-depth analysis investigating the relative importance of these CSFs, and their interrelationships. Within the collection of primary data, the semi-structured interview is by far the most used methodology and plays a role in all approaches considered. Methods such as semi-structured group interviews [25] or the web-based survey [26], e.g., are to be evaluated as outliers that have their origin in specific records, but should not be generally neglected. Bockenet al. [26], e.g., assess a B2C (business to consumer) business model involving fast-moving consumer goods, where the consumer`s perception is essential to define the CSFs. In summary, this shows that the semi-structured interviews represent the cornerstone, but depending on the individual CCBM, complementary approaches should be considered. Secondary data, such as taking literature into account, is mainly used to build a foundation and to be complementary towards triangulation. In detail, this is the case while designing the primary data collection method (e.g. [27]), forming the basis of a coding scheme (e.g. [27, 28]), or in the manner of a complementary source prior to further factor analysis (e.g. [29]). The same role applies to the completion of strategic management tools, such as a business model canvas (BMC) and for CE business models adapted BMC, including collaborative perspectives [30]. They are judged to be insufficient for a detailed investigation of CSFs. In these cases, CSFs occur more likely as a by-product of case studies in an exploratory nature [31]. In the role of the basis for primary data collection, however, it certainly seems to offer the potential to comprehensively cover subjects of investigation.

Table 5. Methods of detecting CSF.
(AHP = Analytical hierarchy process; MICMAC = Cross-impact matrix multiplication applied to classification; DEMATEL = Decision Making Trial and Evaluation Laboratory; ISM = Interpretive structured modelling).

Field of application	Method	Used by
Detect and collect (Primary data)	Semi-structured individual interviews	[25-29, 32-42]
	Observations during on-site visit	[33, 34]
	Fuzzy-Delphi questionnaire	[43]
	Semi-structured group interviews	[25]
	Web-based survey	[26]
Detect and collect (Secondary data)	Literature review	[25, 27, 28, 38, 41]
	Sourcing external data	[27, 32, 34, 35]
	Sourcing internal data	[33-35, 40]
Qualitative data analysis	Content analysis via coding and clustering (open coding, and/or axial coding or unspecified)	[26-28, 32, 33, 35-41]
In-depth analysis: (1) Assess relative importance	Emphasis given during interview (3 step grading)	[25]
	Fuzzy-AHP	[43]
In-depth analysis: (2) Investigate interrelationship	MICMAC	[29]
	DEMATEL (Fuzzy & non-Fuzzy)	[38] [43]
	ISM	[29]

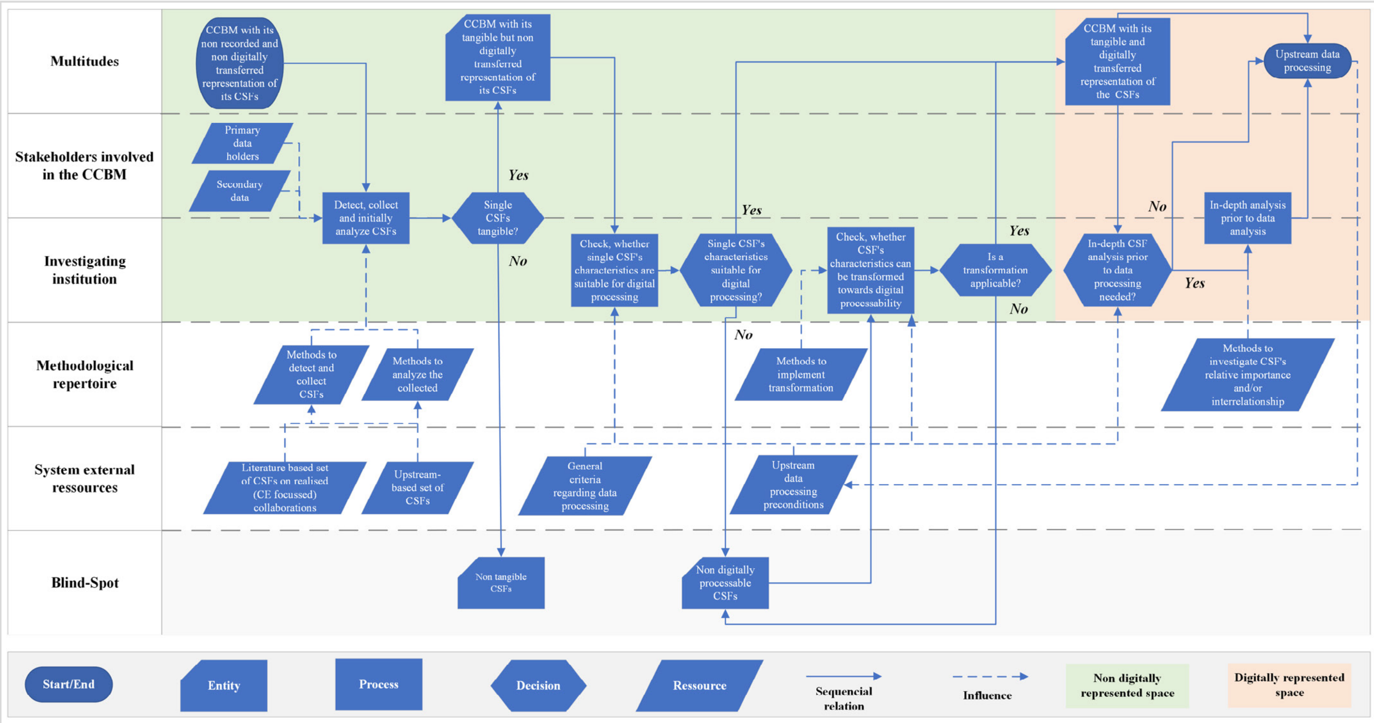

Fig. 2. Conceptual framework for identifying relevant features via critical success factor (CSF) when realizing collaborative circular business models (CCBM).

4. Conceptual framework for identifying relevant features when realizing collaborative circular economy business models

The use of a swimlane diagram is assessed as purposeful for the frameworks illustration. The partly complex and iterative interrelationships in the transition from the real CCBM to a digital image of the CSF can be clearly visualised by this mapping method, and actions and resources can be clearly addressed. Three sub-sectors, as contrasted in colour in Figure 2, are particularly relevant: In addition to (1) the non-digitally represented space, including the CCBM under examination, and (2) the digitally represented space, (3) a blind spot is introduced to critically assess the limits of the conceptual framework.

4.1. Non-digitally represented space

Driven by the findings of the SLR within SF1, primary and secondary data from the stakeholders involved in the CCBM form the basis of the entire process. The methods identified in the SLR within SF2 can now be used to detect and collect the CSFs in cooperation with the investigating institution and the stakeholders to subsequently carry them out in an initial qualitative analysis based on a coding scheme. Table 5 supports the choice of methodology by pointing out that when collecting primary data, underrepresented methods, such as the semi-structured group interviews, should also be considered. The data collection as well as the data analysis, can benefit from the CSFs extracted from the literature, whether in the design of the empirical method or as a basis for coding. Table 4 offers a helpful point of reference. In addition, it is considered valuable to learn from experience, in other words from CSFs that have been extracted from CCBMs and that have already been investigated and processed within the surrounding system, such as, e.g., a digital platform with an ever-growing amount of experience-based data. This contributes to a higher reliability in relation to the individual case. During the analysis, a categorisation as introduced in Table 4 into individual and cross-linking factors is assessed as valuable. Caution is required, however, when abstracting from the cross-linking factors, as discussed in Section 3.1.

The next step is about (1) checking whether the single features and their characteristics are suitable for the intended digital data processing, and if not, (2) if any kind of transformation in terms of transformations in the means of data science and unravelling of abstract CSF might solve reasons for being assigned as not suitable for digital processing. In order for phenomena or characteristics to be mapped in the digital world in a way that enables further processing, certain norms and quality standards have to be adhered to. Therefore, each CSF should be analysed according to whether an associated primary data collection, or using the language of digital processing, whether the characteristics associated with the feature appear quantitative and thereby continuous or discrete, or qualitative in the sense of an ordinal or nominal attribute, or in unstructured open form. Assessment of the usability of the qualitative data applies [44]. The requirements for the data set to be processed depend on the upstream processing approach. If the framework is embedded, e.g., in a machine learning environment, an examination takes place to determine whether the represented CSFs meet the requirements of the specific processing method. Many self-learning models are algebraic, which means that ordinal and nominal data types must be prepared by methods such as one-hot or binary encoding [45]. It could be questionable whether this task is not assigned to the upstream processing itself and thus is to be located outside the framework`s system boundaries. For the sake of completeness, this check has been included in the framework to respect the unforeseen needs of subsequent data processing. Referring to the example of the factor of trust in Section 3.1, the measurability of the characteristics also plays a role at this point. Valid methods are to be implemented in the context of the transformation to unravel abstract CSFs in their building mechanisms.

4.2. Digitally represented space

The factors and their characteristics that have been assessed as digitally representable have passed into the digital space. A general need for a recursive stream, starting from the upstream data processing, has been identified. Depending, on whether a further upstream in-depth analysis in the sense of e.g., the sense of a relevance analysis or the investigation of dependencies is valuable for the upstream method, the set of factors already represents the product or goes through the additional analysis. In addition to the requirements regarding the data structure, this stream also influences the non-digital space, whether only the CSFs are to be individually assigned to the stakeholders, or whether the cross-linking factors are also to be collected. Therefore, it is important to deal with the prerequisites of the upstream tool at an early stage.

4.3. Blind spot

The blind spot serves to acknowledge the limitations of the framework. It is assumed that there are intangible CSFs that cannot be targeted by the capture and analysis methods In addition, it is assumed that there are captured CSFs that may be relevant but that cannot be transferred to the digital world due to upstream data processing preconditions or a high level of abstraction of the characteristics associated with the feature that cannot be resolved through methods available within feature transformation. The goal of keeping the blind spot as small as possible therefore benefits from a continuous improvement of the selection as well as design of the underlying methods.

5. Critical reflection

The CSFs have been clustered to the best of our understanding of the primary source; nevertheless, some formulations leave room for interpretation. This could also be seen as an indication of the difficult process of a valid recording and analysing. Prioritization could not be conveyed due to the heterogenous records, although some authors rated their relative relevance. Nevertheless, thresholds given by the authors are respected. The presentation of CSFs does not claim to be exhaustive, because as studies that have dealt with very specific business cases have shown, unique cases also entail very individual CSFs. Nevertheless, the types of factors to be expected were shown in accordance with the objective. With regard to SF2, it remains unclear whether certain techniques are not used within data analysis or, whether they are simply not explicitly mentioned, because they are taken for granted in favour of a compact presentations of the methodology. Thus an assessment of contextual relevance based on relative occurrence is therefore not advisable and lacking at this point. Furthermore, the extract of in-depth analyses in Table 5 only represents examples of possible methods needed. This lack of definition must be acknowledged as it is intentional, and we do not presume to already know all possible applications of the framework.

6. Conclusion and implications for further research

Based on the research, we developed a conceptual framework, which consists of a swimlane diagram, to identify relevant features when implementing CCBMs. The different categories of methods to be used as part of this transformation are identified, and the partial recursive nature of the process is highlighted. It becomes clear that it is necessary to identify the requirements of the upstream environment in detail at an early stage. In addition, possible manifestations of the emerging CSFs have been presented, and the hurdles associated with the qualitatively recorded factors have been identified to support practicable implementation. The clustering into individual and cross-linking factors and the discussion of limited abstractability are an important basis for the presented and similar approaches. Depending on the objective of the application of the framework, it must be possible to differentiate between the clusters. A classification within a process regarding the different stages of forming strategic alliances (e.g., [21]) is a context that should be investigated to enrich the framework by this dimension. This will help to decide which data can be collected during the different phases of observations, which might be of relevance for certain application systems. It was hypothesised that the individual factors are already established before the strategic alliance is formed, and that the cross-linking factors are to be measured only after the successful or unsuccessful formation.

An evaluation and validation of the framework is pending. Within a proven surrounding system that carries out data processing based on CSFs, we see a possibility to investigate the performance of the framework as an overall construct, as well as the performance of different variants of the methods and resources used by means of parameters, for instance different methods of data collection, and methods to investigate the relative importance of the CSFs identified.

Appendix A. Search logic within the systematic literature review

A.1. Search logic related to SF1

(TITLE OR KEYWORD OR ABSTRACT=("success factor" OR "success factors") AND ("circular economy" OR collaboration* OR "strategic alliance" OR "strategic alliances")) AND (DATE=(2015-2022))

A.2. Search logic related to SF2

(TITLE OR KEYWORD OR ABSTRACT=(“business case” OR “business cases” OR “business model” OR “business models”) AND ("success factor" OR "success factors")) AND (DATE=(2015-2022))

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