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Evaluation Framework for Social Impact on the E-Co-Housing Project in Budapest

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Abstract

In Europe, today's affordable housing and co-housing projects represent complex products, complementing the physical intervention with economic and social techniques. This means that purely environmental and economical evaluation is not sufficient for these projects. While environmental and economical evaluation methodologies are widespread and advanced in the construction sector, methodologies to evaluate the social impacts of housing projects are rarely used and therefore underdeveloped.

This study elaborates a framework to evaluate and monitor the social impacts of a complex social housing and co-housing project. The method adopted implements the Social Life Cycle Assessment, integrating a Post Occupancy Evaluation as the main tool for collecting and analysing data. The presented assessment framework is elaborated for the E-Co-Housing Model, a new experimental model so far as the development of affordable housing in Budapest is concerned. However, it delivers a starting point for more complex sustainability analysis of residential buildings in general.

The guideline for the Evaluation Framework is the methodology of the Social Life Cycle Assessment of Products, clarifying and improving some of its usual elements. The study of the E-Co-Housing Model shows that housing products, especially affordable and co-housing projects significantly differ from other products. The differences are their main stakeholder groups, their life cycle stages and in their impact ways too. Therefore, housing products need a special S-LCA methodology to assess in a balanced way the complex aspects of its environmental, economic, and social sustainability.

Keywords

Social Life Cycle Assessment, affordable housing, co-housing, social sustainability, impact way

1 Introduction

1.1 Measuring complex sustainability in housing projects

Measuring social sustainability in urban housing at the meso- and micro-level is quite underdeveloped (Winston and Pareja Eastaway, 2008). The existing evaluations of housing projects are not complex and concentrate mostly on the environmental or the financial aspect. However, contemporary alternative (affordable and collective) housing projects represent complex products, complementing the technical tools with economic and social techniques (Tummers, 2015). Our study presents a starting point for more complex sustainability analysis of housing projects using the model of the E-Co-Housing project.

We propose an integrated Framework of Environmental Life Cycle Assessment (E-LCA), Life Cycle Costing (LCC), and Social Life Cycle Assessment (S-LCA) using Post Occupancy Evaluation (POE), which models together the interactions between the three sustainability pillars well (Jabareen, 2006). In addition to the environmental impacts of construction, the E-LCA also includes the health impact of the building on tenants. Material and

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energy flows are influenced by residents' lifestyle during the use stage which is expected to be a key issue. The LCC's aims are to analyse long-term economic sustainability from the perspective of the investing municipality and the tenant households, beyond the investment period and election cycles. The economic and financial sustainability of the operation is a basis for the project dissemination and the model upscaling to the urban and national levels.

This complex approach also enables the quantification of the results basing on households (apartments in the house) as function units, the reproduction of the measurements, and later the comparison of the projects with other projects on the urban housing market. The E-LCA, S-LCA and LCC measurements and analyses will be performed in parallel by the experts (architects, sociologists, and economists) of the E-Co-Housing project. The subject of this study is only S-LCA, and Fig. 1 refers to parallel analyses of E-LCA.

2 The E-Co-Housing project in Budapest

"E-Co-Housing – Co-creating a Regenerative Housing Project Together with the Community" is a housing project co-financed by the European Union during the third call of Urban Innovative Action (UAI Program, 2020). The lead partner is the Municipality of the Budapest's 14th District, working together with a large range of scientific, planner and non-governmental organisations.

The purpose of E-Co-Housing project is to build a new multiunit apartment building in Zugló, located in a dense urban area with excellent public transport services. Its apartments will expand the district's social housing supply, severely curtailed by the privatisation of the 1990s and housing market processes since then (Berey, 1994; Csizmady et al., 2017). The new E-Co-Housing project of urban social housing contributes to environmental sustainability with the newest smart building technologies, social sustainability with the co-housing method, and economic sustainability with affordable apartments. However, the new model is not expected to meet the environmental, social, and economic requirements individually (Elkington, 1997). Smart building technologies, social features, and affordable apartments will increase each other's efficiency, thereby also contributing to the UN 2030 Agenda for Sustainable Development (Valencia et al., 2019).

The essence of the model is the interaction between environmental, social, and economic elements, each of which have distinct weights in the construction stage and use stage of the project. For these reasons, an integrated LCA analysis proved to be an obvious methodology with which to assess the project's results. This assessment first evaluates the house built within the E-Co-Housing project (a housing product as scope). Later, based on the results of this integrated LCA, we aim to study the possibility to upscale the model at the urban level of Budapest and the national level of Hungary, thereby raising the assessment to a policy level (Sala et al., 2015).

3 Life Cycle methods in urban housing developments

3.1 E-LCA

Life cycle thinking, born in the scientific thinking of the sixties, was introduced in international sustainability policies with chapter 4 of Agenda 21 (United Nations Sustainable Development, 1992). At the same time, Environmental Life Cycle Assessment (E-LCA), a systemic methodology for the evaluation of the life-long environmental impacts of products, began to be formalised. ISO standards provided the common base for the E-LCA methods in 2006 (ISO 14040:2006; 2006a; ISO 14041:1998, 1998, ISO 14042:2000, 2000a; ISO 14043:2000, 2000b; ISO 14044:2006, 2006b). The four main steps of LCA were identified by these ISO standards: Goal and Scope, Life Cycle Inventory, Life Cycle Impact Assessment, and Life Cycle Interpretation.

E-LCA implementation in the building sector began in 1982 with the study of Bekker (1982) and quickly spread due to international LCA-based labelling evaluation systems like DGNB, giving advantages to the producers on the real estate market (Baranyi, 2008). For a long time, analyses and developed tools have concentrated only on used construction materials or the energy consumption of a building during use. However, only one-third of the more than 800 Life Cycle Assessment (LCA) studies of the residential building topic, reviewed by Janjua et al. (2019), have covered all stages of the LCA.

3.2 S-LCA

Social Life Cycle Assessment (S-LCA), as the similar methodology to evaluate the life-long social impacts of a products, is a later development compared to the E-LCA. The – original – aim of the Social Life Cycle Assessment (S-LCA) is to promote the improvement of social conditions for the stakeholders in the life cycle of products (Jørgensen et al., 2012). As a result of intensive scientific research and publication activity in the early 2000s, the United Nations Environment Programme published the Guidelines for Social Life Cycle Assessment of Products in 2009 (Andrews et al., 2009), and The Methodological Sheets for Subcategories in Social Life Cycle Assessment,

as a first list of recommended indicators in 2013 (Benoît Norris, 2013). At the same time, the EU published a framework standard for measuring social efficiency (EN 15643-3:2012, 2012; BS EN 16309:2014+A1:2014, 2014). Although the methodology focuses on the use phase, the differences in definition, scope, and system boundaries make it difficult to apply in our research. With the E-Co-Housing, we not only consider the building, but the entire social housing project as a product: the tenant selection process, together with the participatory planning and training of residents. Many topics of the EU standard are represented by the E-LCA (e.g. health and security topics).

We therefore needed a more general theoretical framework. In this study, we have relied on the methodology of the widely accepted Guidelines by developing our new Framework.

The Guidelines emphasise features that distinguish the methodology of S-LCA from the methodology of an E-LCA (Andrews et al., 2009). Such features are, for example:

- the importance of activity variables to define boundaries of the tested system;
- the relevance of subjective, qualitative and on- site data in social analysis or;
- the desirable participation of the main stakeholders during the assessment.

S-LCA is hardly used in the building sector. Janjua et al. found only a few studies containing an S-LCA among more than 800 articles on housing project LCA, most of them concentrating on the working conditions in the construction industry (Janjua et al., 2019). Specificities for S-LCAs in the building sector are therefore underdeveloped. First steps were taken by the integration of the impacts of the physical environment on human well- being. Impacts on the health of workers and users was controversial in the scientific discussion, but lately, most researchers list these effects in the E-LCA part of the LCA (Blok et al., 2013). An important step towards a complex sustainability assessment of households was the SusHouse Project (Strategies toward sustainable Household), which tested the consumer acceptance of sustainability scenarios – for a "Shelter for a Sustainable Living" function, among others – as viewed from a life cycle perspective (Bode et al., 2000; Quist et al., 2002). A collective house case study measured in real time the resident's consumption – like the washing machine power consumption or the needed food, etc. – into the material flows of the co-housing (Sundberg, 2014:pp.7–31). However, this approach still does not consider the social aspects of an alternative housing project (Torres-Antonini, 2001:pp.34–175).

4 S-LCA of the E-Co-Housing project

4.1 Life cycle stages

Essential to the E-Co-Housing model is that in parallel to the physical environment's changes, a community building goes through similar stages of preparation, construction, and use until it reaches the end of life of the project. As shown in Fig. 1, physical and social processes not only run in parallel but also interact with each other in some stages. Due to the interactions, our framework belongs to the technology-driven group of S-LCAs, according to the categorisation of Dubois-Iorgulescu et al. (2018). E-LCA analyses the material and energetic flows of the bottom bar, including their impacts on the stakeholders' health and physical well-being. S-LCA of the E-Co-Housing project focuses on the social processes covered by the bottom bar of Fig. 1.

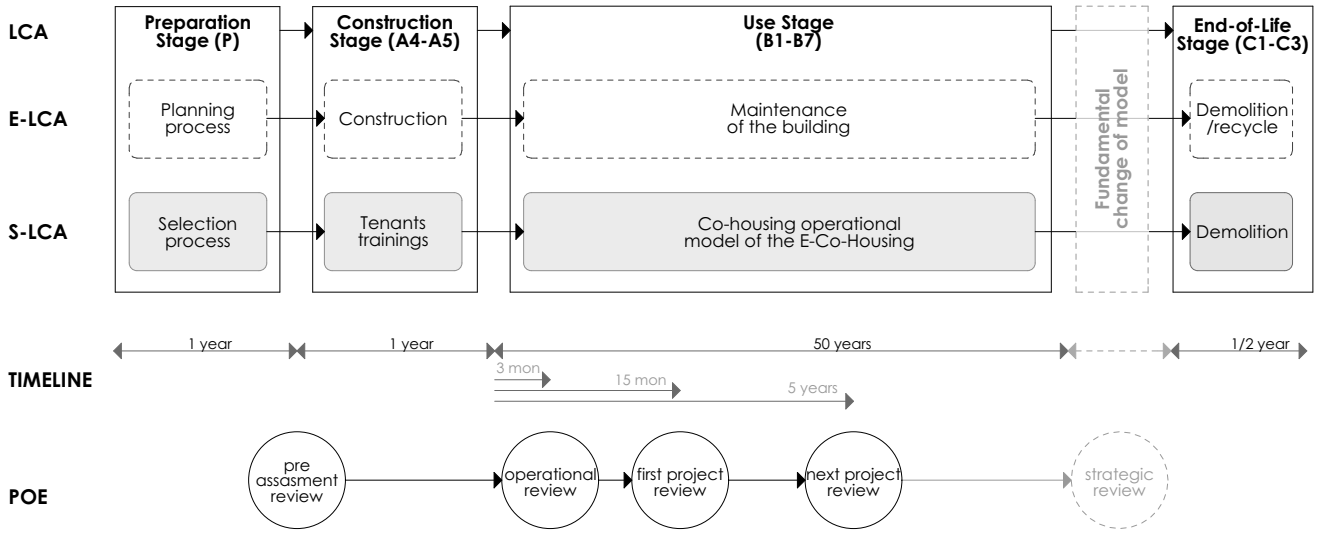

Fig. 1 Life cycle of the E-Co-Housing project (LCA, E-LCA, S-LCA, POE) (Source: own editing)

As I supply chain actors play a role that is not relevant to the social impacts (see later in Section 4.2), we considered the usual production stages (A1-A3) of building LCAs in the system to be irrelevant. By contrast, it became necessary to introduce a preparatory stage (P) into the system border, modifying the usual LCA life cycle stages. The study of Llatas et al. (2020) drew attention to the importance of the design process for the future sustainability of buildings. In the case of the E-Co-Housing project S-LCA, the preparation stage is of particular importance for preparing future tenants and integrating sustainability, economic and social innovations.

In the preparation stage of the collective housing process, new selection criteria were elaborated for the municipality of Zugló by the social housing and co-housing experts of the project team. The main objective of modifying the existing rules was to enable the birth of a diverse, well-cooperating tenants' group in the house. Increasing the variety of lifestyles and individual knowledge, we hope to multiply the value of the future common knowledge in the community.

In the construction stage, the selected tenants participate in an intensive training series. The training units aim to develop basic skills in many areas, like assertive communication or conflict management. These affects the use stage: transfer everyday knowledge, like household tasks, household economics and green living methodologies.

4.2 Stakeholders of E-Co-Housing project

Potential stakeholders of the E-Co-Housing project are determined according to the recommendations of the Guidelines for Social Life Cycle and along lines resembling the proposition of Liu and Qian (2019). The Employees are 50 experts (architects, planners, social workers, municipality employees, co-housing experts, etc.). They work mostly part-time (some 25% of the full-time work) on the project during the preparation and construction stage. The Workers are 40 construction workers and constitute the other major group of workers and employees, working full-time on the project during the construction stage. During the maintenance stage, we assume 10% part-time work on average.

Value chain actors and other stakeholders in the supply chain of the construction are independent from the project management, whose role is – in accordance with the arguments of Liu and Qian (2019) – negligible as regards the social impacts. Accordingly, Fig. 1 depicts the life cycle only from the construction stage (A4), which is however complemented by the preparation stage (planning and tenant selection), which has significant social impacts.

Consumers are the inhabitants of the house, at the same time approximately 100 people of mixed sex, age, and familial status. Local community is defined in our case as the immediate neighbours. They are of outstanding importance because the spatial and social integration of the municipal social housing stock is one of the main issues of a new social housing model. We assume 400 housing units with approximately 1000 inhabitants in the immediate neighbourhood of the E-Co-Housing project. Their involvement is lower than that of the tenants, we estimate it to be10%.

As "Society"[1] we define the population of Budapest, but primarily the inhabitants and the municipality of Zugló, measuring the conformity of the project with the local development strategies and policies and the impact on the local social supply level.

To define the boundaries of our S-LCA, we introduce a new activity variable: the number of years, lived under life- defining effect of the project. As life defining effect, we see living in the E-Co-Housing building or in the immediate vicinity or working on the project in full time. In this sense, the weight of a concerned stakeholder group (W) is proportionate to the number of concerned people (N), to the rate of their involvement (i) and to the number of years lived under the life-defining effect of the project (Y): $W \propto N \times i \times Y$.

Table 1 shows, the most weighted stakeholders of the project are the inhabitants (as Consumers) and their neighbours (as Local Community). We state, that – unlike most S-LCA limitations – the primary stakeholder groups of the E-Co-Housing project's S-LCA are the groups of the inhabitants and the neighbours. So far as this first approach is concerned, this study concentrates on the social impacts on the inhabitants. Due to our limitation methodology, the same finding prevails for other social housing or co-housing projects and thus makes our proceeding useful as it will enable other such projects to be compared with the E-Co-Housing model.

4.3 Impact inventory in E-Co-Housing model

S-LCA methodology distinguishes between final and intermediate goals in the analysis of social impacts as categories and subcategories and sets up a system of indicators (midpoint and endpoint indicators) to measure the process accordingly (Jørgensen et al., 2008). The goal of the S-LCA is to measure the overall impact of the project on the main stakeholders' – in our case the inhabitants' – quality of life.

1 The weight of the society as an abstract concept does not make part of the system's boundaries definition.

Table 1 Weight of the main stakeholder groups in the E-Co-Housing project (Source: own editing)

Stakeholdergroup	Number of concerned people (N)	Involvement	Years (*Y*)	Weight (*W*)
Employees and workers	50	0.25	2	25
	40	1	1	40
Value chain actors	–	–	–	–
Consumers	100	1	50	5000
Local community	1000	0.1	50	5000

Sala et al. see human capital, human well-being, cultural heritage, and social behaviour as the main impact areas of S-LCA (Sala et al., 2015). However, the concept and the components of the quality of life are still debated in the literature (Anderson et al., 2019, Cramm et al., 2012; Dempsey et al., 2011; Diener and Suh, 1997; Hooghe and Vanhoutte, 2011; Tartaglia, 2013; Veenhoven, 1996; 2000; 2005; 2012). Therefore, we base on Veenhoven's (2000; 2012) matrix to show the connection between the hard-to-grasp concept of quality of life and the immediate goals of a social project. As one of the variables, Veenhoven's matrix distinguishes outer and inner qualities according to whether the quality belongs to the environment or the individual. As the other variable, it distinguishes "Life chances" and "Life results". In our interpretation as seen in Table 2, "Life chances" constitute the project provided elements. They influence the subjective satisfaction with life. In the E-Co-Housing project, the elements of liveability correspond to the well-being concept of Sala et al. (2015), the life-ability elements to the impact area on human capital, reflected later in human behaviour.

However, a social project cannot directly develop satisfaction with life. Developers can improve the elements of "Life chances" and wait for the improvement of the stakeholders' satisfaction of life at the individual level, and that of their "Utility of life" at the collective level.

As the main elements of satisfaction of life, say categories to measure by the endpoint indicators in our S-LCA impact way, we have chosen the feeling of autonomy, equalising opportunities, participation and influence, safety, security, and tranquillity. They were introduced as impact categories in S-LCA by Weidema (2006) and proposed later by several analyses too (Andrews et al., 2009; Blok et al., 2013; Kárpáti et al., 2011; Vári et al., 2014).

Although the categories are identical to the impact categories used in most S-LCAs in the construction sector, our subcategories, say midpoint indicators, typically differ due to different stakeholders and the legal, social, and financial background in Hungary. Housing conditions, social integration and participation are in the focus. The impact subcategories are developed from the features of the E-Co-Housing model:

- Location: the construction site provides an extremely beneficial location for the project in a neighbourhood with increasing status, with outstanding mobility and social services.
- Building for community: the architecture of the house uses a proven design toolkit of cohousing buildings (described in Szabó and Babos, 2019), providing a wide range of common spaces. Moreover, the openness of the staircases and corridors permits social control of common spaces and generates spontaneous encounters among the neighbours.
- Affordability: European and municipal subvention assure a lower than market level rent, in addition to the lower overhead costs, thanks to the low-energy technologies of the building (Hulchanski, 1995).
- Skill development: future tenants will be included in an intensive training programme, featuring team-

Table 2 Matrix of qualities of life in the E-Co Housing project (Source: Own editing based on Veenhoven, 2012)

	Outer qualities	Inner qualities
Life chances	Liveability of environment in E-Co-Housing: high functional urban environment, community-friendly architecture, healthy apartments, affordable housing.	Life-ability of the person in E-Co-Housing new skills and knowledge: green living, communication, decision making.
Life results	Utility of life	Satisfaction with life in E-Co-Housing feeling of: autonomy, equalising opportunities, participation and influence, safety, security, tranquillity.

building, and training in communication and conflict management.
- Housekeeping, green living, etc., modules. In parallel to the training process, they participate in the planning of the common spaces, the garden and some details of the house.

Those outputs of the project have direct social impacts on the inhabitants. However, the impacts are never direct, because the elements of the project interact with each other. Each output affects more outcomes in the model, as shown in Fig. 2.

5 Data collection on E-Co-Housing project

5.1 Data collection on site: Post Occupancy Evaluation

There is a fundamental difference between measuring the indicators needed to characterise the project and evaluating its outputs, outcomes, and impacts. Verification of the outputs is easy to quantify and directly obtained from the project documentation, such as municipal ordinances, architectural plans, permits, training descriptions, attendance sheets, energy bills, etc. Data from municipal or national databases can serve as benchmarks here.

By contrast, the evaluation of outcomes and impacts of the project requires targeted, on-site data collection both during the training process and after the moving in of the inhabitants. In agreement with the Guidelines for Social Life Cycle, the main source of that data are our main stakeholders: the inhabitants of the house (Andrews et al., 2009). Therefore, we use for data collection a POE method, proven in the building sector. However, we have improved the POE method to address the complexity of the E-Co-Housing project.

POE is a method to examine the various life stages of a building (after the moving in and before recycling) (Hadjri and Crozier, 2019; Li et al., 2018; Preiser, 2002). It is a widely used method to get information on the quality of built environments and often used to get feedback from employees on their workplace (Young Lee, 2006) or on performance and success of design (Huizenga et al., 2006), etc. POE is a tool for evaluation of environmental performance and is

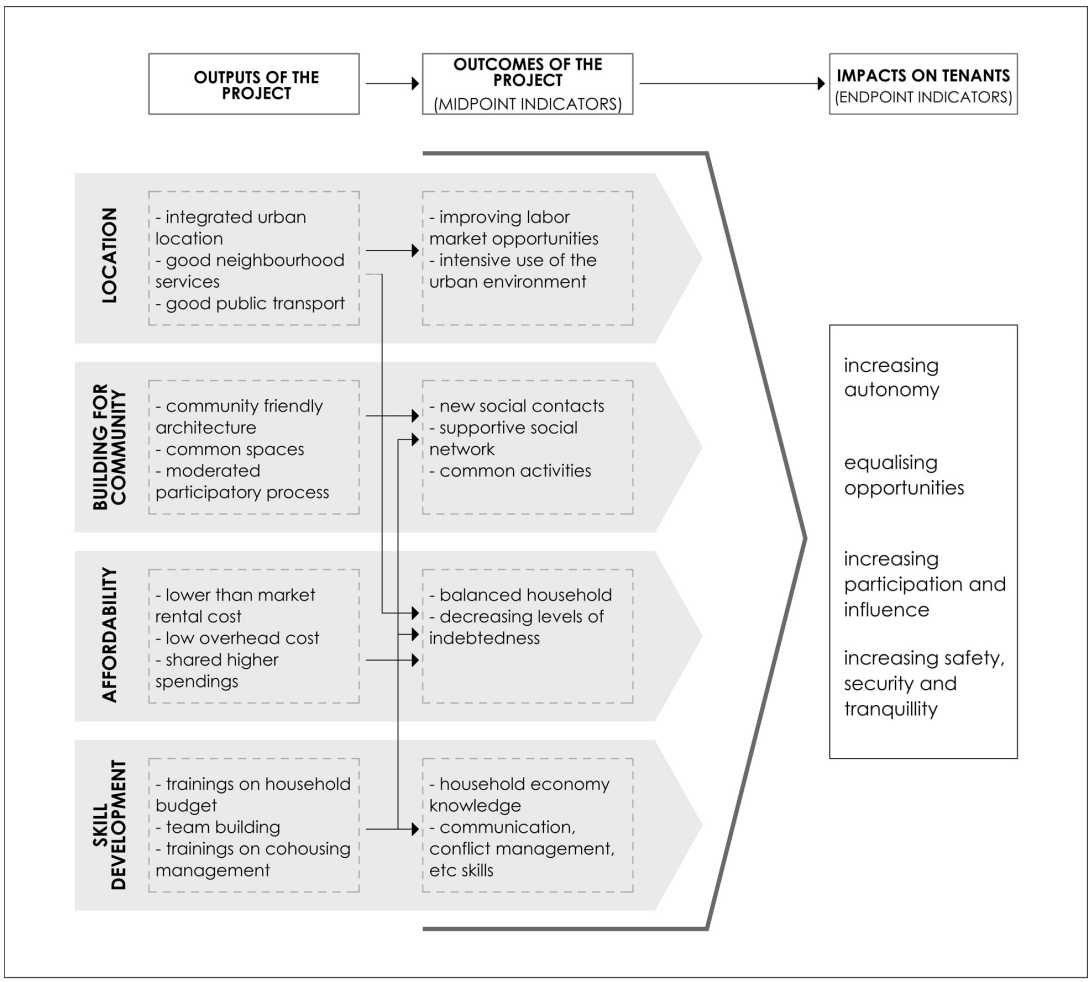

Fig. 2 Impact way (outputs, outcomes and impacts on tenants) in the E-Co-Housing project (Source: own editing)

used mainly with a focus on the requirements of the occupants, but it has rarely been used to measure inhabitants' satisfaction with the built environment and the usefulness/usability of common facilities. Documenting occupants' satisfaction and their perception of how their building performs could be a very important tool for future inhabitants in their decision-making (Baird et al., 2003). We use the POE manual by Blyth and Gilby (2006) as a basis for developing our own research methodology concentrating on inhabitants' opinion. Our investigation could be seen as a pilot project of permanently monitoring the lifecycle from first time use until recycling.

To achieve our main objectives the most appropriate method would be the investigative POE, which is well suited to a mid-range project. The goal of an investigative POE is to get the most reliable data using more thorough and rigorous research techniques. The main tool is a questionnaire, based on representative samples of residents, supplemented by focus groups and interviews in order to gain more information on issues identified in the questionnaire (Blyth and Gilby, 2006).

5.2 Objectives and reviews of POE on E-Co-Housing

We decided to put POE on the project agenda from the start (as suggested by Blyth and Gilby, 2006) and described how the outcome of the project will be measured. The main objectives are defined as follows:

- To evaluate the E-Co-Housing model to meet project expectations.
- To measure the change in everyday life of inhabitants (household budgeting, network, access to local services etc.).
- To measure satisfaction of residents with the co-housing lifestyle (social life, use of public space, functionality, safety, etc.).
- To suggest changes (if any) that would need to be made to make the project successful in the long run.
- To prepare policy recommendations for change, guidelines for planning and development of further E-Co-Housing model projects.

The households and the inhabitants of the E-Co-Housing building will be the units of observation in the research. The team will be investigating different cycles, to obtain information on the aforementioned objectives and to create the midpoint and endpoint indicators using these.

We plan to follow the three stages of the review process clarified by Blyth and Gilby (2006) with some amendments:

- Operational Review: 3–6 months after moving in;
- Project Reviews: first 12–18 months after moving in and further every 5 years;
- Strategic Review, in the case of major change in the model.

We decided to insert one more stage for investigation, called Pre-Assessment Review. In this stage, three months before the future inhabitants move in, we record the initial state of the situation. The timing of the POEs reviews is shown in Fig. 1, integrated with the life cycle stages of the project.

The Pre-Assessment Review will give us a baseline for comparing the results of the later reviews. We record the way in which the inhabitants were chosen; the method of the handover process, the life stories of future residents (education, workplace, housing strategy, financial situation of household, network, etc.).

We schedule the Operational Review to take place three months after the inhabitants have moved into the building. It gives the inhabitants ample time to get to know the E-Co-Housing model, but not so much time that habits obscure first impressions. The Operational Review has a retrospective characteristic, looking back at the selection of the tenants, on the training sessions and the handover process and the experiences of the first year. We are interested in how the inhabitants get on with community life and whether the opportunities of the building meet the needs of the community and the new form of living. The Operational Reviews' data measure exclusively the outcomes in the second column of Fig. 2, as during that phase not enough time has passed for the long-term impacts in the third column to be apparent.

The first Project Review allows us to study one whole year after the first phase of the investigation. The building's systems and the community should have settled down and there is a fair chance to see how the cohabitant model works). The focus of the first Project Review is still on the outcomes of the Project (Fig. 2), but it also measures the impacts on tenants (third column of Fig. 2). Initially, we are interested to discover in which areas the situation of the families has improved (workplace, household budgeting, supportive social network, etc.).

Further Project Reviews, scheduled to take place every 5 years, will increasingly concentrate on the impacts (Fig. 2), judging how E-Co- Housing model performs in the long term.

The Strategic Review is only due if a major change to the model or the building is planned. Therefore, it will not be part of our initial investigation.

5.3 Methods of POE on E-Co-Housing

POE uses quantitative and qualitative measurement methods as well. Measuring the outcomes has a more quantitative characteristic, whereas subjective impacts will be measured primarily by qualitative techniques.

We will use narrative interviews (Given, 2008) with a loose agenda to make the Pre-Assessment Review. That is useful with interviewees with low levels of education because they can talk freely. It will serve to get familiar with every life story of the households (Angel and Heitzmann, 2015).

The purpose of observation is to walk through of the building and to get information on how space is performing. It is a reliable method to have informal discussions with users to identify conflicts. It enables the articulation of unbiased views. Attend house meetings to judge how democratic decision works and to explore the emerging and/or transforming power relationships among the tenants. An observation evaluation sheet will be elaborated with data on time and circumstances of evaluation.

Occupant survey (Fowler, 2009), focusing on the outcomes of the Fig. 2, is the main part of POE, to use in all Project Reviews to measure outcomes and impacts. We will administrate a paper-based survey in person. A short and simplified questionnaire is needed to make it easy to answer for respondents with low education. We envisage 20–25 questions that could be answered in 10–15 minutes. Respondents are required to answer mainly according to a 7-point scale. The necessary midpoint and endpoint indicators could be quantified with the help of these scales. Interviews could serve as an instrument combined with survey questionnaires to get more detailed information on specific problems and issues (emergence of supportive social network, etc.). It is a tool to develop a deeper understanding of particular problems and elaborate solutions on this basis (use of common places, etc.). We will use semi-structured interviews (Given, 2008) at the phase of Operational, Project and Strategic Review. We will conduct interviews with the same set of questions to be asked by all interviewers, with the possibility to ask additional questions to clarify some issues. We will focus on new skills, new social contacts, household economy, conflict management, etc.

Focus group discussion (FGD) (Liamputtong, 2011) could serve to discuss a specific topic and to provide an insight into how a group thinks about a specific issue like the common places of the building. We will use focus group discussion at the phase of Operational, Project and Strategic Review to get more information on how the community works and what should be altered if necessary.

In the different phases of POE we will use the common areas of the building to conduct the research.

6 Conclusion

In our study, we elaborated a Framework to evaluate and monitor the social impacts of the E-Co-Housing model. The specific features of the E-Co-Housing model combine social, environmental, and economic goals and tools. Therefore, the methodology of a complex LCA, consisting of both E-LCA and S-LCA parts, has proved to be useful. In our study we were conceptualising the social evaluation of the model through the application of an S-LCA, integrating the data collection methodology of POE.

The application of the S-LCA methodology led to new results affecting the theory. We defined the "number of years, lived under life-defining effect of the project" as activity variable to define the system boundaries. The analysis of the system boundaries with this activity variable has shown that the main stakeholders of the housing project are – unlike as the most S-LCAs – the Consumers (the inhabitants of building) and the Local Community (the immediate neighbours of the building). This lesson learned in the project can be extended to all housing projects and make the S-LCA methodology applicable to their comparison.

The conceptual social impact analysis of the E-Co-Housing showed that the outputs of the project have effects on two levels. The first, immediate effects on the stakeholders are the outcomes of the project (the middle column of Fig. 2). They are mostly well measurable and quantifiable with traditional social tools like tests, questionnaires, network analysis, etc. In contrast, the long-term impacts (the right column of the Fig. 2) are more subjective and less quantifiable. Their evaluation requires qualitative tools like on-site observations, focus groups, in-depth interviews, and participation.

This system of effects corresponds to S-LCA's impact categories and subcategories. However, the relationships between the impacts and the outputs are in the case of a real project not as hierarchical and graph-like as S-LCA theory would suggest, since almost every outcome affects almost every impact. The outcomes and impacts cannot be brought to common metrics and aggregated into one indicator, as classical E-LCA methodology would make

it desirable. Therefore, we suggest the introduction of the qualitative distinction between the outcomes and the impacts in the S- LCA impact inventory.

The methodology of an improved POE in the S-LCA of the E-Co-Housing project has two advantages. On the one hand, it allows the social evaluation of the model in parallel with the E-LCA, with the same phases and the same measuring methodologies. On the other hand, it enforces the requirement of the S-LCA to involve the main stakeholders – in our case the inhabitants – in the assessment processes. Therefore, we argue for the integration of the POE in the S-LCA of housing projects to investigate the users (tenants).

The Framework to evaluate the E-Co-Housing project can be extended to other housing projects and make the Life Cycle methods applicable to their comparison.

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