7 Circular economy: Delivering social value throughout the supply chain

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Circular economy comprises of business models that replace the linear (take-make-dispose) economy with the alternative of reducing, alternatively reusing, and recycling materials in production, distribution, and consumption processes. In this chapter, we consider seven different circular business models, and present three case studies (two in the UK and one in France) to showcase the links between adopting a circular economy and creating social value. Specifically, we show how social value is created by (i) the localised nature of circular business opportunities, driven by the need for shorter circular resource flow loops to minimise secondary production costs; (ii) opportunities for the establishment of new supply chain start-ups to produce circular products through innovation; and (iii) the health and wellbeing benefits of reduced emissions. We also Present a practical insight from a developer and show how the circular vision and social value relate to the Sustainable Development Goals (SDGs) 8: Decent work and economic growth, 9: Industry, innovation an infrastructure, 12: Responsible consumption and production, and 17 Partnerships for the goals.

Figure 7.1. Circular economy and selected SDGs

Circular economy

A circular economy is an economic model for promoting continuous use of resources to avoid them degenerating into waste. This vision seeks to accomplish sustainable development by reducing, alternatively reusing, and recycling materials in production, distribution, and consumption processes, and creating environmental quality, economic prosperity, and social equity, for the benefit of current and future generations (Kirchherr et al. 2017: 224-225). Such a vision can be achieved through business models that help to intensify the utilised resources by continually preserving or enhancing the quality, integrity, and value of materials over the longer-term.

As shown in Figure 7.2, a circular economy therefore offers an alternative to the linear (take-make-dispose) economy model which relies on use of sometimes scarce and finite natural resources for products that easily loose value and end up as waste. Within a circular economy, materials and components have to be intentionally designed for reuse and recycling. It requires all the necessary structures for ensuring that products or projects, and the materials used in their manufacture, or construction, are continuously reintegrated as resources in a circular flow.

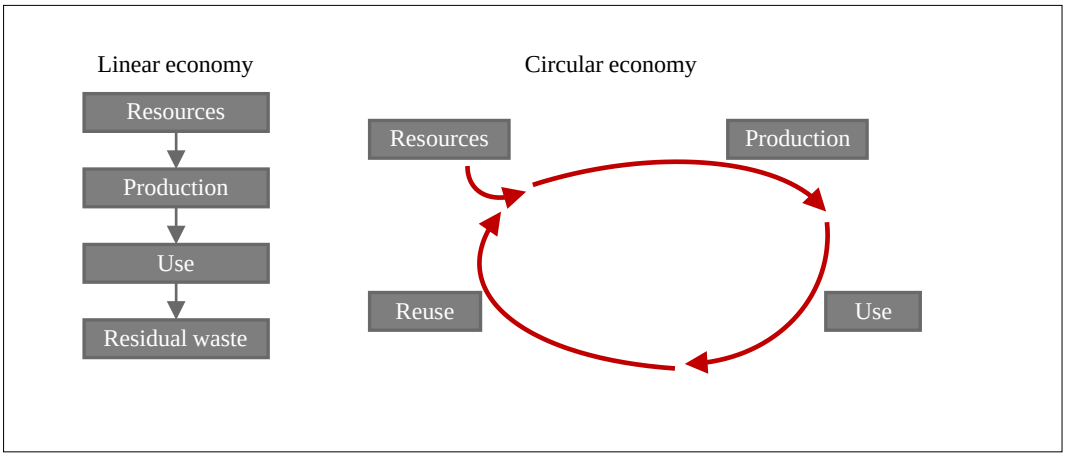


Figure 7.2: Linear and Circular Economy

The aim within circular economy is to bridge the gap between production and consumption activities (Witjes and Lozano, 2016) by keeping materials in their highest integrity as valuable and useful resources for (re)production (Ellen MacArthur Foundation, 2015).

Circular supply chain

The term 'circular supply chains' has emerged as an approach for ensuring that the supply chain generates business value by managing the flow of resources within a circular economy, whilst at the same time achieving environmental and social value. Schraven et al (2019) highlight that bringing about change when implementing circular supply chains needs to take into account the mutual dependency of supply chain actors, which means that each party has a tendency to look up to others as having responsibility for driving change. Schraven et al (2019) also linked the dependence of the recycled aggregate supply chain on others for circular economy transition to the need for external funding support for firms to invest in new technologies. This could help improve the quality and quantity of products from recycled materials, boosting supply (from demolishers and recyclers) and demand of the recycled products (from concrete producers, contractors, and designers). In the case of structural steel reuse, Tingley *et al* (2017) propose that to improve the rates of structural steel

reuse within a circular economy, a database for tracking suppliers, including their location and the availability of steel sections available is needed. They also suggest that the links between demolition contractors and stockists will need to be strengthened in addition to more technical guidance and education for the construction industry focused on structural steel reuse.

To justify the need for transition to a circular economy, Nasir et al (2017) use a life cycle assessment approach to compare the carbon emissions of insulation materials from a circular supply chain (produced from recycled textile) with a product from a linear supply chain (stone wool insulation produced from molten rock) and report on the environmental benefits of the circular supply chain. Their analysis shows that carbon emissions from the linear stone wool insulation supply chain (1.5090kgCO2-eq) was 64.02% higher that of the circular recycled textile insulation supply chain (0.9200kgCO2-eq). From an economic perspective, the World Economic Forum has estimated that adoption of a circular model will contribute about US$100bn a year through an increase in global construction industry productivity (Arup 2016). But can the transition towards a circular economy in the construction supply chain also generate social value benefits?

Circular vision and social value

Social value is integral to the circular vision where social value refers to the benefits that are created for the society beyond those received directly by the individuals or organisations that generated the value (after Auerswald, 2009). Within the circular model, it is transformation *within* organisations and their processes that achieve social value through value creation that will determine the extent to which social value benefits can be sustained. Such intra-organisational transformations that are conducive to social value creation, and yet also generate business or financial value, will ultimately extend across individual organisational boundaries during procurement too. In this way, social value is not an 'added value'. Since the environment, health, wellbeing, and economic sustenance of people in society are at the heart of many social value creation efforts, the circular model aligns well with business goals and the organisational pursuit of social value.

In particular, the circular vision aligns well with social value benefits because successful circular business models tend to be local in nature and these local supply chains strengthen local economies. Social enterprises are beginning to offer specialised labour for local deconstruction activities, and new start-up firms are beginning to emerge through circular innovation, all creating the opportunities for new skills and training opportunities to drive a circular economy – circular jobs (see Figure 7.3).

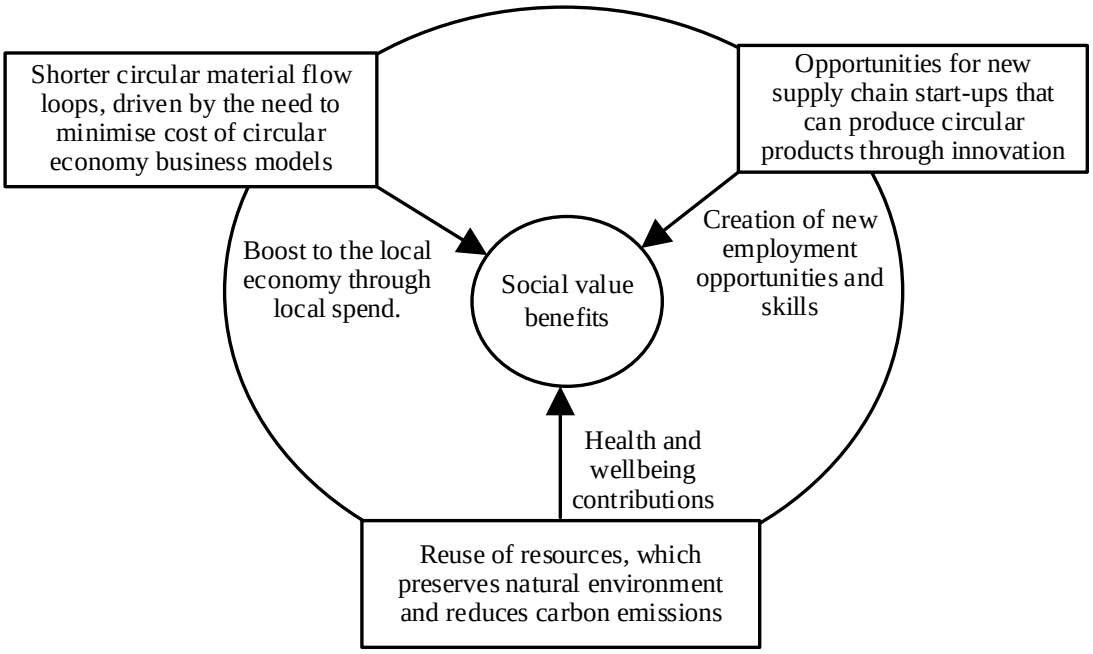


Figure 7.3: Social value creation in the construction supply chain through circular economy adoption (source: author).

We now outline the steps that practitioners can start to take in order to align their business operations with the circular vision.

Circular strategies: reduction, reuse, recycling, and recovery

There are various circular strategies, for example those proposed by Morseletto (2020) who developed a nuanced list of 10 circular strategies: recover, re-use, recycling, repurpose, refurbish, remanufacture, repair, reduce, rethink, and refuse. Most models and frameworks converge around different combinations of the '4Rs' linked to *reduction, reuse, recycling, and recovery* activities however (Kirchherr et al, 2017).

Reduction is about increasing the efficiency in product manufacture or use by consuming fewer natural resources and materials

Reuse is about anther consumer re-using discarded product or component which is still in good condition and fulfils its original function

Recycling refers to the processing of materials to obtain the same (high grade) or lower (low grade) quality, though arriving at a lower grade quality material has been referred to as downcycling and a higher grade quality material as upcycling.

Recovery focuses on incineration of material with the aim of energy recovery (see Table 7.1).

Table 7.1. Circular strategies (after Morseletto, 2020; Kirchherr et al, 2017; Potting el al. 2017)

10 circular strategies (Morseletto, 2020, Potting et al. 2017)	**4Rs** (Kirchherr et al, 2017)

Refuse – Make products redundant by abandoning its function or by offering the same function with a radically different product	Reduce - Refusing, rethinking, redesigning (including prolonging the lifespan of products), minimization, reduction, prevention of resource use and/or preserving of natural capital
Rethink – Make product use more intensive (e.g. through sharing products or by putting multi-functional products on market)	Reuse - Reusing, closing the loop, cycling, repairing and/or refurbishing of resources
Reduce – Increase efficiency in product manufacture or use by consuming fewer natural resources	Recycle - Remanufacturing, recycling, closing the loop, cycling and/or reuse of waste
Reuse – Re-use by anther consumer of discarded product which is still in good condition and fulfils its original function	Recovery - Incineration of materials with energy recovery
Repair – Repair and maintenance of defective product so it can be used with its original function	
Refurbish – Restore an old product and bring it up to date	
Remanufacture – Use parts of discarded product in a new product with the same function	
Repurpose – Use discarded products or its part in a new product with a different function	
Recycle - Process materials to obtain the same (high grade) or lower (low grade) quality	
Recovery – Incineration of material with energy recovery	

Circular Business Models

New circular business models that the construction supply chain can adopt to transition their business operations from linear to circular are beginning to emerge. A business model is an understanding of the logic and strategy that a firm uses to identify, create and deliver value to their clients/ customers, whilst maintaining a viable structure of revenue and cost in alignment with their business priorities (Teece, 2010). Circular business models are driven by circular economy strategies, practices and actions. BAM and ARUP (2017) categorised circular business models that are applicable to the built environment into circular design (and construction), circular use and circular recovery. We highlight eight circular business models in Table 7.2: circular design, circular construction, product as a service, life cycle extensions, sharing platforms, end-of-life management, circular material production and supply (distribution), and energy recovery models, and link them to the abovementioned circular strategies (after BAM and ARUP, 2017; Esposito *et al.*, 2018; EIT Climate-KIC, 2019; Morseletto, 2020). The circular business models are all driven by value identification, addition, and capture throughout the lifecycle of built assets; a vision that can inherently also result in the generation of social value.

Table 7.2: Circular economy strategies and business models

Project lifecycle	Circular strategy	Description	Circular business models
	Refuse	Phase-out materials (e.g. virgin materials) or environmentally damaging production	Circular design model – design of product,

Smarter design and construction		processes by abandoning their function or offering the same function with a different material.	projects, and process for the circular economy Circular construction model– construction for easy disassembly
	Rethink	Design and construction of built assets that facilitate other R strategies so that intensity of use and efficiency is increased (e.g. design for disassembly, design for flexibility and adaptability)	
	Reduce	Design and construction of built assets so that they consume fewer natural resources.	
Extend lifespan of built assets	Reuse	Reuse built assets or their component parts, which are still in good condition, to fulfil original function.	Product as a service model Sharing platforms model Life cycle extension model – repurpose, refurbish and maintenance
	Repair	Repair and maintenance of defective products so that they can be used for their original function.	
	Refurbish	Restore built assets and their components to bring them up to date.	
	Remanufacture	Use parts of discarded components, or parts from built assets, in the construction of new projects with the same function.	
	Repurpose	Adapt built assets for different purposes, or use parts of discarded components from built assets, in the construction of new projects with different functions.	
Useful application of materials	Recycle and Upcycle	Process materials from built assets to obtain the same or higher-grade quality raw materials.	End-of-life management model – deconstruction of built assets Circular material production and supply model – production and supply of recycled/upcycled materials
	Recovery	Incineration of material with energy recovery.	Energy recovery model - waste-to-energy

Circular design model

Circular designs involve the use of products, systems and built structures that are designed to last longer, are easier to maintain, repair, upgrade, refurbish, remanufacture or recycle, with a prioritisation of new materials from bio-based sources that are less resource intensive or fully recyclable (BAM and ARUP 2017). Therefore, circular designs need to prioritise the use of circular construction techniques (e.g. design for manufacture, assembly, and disassembly) as well as specify the use of building products that are circular in nature. The construction of demountable buildings that can easily be dismantled for reuse starts with circular design (ING, 2017). To achieve circular design, organisations and practitioners operating within the design space (e.g. Architects and Engineers) will need to first develop awareness of the circular economy concept. This awareness will help them adopt design practices that intentionally depend less on virgin materials by replacing these with healthy and circular alternatives. One of the key steps that can be taken in this regard is for Architects and Engineers to undertake continuing professional development (CPD) courses on the

circular economy, circular business models and the circular materials and products that can be specified for projects (e.g. Cradle to Cradle Certified Products Registry). Designers will also need to start engaging more with demolition/ deconstruction specialists during the design stage to evaluate and better understand the end of life impact of their designs. They can then alter designs to improve the deconstruction and circularity potential of the assets they design. Engineers will have to work more closely with material scientists and chemists who are constantly researching and discovering new circular innovative materials and products for testing, certification and use in built assets. Architects and Engineers should also think more critically about their designs by exploring options that prolong the lifespan and use of the built assets through flexible and easily adaptable and reconfigurable structures, whilst achieving easy disassembly when these assets ultimately reach their end of life. Architects and Engineers with expertise in designing flexible and easily adaptable structures that respond to the requirements of a circular economy will ultimately become more attractive to clients. This is because clients are increasingly becoming aware that their built assets retain better value in a circular economy, despite the increasingly unpredictable future characterised by constantly changing use requirements over a building's lifetime (e.g. commercial office to student accommodation to hotel accommodation to residential accommodation etc.). A circular economy will be an attractive model to help clients future proof their investment. Project managers that work at the front-end of projects, helping clients define project requirements and scope, will also need to develop more awareness of circular economy and the kind of requirement that can be defined for projects.

Circular construction model

The circular construction model is based on the use of construction techniques and processes (e.g. construction assembly and installation) that achieve circularity (reuse and recycling) of the structure (ING, 2017). This can best be achieved if the entire construction supply chain work together (ING, 2017). Pre-fabrication and off-site construction are techniques that can help achieve circularity (Esposito et al. 2018). Construction firms and specialist subcontractors will have to develop greater awareness of assembly techniques that facilitate a circular economy. These techniques will mostly revolve around assembly of prefabricated modular systems and digital production. Contractors and subcontractors will also have to undertake CPD training to update their knowledge on use of new and emerging circular construction materials so that they are best placed to work with these materials should they be specified for projects. This will also give circular economy-enabled supply chain firms a competitive advantage in tender competitions where circular requirements have been specified.

Product as service model

The product as a service model is based on consumers (clients and end users) purchasing the services required from building products as against buying and retaining ownership of these products (EIT Climate-KIC 2019). Unlike product-oriented business models where firms have an incentive to maximise the number of products sold to make profit, firms operating a product as a service business model generate profits from the services offered by their products, whilst the material products and consumables become cost factors that need to be efficiently managed (Tukker, 2015). Demountable partitions could be sold as a service to clients per m2, lighting could be sold per lux etc. For example, Rau Architects and Philips have pioneered the circular lighting concept in the Netherlands whereby Philips supplies and sells lighting as a service to Rau Architects per lux at affordable rates (Ellen MacArthur Foundation, 2017). Philips then retains ownership of the lighting installations and provides

the specified lighting levels in the architectural studio at competitive rates so that Rau Architects are exempt from any other costs related to their lighting needs. To make this model profitable, Philips had to ensure that they supplied efficient lighting systems to meet specifications and minimise cost. There is potential for more supply chains in the construction sector to offer competitive packages by selling their products as a service. This will become a more viable business model due to the increasing number of times built assets are likely to be modified over their lifetime to meet changing use requirements (e.g. re-partitioning of internal spaces, re-installation of new energy systems to meet new heating and cooling demands, re-installation of lighting to meet different lighting needs etc.).

Sharing platforms model

The sharing model helps to increase the utilisation rate of goods and resources through selling, renting, sharing and exchange of materials and products (EIT Climate-KIC 2019, BAM and ARUP 2017). Digital platforms can be used to enable interconnectivities between multiple clients/customers, supplier to client, or supplier to supplier by tracking, mapping, and matching local demand for idle and/or unwanted resources. This business model promotes an increased utilisation of existing resources and a reduction in demand for new products. A typical example of such digital platforms that facilitate resource sharing is FLOOW2, which allows contractors with idle construction equipment (e.g. earth diggers and excavators) to maximize equipment utilization through sharing or exchanges (Esposito *et al.*, 2018). Another example is the Materials Exchange Platform Map (MEP Map), which has been launched by the Supply Chain Sustainability School in the UK (CIOB, 2020). This platform allows contractors and their suppliers to freely map and locally exchange unused construction materials through a central database. These digital enablers of the circular economy in the construction industry will continue to grow, with an increasing potential for new supply chain firms to emerge and provide more sophisticated digital mapping services, both to drive the sharing model and the product as service model. The rest of the construction supply chain will, however, only need to develop awareness of how these digital platforms will influence their procurement functions, as the switch from buying products to buying the services that products provide continues to advance and become mainstream.

Life cycle extension model – repurpose, refurbish and maintenance

The life cycle extension model involves active maintenance, repair, upgrading, remanufacturing and remarketing of products, components, and systems including entire built assets (EIT Climate-KIC 2019, BAM and ARUP 2017). The aim is to extend the service life, integrity and quality of the products, components and systems that are used in built assets (BAM and ARUP 2017) so that the value of the entire asset is preserved or enhanced. The constantly changing use of built assets will also continue to increase demand for construction services to adapt and extend the lifespan of these assets. As such, demand for supply chain firms that have expertise in extending the lifespan of built assets through active maintenance regimes, repairs, upgrades, and refurbishments will continue to grow. . Firms that specialise in refurbishment works will therefore need to develop greater awareness of the circular economy and the use of material passports to define the characteristics of materials and their pathways within a circular flow. They will also need to develop more expertise in the use of digital tools that facilitate tracking and circulation of materials within a local circular flow loop or ecosystem.

End of life management model

The end of life management model is a circular business model that focuses on deconstructing built assets at their end of life phase. Demolition specialists that operate in this space will first need to re-orient their perspectives from demolition and waste management experts to deconstruction and resource management experts. These firms will need to develop an awareness of built assets as material banks that need to be mined for their resources, rather than managing these assets as waste liabilities. Increasingly, specially trained labour forces will be required to carefully dismantle and separate end of life materials from the built assets. This labour force will need to be competent in the use of advanced dismantling and separation process, including the use of material passports and other digital informatics during pre-deconstruction audits. For example, Akanbi et al (2020) have developed a decision support tool for predicting demolition waste in a circular economy. This artificial intelligence (AI) driven tool can help deconstruction specialists to quickly predict the quantity of resources in a built asset earmarked for demolition, mobilise the supply chains that will need to be engaged prior to actual demolition, and identify the storage and logistics requirements in a timely fashion. There are also opportunities for construction supply chains that operate as social entrepreneurs to train and offer labour with specialised expertise in dismantling and deconstructing materials, fittings, appliances, and components (e.g. bricks, sanitary appliances, mechanical and electrical fittings etc) from built assets for reuse or recycling.

Circular material production and supply model

The circular material production and supply model is driven by recycling or upcycling of used (non-virgin) materials that would otherwise have resulted in waste - ensuring that these materials become useful resources again. The circular supply aspect of this business model also focuses on the development of new bio-based materials that are less resource intensive, enhance renewable energy and are fully recyclable (BAM and ARUP 2017). Through secondary production, these used materials are re-produced as resources for the same product (recycling) or a higher-grade product (upcycling). Supply chain firms that re-process used materials through secondary production or supply recycled and upcycled materials for construction will be paramount in the transition of the construction industry towards a circular economy. Some of these secondary production activities can be energy intensive and will not be truly circular if the carbon equivalent of the energy required for recycling (haulage, reprocessing and distribution) exceeds the embodied carbon in the recycled materials. For this reason, circular material production and distribution should also extend to supply chain firms that specialise in the capture, storage, and recycling of waste energy (e.g. waste heat). For example, EcoStock, a start-up organisation in France has designed a mobile thermal storage solution that enables recovery of industrial waste heat through storage in recycled ceramics devices for later use as a heating source or for electricity generation (Ecotechceram n.d.)). There are also opportunities for other supply chain start-ups that specialise in the capture and sale of waste energy within a circular economy.

Energy recovery model

The energy recovery model is arguably the least circular as it involves the recovery of energy by degenerating the value of the materials that would have ended up as waste. These are achieved through waste-to-energy processes to extract energy as the only valuable resource left in these materials for which they would otherwise have gone to landfill. According to some (Van Caneghem *et al.*, 2019; Morseletto, 2020), energy recovery through waste-to-energy processes are compatible and

complimentary with recycling in a circular economy. Others (Rollinson and Oladejo, 2019; Vilella, 2019) have affirmed that this is the least sustainable of the circular business models because it destroys materials forever and encourages waste of scarce natural resources. Until built assets are better designed for deconstruction, this business model will still be required to compliment the other circular business models.

Circular vision for a construction supply chain

The realisation of a circular vision in construction will require construction supply chain firms to understand the circular economy strategies (reduction, reuse, recycling, and recovery), the circular business models, and how they are linked so that they can begin to consider and then adopt the best fit to their business purpose. Ultimately, a combination of a specific circular strategy (or strategies) and relevant circular business model(s) that fit an organisation's business purpose help achieve a configuration of a circular supply chain.

The supply chain that plays a vital role in the construction industry in general and is understandably central to adopting a circular economy. Where the traditional linear supply chain model is unsustainable and wasteful, the circular vision offers a useful alternative model. The conceptualisation of a circular construction supply chain, as illustrated in Figure 6.4, begins with designs that are dismountable and specification of products that have been carefully designed to drive a circular economy. Construction clients and investors will then opt for circular built assets that retain and even enhance the value of their assets over time, which can be achieved by specifying procurement and tendering requirements that prioritise circular economy targets. In turn, contractors will bring in expertise in circular construction methods and the use of circular building materials. Suppliers of basic low-tech building materials (e.g. masonry etc.) will offer circular building products with a material passport that specify their circular pathway, whilst suppliers of high-tech building materials, components, and systems (boilers, ventilation systems and the like) will adopt innovative service-oriented models as a leased package to provide a service, in addition to full maintenance responsibility at competitive prices for both clients and suppliers. Demolition specialists adopt deconstruction practices that at present will be more challenging because most of the built assets that have reached their end of life were not intentionally designed for deconstruction. Whilst this remains a challenge, smarter approaches to demolition can result in valuable high-grade building materials that can be reused or recycled. These demolition specialists will also diversify into recycling specialists and urban miners with expertise in applying cutting edge technologies and innovations in transforming deconstructed materials into valuable resources as required. Distributors and builders' merchants operate as a link between new building projects and building material banks, facilitated by material passports that enable information on the value of these materials, as resources, to be distributed to their next point of use. The circular supply chain requires and produces information and materials that flow in a circular manner so that Architects and Engineers are designing to meet the requirements of end of life supply chain actors (e.g. deconstruction and recycling firms) whilst also specifying use of materials from the circular flow into the projects they design.

The key message to the construction supply chain is that through circular strategies and circular business models, circular disruption will continue to happen gradually in the industry and practitioners within the supply chain that start to take the necessary steps now will eventually become the disruptors rather than the disrupted. Innovative thinking, the flexibility and boldness to adapt to change by applying new techniques and processes will be central to future-proofing business that operate within the construction supply chain. The transition towards a circular economy will not be devoid of risk, but the focus on long term rewards should be the priority. We present three case studies to demonstrate how the pursuit of circular business models can be profitable and at the same time generate social value and achieve selected SDGs.

AR Demolition and Aggregate Recycling, UK

AR Demolition and Aggregate Recycling is a UK-based organisation with two subsidiaries: one that specialises in demolition, and the other in aggregate recycling and supply. Their business model is well aligned with both the end-of-life management (deconstruction of built assets) and circular material production and distribution (production and supply of recycled/upcycled materials) models presented in Table 7.2. To produce the recycled aggregates, the demolished waste is first crushed, screened, and then reprocessed and graded for reuse in the construction industry as sub-base material, void filling material and for manufacture of pavement concrete. A snapshot of this process is illustrated in Figure 7.4.

Figure 7.4: Stages of the aggregate recycling process in Company A (source: author)

The firm operates a range of plants at their main aggregate recycling facility. Initially, they began by recycling demolition waste from their own demolition activities, but soon scaled up to accept free demolition waste from the local area to generate the economies of scale needed to keep the facility profitable. After a few years, they transitioned from receiving free demolition waste from other demolition contractors to paying for the demolition waste that is brought to their facility for recycling. This was to achieve the required volume for operational efficiency of their growing recycling facility as explained below:

"we collect it [construction waste], and we pay them for it, it probably costs us by the time we've finished – [£X to £X] a tonne, to buy it in, and then we've got to crush it, and process it and sell it, so, our biggest concern is….just getting enough volume to keep the plant running" (Managing Director, AR Demolition and Aggregate Recycling)

The rate that has been set for purchasing the demolition waste from other local firms still ensures that they are able to sell on the recycled aggregates for a profit. For the business model to be economically viable, the firm also ensures that a shorter material flow loop is achieved to keep transportation and logistics costs to a minimum. To achieve this, they only transport demolished materials from a 25-mile radius to their facility for processing and recycling. They otherwise deploy a mobile recycling plant if the demolition subsidiary has a job that is outside of this 25-mile radius. This mobile plant still crushes, screens and re-processes the aggregates at the demolished site, which is then supplied to their existing network of recycled aggregate users for new construction activities locally. Whilst this operational emphasis on a shorter resource flow loop was a cost minimization exercise, it also minimises the carbon emissions from hauling demolition waste across longer distances, which would increase whole-life carbon. This case study shows that a truly circular supply chain will operate within shorter, and hence local, material flow loops to create both financial and economic value, with the localise approach also driving social value creation. In an era where globalised supply chains have had a negative effect on local economies, this emphasis on shorter circular resource flow loops can contribute to social value by boosting local spend and job creation.

Further information available via:

https://www.ardemolition.co.uk/our-services/ar-aggregates

Thermal Recycling, UK

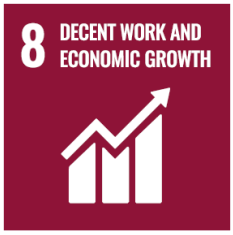
Thermal Recycling is a start-up firm that has pioneered a new innovative approach for safe recycling of asbestos. Their business model is aligned with the circular material production and distribution (production and supply of recycled/upcycled materials) model presented in Table 7.2. The asbestos material is upcycled into other higher grade masonry products. To achieve this, the asbestos is put through a thermal treatment process that transforms this naturally occurring, but harmful product, into a harmless inert material for other production processes (asbestos de-naturing). This asbestos de-naturing technique had previously been achieved at a laboratory scale on a fibre by fibre basis in the 70s but had never been achieved at scale (de-naturing asbestos in large packs). The firm has commissioned the kiln plant shown in Figure 7.5, which is the world's first for achieving this process on a large scale as the Managing Director explains:

"…we created that quantum leap, and now we're looking to replicate that quantum leap again and again and again. So, that was a real buzz, to be able to take something that people have tried and not managed to do but then trusting that the science does make sense, we just need to be diligent, scale it correctly, thinking about the engineering…you know." (Managing Director, Thermal Recycling)

The successful development of this patented asbestos recycling plant is a transformational innovation that will potentially create financial value, environmental value and new training and employment opportunities. With the limited number of landfill cells in the UK, there is a significant potential for setting up other local asbestos recycling plants across the UK and other international markets to minimise the carbon footprint of the asbestos recycling activities. At present, the only other alternative is to transport asbestos from the 100s of asbestos transfer stations up and down the UK to one of only three remaining landfill cells. This requires journeys estimated at around 140 miles to the nearest landfill cell from most parts of the UK, representing an almost 300-mile round trip.

Figure 7.5: Asbestos de-naturing plant for recycling asbestos

The inert output from this treatment process, which has no asbestos content, is used to produce building aggregates and other alternative masonry products (upcycling). The firm has been granted an Environment Agency permit to treat an estimated 29,500 tonnes of asbestos per year. Through this innovation, Thermal Recycling now has the potential to create more new jobs and provide new skills and training for working on this recycling plant. This was acknowledged prior to commissioning of the plant:



> *"So, our kiln is going to be installed at the end of the month. From there we will be running our commissioning processes where the kiln is set up and then all firing cycles are determined and then from that we will be looking to ramp up and engage with contractors and bringing in specific jobs"* (Managing Director, Thermal Recycling)

This is a clear example of new supply chain start-ups that can produce circular products through innovation, leading to new job opportunities and support for livelihoods whilst at the same time solving environmental problems whilst creating financial value. The development and testing of this innovation also benefited from external government support in the form of Research and Development (R&D) funding. There is opportunity for more supply chain firms that will pioneer various other innovative recycling solutions. Such firms will also be aware that pioneering new solutions requires patience to achieve successful prototypes, going through rigorous testing and certification processes before getting to the point where full-scale commercial production can commence.

Further information available via:

https://www.thermalrecycling.co.uk/

https://www.thermalrecycling.co.uk/storage/media/content/files/ARCA%20NEWS%20Recycling%20article.pdf

Upcyclea, France

Upcyclea is a start-up in France that operates a digital collaborative platform which enables the efficient management of resources from built assets in a circular flow. Their business model is aligned with the sharing platforms model presented in Table 7.2. This digital platform combines big data analytics and AI algorithms to generate informatics that help clients manage their assets in a circular economy. It utilises data on healthy and circular products, digital bank of materials imported from building data, including BIM data, and details of all the stakeholders on the platform (e.g. Architects, manufacturers, contractors, suppliers) as the input to data to map out local material flows and connect the various stakeholders via reuse or upcycling ecosystems.

The subscription-based digital platform also has a functionality for valuation of built assets within a circular economy based on key input parameters related to the existing asset (e.g. BIM designs and material inventory of the asset). This provides building owners and planners with a measure of the circularity potential (measuring the environmental and economic performance) of the asset and its residual value for decision making purposes. The AI algorithm also maps material flows to local demand to create an optimised ecosystem of resource flow that minimises the associated carbon footprint. This case is a good example of the enabling role that digital technologies will play in the transition of the construction supply chain towards a circular economy. There will continue to be opportunities for other supply chain start-ups in the construction sector that provide various other digital platforms to support the various circular economy business models.

Further information available via:

https://www.upcyclea.com/en/

Marga P`erez, Lanzarote

Marga P`erez is an artist and sustainable developer who looks to engage others in the circular economy through 'creativity not consumption' philosophy and practice, and the creative and transformative process of working with items that others throw away. As an artist, her work is focused around the interplay between creativity and caring for the environment. Her approach to reducing, reusing, repairing, renovating, and recycling permeates Marga's approach to her sustainable fashion house Margamod, as well as her work as a sustainable property developer on the island of Lanzarote.

> 'Creativity is an inherent value of the human being, given the same object, each person sees a different solution, which gives a unique value to the work they carry out'.

In a world where people are encouraged to increase their consumption of new products, she is keen to encourage people to engage creatively with the world they inhabit.

> 'The purchase has an immediate and ephemeral satisfaction, whereas the artistic intervention with the objects has a lasting satisfaction over time'.

One approach to embedding her philosophy on a larger scale is to change the face of recycling centres. Rather than being places we inhabit briefly, often as an inconvenience to be endured, they can become reception, storage, and education centres. In this way, they have a potential to provide valuable places for people to access items as well as learn how to repair or reuse them in new ways. She sees the benefits of extending far beyond the items themselves, by having a positive impact on people and planet.

> 'A receiving centre for objects to be recycled or restored can in turn be a teaching centre. Open to people of all backgrounds, they will prove particularly useful for those from disadvantaged backgrounds. In this way, both the objects and the people are transformed. People would regain value through recovering the objects and learning different trades, such as carpentry, sewing and locksmithing'

In this way, Marga provides practical steps to involve the public in creating a circular economy and sustainable value chains.

> 'A chair in the garbage, even if it only has three legs, has the value of wood whose tree was planted, grew, passed through the carpenter, was pointed, assembled and has the soul of objects that have lived a little history. That chair is a good canvas for your creativity and again increases it's value, in addition to contributing to a more respectful relationship with our planet'.

Chapter summary

The drive to promote a circular economy model in the construction industry and the built environment will continue to intensify. Sustained efforts in generating social, financial, and environmental value through the circular economy in the construction industry will largely depend on adoption of circular strategies and business models within the whole supply chain. Circular business models provide an innovative thinking platform for the construction supply chain, new entrepreneurs, and construction practitioners to think about how they can create new products, processes, and deliver new services

within a circular economy. The firms that will be successful are those that focus on solving problems and making things work by being adaptable and flexible. Supply chain organisations will also need to recognise and empower their people with skills that enable them to perform to their highest potential within a circular economy. This focus on training, talent, new skills, and general awareness of the creation of a circular economy amongst construction supply chain businesses will stimulate innovative thinking and circular solutions. This will create financial value through new business streams, whilst also creating social value through new job opportunities. Successful adoption of circular business models will require localised rather than global supply chains, with an emphasis on shorter material flow/ circulation loops that provide both the environmental benefit of minimising whole-life carbon, whilst reinforcing the creation of local employment and business opportunities to generate social value. Construction supply chains that position themselves as early movers by developing the necessary circular competencies, and even going a step further to establish subsidiaries driven by circular business models, will be at the forefront of disrupting the linear (take-make-dispose) model and as such be able to future-proof their businesses. The future is looking promising for financially viable, environmentally supportive, and socially equitable businesses.

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