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FINDING THE RIGHT INCENTIVES; CIRCULAR BUSINESS MODELS FOR THE CONSTRUCTION INDUSTRY

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Abstract: After its launch, the circular economy gained popularity all over the world as the new sustainability paradigm. Despite its popularity there is little to no material to be found on the implementation of the circular economy in the construction industry. Through a mixed method methodology using literature reviews, case studies, thought exercises, and interviews to both build and subsequently validate theory, five circular business models for service providing in the construction industry were developed. Next a roadmap for advance circular services was set up. These models show internal and external supply-side stakeholders how to implement the circular economy, and that this implementation is thinkable on a business-case level, but less evident on an industry level. This as previously unaddressed financial and regulatory aspects challenge the implementation of the circular economy in the construction industry. Considering these challenges, implementing the circular economy in the construction industry might be considered even more disruptive as in other sectors of our industrial economy.

Keywords: Circular business models, Construction industry, Service providing, Supply-side stakeholder

1. INTRODUCTION

Although circular economy (CE) in essence, given its constituent concepts, is not a new idea, after its launch by EMF in 2012 it gained popularity all over the world as the new sustainability paradigm (Ellen MacArthur Foundation, 2014; Van Dijk et al., 2014). Part of its popularity might be explained by the accent on the economic rationale behind the thinking, which is distinctive for CE as opposed to other sustainability concepts. Being sustainable within a CE perspective does not cost money, but is profitable for businesses as well as for the economy as a whole. The basic idea stems from price increases on –raw materials- combined with Stahel's (2006) concept of service providing. Service providing, in essence, means that a supplier retains ownership rights over its products while clients pay (merely) for the delivered services (Bakker et al., 2014; Ellen MacArthur Foundation, 2012; Roos, 2014).

There is little to no research to be found on the implementation of CE in the construction industry, despite the fact that 40-50% of raw materials that are used each year are construction industry based, and that the sector accounts for 40% of solid waste streams, (Antink et al., 2014; Bakker et al., 2014; Bom, 2012). This might be partly explained by the lack of precedents, which makes it unclear what the construction process will look like under the influence of CE. However, as current construction processes are typified by project-based production solutions that are tailored for each individual project by project-specific teams of supplying parties, it is clear that the incentive imposed by CE upon a supplier to retain ownership rights over its products, proposes changes to current practices in the construction industry (Segerstedt & Olofsson, 2010; Van de Kaa, 2013). Furthermore, each project involves a relatively high amount of unique components that are often assembled in an artisanal way (Eastman et al., 2008). A production chain like 'make-to-stock' therefore does not exist in the construction industry (Segerstedt & Olofsson, 2010).

Under the influence of CE the short-term mindset that is apparent with the supplying parties in the industry will have to change to a long-term mindset and commitment, as the traditional ownership model will disappear when suppliers retain ownership rights over their products. Without changes to the current construction process as introduced above, this will lead to a situation where different stakeholders will be able to call themselves 'owner' of a constructed building. With more owners and (arguably) more building components it will become harder to implement CE in the construction industry, as this will increase the complexity of the process, and increase the need to cooperate. This while the industry has historically been unable to form long-term partnerships (due to the absence of a supply side focal firm among other things) (Bastein et al., 2013; Geldermans & Rosen Jacobson, 2015; Vrijhoef, 2011).

However within CE, delegating ownership to the contractor or developer responsible for the project in order to counteract the ownership problem as described above, is not a feasible option, as this would mean that the incentive for sub-suppliers to operate in a circular way would not be present any more than it is in the current construction process. Also, the long lifetime of buildings will reasonably make it financially difficult for the 'owners' of a circular building to retain ownership rights through for instance leasing solutions (Prins, 2017).

The circular construction industry is in need of the entry of a new stakeholder to the construction process, creating a clear focal firm for the supply-side. A research project was conducted with the objective to investigate the roles of this new stakeholder. This gave the opportunity to study what the supply side needs to offer in a (idealized) circular construction industry without being hindered by current conventions, rules and laws. This entity is referred to as 'service provider' (SP), and differs from the one that is proposed by the EMF (2012), in that the operations and surrounding relationships of the SP with other stakeholders are the subject of investigation. This while the SP as proposed by the EMF has a rather fixed position, with unclear operations and relations, thereby surpassing deeper research into its role. This research used the following definition of CE (adapted from Mentink, 2014): 'a circular economy is an economic system with cyclical material loops based on a financial incentive.' This definition does not contain anything related to the terms sustainability or value creation, as CE axiomatically implies sustainably responsible behavior by all stakeholders (Mohammadi et al., 2015; Prins, 2017).

2. METHODOLOGY

The main research question is: 'How to organize a service provider in the construction industry in such a way that its role adheres to the definition and principles of the circular economy?', and secondly: 'How does this service provider relate to the current supply- and demand-side stakeholders in the construction process?'. As such, the research question will essentially deal with the organizational setup of the service provider and two different transactions; (1) between the client and the service provider, and (2) between the service provider and the supplying parties.

This research yields a final result in the form of different business models together with a complementary roadmap. These provide insight and/or solutions as to how the SP might deal with the 'new' context an ideal CE provides for supplying parties in the construction industry. Each model is presented through the so-called sustainable business model framework as defined by Bocken & Short (2015). This framework is used because of the

match between the sufficiency-driven logic behind the framework, and the radically innovative nature of the business models (Bocken & Short, 2015; Dangelico & Pujari, 2010; Straub, 2011). Because of their set-up, the models will also be fit for use in business plans (e.g. Osterwalder & Pigneur, 2010), and they may be used as scenario's to form a basis for scenario planning (Lindgren and Bandhold, 2003). This research is unique in that it (1) investigates the circular SP from a supply-side perspective, and (2) does this from a built-up theoretical construct that critically reflects upon both existing CE theory and the current construction industry, before coupling the construct back to practice.

There is, as of yet, no paradigm on which to build further research, so pragmatic research methods are a viable option for this research. Eisenhardt's (1989) method will be used in this research as a guideline on how to deal with different data gathering methods and the gathered data itself, resulting in a pragmatic mixed method methodology. Furthermore, for data collection methods the following frameworks have been used. (1) The literature studies undertaken in this research follow the four steps as outlined by Kumar (2011). (2) A total of 6 interviews have taken place in this research, 4 of which served to validate the theoretical construct. The validation interviews have been undertaken with different kinds of stakeholders as to provide different perspectives upon the construct. All of the interviews were of a semi-structured nature (Bryman, 2012), and subsequently coded according to Dieckx de Casterlé et al. (2012) allowing further data analysis. The software package Atlas.TI was used for this data analysis. (3) Thought experiments or exercises have been used in a similar way as 'field notes' as described by Eisenhardt (1989). (4) A total of 8 case studies have been carried out following Eisenhardt (1989), allowing for pragmatic data gathering by combining several of the aforementioned methods. Four of these served as input for the theoretical construct and four others served as input for validation of the construct and the subsequent discussion.

3. LESSONS FROM OTHER INDUSTRIES

Since the role of the SP is more mature in other industries (Schmenner, 2009), a look is given to these industries to form an understanding of the operations of this stakeholder (note the absence of CE thinking within these industries and their SP's). First of all there is a distinction between pure service providers and manufacturing service providers. The first form focuses on delivering services without any physical, underlying product (e.g. consultancy firms), and the latter form is a combination of a manufacturer and the first form (Baines & Lightfoot, 2013; Biege et al., 2012; Tukker, 2004).

Given the similarity to the construction industry, this research will focus upon manufacturing SP's. Although there are several reasons for manufacturing SP's to appear in an industry (e.g. environmental), economic reasons prevail in literature. This argument mainly follows from a substantial installed base of products, intensifying the need for companies to diversify through service providing (Bastl et al., 2012; Biege et al., 2012; Fang et al., 2008; Gebauer & Friedli, 2005; Oliva & Kallenberg, 2003; Windahl & Lakemond, 2006). Research by Fang et al. (2008) shows that it is indeed possible to obtain financial gain from offering services, under the conditions that (1) services make up at least 20-30% of the company's operations and (2) that the services are related to the provider's core business.

A manufacturing SP might offer three different kinds of services; base, intermediate, and advanced services (Baines & Lightfoot, 2013). While base- and intermediate services are

product driven, advanced services are ability-driven (e.g. revenue through use) and usually require the manufacturer to retain ownership rights over its products. With advanced services it might be necessary for the manufacturer to acquire or set-up new business units in order to be able to provide the 'ability' towards a customer (Bastl et al., 2012, Fang et al., 2008). This process is referred to as 'organizational stretch' and describes the stretch in the range of activities the service provider has to undertake in order to be able to offer these advanced services (after: Baines & Lightfoot, 2013). The dynamic between the ownership rights (together with the underlying incentive) and the presence of the organizational stretch is presented in figure 1, where the different service levels are coupled to the definition of CE. Figure 1 also captures the opposite dynamic, where base- to intermediate services are delivered. With these services, the manufacturer will not retain ownership rights over its delivered products, and therefore the incentive shift does not take place. Lessons from three case studies on circular and/or sustainable products show that, in order to guarantee sustainability (at an end-of-loop situation) in such a case, a high level of agreements of intention and/or supplier monitoring between stakeholders might be necessary, since a real incentive shift according to CE principles does not take place here.

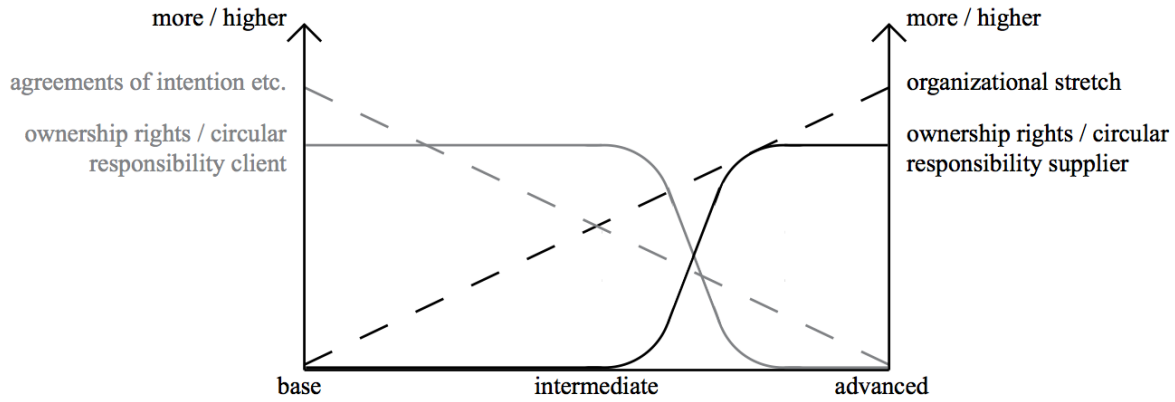

Figure 1: incorporation of CE with the service levels as distinguished by Baines and Lightfoot (2013), hereafter referred to as the 'circular service level framework' (CSLF) (source: own image)

At this point, a note of caution is in place as it is, as of yet, impossible to say whether offering circular services is as beneficial as offering services in general (since circular products need to be taken back, and possibly altered at the end of their lifetimes). These costs are currently not incurred by the observed SP's in other industries. Therefore this circular step will only be beneficial when resource prices are on a constant rise. If resource prices are not on a constant rise, it comes down to the ability of the circular SP to be more efficient in using circular materials as opposed to using 'new' resources, in order to make circular business operations not more expensive than linear operations. This observation links-up with the definition of CE, and leads to the following statement: 'a CE business strategy is a strategy that, if governed correctly, is sustainable'.

4. ADVANCED CIRCULAR SERVICES BUSINESS MODELS

Through figure 1 it becomes clear that the chosen level of services has consequences for the cooperation between SP and client. If the client opts for base to intermediate services, possible solutions for circularity can be found in, e.g. buy-take-back or buy-buyback solutions with the SP. If the client opts for advanced services, possible solutions for circularity can be found in e.g. financial- or operational lease constructions. This study

focuses on designing circular business models for advanced services. This is done for two reasons; (1) an advanced services model is as of yet not present in the construction industry, as opposed to base- to intermediate services solutions of which some examples can already be found (see: Van den Brink, 2016). (2) Offering capabilities (through advanced services) show the greatest potential for profitability and sustainability gains (mainly through the incentive shift) (Tukker, 2004).

When providing advanced services, the SP needs to offer a performance that is supported by a service that optimizes said performance. The performance is based upon a delivered product (i.e. the building). The building is a collection of products (providing services) that are interrelated at different scale levels and characterized by their economic life span (partly based upon and adapted from: Prins, 1992). These products are delivered by the SP, in combination with (different) supplying parties, but the SP manages the overall performance. In order to be able to operate in the above way, several requirements need to be in place for the service provider to operate effectively. (1) The client should ask for performances (product specific housing services) instead of physically defined products (Jonker, 2015). (2) Client-demand for the performance should not specify the to be delivered performances too much, as this will impede upon the ability of the SP to deliver a competitive service (Sexton & Barret, 2005). (3) Because of the increased complexity, and intensified and prolonged relationships between stakeholders within a circular construction industry, a tighter organization on the supply side's part with willingness, trust, and transparency is needed among these stakeholders (Bastl et al., 2012; Geldermans & Rosen Jacobsen, 2015). (4) If suppliers should be able to take back their products at the end of the building lifetime, they should be able to do so without damaging these –and each others'- products. Therefore the used products should make use of so-called 'decoupling points' that connect the different products together constituting a building.

Through the lessons learned, five different advanced services business models can be made, based upon three underlying variables. (1) The competences that are present within the organization of the SP (as an SP should only pursue offering services in those areas that are part of its core business); (2) presence of an organizational stretch; (3) the relationship with suppliers. Variables two and three allow for different ways to deal with the high fragmentation and traditional ways of cooperation between the different supplying parties that persist in the construction industry. These aspects only influence certain elements of the different business models, therefore the largest part of the business models will be the same (see figures 2,3). Distribution channels and growth strategy are provider-specific and will differ for each provider, these are therefore not worked out in detail in this research. A description of the business model prototype is presented following the building blocks of Bocken & Short (2015);

1. Value proposition
   The product/service that the SP delivers is; housing for a client through a performance that is completely tailored to said client's specific needs. In offering its product, the SP is faced with a broad segment of clients looking for a specific performance. The relationship with the client is provider-specific, however since the SP offers a tailored service it is important that the client is in close contact with the SP. The value for the customer is thus that he receives fully tailored housing. The value for society and environment can be found in the fact that this housing is delivered in a sustainable manner. And the value for the SP is economical in attracting business with higher profit margins and prolonged client relations (see section 3).

2. Value creation and delivery

The SP performs either all of the following activities: designing, building, financing, maintaining, and operating, or (more likely) it performs one or more of these activities. If the SP performs the 'financing' activity, this is always done in combination with one of the other activities, as the product or (performance) on offer is supported by an underlying (physical) product. Besides these activities, the SP will be responsible for the operational lease-solution towards the client. Following this responsibility, the SP is also responsible for picking those products (if needed from upstream suppliers) to compose a building that allows for the agreed upon performance(s) to be met. This also means that it is the SP's responsibility to verify whether the incorporated products can actually deliver upon this requirement. Following the SP's activities, one of its core resources is the inherent knowledge it has about the activities it performs.

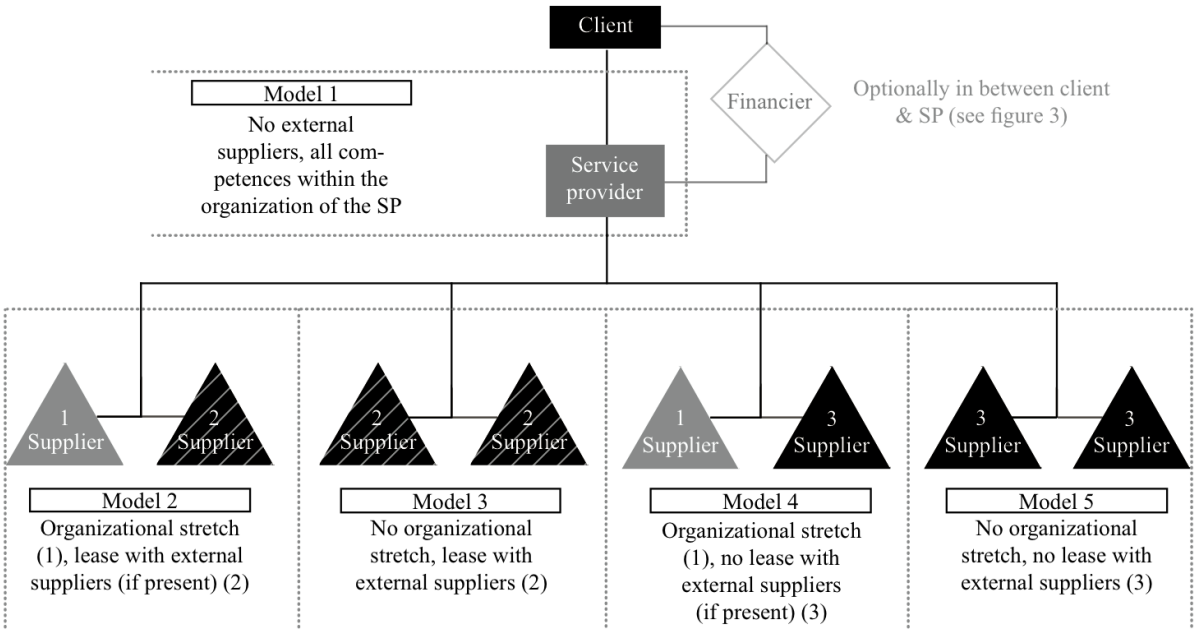

Figure 2: Characteristics of the partners and suppliers of the five advanced circular business models (source: own image).

The partners and suppliers are subject to the underlying variables and are worked out in five different models (see figure 2). Although the relevant partners and suppliers differ depending upon the chosen model, the partners will always involve one or more of the following: the client, external suppliers and/or financiers. The client always is a key partner because of the product on offer. Figure 2 exemplifies the way the different models are composed, where the link with the financier is optional depending upon the financial means of the service provider. Furthermore in figure 2, suppliers can be related to the SP through an organizational stretch (its presence being dependent upon the chosen model). Other suppliers are related to the SP through a lease-solution, and the final group of suppliers are not related to the SP through a lease-solution.

3. Value capture

The value capture and cost- and revenue streams depend upon the underlying variables and the effects thereof are shown in figure 3. For instance, if an SP would choose for a model 3 solution over a model 1 solution, the amount of (external) stakeholders would be larger and therefore the complexity of model 3 would (reasonably) be higher. This is

recognizable in figure 3 under the more extensive cost structure for model 3 when compared to model 1. Similar analyses between the other models show that model 1 comes closest to CE theory as it was outlined in this research, whereas the other models can be placed closer to intermediate services solutions (with model 5 coming the closest to intermediate solutions).

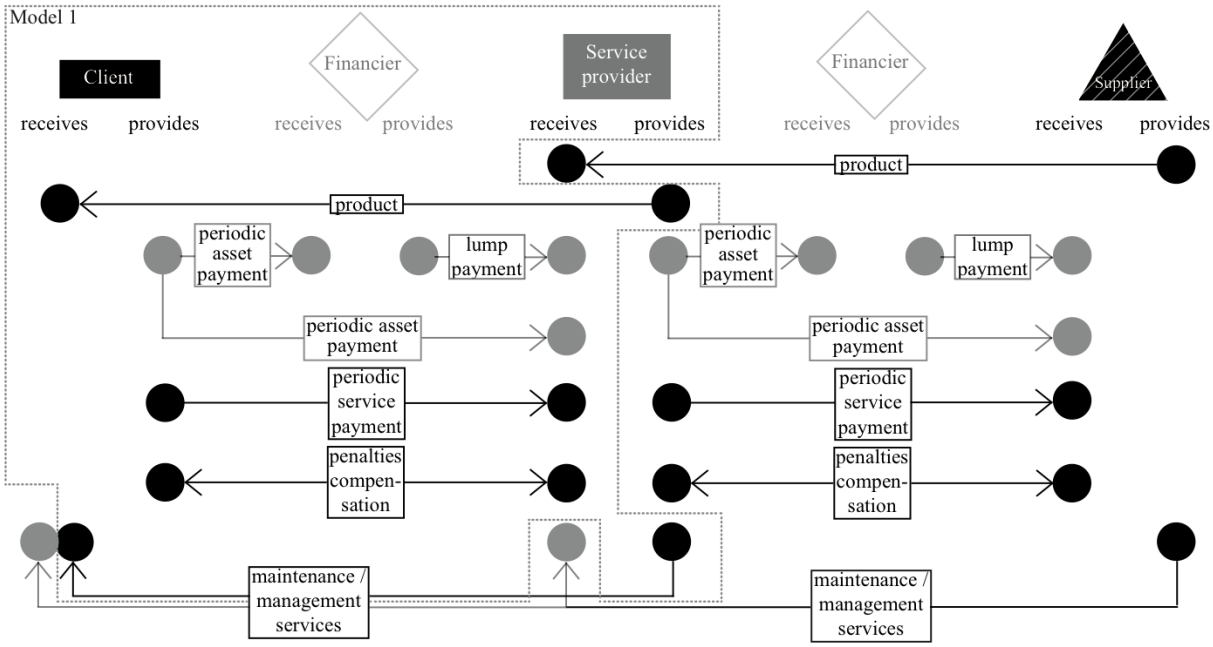

Figure 3: The cost structure and revenue streams of model 1 (in between the dotted line) & model 3 (whole image including the area in between the dotted line); the black streams represent necessary relations, while the grey streams represent possible relations. Similar structures can be made for the other models (source: own image).

5. EXPERT CONSULTATION

Expert consultation took place on the above business models (two contractors, a contractor/developer and a maintenance provider). When asked whether CE could be seen as a potential business opportunity, all parties replied that this is, or could indeed be, the case. However, the respondents think it is unlikely that they would enter into an organizational stretch or into lease-solutions (with clients) in the near future. Concerning these solutions, the respondents would primarily enter into lease-solutions with suppliers with whom they work together in multiple projects (so called 'chain-partners' or 'co-makers'), as opposed to one-off suppliers. As three out of four interviewees indicated that they are already involved in contracts with longer project commitments, it is clear that the respondents did not regard longer commitments as an issue. Concerning both re-design and long-term commitment, the (financial) value of a product at an end-of-loop situation is seen as a big question by the interviewees, as three out of four interviewees state that this value will be (predominantly) determined by the ease with which products will be able to be redeployed in other projects.

For the respondents this raises the question as to how this uncertainty will be incorporated into the product-price. And if, in return for taking on more risk on the supply-side's part, products offered through advanced services will not be more expensive than 'traditional' products, due to a risk-premium. In the end, three out of four respondents ended up with either model 3 or 5, whereas one of the interviewees also thought of model 2 as a plausible

future business model. One interviewee could not relate himself to any of the prototypes yet, but explained that if advanced-services models would prove to be fruitful, his company would naturally pursue these solutions as well. Among the other respondents, two contractors would see themselves as an SP in the developed variants, while an interviewed maintenance provider would prefer to be a supplier.

6. FURTHER ANALYSIS OF THE BUSINESS MODELS

In general, the respondents acknowledged the requirements and business operations of the SP as presented in this study. However, with the respondent's short-term belief in base- to intermediate circular services, the sustainable impact of CE will reasonably only be incremental if implemented at these service levels. This as we have seen in section 4 that offering capabilities (through advanced services) show the greatest potential for sustainability gains (Tukker, 2004). In the long term however, the advanced business models were seen as probable, with models three and five being seen as the most probable. A possible explanation for this can be found in the fact that among the developed models, these two bear the highest amount of similarities with the current construction industry. Especially if these variants are realized through consortia, they show a resemblance towards public-private-partnership solutions that are becoming more common in the construction industry.

It remains somewhat unclear which stakeholder would be able to pick up the role of the SP. Given that the competences inherent in an organization determine the capability to act as a service provider, it is surprising that parties like contractors see themselves as fit to perform the role of the SP, as the consulted contractors view their role as one of 'merely' coordinating. However in the light of the fragmented supply chain it might just be these parties that are able to attract the necessary competences the easiest, as attracting competences in a construction project is already part of their current operations.

Given the fact that the respondents have a preference for models 3 and 5, and for operating in consortia, the topic of the organizational stretch can be discussed. If the SP would be an existing party in the construction industry, this role would most likely be formed through a consortium. In this consortium, parties that are currently coordinating the building process might be best suited to perform a leading role (a de facto SP), as we have seen that attracting competences is part of their current operations already. However these consortia could need to be of a considerable size, i.e. meaning that these leading parties could be heavily reliant upon external suppliers to obtain enough competences for the realization of the project. Besides that, the costs that are associated with setting up a consortium can be quite high (Straub, 2007). Considering these aspects, it seems that advanced circular services projects that are delivered through models 3 & 5 with a consortium might need to be of a considerable (financial) size like current DBFMOs.

7. DISCUSSION

The interviews also revealed some challenges that could limit the probability of use of the business models;. First, there are several legal issues that arise through the implementation of CE under Dutch property law (remarkably however, none of the interviewees mentioned this aspect). Through the rule of accession, delegated ownership of individual components that are part of a larger construction is principally prevented. Although some (very specific)

exceptions can be made to the rule of accession (e.g. right of rem), and its foundations are at least questionable from the perspective of CE, it cannot be expected that the rule will be changed in the near future. When a look is given to the different models, this means that any model that engages stakeholders into 'shared' ownership (i.e. all variants except number one) of the building will only be possible through a consortium. This consortium as a unity will hold the ownership rights of the entire building, while internal contract agreements have to be made between stakeholders to ensure that products are returned to the right stakeholder at the end of the building's lifetime. These internal contracts cannot lay a claim upon the ownership right of particular products in the building, but may for instance represent shares in the consortium that represent the value of the underlying products. A possible solution, given the similarity with current integrated contracts, could be a 'design, build, finance, maintain, operate, and return' (DBFMOR) contract, which would operate in a similar way as DBFMO-contracts, but also contains the internal contracts needed for the proper return of products at an end-of-lifetime situation. In such a situation it can be questioned whether the term 'operational lease' does any justice to the operational reality, because it does not make any sense for suppliers to provide their products through a lease-solution as this does not provide them with ownership rights over their products, rendering model 3 an improbable solution.

Another issue is financial uncertainty; Stigter's (2016) findings deal with this uncertainty and show that the profitability of circular lease-solutions is mostly dependent upon resource price levels. Stigter (ibid) found that a decline in capital gain by just 2% (i.e. a decline in resource prices by 2%) causes a decline in the internal rate of return of around 8%, making these lease-solutions volatile. Thereby acknowledging that CE does not need to be sustainable under situations where resource prices are not increasing. Furthermore, in accordance with the respondents and Stigter's work it seems one has to take a 'substitution risk premium' into account when modeling the costs of lease-solutions. This substitution risk premium is necessary because of two factors: first, regulation might change over time, possibly rendering a product obsolete after a period of time. Second, today's building materials and products might not be the building materials of tomorrow, influencing future demand for these materials.

Further investigation by the researchers, although not acknowledged by the interviewees, shows that, despite the fact that the models attempt to mitigate financial risks by utilizing a similar way of financing as in ESCO's (Zhang et al., 2015), the long product lifetimes in the construction industry do complicate the profitability of lease-solutions. Prolonged ownership of products by supplying parties in the construction industry is likely to have a significant impact on the liquidity and solvency rates of these companies (Prins, 2017). These findings increase the likelihood of advanced circular services models appearing through model 5 with consortia. This also increases the likelihood that the SP would be a supply side party with high amounts of (own) equity, as these parties would arguably be able to suppress the cost of capital that is necessary (Prins, ibid). Within the construction industry, the modus operandi of contemporary real estate investors seems to fit this bill. Outside of the industry, a thought may be given to e.g. Dutch pension funds. For other regular construction companies as known on todays markets, which are primarily capacity and service driven, acting business case wise in consortia is thinkable, but one might question the abilities to cope with the equity demands needed to make a shift in terms of their business model.

Although market demand is as of yet not present (which might be due to the organizational difficulties of advanced circular services), the respondents think that emergence of this demand is likely. In other industries it seems that risk outsourcing is the main reason for

demand for advanced services to appear (Baines and Lightfoot, 2013). Translated to the construction industry, this could mean that demand for advanced circular services is most likely to arise with parties whose housing needs are uncertain over longer periods of time. Examples of parties that would demand these services could therefore be; parties that deal with temporary demand, new businesses (start-ups), businesses that need to be on a particular location for the duration of a particular contract, and/or parties liking to maintain their liquidity and solvency rates (or which cannot afford the initial investment costs), associated with housing.

8. A ROADMAP FOR ADVANCED CIRCULAR SERVICES

Although in the short-term base- to intermediate circular services are more likely to appear than advanced circular services, limiting the sustainable impact of CE, in the long-term the developed prototypes are considered probable by the interviewees. In the discussion several legal and financial issues were taken into account. Based upon these findings it is possible to create the following roadmap for the delivery of these advanced circular services:

1. The circumstances meet the requirements as set out in section 4, concerning value propositions, -creation, -delivery and -capturing.
2. The supplying party is willing to deliver advanced circular services, and expects resource prices to rise in the future. Thereby ensuring the sustainability of the offered advanced circular services. Furthermore, the SP has enough equity to sustain the delivery of advanced services over a longer period of time as part of their wider business model.
3. After these requirements are met, the SP starts with determining the lifetime of the building, as well as the economic lifetime of its constituent parts, which depend on the length of the contract with the client, as well as expected market prices respectively.
4. The SP picks or develops those products that are able to meet the agreed upon performance, as well as which contain future market value to ensure multi cyclic behavior.
5. The SP needs to deal with the specific characteristics of the construction industry through the choice for one of the developed models. If a model other than number one is chosen, a consortium needs to be set-up that makes use of a so-called ‘DBFMOR-contract’. For making a transition to a CE, these types of contracts need adjustments being feasible and thinkable for all sorts of construction projects.
6. The SP takes on the operational responsibilities towards the client regarding the lease during the contract period.
7. The SP makes sure, through incorporation into its business model or through agreements of intention, that the used products are redeployed, one way or another, at the end of the contract or at an end-of-loop situation, in any case not generating waste nor resulting in the need to –excessively- mine new raw materials.

If the roadmap were to be followed by a, currently, internal stakeholder in the construction industry, it would likely be carried out through model 5. This would be done through a consortium, which contains a supplying party with enough equity (e.g. a contemporary real estate investor). Given the high initial investment costs associated with integrated contracts and consortia, this solution would arguably only be viable for considerably sized projects. Also, from a CE point of view, model 5 does not represent the most theoretically pure solutions, and although these models propose a radically different way of working, their impact on current stakeholders might be (relatively) limited. Interesting in this respect is that current Dutch property law complicates the feasibility of theoretically more pure solutions (excl. model 1), contradicting the ‘leasing narrative’ as linked with CE in the (Dutch)

construction industry.

9. CONCLUSIONS

Current business models as propagated in the literature on 'CE success cases' most often concern – (relatively) fast moving- consumer goods, like 'lease a jeans', 'pay per wash', and 'pay per lumen'. The rather abductive study reported on in this paper started with the aim to design an organizational set-up for a 'CE Service Provider' within the construction industry. As the project progresses, more and more also rather fundamental challenges and barriers were found.

This study shows that, implementing CE within the construction industry is less evident but thinkable on a business case level. However, CE business models for the construction industry are at the moment far less evident as sometimes assumed within current markets and under current regulations. The main challenges and barriers found for CE service providing within the construction industry are very limited, if not at all, addressed in CE literature, nor are acknowledged, this as far as according to our findings, by construction industry partners.

CE thinking in general as acknowledged in literature has a rather disruptive nature in both its axioms (e,g, the availability of clean and cheap energy and the assumed moral sustainable behaviour of the industry and their markets), and in needed adaptions on current regulations as for instance reducing the tax on labour (ExTax) and preventing VAT accumulation while riding the –technical- loop (Mohammadi et.al. 2015; Prins, 2017). Considering these challenges, implementing CE in the construction industry might be considered even more disruptive as in other sectors of our industrial economy.

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