



# Drivers of adopting Circular Economy in Oman built environment

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Circular Economy is a sustainable transition from the current linear thinking to a circular approach. The construction industry is criticized as the first responsible of waste generation and resources consumption, thus, it will be the sector which has potential of adopting the Circular economy approach. Oman construction industry is not an exception, it also negatively suffers from high waste and therefore adopting CE approach will be crucial to enhance the industry reputation and sustainability aspects. According to previous research, the critical challenges facing the adoption of circular economy concept in Oman built environment were introduced firstly with absence of clear vision and legislation supporting CE, as well as, lack of government funding of research, innovation, and investment as governmental barriers, followed by a technical barrier which is absence of qualified professionals in CE in construction industry.

The aim of this study is to explore the drivers supporting the adoption CE in Oman Built Environment. An exploratory study was conducted to explore the main drivers of CE in Oman built environment through 10 interviews of the built environment professionals and 80 questionnaire survey responses of built environment stakeholders. The results revealed that the key findings of the critical drivers of adopting CE in Oman built environment are: governmental responsibility through establishment of a clear vision and regulations of CE, upgrade public awareness, being a role model of CE implementation, as well as, establishing of supportive infrastructure for recovery process through collaboration with the private sector.

Finally, gaining momentum in CE in Oman built environment shall be initiated by governmental effort to benefit economically, socially and environmentally.

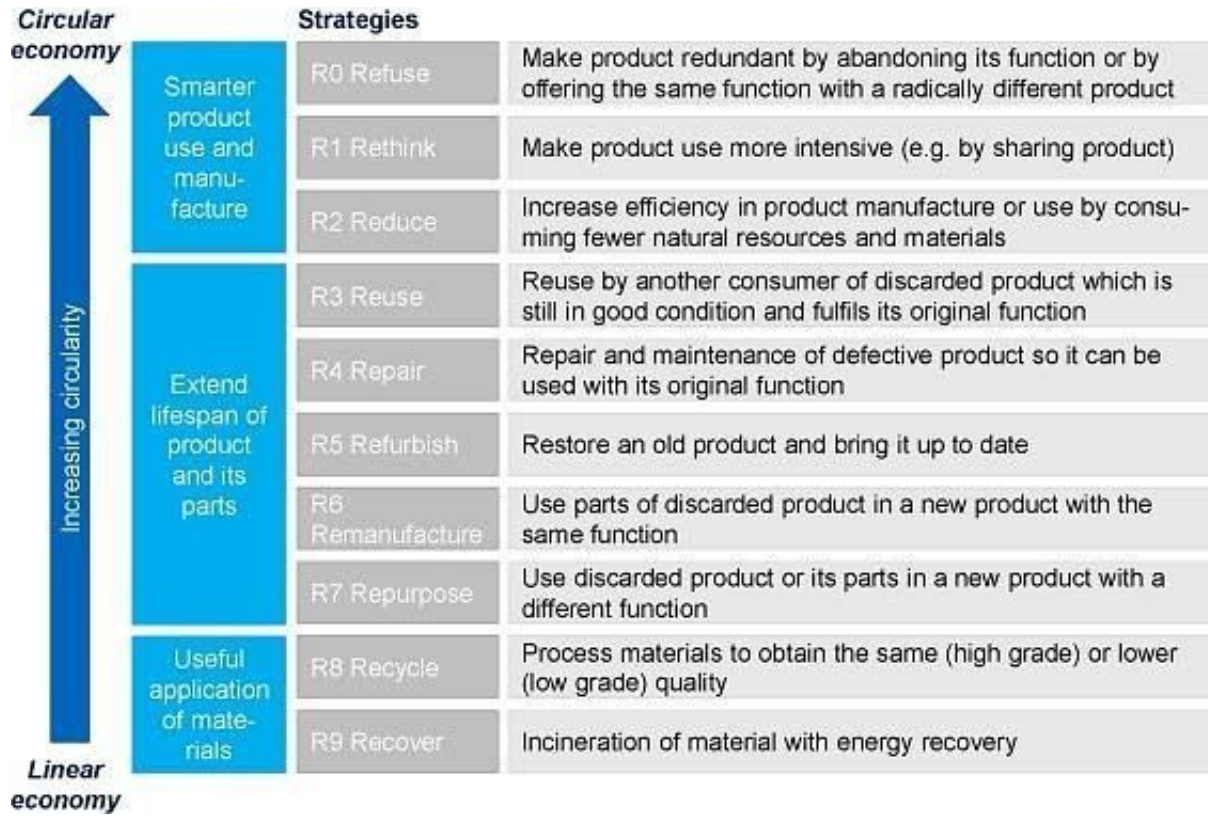
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## Introduction

After several attempts towards more sustainable practices, such as, Cradle to cradle concept, Circular economy was introduced in 2010 by The Ellen MacArthur Foundation through establishing a series of research and reports (Ellen MacArthur Foundation 2013). The Ellen MacArthur Foundation defined Circular Economy (CE) as:

‘An industrial economy that is restorative or regenerative by intention and design’

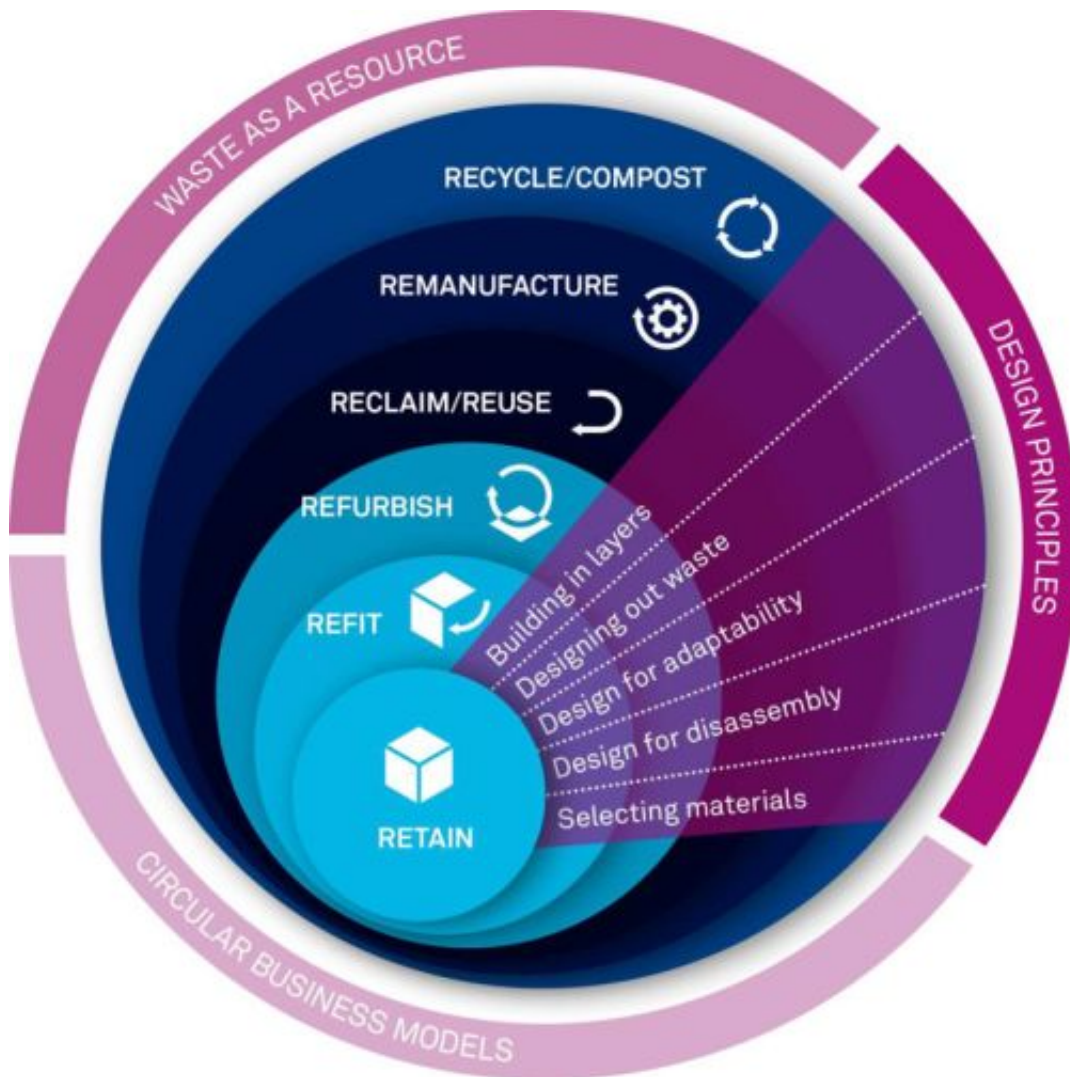
Most of the literature highlighted three main principles (3R) of CE as Reduce consumption, Reuse and Recycle the existing (Jonker et al., 2017; Ghisellini et al., 2016; Feng & Yan, 2007). However, after critical studies, Kirchherr et al. (2017) concluded with 9R, as shown below in Figure 1, initiated with the lower strategy (Recover 09) to the highest strategy (Refuse 01).



**Figure 1.** The 9R CE principles Framework (Source: Kirchherr et al., 2017)

Implementing CE principles in built environment was discussed by several researchers and Ghisellini et al. (2016) summarized the level of implementing CE as Micro (Building level ‘circular buildings’/ company or organization, single consumer), Meso (eco-industrial parks/ Product or materials level) and Macro (cities, regions and provinces).

In this study, the focus is on building level. Meso level was obtained by David Cheshire (2016), in his book ‘Building Revolution: Applying Circular Economy to The Built Environment’. The book clearly outlined the circular economy principles in building design as shown in figure 2.



**Figure 2.** The main principles of CE in the built environment (Source: Cheshire, 2016)

The diagram could be understood by the observed circles, nested concentric circles. The six internal circles initiated by Recycling, Remanufacturing and Reusing and ended by Refurbishing, Refitting and the best option which is Retaining (Cheshire, 2016). The external circles focusing on three aspects starting with considering existing waste as resource. Implementing five designing principles which are building in layers, designing out of waste, designing for durability, designing for disassembly and proper selection of the materials. This is concluded with Circular Business Models that will facilitate implementing the previous aspects.

Knowing the drivers of adopting CE will facilitate and accelerate the implementation. Several studies mentioned the drivers for adopting of circular economy in the built environment which are categorized into five groups based on their nature as cultural support, social drivers, governmental support, financial drivers and technological drivers as the following.

A workshop of circular economy in the built environment was organized in Singapore (2016) suggested that increasing awareness of circular economy through workshops and education programs is an initial step toward circular economy (Boer & Cui, 2016). Similarly pointed, Ghisellini et al. (2016) and MacArthur & McKinsey (2014) observed that upgrade awareness of environmental and economic benefits of the transition to CE is important. A research done by BAM researchers and Arup, studied the ways of achieving Circular Business Models, suggested that designing the products to last longer and preserve its validity is essential to facilitate the maintenance, reusing,



refurbishment, upgrading, repairing and recycling processes (Carra & Magdani, 2016) as well as Esposito et al (2018) and WRAP (2017) studies. However, Jones & Comfort (2018) pointed that upgrade the understanding of controlling resources in the circular supply chain is a massive driver.

Furthermore, Carra & Magdani (2016), Ghisellini et al. (2016) and De Angelis et al. (2017) demonstrated that the Social collaboration between different parties in the industry is essential to sharing information and best practices. Lemmens & Luebkehan (2016) added that creating a communication platform will facilitate sharing values and gain economic and social benefits.

The third main driver is governmental support. Boer & Cui (2016), MacArthur & McKinsey (2014), Eijk (2015), Preston (2012), [Ranta](#) et al. (2018), Ghisellini et al. (2016) and Geldermans (2016) suggested that the government could motivate the private sector toward circular economy by setting spectacular vision and coherent guidelines that enable and encourage the private sector. Moreover, Lemmens & Luebkehan (2016) suggested that government shall set new regulations that enforce the private sector to train and educate the workforce on CE. Furthermore, Carra & Magdani (2016) and Van Sante (2017) suggested that the government shall enforce the designers by standards that upgrade the longevity range of the buildings rather than just finishing the building with low quality. However, Henrotay et al. (2017) found that the hard regulations on waste management and construction policy will support the implementation of circular thinking. For instance, the UK, in 2014, increased the landfill taxes to be £80/t (Essex & Whelan, 2010) to support reusing and recycling materials.

Boer & Cui (2016), Eijk (2015) and Essex & Whelan (2010) demonstrated that the government shall upgrade the infrastructure to facilitate adopting circular economy by providing plants for sorting the components for reuse, refurbishment or repair centers. However, the government shall play a critical role and the public procurement shall be the leader of implementing circular economy in the market (Boer & Cui, 2016; Eijk, 2015; De Angelis et al., 2017; Xue et al., 2010). De Angelis et al. (2017), Eijk (2015) Van Sante (2017) and Lacy & Rutqvist (2015) argued that the government shall encourage and promote pay-per-use model or paying service instead of having the ownership. Indeed, public funding for circular innovation, investment, and researches to support the transition toward the circular economy is essential (Rizos et al., 2016; Eijk, 2015; Liu et al., 2009). In addition, establishing competitions to encourage innovation in CE (Boer and Cui, 2016) and offering incentives (Lemmens and Luebkehan, 2016) are important drivers.

The fourth main driver is financial drivers. The closed loop or secure resources could lead to a stable economy (Akanbia et al., 2018) and gain financial profit (Ormazabal et al., 2018) through reduction of materials prices and construction cost (MacArthur and McKinsey, 2014; Galle, 2017; Zhu and Geng, 2013). Esposito et al (2018) and MacArthur and McKinsey (2014) added that the design of assets with high productivity, durability, and quality will decrease the operation cost, which relays on low maintenance costs. Furthermore, MacArthur and McKinsey (2014) suggested that using new technologies that gathering all the information of the structure may reduce costs.

The last main driver is technological drivers. Using new technologies that support transparency and sharing information, such as, BIM ([Minunno](#) et al., 2018; Lemmens & Luebkehan, 2016; Akanbia et al., 2018) and gathering all the data of the structure, such as, Materials Passports (Jones & Comfort, 2018) will facilitate implementing of circular economy. Indeed, MacArthur & McKinsey (2014) and Garmulewicz et al. (2018) demonstrated that innovative manufacturing technologies, such as 3D printing will help to reduce manufacturing waste. Lastly, innovated platforms that help to sharing and collaborating experience are essential to facilitate reuse of assets and materials (Lemmens & Luebkehan, 2016; Esposito et al., 2018; Abreu and Ceglia, 2018), such as the (UK-GBC) online market for salvaged materials (Cheshire, 2016). Table 1 summarises the drivers identified from the literature.

| Sr No | Major Drivers    | Drivers               | Sources                     |
|-------|------------------|-----------------------|-----------------------------|
| 1     | Cultural support | Increase awareness of | Boer & Cui (2016) MacArthur |





|    |                       |  |   |
|----|-----------------------|--|---|
|    |                       | circular economy and its benefits through workshops and education programs                             | and McKinsey (2014); Ghisellini et al. (2016)   |
| 2  |                       | Upgrade awareness to designing the products to last longer and preserve its valid value                | Carra & Magdani (2016); Esposito et al (2018); WRAP (2017)  |
| 3  |                       | Upgrade understanding of controlled resources  | Jones and Comfort (2018)  |
| 4  | Social drivers        | Collaboration between different parties in the industry and sharing information and best practices     | Carra & Magdani (2016); Ghisellini et al. (2016); De Angelis et al. (2017)  |
| 5  |                       | Creating communication platforms for sharing values and gain economic or social benefits               | Lemmens & Luebkeman (2016)  |
| 6  | Governmental support  | Setting spectacular vision, coherent guidelines, requirements, standards, and rules                    | Boer & Cui (2016); MacArthur & McKinsey (2014); Ranta et al. (2018); Eijk (2015); Preston (2012); Ghisellini et al. (2016); Geldermans (2016) |
| 7  |                       | New regulations that enforce the private sector to train and educate the workforce on circular economy | Lemmens & Luebkeman (2016)  |
| 8  |                       | Standards to upgrade the longevity range of the buildings  | Carra & Magdani (2016); Van Sante (2017)  |
| 9  |                       | Setting hard regulations on waste management, energy performance, and construction policy              | Henrotay et al. (2017); Lemmens & Luebkeman (2016)  |
| 10 |                       | Upgrading the infrastructure to facilitate adopting circular economy                                   | Boer and Cui (2016); Eijk (2015); Essex & Whelan (2010)   |
| 11 |                       | Public procurement shall be demonstrative of circular economy  | Boer & Cui (2016); Eijk (2015); De Angelis et al. (2017); Xue et al. (2010)   |
| 12 |                       | Encourage and promote pay-per-use or paying service instead of having the ownership                    | De Angelis et al. (2017); Eijk (2015); Van Sante (2017); Lacy & Rutqvist (2015)   |
| 13 |                       | Public funding for circular innovation, investment, and researches                                     | Rizos et al. (2016); Eijk (2015); Liu et al. (2009)   |
| 14 |                       | Competitions to encourage innovation in circular economy   | Lemmens & Luebkeman (2016); Boer & Cui (2016)   |
| 15 | Financial drivers     | The closed loop or secure resources could lead to a stable economy and gain financial profit           | Akanbia et al. (2018); Ormazabal et al. (2018); MacArthur & McKinsey (2014); Galle (2017); Zhu & Geng (2013)                                  |
| 16 |                       | High productivity, durability, and quality of asset will decrease the operation cost                   | MacArthur & McKinsey (2014)   |
| 17 |                       | New technologies may reduce costs  | Esposito et al (2018); MacArthur & McKinsey (2014)  |
| 18 | Technological drivers | New intelligent technologies will support transparency and   | Lemmens & Luebkeman (2016); Jones & Comfort   |



|    |  |   |  |
|----|--|---|--|
|    |  | sharing information like BIM, Materials passports and 3D printing                                       | (2018); Minunno et al. (2018); Akanbia et al. (2018); MacArthur & McKinsey (2014); Garmulewicz et al. (2018) |
| 19 |  | Innovated platforms to sharing and collaborating experience to facilitate reuse of assets and materials | Lemmens & Luebkehan (2016); Cheshire (2016); Esposito et al. (2018); Abreu & Ceglia (2018)                   |

Table 1. Drivers of adopting circular economy in the built environment

It can be observed from the previous studies that the main drivers toward circular economy were setting of the spectacular vision and coherent guidelines by the government, the closed loop could lead to a stable economy and gain financial profit, and using new intelligent technologies will support transparency and sharing information.

## Methodology

This section presents the data analysis of the captured data through interviews and questionnaire. It starts with analysis and discussion of qualitative data collected through the interview. Then, analysis and discussion of the quantitative data collected through questionnaire are presented.

Interviews were conducted with 10 professionals in Oman built environment/ construction sector categorized into two Researchers/Academics, two contractors, two clients, two consultants, and two waste management organizations. The selection of the interviewees was based on the familiarity of sustainability or circular economy and building innovations as well as more than 10 years of experience. As the topic of the research is new, Thematic analysis was adopted where it was defined by Boyatzis (1998) and Braun & Clarke (2006) as semi-structured interviews that starting with recorded, highlighted the major quotes, coded into main headings, summarized into groups or themes and result discussion. Themes will facilitates gathering and categorizing the obtained data into the main categories of drivers.

The questionnaire was collected based on 80 respondents from the built environment. The majority were Civil engineers with more than half of respondents having bachelor degree, master degree and Ph.D., which believed that the majority will have a good awareness and understanding of CE in the built environment. Moreover, a good percentage of respondent having from 5 to 10 years and above of experience that believed to deliver results based on experience. The Questionnaire was rating numerically by Likert scale and analyzed through statically analysis.

## 1. Analysis and discussion of data collected through (interviews)

### 1.1 The drivers supporting the adoption of Circular Economy in Oman

The question was (What are the drivers supporting the adoption of Circular Economy in Oman?)

#### Governmental support:

According to the majority of respondents, the first step toward a circular approach is establishing of supportive vision, regulations, and standards. legislation that ‘enforce selecting materials that reusable’, ‘legislation to design buildings to disassembly’, ‘restrictions to minimize using raw materials’, ‘increase the cost of Raw materials’ and ‘ensure the waste generators divert the waste to the appropriate processing facility’. One respondent commented that ‘legislation shall be



applicable to Oman industry conditions to ensure the success of the implementation'. However, a study carried out by Ranta et al. (2018) stated that China government already took this step and established a high level of CE law (the CE promotion law), in 2009, and gave CE the priority in the national policy which enforces the transition toward CE. Oman could benefit from Chain strategy and ensure implementing the applicable legislation for Oman situation.

Furthermore, most of the respondents agreed that the government shall be the role model and the leader of the transition. A respondent replied that 'government role is essential at initial stages of the transition'. Similarly, Wisse (2016) found that the Green Public Procurement, in Amsterdam, could play a critical role in the transition to CE as public procurement has the major proportional of investment. While Oman Government vision 20/20 shows a continuous huge growing of development investments in large infrastructure and construction projects (Strolla, 2013), it could have the potential to be the first role model of CE.

Some of the respondents suggested that the government shall facilitate investment legally and financially through offer incentives. This concurs with a study carried out by Ghisellini et al. (2017) that suggested offer incentives and decrease the prices of recovery products.

### **Cultural support:**

Most of the interviews respondents demonstrated that raising the awareness of CE is a fundamental driver. As one respondent commented that 'a greater awareness needs to be introduced into the market about the long-term cost and environmental benefits of CE principles and this needs to be done in a way that focuses on the benefits to the end user'. Similarly, a study conducted by Wisse (2016) found that the interviews results concluded that the first driver of CE is establishing educational institutions to educate the circular economy principles.

### **Social support:**

Most of the respondents mentioned that collaboration between different stakeholders to provide supportive infrastructure is the essential driver. One of them stated that 'collaboration of the public and private sectors is essential to provide the supportive infrastructure through establish reuse centers to turn waste into a resource and facilitate recovery process of construction element'. Similarly, Essex & Whelan (2010) studied the possible network to establish reuse centers in the UK for all local construction products as the essential step for implementation of circular economy and planned to be not for profit to encourage the private sector.

### **Technical drivers:**

Using innovation and smart technology is commended as a driver of CE. A respondent commented that 'More modern methods of assembly and disassembly need to be introduced into the market'. Another suggested that 'We are aware that the availability of 3D printing allows material scientists to explore new and innovative ways to create material that can be printed'. A study conducted by Geldermans (2016) concluded that monitoring building elements through systemic data control of materials quality, compositions, properties and supply chain is important to conserve the data and keep it up to date.

To summarise, the important drivers found to be: supportive vision, regulations, and standards, raising the awareness of CE, the government shall be the role model and collaboration between different stakeholders to provide supportive infrastructure.

## **2. Analysis and discussion of data collected through (Questionnaire)**



## 2.1 Analysis of drivers support the adopting circular economy in Oman built environment:

The drivers supporting the adoption of CE were 19 drivers and rating numerically by Likert scale as the following:

(Not Important (NI) = (1), Low Importance (LI) = (2), Neutral (N) = (3), Very Important (VI) = (4) and Extremely Important (EI) = (5))

The following table 2 illustrates the listed drivers according to the Likert scale of level of importance with the average of each driver.

| No | Drivers   | NI (1) | LI (2) | N (3) | VI (4) | EI (5) | Average |
|----|---|--------|--------|-------|--------|--------|---------|
| 1  | Increase awareness through workshops and education programs | 0      | 3      | 8     | 36     | 33     | 4.24    |
| 2  | Increase awareness to design products for last longer       | 0      | 4      | 20    | 38     | 18     | 3.87    |
| 3  | Increase understanding of secure materials                  | 0      | 6      | 42    | 23     | 9      | 3.44    |
| 4  | Collaboration between different parties in the industry     | 0      | 5      | 25    | 33     | 17     | 3.78    |
| 5  | Communication platforms to share experience                 | 2      | 15     | 42    | 13     | 8      | 3.12    |
| 6  | Supportive vision, standards and regulations                | 0      | 3      | 7     | 32     | 38     | 4.31    |
| 7  | Regulations to train workforce                              | 3      | 6      | 41    | 14     | 16     | 3.42    |
| 8  | Standards to increase life span of the buildings            | 0      | 8      | 37    | 20     | 15     | 3.53    |
| 9  | Strict regulations on waste, energy and water management    | 0      | 4      | 8     | 34     | 34     | 4.23    |
| 10 | Supportive infrastructure to facilitate re-use              | 0      | 2      | 20    | 22     | 36     | 4.15    |
| 11 | Government projects shall be the leader                     | 0      | 4      | 12    | 29     | 35     | 4.19    |
| 12 | Encourage   | 4      | 19     | 32    | 11     | 14     | 3.15    |





|    |  |   |    |    |    |    |      |
|----|--|---|----|----|----|----|------|
|    | manufacturer to provide services instead of sell products                              |   |    |    |    |    |      |
| 13 | Funding researches, innovation and investment  | 1 | 7  | 15 | 35 | 22 | 3.88 |
| 14 | Establish competitions on circular economy   | 0 | 17 | 39 | 15 | 9  | 3.20 |
| 15 | Financial profit due to the closed loop of resources                                   | 5 | 21 | 42 | 9  | 3  | 2.80 |
| 16 | Decreasing in operation cost   | 7 | 27 | 44 | 2  | 0  | 2.51 |
| 17 | New supportive technologies could save costs   | 3 | 8  | 19 | 35 | 15 | 3.64 |
| 18 | New technologies may reduce manufacturing waste (i.e. 3D printing)                     | 2 | 10 | 29 | 33 | 6  | 3.38 |
| 19 | New technologies will save data of re-use materials (i.e. BIM and Materials passports) | 0 | 4  | 25 | 35 | 16 | 3.78 |

Table 2. Circular Economy Drivers according to the survey.

In order to rank the listed drivers, factor analysis of the level of impact of each driver was calculated as table 3.

|               |                 |
|---------------|-----------------|
|               | Overall Average |
| Minimum       | 2.51            |
| Maximum       | 4.31            |
| Range         | 1.8             |
| Section Range | 0.36            |
| NI            | 2.5-2.9         |
| LI            | 3-3.2           |
| N             | 3.3-3.6         |
| VI            | 3.7-3.9         |
| EI            | 4-4.3           |

Table 3. Circular Economy Drivers (Factor Analysis)

The Circular Economy drivers in Oman built environment were ranked according to factor analysis as shown in the following table that outlines the main category of each driver, listed drivers, the



range of each driver and the average.

| No. | Main categories       | Drivers  | Average |
|-----|-----------------------|--|---------|
| 1   | Governmental support  | Supportive vision, standards, and regulations  | 4.31    |
| 2   | Cultural support      | Increase awareness through workshops and education programs                            | 4.24    |
| 3   | Governmental support  | Strict regulations on waste, energy and water management                               | 4.23    |
| 4   | Governmental support  | Government projects shall be the leader  | 4.19    |
| 5   | Governmental support  | Supportive infrastructure to facilitate re-use   | 4.15    |
| 6   | Governmental support  | Funding researches, innovation, and investment   | 3.88    |
| 7   | Cultural support      | Increase awareness to design products for the last longer                              | 3.87    |
| 8   | Technological drivers | New technologies will save data of re-use materials (i.e. BIM and Materials passports) | 3.78    |
| 9   | Social drivers        | Collaboration between different parties in the industry                                | 3.77    |
| 10  | Financial drivers     | New supportive technologies could save costs   | 3.64    |
| 11  | Governmental support  | Standards to increase lifespan of the buildings  | 3.53    |
| 12  | Cultural support      | Increase understanding of secure materials   | 3.44    |
| 13  | Governmental support  | Regulations to train the workforce   | 3.42    |
| 14  | Technological drivers | New technologies may reduce manufacturing waste (i.e. 3D printing)                     | 3.38    |
| 15  | Social drivers        | Establish competitions on circular economy   | 3.20    |
| 16  | Governmental support  | Encourage manufacturer to provide services instead of sell products                    | 3.15    |
| 17  | Social drivers        | Communication platforms to share the experience  | 3.12    |
| 18  | Financial drivers     | Financial profit due to the closed loop of resources                                   | 2.80    |
| 19  | Financial drivers     | Decreasing in operation cost   | 2.51    |

**Table 4.** Ranking of Circular Economy Drivers in Oman built environment.

The level of importance of drivers supporting the adoption of circular economy in Oman built environment found to be categorized as (five were Extremely Important, four were Very Important, five were Neutral, three were Low Importance and two were Not Important). The Extremely Important and Very Important drivers are discussed in the following lines.

## 2.2 Discussion of (the extremely important drivers) of the circular economy in Oman built environment

According to the survey, the drivers that got the highest averages on the most important drivers



are mostly from Governmental support category as following:

### **Supportive vision, standards, and regulations**

According to the survey respondents, the most important driver of CE in Oman built environment found to be establishing of supportive vision, standards and regulations by the government. This concurs with different studies, such as, a study conducted by Preston (2012) suggested several smart regulations that enforce the transition to CE, such as, restriction of resource prices, End-of-life legislations and policies enforce investment in innovations.

### **Increase awareness through workshops and education programs**

As the survey result, increase the awareness of CE and its benefits through workshops and education programmes is one of the most important supports. Similarly, a study carried out by Boer & Cui (2016) in Singapore illustrated that the government shall prepare well-organized educational programs to raise the awareness and knowledge of CE in the built environment.

### **Strict regulations on waste, energy and water management**

The respondents of the survey considered setting strict regulations on waste, energy and water management by the government as an important driver that support the transition to CE. Although low attention of literature of this driver, Henrotay et al. (2017) and Lemmens & Luebkehan (2016) demonstrated that setting of hard regulations on waste management, energy performance and construction policy will facilitate implementing CE regulation as disposal process will be costly and difficult. For instance, increasing the landfill cost will encourage transferring landfill waste to useful reusing materials (Lemmens & Luebkehan, 2016).

### **Government projects shall be the leader**

According to the respondent's result, Oman government and public procurements shall be the demonstrative of CE. Similarly, a study carried out by Xue et al. (2010) founded that the current situation in China was focusing on the transition of CE on private sector rather than public sector, therefore the research was called the public sector to participate and be the leader of the transition.

### **Supportive infrastructure to facilitate re-use**

Survey results showed that upgrading the infrastructure by collaboration between government and the private sector is an essential step to support and facilitate the circular transition. Several studies demonstrated the importance of providing centers to aid secondary materials, such as Boer & Cui (2016), Eijk (2015) and Essex & Whelan (2010).

## **2.3 Discussion of (the important drivers) of circular economy in Oman built environment**

According to the survey respondents, the important drivers were diversity from different categories:

### **Funding researches, innovation, and investment**

Survey respondents considered funding research, innovation, and investment as an important driver. This concurs with a study carried out by Rizos et al. (2016) that found offering incentives to Small and Medium-Sized Enterprises is an important enabler of the transition toward CE.



### **Increase awareness to design products for last longer**

According to the respondents' views, the high manufacturers' awareness of designing construction elements for last longer and preserve its valid value was found as an important driver toward circular process. According to a survey conducted by WRAP (2017), increase the products scarcity for last longer was found to be the second major driver of CE in the UK.

### **New technologies will save data of re-use materials (i.e. BIM and Materials passports)**

The result demonstrates that using new intelligent technologies that support transparency and sharing information of re-usable elements could be an important enabler toward circularity. A study carried out by Akanbia et al. (2018) found that BIM programme facilitates reuse or recycle at the end of buildings lifespan through save data of recoverable elements. Moreover, Van Sante (2017) suggested that circular construction begins in the design stage that design for respect for reuse with the support of material passport that gathering all the information.

### **Collaboration between different parties in the industry**

The last importance of CE driver according to the survey result was the collaboration between different parties in the industry and sharing information and best practices. This concurs with Ghisellini et al. (2016) study that concluded that collaboration and involvement of the all-important actors in the society and creates a link between partner is one of the most important drivers of CE.

While ten of the drivers were considered as neutral, low importance and not important, some of them are important drivers but they got less attention because of several reasons. The three financial drivers reflect unclear financial case of CE. The three governmental drives, such as, (service-as-product) reflect the lack of understanding its benefits. The remains technological and social benefits could be considered as a second stage of implementing CE.

## **Conclusion**

To summarize, the main drivers that found through interview results and questionnaire survey are categorized into three sections as the drivers that considered as very important driver in both ways, the drivers that considered an important driver in both ways and the drivers that considered as important driver either in interviews results or Questionnaires survey.

The drivers that considered as *very important drivers* in both ways were introduced by the governmental supportive vision, regulations, and standards of CE. Followed by, increasing the public awareness through workshops and education programs, Government playing a critical role through being the role model of implementing CE in the public projects and Collaboration between different construction stakeholders to establish supportive infrastructure to facilitate recovery process.

The drivers that considered *important drivers in both ways* are Governmental financial support of researches, innovation, and investment, as well as, using innovation and smart technology that save data of re-usable materials (i.e. BIM and Materials passports) to facilitate recovery process.

The drivers that considered as *important drivers either in interviews results or Questionnaires survey* are establishing of strict regulations on waste, energy and water management, the government encouraging the transition to CE through facilitates the investment of CE legally and financially and upgrading awareness of construction stakeholders to design products for last longer is critical support of circularity.

Lastly, while all construction stakeholders shall collaborate to success and overcome CE



challenges, the government is recommended to become the first role to initiate the transition toward CE in Oman built environment.

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