4th PLATE 2021 Virtual Conference
Limerick, Ireland - 26-28 May 2021

CIRCULAR HOUSING – Circular economy in the Real Estate Field

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Keywords: circular business model; real estate; product as a service; circular economy.

Abstract: According to Ellen Macarthur Foundation cities play a key role in the global economy and the implementation of circular economy concepts could lead to important social, environmental and economic benefits. Cities produce 50% of global waste and 60-80% of greenhouse gas emissions: the implementation of circular economy vision could change the consumption of resources reducing waste production. This research investigates the definition of a new circular economy business model to be applied to apartment for lease business, offering an innovative service to tenants. In detail, the business model aims at design and implement a rental service for social housing that includes the rental of furniture and appliances, defining a fully circular model that considers all phases of the assets life cycle and involves all the actors of the whole chain, from production, to use, to end of life management. Specifically, the project aims to investigate the possibility to offer furniture and electric appliances that are fully circular, i.e. reusable, refurbishable, recyclable, to tenants at a fare monthly rate within their rental agreement with the apartment owner.

Introduction

According to Ellen Macarthur Foundation cities play a key role in the global economy. Even though cities take up less than 3% of the earth's land surface, they account for 85% of global GDP generation and for 75% of natural resource consumption. Cities also produce 50% of global waste and 60-80% of greenhouse gas emissions. These figures show an emerging and urgent transition towards a circular economy driven by cities.

The implementation of circular economy vision in cities could lead to significant social, environmental and economic benefits: i) growth of economic productivity through the reduction of congestion, elimination of wastes, and reduction of costs; ii) cities livable thanks to the improvement of the air quality, reduction of pollution; iii) reduction of raw materials used by keeping products in use.

Each urban system is a set of themes integral to the circular economy such as the role of design, new business models and means of access, and use of digital technology.

Within this process, the Circular Housing project, founded by EIT Climate KIC, aimed at defining a sustainable, replicable and less carbon-intensive business model for leased household appliances and interior furnishings, achieving the following objectives:

- qualitative and quantitative evaluation of both current and proposed business model identifying potential critical aspects such as asset ownership, engagement of industrial and financial stakeholders;
- investigation of the attractiveness for the users of the proposed business model;
- validation of the model through the establishment of a strong network among relevant actors (industrial/financial stakeholders and tenants);
- evaluation of the environmental impacts of the proposed solution.

The innovation lies in particular in the systemic approach: the promotion of innovative circular economy model in the building sector implies the redesign of the current business model involving the financial, technical and governance drivers redefining the actors involved in the whole value chain.

Business model definition

Context description

As mentioned above this paper investigates the introduction of a new business model in the field of real estate with a specific focus on social housing that includes accommodation provided at affordable rates, on a secure basis, to individuals according to specific criteria (such as people on low income). As well as in other contexts furniture and appliances follow a linear life cycle in social housing field. The short-term of rental contracts, which usually last 4 up to 8 years, pushes towards mobility of urban modern life and leads to high rate of waste generation.

The study started evaluating the **traditional purchasing scenario**: furniture and domestic appliances are purchased as usual by the tenant. Considering the wide range of products available on the market and the possible preferences of users **3 different types of furnishings** are considered in the evaluation of the traditional purchasing scenario:

i. basic - furnishings characterized by low cost;
ii. medium - furnishings characterized by an average ratio between quality and price, and
iii. high - furnishings top of the range, characterized by design and quality elements.

Regarding the apartments, are evaluated **two-room configurations** (for single or couples) and **three-room configurations** (for couples with children) considering the following domestic environments: living room, kitchen, bathroom, double room and teen room.

Finally, it was considered to evaluate different purchase options: direct purchase (**without financial loan**) and purchase with financing (**with financial loan**). The evaluation of costs to be incurred includes the purchase of furnishings as well as the costs of installation and maintenance.

Business model and ecosystem description

Considering the transition towards a circular economy it's an ever-changing process, it is adopted an incremental approach for achieving a circular business model; **three development phases,** each one characterised by different business model, are investigated:

i. **as-is** - it presents the current and linear way in which rental activity can be carried out. Furnishings rented are managed as waste after 8 years of use;
ii. **transitional** - it presents the transition phase that will need to be addressed in order to reach a market maturity (adaptation of production cycles towards a circular model). Furnishings rented are checked after 4 years of use and are managed as waste after 8 years of use;
iii. **to-be** - it presents the fully circular business model which identifies a new model for the rental service of furnishings in the context of social housing, leveraging on a sustainable, replicable and scalable model. Furnishings rented are checked after 4 and 8 years of use. After 8 years of use it is thus possible, through ordinary maintenance interventions and regenerative ones, to extend the useful life of the furnishings to 12 years and above if such interventions can still be performed.

For each model described above, tenants select the furnishings desired that will be installed in the rented apartment signing a simplified lease contract including several services (installation, assistance, maintenance etc.). In addition, furnishings are classified as new goods, used-guaranteed or refurbished; considering that a wide range of products could better match tenants' needs. The monthly instalment, as reported in Table 1, is calculated including additional services and to last for 8 years as the hypothetical duration of the contract (with the possibility to further extent the renting with a lower instalment).

Type of furnishings	Two-room apartment (€)	Three-room apartment (€)
Basic	61.2	69.8
Medium	84.5	97.4
High	116.3	133.5

Table 1 – Instalments for the different type of furnishings and apartments

Moreover, the adoption of a new business model within the social housing renting context brings the needs (i) to identify and get involved different actors (benefit real estate investment management company, manufactures of

appliances and furniture, financial player, living manager and waste operators) and (ii) to establish business relationships.
The economic evaluations, reported in Table 2, have been performed for **to-be business model** and adopting the perspective of the living manager who is the actor responsible for the management of renting contracts and the provision, through agreed condition with appliance and furniture manufacturers, of assistance services to tenants. Moreover, the economic evaluations are conducted assuming that at full capacity, thanks to a scalable business model, the Circular Housing ecosystem can involve a number of apartments of 3,000 units.

Type of furnishings	Investment (€)	NPV (€)	IRR
Basic	11,990,000	450,000	1.7%
Medium	16,550,000	620,000	1.7%
High	22,770,000	850,000	1.7%

Table 2 – Economic evaluation for two-room apartment

The tenants' engagement

The introduction of a new business model envisages a strong final users' involvement in the business model development and validation. The overall objectives of the users' engagement process are:

i. **investigating the attractiveness of the new model** for the users and their **willingness to adopt the new model**;
ii. **supporting the behavioural change towards the new model**, through the improvement of the knowledge about environmental sustainability and circular economy themes and, thus, of their capacities to make aware individual choices.

To reach these objectives a user-centered design approach[1] was adopted in combination with a co-design methodology.
The engagement activities are structured into two main phases: the **analysis of the context** and the **validation of the solution designed**.

The analysis activities have been structured into the following steps:

i. an **ice breaking online survey** to investigate the user's experiences. The results provide information about purchase habits while buying household appliances and furniture, finding out more on the type of choice made while buying and understanding how sustainability impacts on decisions. From the answer received, a variegate sample of users with different characteristics has been selected;
ii. a **second online survey** to investigate the potential users' points of view on the new model. The results obtained help to identify barriers and desires of each user. Through the analysis is possible to highlight the points of attention for developing the customer-related aspects of the business model.

Based on the results of the two surveys, the most significant user archetypes (Personas) has been delineated. The Personas' tool is useful for driving the citizens involved in the workshop activities in empathizing themselves as a "typical users", better understanding the proposed solution adopting different points of view, and to bring meaningful opinions for shaping the business model.

The **validation activities** have been structured into the following steps:

i. a **training and mock-up workshop**, organized to give the chance to users to know the model deeply and to share opinion through participatory activities. These activities include the simulation of the purchasing of the service, through the customization and the assessment of the quality-price ratio.
ii. an **evaluation survey** for collecting information about results of the engagement activities in terms of behavioural change.

The general perception about the ideated concept acquired from the 65 answers obtained from the **ice breaking online survey** is positive

[1] User-centered design is an iterative process that foresees the involvement of users in the design of the solution, in order to capture and address the whole user experience and to take into account their needs and desires, adopting a series of research tools and design techniques to collect feedback.

and the propensity to change the habits in order to make them more sustainable is diffused as shown in Figure 1.

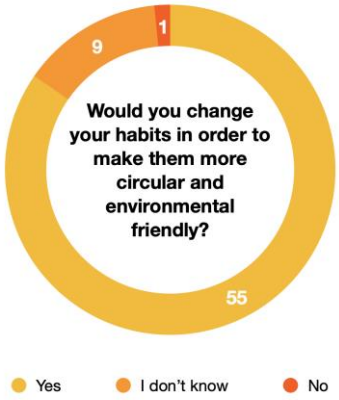

Figure 1 – Willingness to change habits towards the circular models

The **second online survey** achieved the collection of 20 answers that indicate a spread interest in adopting the new rental service. The highlighted strength points of the new model are the economical convenience, the flexibility and the sustainability; while the main weakness regards the worries about using reconditioned household appliances and used furniture that could be not performing as the new ones.

The participative activities of the **workshop** allowed the involved users to validate the model through the evaluation of the proposed service options and the coherence of the cost, expressing their opinions and giving further suggestions for improving the service. The service was rated by most of them advantageous and interesting; the major strengths of the model highlighted related to the inclusion of the assistance service, the flexibility of the offer - which includes packages by environment and price range -, the breakdown of payment in light monthly instalments. The insights collected concern the opportunity to have a physical display of the furniture, the provision of packages that can evolve over time, the introduction of used furniture packages, the management of the early conclusion of the contract.

Finally, the **evaluation survey**'s results confirmed that the majority of the engaged users, thanks to their involvement in the project activities, acquired new competences as regard the environmental sustainability and the circular economy and the environmental impact of the individual behaviour, and have a greater awareness and determination in making sustainable choices compared to the beginning of the involvement path.

The environmental evaluation

Environmental evaluation aimed to quantify potential environmental benefits arising from the implementation of the new circular business model in substitution of the current linear one. The analysis was conducted considering the impacts generated during the whole life cycle of the systems considered, by using the Life Cycle Assessment (LCA) methodology.
The analysis considered the use of apartments (two-rooms and three-rooms) rented for a period of 8 years in the linear and in the circular model (deployed in three phases mentioned above).
The study adopted a cradle-to-grave approach. The system under study included:

- the manufacturing of appliances and furniture pieces (from the extraction of raw materials to the assembly of the final product)
- their distribution from the manufacturer to the retailer (which includes import from non-EU countries, whenever relevant) and the retail
- use and maintenance of the items during the renting period
- the End of Life (EoL) of the items at the end of their useful life (which can include reuse, recycling or disposal, in different shares depending on the scenario analysed).

The life cycle inventory (LCI) of the items considered was largely based on the work done by the Joint Research Centre (Castellani et al., 2019; Reale et al., 2019). The furniture pieces considered are: kitchen cabinets, sofa, TV cabinet, wardrobe, bed structure, bed mattress, table and chairs.
The appliances included are: washing machine, laundry dryer, TV, Induction hob, combined-refrigerator-freezer, dishwasher, electric oven, cooker hood.
The main impact considered in the study was climate change, calculated using the indicator Global Warming Potential (GWP – 100 years) based on the characterization factors provided by the latest IPCC report (IPCC, 2013), as

implemented in the Environmental Footprint (EF 3.0) impact assessment method, recommended by the European Commission (Zampori and Pant, 2019; Fazio et al., 2018). In addition, the other indicators included in the EF 3.0 method are calculated for the characterization, normalization and weighting steps and the resulting weighted score is reported for each of the scenarios analysed.

	Climate change (kg CO_2eq)			
	Linear	**As is**	**Transit.**	**To be**
Per dwelling	1708	1449	1312	1023
Per dwelling/ person	671	570	516	402
Per dwelling/m^2	19.99	16.97	15.37	11.98
Reduction		***-15%***	***-23%***	***-40%***
	Weighted score (mPt^2)			
	Linear	**As is**	**Transit.**	**To be**
Per dwelling	376	343	310	260
Per dwelling/ person	148	135	122	102
Per dwelling/m^2	4.41	4.03	3.64	3.05
Reduction		***-9%***	***-18%***	***-31%***

Table 3 – Results of environmental evaluation

In the linear scenario, the most relevant life cycle phase (about 50% of the impact on climate change) is the use phase, and especially the energy consumption generated by appliances (45% of the whole GWP impact). The second most important phase is the production of raw materials and components used to manufacture appliances and furniture (33%). Due to the importance of energy consumption in the use phase, appliances are the most relevant product category (70% of GWP generated by the linear system), whereas furniture has lower contribution (30%).
The solutions implemented in the circular model proved to be effective in reducing the impact on climate change generated by the system under study. The most effective change between the linear model and the circular models appeared to be the possibility to rent appliances that ensure energy performance that are better than the average available on the market. The analysis of the impact generated on a wider set of impact categories highlighted that not only energy efficiency but also resource efficiency should be taken into account in the development of new business models aimed at reducing environmental impacts and implementing circularity principles. In this light, the complete set of innovations implemented in the circular business models (use of more efficient appliances, extension of the useful life of appliances and furniture, etc.) proved to be effective.
The circular scenario “To be” allows for higher reduction of impacts compared to the other circular scenarios analysed. It means that the production of additional resources need for maintenance and regeneration of appliances and furniture generates impacts that are largely compensated by the extension of useful life and by the other innovations implemented. This holds true also when the effect of improved energy efficiency is not taken into account.

Conclusions

The results across economic, social and environmental dimensions have highlighted that it’s feasible to create an ecosystem of actors able to offer tenants ‘circular’ furniture and household appliances at a fare monthly rate within their rental agreement with apartment owner, reducing the generation of household waste significantly, through a gradual and incremental path.
Additional research effort will be devoted to validate the obtained results implementing the model designed at real scale.

Acknowledgments

This research is part of the Circular Housing project funded by Climate-KIC, supported by the European Institute of Innovation and Technology (EIT) a body of the European Union.

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