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The construction industry and the circular economy

Peter Jones
University of Gloucestershire, UK

Daphne Comfort
University of Gloucestershire, UK

Abstract

The concept of the circular economy is increasingly seen as a major policy agenda item and a testing challenge for the construction industry within Europe. This short case study outlines the characteristics of the circular economy, provides an exploratory review of how some companies and industry bodies within the construction industry in Europe are publicly addressing the concept of the circular economy and offers some general reflections on the application of the concept within the construction industry. The findings suggest that while some of the major construction companies within Europe are currently looking to integrate circular economy thinking into their strategic planning and a number of them have reported on innovative and experimental initiatives, the widespread and comprehensive translation of such thinking into construction practice is still at an early stage. At the same time the authors suggest that the widespread adoption of the concept of the circular economy within the construction industry will face a number of challenges. More contentiously, there must be concerns that the major construction companies might effectively capture the concept of the circular economy to justify continuing economic growth.

Keywords: Circular economy; circular business models; European construction industry; product life cycle.

Introduction

The concept of the circular economy is increasingly seen as a major policy agenda item and a testing challenge, for the construction industry within Europe. The European Commission (2018, webpage), for example, argued that 'the built environment is a key target' in its 'policy for circular economy' and the European Environment Agency (2016a, webpage) identified construction and demolition as one of five priority areas in the transition to a circular economy. The European Construction Industry Federation (2016, p.1) reported that it 'strongly supports action that will make the circular economy a reality' but argued that 'for the circular economy to become a reality, there needs to be greater acceptance in the relevant markets and both the supply and demand side need to be addressed.' The UK Green Building Council (2018, p.1) argued 'circular economy is a term and a concept that has risen rapidly up the agenda for property and construction professionals, but all too often it challenges the status quo and has struggled, as a concept, to progress.' The UK Green Building Council (2018, p.1) further suggested that 'despite several organisations leading initiatives to raise awareness and encourage circular thinking, many construction and property professionals are still struggling to apply true circular thinking to their business models, services and products.'

While some of the major construction companies within Europe are currently looking to integrate circular economy thinking into their strategic planning and a number of them

have reported on innovative and experimental initiatives, the widespread and comprehensive translation of such thinking into construction practice is still at an early stage. This might be seen to be reflected, for example in company, Bam (2018, webpage), the Netherlands based construction company, reporting on continuing 'to get to grips with the circular economy' as part of its vision for building a more sustainable future, in Vinci (2016, p. 180), the French headquartered international construction company, reporting setting up 'a centralised focus group to advance its study of the circular economy' and in Interserve (2016, p. 38), the UK based construction company, reporting on continuing 'to support the development of circular economy thinking.' With these comments in mind this short case study outlines the characteristics of the circular economy, provides an exploratory review of how some companies and industry bodies within the construction industry in Europe are publicly addressing the concept of the circular economy and offers some general reflections on the application of the concept within the construction industry.

The Concept of the Circular Economy

Murray et al. (2015, p. 10) suggested that the term circular economy has 'been linked with a range of meanings and associations by different authors' and Kirchherr et al. (2017) identified 114 definitions and argued this 'variety of understandings can result in CE concept eventually collapsing or ending up in conceptual deadlock.' The Ellen McArthur Foundation, established in 2010 with the aim of accelerating the transition to a circular economy, argued that 'a circular economy is restorative and regenerative by design, and aims to keep products, components, and materials at their highest utility and value at all times' and that 'the circular economy is a continuous, positive development cycle. It preserves and enhances natural capital, optimises resource yields, and minimises system risks by managing finite stocks and renewable flows' (Ellen McArthur Foundation 2017, webpage). The Ellen McArthur Foundation and Granta Materiality intelligence (2015, p.1) define 'a circular economy' as 'a global economic model that aims to decouple economic growth and development from the consumption of finite resources.' Equally ambitiously, the US Chamber of Commerce Foundation (2018, webpage) defined the circular economy as 'a restorative model that decouples economic growth from natural resource use, and emphasizes longevity, reuse, and recycling. All resources and energy are renewable and regenerative, all durable resources are endlessly cycled back into supply chains, and waste does not exist.'

Typically, the concept of the circular economy is contrasted with the traditional 'linear economy' which turns raw materials into waste in the production process and which is seen to lead to environmental pollution and the removal of natural capital from the environment. In theory the concept of the circular economy embraces all stages of the product life cycle from both the product design and the production process, through marketing and consumption to waste management, recycling and re-use. Within such an economy an initial focus on designing products that are more resource efficient throughout their life cycles can make products more durable, easier to repair and to recover constituent, and potentially still useful, materials from the products when their initial lifespan is over. As long as the majority of environmental costs are borne not by producers but more generally by a potentially wide range of stakeholders then there is limited incentive to introduce more innovative design thinking. The circular economy also demands greater efficiency in production processes and here the focus is on looking to reduce the environmental and social impact of production, for example,

through more sustainable sourcing and the promotion of innovative industrial processes.

A variety of potential economic and environmental benefits are claimed for a transition to a circular economy. The World Economic Forum (2014, p.13), for example, estimated that globally the circular economy is a 'trillion-dollar opportunity with huge potential for innovation, job creation and economic growth.' While the European Commission (2018, webpage) argued that the 'circular economy offers an opportunity to boost our economy, making it more sustainable and competitive in the long run.' McKinsey and Company (2015, webpage) argued that a circular economy 'would allow Europe to grow resource productivity by up to 3% annually' and that it could generate a net economic benefit of 1.8 trillion Euros by 2030. More specifically EY (2015, p.10) suggested that 'the circular economy helps to contain risks', for example, in managing raw material supply in competitive markets, and in providing opportunities to 'extend and strengthen customer relationships', 'tap into new markets', 'become more efficient' and 'yield extra income.' On the environmental side, Het Groene Brein (2016, webpage) argued that 'the initial target for the circular economy is to have a positive effect on the ecosystem and to counteract the overload and the exploitation of the environment. The circular economy has the potential to result in a reduction in emissions and use of primary raw materials, an optimization of agricultural productivity, and a decrease in negative externalities.'

A number of factors help to explain the pressure for the transition to a more circular economy. These factors include the continuing depletion of scarce natural resources, the supply problems associated with the increasingly volatile international political situation and the unpredictable events associated with climate change, and the potential price volatility associated with both these factors. At the same time, the continuing environmental degradation and natural resource depletion associated with the current dominant traditional business model, the increasing introduction of national and international statutory legislative regulation designed to reduce environmental problems, and investment in technological innovations, which promote the more efficient use of natural resources, are all important drivers for a circular economy. More generally, indications of the emergence of new strategic corporate thinking that recognises the imperatives of business continuity will encourage the adoption of new and more resilient business models.

However, while 'some companies are beginning to test circular economy principles in their business models' (UPS and Green Biz 2016), there are major challenges in measuring how effectively and economically a company is making the transition to a more circular business model. Such challenges in part reflect the variety of meanings attributed to the concept and to 'the complexity and variety of actions, activities and projects that could be called circular' (US Chamber of Commerce Foundation 2018, webpage). Currently, there is no universally agreed framework to enable companies to measure their progress in working towards a circular business model but a number of approaches can be identified. The US Chamber of Commerce Foundation (2018, webpage), for example, suggested that 'a complete accounting of all activities, at least early on, is not necessary to communicate about how a circular program is progressing.' Rather the US Chamber of Commerce Foundation (2018, webpage) advised that 'the initial focus of program measurement should be on measuring attributes or activities that reflect circulating materials through the supply chain rather than using virgin materials or disposing of products in a landfill at the end of their useful

life.' The Ellen McArthur Foundation and Granta Materiality Intelligence (2015 p. 4) have developed a methodology to provide 'indicators to estimate the circularity of products and businesses' and initially these indicators 'focus exclusively on technical cycles and materials from non-renewable sources, as their circularity strategies and associated business benefits are better understood.'

Approaches to the Circular Economy within the European Construction Industry

The construction industry in Europe is approaching the concept of the circular economy in a variety of ways and thinking amongst companies, industry bodies and consultants is evolving over time. Ideally the circular economy should involve the whole of the construction supply chain but in many ways the main thrust of the initial approaches have been dominated by a focus on waste and recycling. Ferrovial, the Spanish based construction company, for example, created a circular economy working group in 2016 'to identify and promote opportunities for transforming waste produced and managed' by its two divisions 'into raw materials or secondary fuels, which can subsequently be used in other works and infrastructures designed, built and operated by Ferrovial' (Ferrovial 2016, webpage). Under the banner 'Make Waste a Thing Of the Past', Interserve (2016, p. 36) reported that its next priority was 'engaging with a wide range of stakeholders…. to discuss closed loop systems and the circular economy.' Vinci (2018, webpage) reported that the company's general policy on waste and recycling 'is geared to the circular economy.' In addressing 'resource efficiency and waste minimisation' Skanska (2017, webpage), the Swedish based multinational construction company, recognised that 'significant opportunities exist in construction to prevent waste from occurring' and reported that 'we operate in line with the waste hierarchy and are working on several initiatives which aim to eliminate waste to landfill and promote the circular economy.'

More generally Arup and Bam (2017, p. 9) suggested that construction and demolition waste accounted for 25-30% of all waste arising in the European Union. More ambitiously Arup and Bam (2017, p. 9) claimed that 'by adopting circular economy business models' the company will not only 'help businesses save on raw material costs and waste management costs' but also that there 'will be little or no waste to landfill and environments will be enriched by biological nutrients reintroduced into the biosphere through composting and bio-digesters.' The Construction Products Association (2016) has identified a number of mechanisms by which construction products and materials can be reused. Salvo, for example, trades in France, Germany, Netherlands, Ireland and the UK, and offers a reclamation service for architectural antiques, doors, fireplaces, ironwork, lighting, radiators, windows and stained glass. There are also a growing number of material exchanges and a variety of community reuse schemes.

However, van Sante (2017, p.5) stressed that 'circular construction is more than recycling' and argued that 'circular construction involves the entire construction supply chain.' Further, van Sante further argued circular construction 'is not only working out how the materials can be best reused when a building is demolished' rather 'in circular construction, architects, engineers, and contractors take minimising the use and maximizing the reuse of entire buildings and/or building materials into account at the very start of the construction process.' If circular construction is to become a reality then the entire construction supply chain will have to be involved. In proposing that

'there are many different ways to make construction circular', van Sante (2017) argued that 'circular construction starts with circular design.'

Arup and Bam (2017, p. 24) suggested that building circular design into projects at the initial 'development and planning phase of a built asset' offers an 'opportunity.' Such opportunities are seen, for example, in that 'products, systems and the entire build structures are designed to last longer with a higher residual value' and that 'they shall be easier to maintain, repair, upgrade, refurbish, remanufacture or recycle with respect to traditional ones' (Arup and Bam 2017, p. 24). At the same time (Arup and Bam 2017, p. 24) suggested that 'new materials can be developed and sourced, particularly bio-based, that are less resource intensive or fully recyclable' and that 'there is an opportunity for designers to engage with potential partners who may have an interest in the development of post initial use.' Toyne (2016) has provided some illustrations of how Balfour Beatty employed a circular design approach in using King Sheet Piling on the M25 widening project and the A421 improvement project in the UK and claimed significant savings in the steel used and reductions in carbon dioxide emissions.

In the Netherlands Bam employed circular design principles in the construction of a new town hall extension for the municipality of Brummen. Here the local authority commissioned a building for a service life of just 20 years and Bam designed a building for disassembly. The extension's modular design will not only enable easy disassembly and some 90% of the materials in the newly added space can be dismantled and reused at the end of the extension's service life. In the UK the Queen Elizabeth Olympic Park in London, originally used for the Olympic Games in 2012, was also designed for reuse though here long delays between the original planning and design stage and the eventual transformation meant that not all the proposed new features materialised. More generally within the UK, the Construction Products Association (2016, webpage) claimed that 'whilst many buildings/infrastructure projects are designed with sustainability principles and may incorporate aspects of the circular economy, there are few examples as yet of the "full" application of circular economy thinking.' At the same time the Construction Products Association (2016, webpage) also claimed that 'a reasonably high level of understanding of the generic principles of designing for deconstruction exists but there seems little commercial appetite for doing it.' More positively the Construction Products Association also reported that the Building Research Establishment has generated number of case studies to help increase awareness amongst designers, architects and contractors of how the construction industry can unlock the benefits of the circular economy and that the Association of Sustainable Building Products have a website that provides information on designing for deconstruction.

While design can be seen as the first step in the circular construction process van Sante (2017, p. 7) suggested there were 'many different methods to make construction circular.' These methods include maximising the life span of a building; designing buildings with fewer materials; using bio-based construction materials; using buildings that have come to the end of their useful or commissioned life as a 'building bank' for other building structures; and materials passports. The UK's Building Research Establishment is a partner in the EU Horizon 2020 Buildings as Materials Banks project, for example. This project, launched in 2015, looks to provide support for research to develop new ideas and ways of embedding circular economy thinking into the built environment. Materials passports are electronic sets of data that describe those characteristics of building materials, products and product systems that enable

value recovery from materials. The resources and materials used in a construction project can be recorded and passed from the supplier, to the construction contractor, the owner and finally to the demolition contractor.

More generally within the construction industry, there is growing interest in circular business models. Guglielmo for example, argued to embrace a change of paradigm in construction, it is crucial to understand the logic behind circular business models' (Arup 2017, webpage). Arup and Bam (2017, p.20) suggested 'to support the transition to the circular economy, governance, regulation and business models will play a crucial role' and argued that 'circular business models would allow the retention of an asset at its highest value over time and support enhancement of natural capital.' More specifically Arup and Bam (2017, p.20) suggested that new business models would allow 'greater control over resources through the value chain so that added value can be identified and captured' and that this in turn will see the 'creation of services that capture valuable products/resources.'

At the same time Arup and Bam (2017, p. 20) argued that 'different circular business models will be required at different stages of a lifecycle of an asset'. In a similar vein van Sante (2017, p. 16) suggested that within the circular economy a range of business models may be identified. Here van Sante (2017, p. 16) identified three models 'on the road to circular construction' namely, the 'sale of product', the 'maintenance model', and the 'service model.' The first model is the 'production and sale of a product', in the second model 'maintenance becomes more important to lengthen the lifespan and manufacturers provide a service and no longer sell a product' and the supplier provides 'more technical services…. such as installation and maintenance with the goal of increasing the lifespan and thus circularity.' In the third model 'ownership and the associated risks remain with the supplier' and 'the user only has access to a service' (van Sante 2017, p. 16). By way of an illustration, van Sante (2017, p. 16) outlines how 'the installer, for example, ensures pleasant interior climate for several years and remains the owner of the system. The idea behind this is that this gives the installer the added incentive to ensure high-grade use in the construction sector.'

At the company level, in proposing a 'possible construction circular economy model' Bam (2014. webpage), argued that 'rather than selling the customer a product and walking away, we should be looking at providing them with a service contract.' So for example, Phillips, as a provider of lighting, will provide light or lux, and as part of its service contract to provide light, they will provide the light fitting, which the client uses, with a type of material passport to enable it to be tracked over its lifetime.' Further Bam (2014, webpage) suggested 'if the light fitting breaks down, Phillips repair it (by replacing the bulb, part of the electronics, or the whole fitting), to continue its use for as long as practicable' and then 'when light is no longer required, they take back the light fitting for remanufacture.'

Reflections

There is evidence of growing interest in the concept of the circular economy and the development of circular business models within the European construction industry. A number of the major construction companies are emphasising their commitment to the concept of the circular economy and to the principles underpinning it, though some of these commitments are currently aspirational. Looking to the future many companies may well look to follow their aspirations and pursue their commitments as an important

contribution of the wider transition to a more sustainable future. That said, two sets of general issues surrounding the more widespread adoption of the concept of the circular economy within the construction industry merit attention and discussion.

Firstly, it is important to recognise that the development of circular business models and the widespread adoption of the concept of the circular economy within the construction industry will face a number of challenges. Gumilar and Dana (2017, webpage), for example, argued that the adoption of the circular economy within the construction industry will be 'a very challenging task because of the sector's complexity and its various players.' In a similar vein, the Construction Products Association (2016, webpage) noted that, 'work to develop circular economy thinking to date has been focused on short-term consumer goods', questioned 'can this thinking also be applied to buildings and infrastructure that exist for decades if not centuries' and argued 'the challenges for adapting circular economy thinking in construction are likely to be complex.'

More specifically, the Construction Products Association (2016, webpage), identified a range of challenges for the construction industry relating to 'products, buildings and infrastructure', 'recovery of products/materials' and 'business considerations.' In addressing products, building and infrastructure, for example, the Construction Products Association (2016) drew attention to the challenges associated with the long life and the complexity of buildings, the variable lifespan of many of their component parts and changes in specifications and technology over time, which may make some products effectively redundant in the future. In addressing recovery, the Consumer Products Association (2016) suggested that the often low current commercial value of materials and products, the lack of secondary market mechanisms and the lack of effective quality assurance for recycled materials were barriers to the adoption of greater circularity within the construction industry.

In a survey and follow up workshop of over 100 companies within the construction industry, Adams et al (2017) identified a number of key challenges for the adoption of the circular economy across the construction industry. Major challenges included the complexity of buildings; the fragmented supply chain; lack of a market mechanism for recovery; lack of circular economy knowledge; lack of incentives to design for end-of-life products; limited awareness across the supply chain; and lack of interest. The lack of incentives to design for end-of-life issues for construction products was seen as the single most important of these challenges and Adams et al. (2017, p. 20) reported that 'this view was held regardless of the company size or length of experience.' The authors also reported that there 'was a lack of clarity on what the circular economy actually entailed' and that 'the apparent confusion between terms such as reuse and recycling' suggested that 'greater precision is required' (Adams et al. p. 20). This must be seen as a concern for the construction industry, but in par at least, it can be seen to reflect wider views that the 'circular economy seems to be a collection of vague and separate issues from several fields' (Korhonen 2018, p. 37) and that the idea of the circular economy is 'more often celebrated than critically interrogated' (Gregson 2015, p. 218).

In addition to the industry specific challenges outlined above Ritzen and Sandstrom (2017) have identified a number of more general attitudinal, financial, structural, and technological barriers to a transition to a more circular economy. In attitudinal terms, for example, their findings revealed that risk aversion was a prohibitive factor in making

what were seen as disruptive changes to adopt a circular business model. A shift towards a circular model was also perceived to require far reaching changes within companies and to influence all departments and activities. Such changes take both time and investment and where corporate financial systems are focused on rapid returns on investment and cost savings this currently does not encourage long term strategic change. There are also challenges in developing indicators or measures that might help to monitor how a product or a company is progressing towards the circular economy. At the same time corporate finance departments are developing and refining tools to measure the financial costs and benefits of pursuing circular business models.

Secondly, there are wider, fundamental and arguably more contentious issues about the relationship between the emergence of a circular economy, sustainable development and existing economic and political structures. On the one hand, some commentators see the circular economy as 'only a small part of the being sustainable' rather that 'the circular economy is part of how we get there, but not the end goal.' (Sustainablesmartbusiness. com 2015.) However, the vast majority of corporate strategies for sustainability are couched within the idiom of continuing economic growth and business expansion. Bam for example, reported that 'our objective is to continue to grow profitably and capital efficiently' (Bam 2017, p. 5) and suggested that 'mega trends such as sustainability and energy efficiency are creating areas of higher growth' (Bam 2017, p. 7). Such an approach is rooted in the general belief that continuing economic growth will be accompanied by the more efficient use of resources. This trend which is seen as either relative or absolute decoupling (relative decoupling refers to using fewer resources per unit of economic growth while absolute decoupling refers to a total reduction in the use of resources) underpins many conventional definitions of sustainability and the vast majority of current corporate sustainability strategies and programmes.

This position is reflected in some of the general narratives of the benefits of the circular economy. Govindan and Hasanagic (2018,webpage), for example, suggested 'in the last few years, the circular economy has received considerable attention worldwide because it offers an opportunity to optimise and promote sustainable production and consumption through new models based on continuous growth and limitless resources.' In an even more positive vein Glasgow Chamber of Commerce (2016, p. 2) claimed 'the circular economy means enough for everyone forever' and that 'the benefits of the circular economy are endless: reducing dependency on scarce natural resources; increasing their competitiveness; and realising significant financial savings.' Equally pointedly the belief that 'the circular economy would decouple economic growth from resource use' (McKinsey 2015, webpage) can be seen to justify the commitment to both the circular economy and to continuing business expansion and growth despite wider concerns about the continuing consumption of scarce natural resources and the damaging environmental impacts of such growth.

On the other hand, Gregson et al. (2015, p.235) argued that a circular economy 'would require radical transformations to the economic order, including fundamental recasting of manufacture, retail, consumption and property rights.' Such radical changes would extend far beyond the construction sector of the economy. As such, concerns have been expressed that the concept of the circular economy might be captured by corporate interests, and more specifically by corporate capitalism. Valenzuela and Bohm (2017, p. 23), for example, suggested that 'given the all too obvious social and environmental consequences crises associated with out-of–bounds growth capitalism,

the circular economy has been one of the main references for rebuilding and reforming a political economy of sustainable growth.' However, Valenzuela and Bohm (2017, p. 27) further argued that the terms circular economy and sustainability were effectively being 'captured by politic-economic elites claiming that rapid economic growth can be achieved in a way that manages to remain responsible to environment and society.'

Conclusion

A number of the major construction companies within Europe are currently looking to integrate circular economy thinking into their business models and some of them have reported on innovative and experimental initiatives but the widespread and comprehensive translation of such thinking into construction practice is still at an early stage. Ideally the development of the circular economy should involve the whole of the construction supply chain but the main thrust of the initial approaches within the industry within Europe have been dominated by a focus on waste and recycling. More generally, there is growing recognition that if the circular economy is to grow then a range of business models rooted in maintenance and service rather than sales may become an increasingly important feature of the construction industry. That said the widespread adoption of the concept of the circular economy and of circular business models within the construction industry seems likely to face a number of challenges. Indeed, it remains to be seen whether the circular economy can become a workable and realistic business model for the construction industry. More contentiously there are concerns that the major construction companies might effectively capture the concept of the circular economy to justify continuing economic growth while effectively and conveniently ignoring the reality that such growth is essentially unsustainable.

References

Adams, K. T., Osmani, M., Thorpe, T. and Thornback, J. (2017) 'Circular Economy in Construction: Current Awareness, Challenges and Enablers', Proceedings of the Institution of Civil Engineers: Waste and Resource Management', Vol. 170, No. 1, pp. 15-24

Arup (2017) 'New Report reveals the benefits of circular business models for the built environment', https://www.arup.com/news-and-events/news/new-report-reveals-the-benefits-of-circular-business-models-for-the-built-environment (Accessed 2 February 2018)

Arup and Bam (2017) 'Circular Business Models for the Built Environment', https://www.bam.com/sites/default/files/domain-606/documents/8436_business_models-606-1490949582322972999.pdf (Accessed 5 February 2018)

Bam (2014) 'The circular economy: a new resource model for the built environment', http://sustainability.bam.co.uk/insights/2014-09-18-the-circular-economy-a-new-resource-model-for-the-built-environment (Accessed 6 February 2018)

Bam (2017) 'Building the Present Creating the Future', https://www.bam.com/sites/default/files/domain-606/documents/bam-2016-integrated-report-606-1488263741154409869 8.pdf (Accessed 9 February 2018)

Bam (2018) 'Our Vision', http://sustainability.bam.co.uk/our-vision (Accessed 2 February 2018)

Construction Products Association (2016) 'Knowledge Resource for Circular Economy Thinking in Construction', https://www.constructionproducts.org.uk/media/177748/gcb-circular-economy-april-2016-v3.pdf (Accessed 23 January 2018)

Ellen McArthur Foundation (2017) 'Circular Economy Overview', https://www.ellenmacarthurfoundation.org/circular-economy/overview/concept (Accessed 14 November 2017)

Ellen McArthur Foundation and Granta Material Intelligence (2015) 'Circularity Indicators: An Approach to Measuring Circularity', https://www.ellenmacarthurfoundation.org/assets/downloads/insight/Circularity-Indicators_Project-Overview_May2015.pdf (Accessed 5 February 2018)

European Commission (2018) 'Circular Economy', https://ec.europa.eu/growth/industry/sustainability/circular-economy_en (Accessed 24 January 2018)

European Construction Industry Federation (2016) 'Circular Economy Action Plan welcomed by FIEC', http://www.fiec.eu/en/fiec-positions/position-papers.aspx (Accessed 31 January 2018)

European Environment Agency (2016a) 'More from less – material resource efficiency in Europe', https://www.eea.europa.eu/publications/more-from-less (Accessed 31 January 2018)

European Environment Agency (2016b) 'Circular Economy in Europe- Developing the Knowledge Base', file:///C:/Users/Asua/AppData/Local/Temp/Circular%20economy%20in%20Europe-1.pdf (Accessed 30 January 2018)

EY (2015) 'Are you Ready for the Circular Economy', http://www.ey.com/Publication/vwLUAssets/EY-brochure-cas-are-you-ready-for-the-circular-economy/$FILE/EY-brochure-cas-are-you-ready-for-the-circular-economy.pdf (Accessed 8 August 2017)

Ferrovial (2016) 'Ferrovial creates the circular economy working group', https://www.ferrovial.com/en/press-room/news/ferrovial-creates-circular-economy-working-group/ (Accessed 5 February 2018)

Glasgow Chamber of Commerce, Zero Waste Scotland, Glasgow City Council and Circle Economy (2016) 'Circular Glasgow: A Vision and Action Plan for the City of Glasgow', https://www.circle-economy.com/wp-content/uploads/2016/06/circular-glasgow-report-web-low-res.pdf (Accessed 27 January 2018)

Govindan, K. and Hasanagic, M. (2018) 'A systematic review on drivers, barriers, and practices towards circular economy: a supply chain perspective', International Journal of Production Research, http://www.tandfonline.com/doi/abs/10.1080/00207543.2017.1402141?journalCode=tprs20 (Accessed 29 January 2018)

Gregson, N., Crang, M., Fuller, S. and Holmes, H. (2015) 'Interrogating the Circular Economy: The Moral Economy of Resource Efficiency in the EU', Economy and Society, Vol. 42, No. 2, pp.218-243

Gumilar, V. and Dana, P. (2017) 'European circular construction alliance- adopting circular economy for internationalization and global competitiveness of European SME's in building and construction', https://repository.tudelft.nl/islandora/object/uuid%3Adff5a991-da8d-4774-886d-8cecb7369c32 (Accessed 8 February 2018)

Het Groen Brein (2016) 'Circular Economy: What are the Environmental Benefits', https://kenniskaarten.hetgroenebrein.nl/en/knowledge-map-circular-economy/ce-environmental-benefits/ (Accessed 30 February 2018)

Interserve (2016) 'Looking Back Looking Forward', http://www.interserve.com/docs/default-source/about/interserve_sustainabilities_2016.pdf (Accessed 5 February 2018)

Kirchherr, J., Reike, D. and Hekkert, M. (2017) 'Conceptualising the circular economy; an analysis of 144 definitions', Resources, Conservation and Recycling', Vol. 127, December 2017, pp.221-232

Korhonen, J., Honkasalo, A. and Seppala, J. (2018) 'Circular Economy: The Concept and its Limitations', Ecological Economics, Vol. 143, No. 1, pp. 37-4
McKinsey and Company (2015) 'Europe's Circular-Economy Opportunity', http://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/europes-circular-economy-opportunity (August 4 2017)

Murray, A., Skene, K. and Haynes, K. (2015) 'The Circular Economy: An Interdisciplinary Exploration of the Concept and Application in a Global Context', Journal of Business Ethics, http://eprint.ncl.ac.uk/file_store/production/208884/EB16068A-8D6E-4D8F-9FA3-83DF5775D4FE.pdf (Accessed 7 August 2017)

Ritzen, S. and Sandstrom, G.O. (2017) 'Barriers to a Circular Economy – Integration of Perspectives and Domains', http://ac.els-cdn.com/S221282711730149X/1-s2.0-S2212827117301149X-main.pdf?_tid=28fe8bd4-7b50-11e7-b422-00000aab0f26&acdnat=1502097167_8c969821720e4b31b7e5f40c9b528f4d (Accessed 7 August 2017)

Skanska (2017) 'Materials', https://www.skanska.co.uk/about-skanska/sustainability/green/environmental-management/materials/ (Accessed 30 January 2017)

Sustainablesmartbusiness.com (2015) 'The Dangers of Circular Economy Thinking', http://sustainablesmartbusiness.com/2015/04/the-dangers-of-circular-economy-thinking/ (Accessed 30 January 2018)

Toyne, P. (2016) 'Circular Economy in the Built Environment: A Balfour Beatty Perspective', http://constructingexcellence.org.uk/wp-content/uploads/2016/04/Constructing-Excellence-CE-workshop-Toyne-25022016.pdf (Accessed 24 January 2018)

UK Green Building Council (2018) 'Circular Economy', https://www.ukgbc.org/ukgbc-work/circular-economy/ (Accessed 24 January 2018)

UPS and GreenBiz (2016) 'The Growth of the Circular Economy', https://www.greenbiz.com/report/growth-circular-economy (Accessed 28 January 2018)

US Chamber of Commerce Foundation (2018) 'About Circularity', https://www.uschamberfoundation.org/circular-economy-toolbox/about-circularity (Accessed 2 February 2018)

Valenzuela, F. and Bohm, S. (2017) 'Against Wasted Politics: A Critique of the Circular Economy', Ephemera: Theory and Politics in Organization, Vol. 17, No. 1, pp. 23-60

van Sante, M. (2017) 'Circular Construction', https://think.ing.com/uploads/reports/ING_EBZ_Circular-construction_Opportunities-for-demolishers-and-wholesalers_juni-2017.pdf (Accessed 23 January 2018)

Vinci (2016) 'Extract from the 2016 Annual Report', https://www.vinci.com/vinci/presentations-dd.nsf/145717395AFCC0EAC1258220005B8C94/$File/2016_annual_report_extract.pdf (Accessed 2 February 2018)

Vinci (2018) 'Green Products and Services', https://www.ferrovial.com/en/press-room/news/ferrovial-creates-circular-economy-working-group/ (Accessed 5 February 2018)

World Economic Forum (2014) 'Towards the Circular Economy: Accelerating the Scale-Up across Global Supply Chains', http://www3.weforum.org/docs/WEF_ENV_TowardsCircularEconomy_Report_2014.pdf (Accessed 6 August 2017)