Case Study: Taiwan’s pathway into a circular future for buildings

B J A van Bueren1,2, M A M Leenders3 and T E M Nordling4

1 Department of Life Sciences, Circular NCKU, National Cheng Kung University, No 1 University road, Tainan, 70101, Taiwan
2 Waterarchitect van Bueren, Geestweg 40a, Naaldwijk, 2671ED, the Netherlands
3 Graduate School of Business and Law, Royal Melbourne Institute of Technology, 124 La Trobe Street, Melbourne, VIC 3000, Australia
4 Department of Mechanical Engineering, National Cheng Kung University, No 1 University road, Tainan, 70101, Taiwan

bartvanbueren@gmail.com

Abstract. The aim of this paper is to explore successful paths and potential obstacles for introducing circular buildings to a region new to the strategy of Circular Economy (CE). For this, the process of circular buildings development in Taiwan is analysed. In 2016, the government of Taiwan passed an act that put a focus on CE. Taiwan entered this field with nearly no prior experience. This paper analyses three cases: The Holland Pavilion for the World Flora Expo Taichung; the TaiSugar Circular Village Tainan; and the CE Social Housing Taipei. Interestingly, Taiwan choose the Netherlands as a country for guidance on best practices and the path to implementation. Our analysis focuses on barriers and opportunities found in the initiation, commissioning, and the ongoing development process of these projects. Data is collected through interviews with 30 stakeholders, from government, industries and academia who are involved in the projects. International collaboration is shown to have speeded up the CE building innovation process in Taiwan.

Keywords: Taiwan, circular economy, circular buildings, innovation strategy, internationalizing, triple helix.

1. Introduction

Nations and regions around the world set ambitious targets to cut down greenhouse-gas (GHG) emissions, to avoid over-extraction of natural resources, and to reduce waste. To reach these targets, the building industry must transform as it’s one of the big polluters, with high GHG-emissions, high resource intensity and responsibility for over 50% of the landfill volumes [1].

Strategies to reach the environmental targets can be based on the concept of a Circular Economy (CE), which was first raised by Pearce and Turner in 1989 [2]. The CE is a regenerative system in which
resource input, waste, emission, and energy leakage are minimized by slowing, closing, and narrowing energy and material loops; this can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, recycling, and upcycling [3]. Since 2006, governments started experimenting with CE [4] and more regions pick up similar policies. CE can potentially become a widespread strategy, implemented rapidly to disrupt polluting ‘linear economy’ developments. However, we are not aware of any study done on how CE practices and strategies develop into a new region.

Authors observed that Taiwan has recently started to develop CE practices. A Taiwanese strategy was observed where the government, the industry, and universities are working together on CE innovations, and that many Taiwanese stakeholders actively seek to learn on CE buildings from the Netherlands [5]. One reason for this is that the Netherlands is one of the leaders in this subject [6], but there seems to be more strategy behind this. Authors choose to analyze this phenomenon aiming to find strategies to develop CE in a new region.

The Taiwanese government is one of the forerunners in Asia on setting environmental policy goals [7]. The Executive Yuan of Taiwan presented the 5+2 industrial innovation plan on October 2016 [8]. Two of its spearheads that particularly aim for reaching sustainable goals are ‘Green Energy’ and ‘Circular Economy’. The industrial innovation plan recently led to the first pioneering CE-strategies for construction of new buildings. Taiwan’s first three CE building projects are: The Holland Pavilion for the World Flora Exposition 2018 in Taichung; TaiSugar Circular Village in the High-Speed-Rail developing area in Tainan; and the Social Housing projects in several locations of Taipei. See Table 1 for an overview of these projects.

|                      | Holland Pavilion | TaiSugar Circular Village | CE Social Housing Taipei |
|----------------------|------------------|--------------------------|--------------------------|
| **Location**         | World Flora Exposition, Taichung | High Speed Rail development area, Tainan | Nangang, Taipei |
| **Function**         | Expo pavilion    | 429 households           | 1,545 households         |
| **Size**             | 100m² building + 600m² plot | 14,000m²                 | 77,800m²                 |
|                      |                  |                          | (9 milliard ntd)         |
| **Client**           | The Netherlands Trade and Investment Office (NTIO), | Taiwan Sugar Corporation | Taipei City Government |
| **Architect**        | JCS Architects (et al) | Bio-architecture Formosana | EcoLand & DeltaDevelopment |
| **Procurement**      | January 2018     | November 2017            | February 2018            |
| **Opening**          | November 2018    | July 2020a               | 2022a                    |
| **End of first cycle** | January 2019a    | 2035a                    | Not set                  |

*Expected date

The developments of these three projects have been analyzed to explore how the CE practices and strategies developed over time. The research question is: “What is a successful path and potential obstacles for introducing circular buildings to a region new to the strategy of Circular Economy?” Here, the focus was given to the collaboration between government, the building industry, and universities. Another focus was given on analyzing impact of choosing a lead country to learn from. Along these two focus points, various other practical lessons were learned by this analysis and summarized as recommendations.

This paper first elaborates on the theory of innovation strategies, then the methodology is explained and the findings from conducting the research are presented. From the findings, conclusions and recommendations are distilled. This paper is mostly limited to the development steps of initiation, procurement and design, as during this analysis, only one of the building projects is completed.
2. Theory

2.1. Internationalizing the triple helix
A proven successful regional innovation strategy is collaboration between parties of the government, academia, and industry. The strategy is widely known as the Triple Helix model by Etzkowitz and Leydesdorff in 1995 [9]. Sørensen and Hu in 2014 opted that two regions in different countries can successfully innovate by internationalizing their Triple Helices together [10]. Three stages of internationalizing are described. First, the Pioneering stage, where one region starts to meet counterparts of parties in another region on a specific innovation field. Typically, universities, municipalities and companies meeting their counterparts of the regions and they seek for beneficial overlap or possible extensions. One region may already be organized into a triple helix on the specific innovation field. Second, the Exploration stage, where closer collaborations are made, dominantly between the matching parties. Thirdly is Integration Stage, here both regions have formed a triple helix and collaborations happen on helix-level besides just on party level, through this, deep and lasting collaboration is achieved. As catalyzer, a Social Agent can aid to mediate between the large number of stakeholders, the physical distance and barriers such as different languages [11].

2.2. Lead Users as forecasting laboratory
‘Internationalizing the triple helix’ may occur between two regions who are not yet on the same level of innovation. In this case, Taiwan seeks actively to learn on CE from the Netherlands. Can the Netherlands be identified as a Lead User, guiding Taiwan into the novel concepts of CE? Lead Users are identified by Von Hippel in 1986 as users whose present strong needs will become general in a marketplace months or years in the future. As Lead Users are familiar with conditions which lie in the future for most others, they can serve as a need-forecasting laboratory [12]. Lead User seems to have a similar definition as Lead Market, presented by Beise and Cleff in 2004 [13]. For the subject of CE, this ‘need-forecasting’ may be of extra importance to act before the system collapse of over-extraction and pollution of natural resources.

2.3. Five phases of innovation
The process of innovation can be described in five phases by Desouza, Dombrowsk, et al in 2009 [14]; 1. Idea Generation and Mobilization; 2. Advocacy and Screening; 3. Experimentation; 4. Commercialization; 5. Diffusion and Implementation. The real impact of innovation is mostly to be observed when it impacts the stakeholders and users. Did ‘internationalizing the triple helix’ help Taiwan for an acceleration of the innovation phases? Can the Netherlands be considered as a Lead User or Market for Taiwan? Is this part of the successful path for introducing circular buildings to a region new to the strategy of Circular Economy?

2.4. Analyzing the circular quality of the projects.
No satisfying method was found to objectively qualify or quantify the actual circularity of the materials, elements, building and process. The most ideal method would be a life-cycle assessment on GHG-emission on each element, including a conversion of residual value in this. However, this would be needlessly complex and include many future assumptions. Instead, peer-discussion with involved stakeholders was conducted to obtain their expert-opinions.

3. Method
This study uses a comparative case study design as described by Eisenhardt in 1989 to identify patterns in the collected data [15]. Data has been collected for a period of 1.5 years via interviews and observations of stakeholders and document analysis. Thirty stakeholders were interviewed during various steps of the building process, from the initiation, procurement, design, construction, and completion. Half of these stakeholders have been interviewed twice or three times to get insights from
the various steps in the process. The stakeholders come from various industries and one-third of them were Dutch CE experts, invited to consult or review the aforementioned three CE building projects.

| Table 2. Distribution of interviewed stakeholders |
|--------------------------------------------------|
| Taiwan | The Netherlands |
| Construction industry | 10 | 4 |
| Government | 5 | 5 |
| Academia | 5 | 1 |

The interviews occurred mostly under informal settings and lasted on average for 45 minutes. One author of this article—Van Bueren—was involved in all projects as a Taiwanese academic CE expert and it should be stated that he received financial compensation on several occasions for his involvements. The interviewees were selected based on Van Bueren’s personal connections, while ensuring that key stakeholders were included both from the Taiwanese and Dutch side. Careful attention has been paid to transcribe all materials in an unbiased manner and without violating any non-disclosure agreements. The interviews and other materials were transcribed, coded, and structured to induct themes and relationships. The three main themes identified during the analysis were:

- The collaboration between Taiwan and the Netherlands.
- The innovation phase of Taiwan on CE buildings.
- Obstacles found on integrating CE into Taiwanese buildings.

4. Results

4.1. Findings related to the collaboration between Taiwan and the Netherlands

After the 5+2 industrial innovation plan was introduced in October 2016, all 30 interviewed stakeholders had visited the Netherlands and had met various Dutch CE experts visiting Taiwan. These visits took place as a coordinated effort financed from various stakeholders to learn from the leading CE work done in the Netherlands. The most prominent Taiwanese visitor to the Netherlands was Taipei mayor Ko, whom media quoted saying “Taipei will learn from Netherlands, not Singapore” in the context of circular buildings [5]. Shortly after this visit, the Taipei City Government initiated the CE Social Housing project.

The Netherlands Trade and Investment Office in Taiwan (NTIO) acted as a Social Agent, introducing stakeholders from government, universities, and industries to each other both in Taiwan and between Taiwan and the Netherlands. Their proactive attitude in this is more assertive than the typical role of a national representative and can largely be contributed to its dynamic leader Wittich, who is passionate about CE. The Netherlands offered a guidance role in CE building by active promotion and matchmaking of Dutch CE experts to Taiwan. As a result, many Dutch CE experts got invited to Taiwan, and project commissions from Taiwan to Dutch companies where made. Taiwanese stakeholders also invited several Dutch CE experts as external reviewers. At least two Dutch companies became consultants within the design team.

Taiwan and the Netherlands seem to have entered the Exploration stage of internationalizing their triple helixes. This is where all international counterparts of the parties have established contact, and both regions have started organizing on the innovation topic.

4.2. On the innovation phase of Taiwan

After studying Taiwan’s innovativeness on CE in buildings, it seems Taiwan is entering phase 3 Experimentation. Phase 1 Idea Generation and Mobilization was when Taiwan government set the sustainable goal of Circular Economy in October 2016. Phase 2 Advocacy and Screening was largely
done in the process of procurement of the 3 analyzed projects. During the procurement phase one of the stakeholders said: “We were happy that a large organization with leverage was selected as architect, and also their design was visually most impactful”, with this it was also observed that the actual CE quality of the design was valued as less important. Apparently, wide advocacy of CE was more leading than successful implementation. After the procurement, the CE quality was eventually targeted more seriously, which lead to the beginning of phase 3 Experimentation. Similar observations were made in the other two analysed projects, announcing phase 3 Experimentation for Taiwanese projects into CE buildings. All three projects have very tight timelines for experiments and R&D; this resulted in a lower level of actual circularity of the materials, elements, building and process. Also through the additional R&D and cost of experts, the total building cost is higher than in the following ‘phase 4 Commercialisation’. However, through these projects many stakeholders become aware what role they can play to make the building industry more circular. They may have failed to offer their product or service according to a CE strategy this time, but they have become inspired to make it more possible next project. Taiwan’s building industry is standing at the beginning of a transition of their complete infrastructure.

Taiwan is successful in quickly acquiring knowledge by series of expert meetings, consults and online documentations on CE. Although knowledge was available and offered from many countries, it became clear that Taiwan preferred sources from the Netherlands for its reputation as Lead User.

4.3. Obstacles found on integrating CE into Taiwanese buildings

One big obstacle involved the low level of understanding the principles of CE buildings by stakeholders. This suggests that many stakeholders were still in the ‘phase 2 Advocacy and Screening’, but already working on ‘phase 3 Experimentation’. For example, most stakeholders from the Taiwanese building industry are inexperienced in Building Information Management (BIM). Furthermore, there is a lack of datasets to use BIM as an asset management tool. Datasets are very difficult to create, as suppliers are unwilling to be transparent on the origin of their materials. Suppliers lack trust between companies and they keep their profit models secret.

Another obstacle found is on the regulations to implement CE. On all three projects, the interviewed architects mentioned that the procurement guidelines and rules were overly complicated and sometimes even contradicting themselves. Several conventional rules caused obstacles, however, the projects did not allow exceptions on the conventional rules; instead, just additional rules and guidelines were given. Architects claimed that the design period, and design budget were too small to fulfil the unconventional requirements. An example of conflicting rules is that procurement rules forbid architects to make deals with contractors and suppliers. This rule is to avoid corruption. However, this rule directly blocks many opportunities to source for circular products and services from contractors and suppliers.

Besides difficult regulations, also some government incentives were perceived as counterproductive. Many incentives are project-based and not intended to head towards any commercial exploitation. Through this, many innovations do not reach ‘phase 3 Experimentation’ or ‘phase 4 Commercialisation’, because outcomes are not disseminated outside academic circles.

Another observed obstacle was a premature CE service and product infrastructure in Taiwan, this in contrast with the Netherlands where already many services and products are offered to improve circularity. For example, an old steel beam cannot receive a certificate of strength quality, by lack of inspecting and testing service in Taiwan.

5. Conclusions and Recommendations:
The Taiwan case in its pathway for introducing circular buildings teaches us that international collaboration benefits to speed up the innovation process. The Netherlands functions as a Lead User as the theory of Von Hippel describes, moreover the Dutch involvement seems to create legitimacy of CE quality. The branding impact for reaching a larger audience for CE is still leading above actual CE quality, but for this phase of innovation this may actually benefit acceleration of the CE innovation.
The case studies show that academia gain knowledge, industry gain technologies and governments gain new policies through foreign institutions. These gains would give more results when the triple helix collaboration in Taiwan gets stronger, as it seems the institutions still struggle with each other. More effort should be made to make the institutions innovate together.

Taiwan government sets the right targets and ambitions, but it may need to improve regulations and incentives for it. This includes loosening rules for pioneering projects, to test her new policies of rules and guidelines. When it is observed that certain key CE services or products do not exist in the region, then government and academia should support the industry to initiate these. Industries should become more transparent to work together (international and with themselves). Creating datasets for BIM asset management and creating a market with more CE products and services is still a time consuming, but ongoing process.

6. References

[1] Environmental Protection Agency 1998 Characterization of Building-Related Construction and Demolition Debris in the USA. EPA 530-R-98-010

[2] Pearce D W and Turner R K 1989 Economics of Natural Resources and the Environment Maryland: Johns Hopkins University Press

[3] Geissdoerfer M, Savaget P, Bocken N M P and Hultink E J 2017 The Circular Economy – A new sustainability paradigm? J. of Cleaner Production vol 143 p 757–768

[4] Su B, Heshmati A, Geng Y and Yu X 2013 A review of the circular economy in China: moving from rhetoric to implementation. J. of Cleaner Production vol 42 p 215–227

[5] Liu C P, Wu L 2016 Focus Taiwan http://focustaiwan.tw/news/aipl/201610130017.aspx (last visited 2018-12-04)

[6] Pomponi F, Moncaster A 2017 Circular economy for the built environment: A research framework J. of Cleaner Pr. Elsevier

[7] Wendling Z A, Emerson J W, et al 2018 Environmental Performance Index New Haven, CT: Yale Center for Environmental Law & Policy.

[8] Website Executive Yuan https://english.ey.gov.tw/News_Content.aspx?n=0899B3FCC4B38357&sms=8BCD9CBBA95A001D&s=9FDC09B0F3DB4F96 (last visited 2018-12-04)

[9] Etzkowitz H and Leydesdorff L 1995 The Triple Helix: University-Industry-Government relations: a laboratory for knowledge-based economic development EASST Rev. vol 14 (1), p 14-19

[10] Sørensen O J and Hu Y -M 2014 Triple Helix going abroad? The case of Danish experiences in China, European J. of Inn. Man. 17(3), 254–271

[11] Van Bueren, B J A and Goh Y S 2016 Internationalizing SMEs in Creative Industries via Triple Helix Strategy, Int. J. of Cult. Creat. Ind. Vol 3-2

[12] Van Hippel E 1986 Lead Users: A Source of Novel Product Concepts, Man. Sci. vol 32 (7)

[13] Beise M and Cleff T 2004 Assessing the lead market potential of countries for innovation projects, J. of Int. Man. vol 10-4 p 453–477

[14] Desouza K C, Dombrowski C, et al 2009 Crafting organizational innovation processes, Inn. vol 11(1) p 6-33

[15] Eisenhardt K M 1989 Building from Case Study Research, Ac. of Man. Rev. vol 14-4

Acknowledgments

The work of TEMN was funded by the Ministry of Science and Technology in Taiwan (grant number MOST 107-2634-F-006-009). TEMN wish to acknowledge the MOST AI Biomedical Research Center at NCKU (National Cheng Kung University). The funders had no role in the study design, data collection and analysis, decision to publish, or preparation of the manuscript.