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Unravelling the Impact of Co-Production on Social Sustainability in Co-Housing:

A Case Study of Centraal Wonen, Delft

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Summary

The housing shortage in the Netherlands has triggered significant changes in the housing market, characterized by a surge in demand and subsequent price inflation. This has resulted in intense competition for housing, creating a disparity between the financial and social value of houses. As a consequence, social issues have emerged, including the erosion of social networks and increased housing inequality. In response to these challenges, the Dutch government has identified co-housing as a potential solution to the affordable housing crisis and a means to alleviate these social issues.

This research aims to investigate the nature of co-housing and engage the community in identifying their priorities through a co-production process, ultimately promoting the concept of social sustainability. The study begins by elucidating the concepts of co-housing, co-production, and social sustainability, and explores the potential interconnections among them.

To examine these concepts in a real-world context, the research delves into the case of Centraal Wonen (CW) in Delft, an innovative co-housing project that is currently under development. The study investigates the co-production process within CW and assesses its contribution to the community's social sustainability, taking into account both its positive and negative implications. Primary data was collected through site visits, observations, and interviews with residents and experts. This primary data was further substantiated by secondary data sourced from online articles and residents' documents.

The findings, analyzed using Atlas-ti software, unveil a correlation between co-production and its influence on the concept of social sustainability within CW. Co-production is identified as a process that fosters social equity and bolsters social sustainability by empowering the community. Moreover, the co-production process positively impacts the community's capacity to reduce costs and fulfill their housing needs.

It is important to note that this research is specific to the context of co-housing in Delft within the Dutch context. Conducting similar studies in different contexts may yield varying results and conclusions.

Keywords

Co-housing, Affordable housing, Co-production, Social sustainability, Community participation, Social equity, Centraal Wonen, Delft

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Abbreviations

IHS	Institute for Housing and Urban Development Studies
CW	Centraal Wonen
DUWO	Housing Association for cooperative housing
ALV	General Meeting of Members
R	Respond

Chapter 1: Introduction

1.1 Background and problem statement

The housing market in the Netherlands has experienced significant changes in recent years, leading to a shortage of housing supply in relation to the increasing demand (Boelhouwer, 2020; Czischke & Bortel, 2018; Hoekstra, 2017). This situation has created a disparity between the monetary and social value of housing, intensifying competition in the housing market and exacerbating social issues such as the erosion of social networks and inequality in the housing sector (Boelhouwer, 2020). The prioritization of financial profit over social benefits has contributed to the financialization of housing, enabling private actors to exert more influence in the housing sector (Leijten & de Bel, 2020).

To mitigate these social issues and achieve a sustainable living environment, multidimensional urban transformation has become a critical objective in contemporary urban planning (McCormick et al., 2013). One such transformation in the housing sector is collaborative housing, which involves different housing types sharing facilities or spaces and could potentially address these social issues (Lang et al., 2020). Co-housing, a form of collaborative housing, emphasizes cooperation, solidarity, and participation in the development of the design process (Balmer & Gerber, 2018; Choi, 2013; Wang et al., 2021). The Dutch government recognized the potential of housing cooperatives, leading to their legalization as a housing form in the new 2015 housing act (Wooncoöperaties). This development has provided affordable housing for various groups and bridged the gap between the social-rented and owner-occupied sectors (Ahedo et al., 2021; Czischke & Bortel, 2018).

To fully comprehend the potential of co-housing, it is essential to examine the system from within, including individual motivations for participation, the nature of relationships between participants, and the housing cooperative arrangement. This examination can reveal social relation patterns between co-housing units and the embedded resources within this structure, known as co-production (Brandsen & Pestoff, 2006; Czischke, 2018; Pestoff, 2009). Co-production emphasizes enhancing the human factor in societies by promoting fair participation in activities and the exchange of services among society members. This collaborative approach distributes responsibilities to various stakeholders, as opposed to the individualistic approach, and consists of three factors: who participates, where the location is, and how it works (Pestoff, 2009; Verschuere et al., 2012). Consequently, co-production builds a robust social network based on trust and respect, which can also lead to economic growth (Boyle & Harris, 2009).

1.2 Research objective

The objective of this study is to analyze the correlation between the co-production process implemented in 'Centraal Wonen (CW), Delft' and its contribution to social sustainability. The research will be divided into two main components: the first part will focus on conducting a literature review, and the second part will involve a case study analysis.

1.3 Main research question and research sub-questions

1.3.1 Main research question

How does the co-production approach of co-housing, as exemplified in 'Centraal Wonen, Delft,' contribute to social sustainability?

1.3.2 Sub-research question

1-How is the co-production approach applied in the co-housing project at 'Centraal Wonen, Delft'?

2-How might co-production in co-housing at 'Centraal Wonen, Delft' lead to anticipated outcomes and challenges?

3- What are the elements of social sustainability applied in the co-housing project at 'Centraal Wonen, Delft'?

1.4 Relevance of the research topic

1.4.1 Scientific relevance

This research seeks to enrich the academic dialogue on sustainability by emphasizing the social dimension within the co-housing context. Prior studies have predominantly focused on energy efficiency and environmental factors in sustainability discussions, often overlooking the social aspect. It is crucial to acknowledge that social sustainability is a vital facet of comprehensive sustainability, given its capacity to foster social well-being, equity, justice, and community sustainability (Shirazi & Keivani, 2017). Moreover, a significant obstacle to realizing sustainability through co-production is the absence of robust evaluation frameworks that can effectively assess the co-production process outcomes across various sustainability dimensions (Chambers et al., 2021; Norström et al., 2020). Consequently, this research endeavours to investigate the co-production process outcomes and scrutinize their contribution to the social sustainability of co-housing residents.

1.4.2 Social relevance

This research delves into the societal implications of co-housing and co-production, emphasizing their roles in fostering social sustainability, bolstering social cohesion, and enhancing well-being outcomes. Co-housing offers residents mutual support encourages intergenerational and intercultural exchanges, and augments affordability via shared ownership and management (Wang et al., 2021). Co-production, on the other hand, facilitates social inclusion, empowerment, and democracy by actively involving users or citizens in the creation and provision of public services (Pestoff, 2009). Social sustainability plays a pivotal role in promoting individual and community well-being, dignity, and flexibility by guaranteeing basic needs, rights, and aspirations are fulfilled, while also nurturing social networks and equity (Wyborn et al., 2019). Moreover, co-housing and co-production hold the potential to elevate residents' well-being by fostering a sense of belonging, safety, and identity, and by mitigating feelings of loneliness and stress (Choi, 2013).

1.5 Research framework

The research framework of this thesis is structured into five chapters. Chapter 1 lays the groundwork by presenting the problem statement, research objectives, and research questions. Chapter 2 delves into a thorough literature review and theoretical framework, offering a critical examination of the existing body of research. Chapter 3 is dedicated to the research design and methodology, detailing the approach taken in this study. Chapter 4 presents an in-depth case study, inclusive of data analysis and the resulting findings. Lastly, Chapter 5 wraps up the thesis by summarizing the research findings and proposing recommendations derived from the study's outcomes. This framework is shown in (Figure-1).

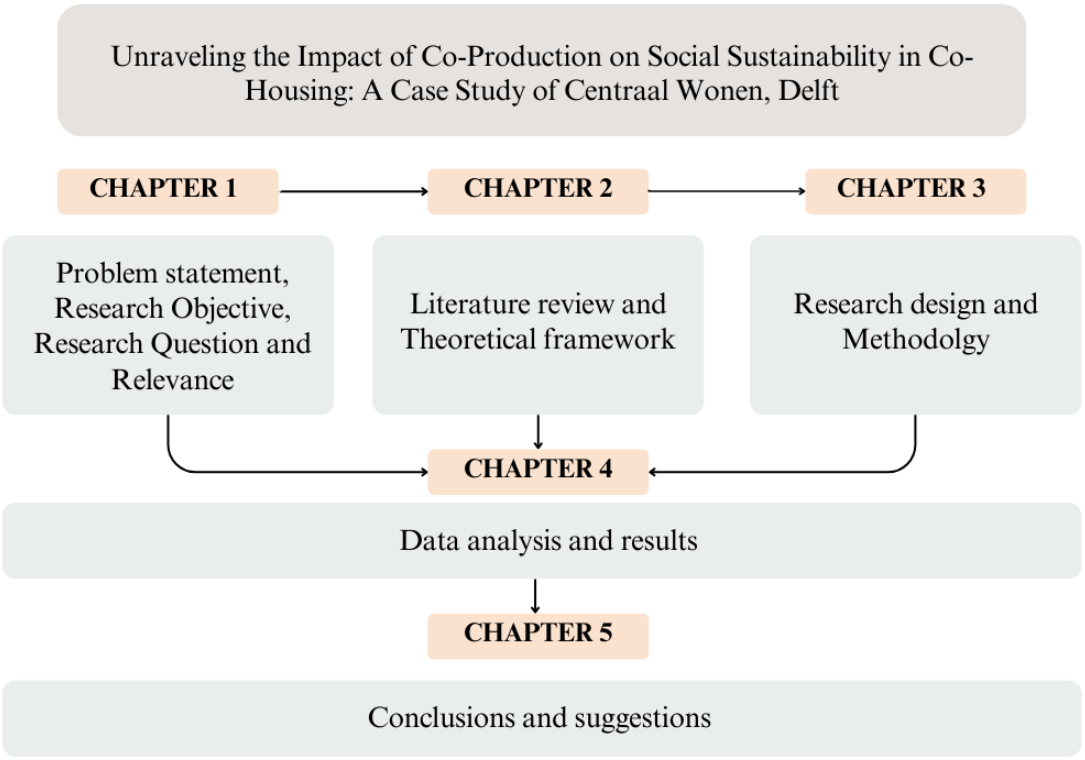

Figure-1. Research framework

Source: Author (May-2023)

Chapter 2: Literature review and hypotheses

2.1 Co-housing and co-production process

This chapter aims to elucidate the first two sub-questions. In the first part, it will delve into the concepts of co-housing and co-production, while also exploring the interrelationships between them. The second part will focus on the expected outcomes and challenges associated with these two concepts.

2.1.1 Co-housing definition and conceptualization

Co-housing, as defined by scholarly literature, is a collaborative housing model based on the individual and collective needs of its residents (Chiquier & Lea, 2009; Choi, 2013; Corfe, 2019). This model brings together residents from different backgrounds who equally engage in decision-making, resulting in a desirable common ground (Beck, 2019; Wang et al., 2021). Such equal engagement provides residents with a sense of safety and attachment to the community, increasing support for social networking (Beck, 2019; Christin, 2021; Medar & Ćurĉić, 2021). These aspects outline the social behaviours that underpin co-housing, which include collective aims, shared activities, and shared ownership and monitoring of space (Choi, 2013).

Co-housing design typically includes both private and shared areas, such as gardens, dining rooms, lounges, and communal spaces (Corfe, 2019). Williams (2005) identified a number of principles that influence the design of co-housing communities. These principles include ensuring that all communal areas are easily accessible, minimizing car traffic, positioning important facilities and access points along shared pathways, creating zones that serve as semi-private socializing spaces near private units to facilitate the transition between public and private spaces, and designing private units that are typically smaller in size and equipped with kitchen and laundry facilities. This way, co-housing design can preserve personal space while also encouraging social interaction (Czischke, 2018).

Successful co-housing encourages collaborative development and design. This promotes unity, safety, support, participation, and social interaction (Czischke, 2018; Wang et al., 2021; Williams, J., 2005). It also allows the entire resident group to shape the vision and formation of their community (Ahedo et al., 2021). Recognizing this, the Dutch government identified co-housing as a potentially affordable alternative for many communities, bridging the gap between the rental and privately owned social sectors. Consequently, they implemented the new Housing Act of 2015, which includes 'Wooncoöperaties,' a legal framework for co-housing (Czischke & Bortel, 2018). One potential approach to implementing co-housing is through the collaborative process of co-production (Czischke, 2018).

2.1.2 Co-production definition and conceptualization

Co-production has been a topic of interest for American management researchers since the 1970s, both in the commercial and governmental sectors. Elinor Ostrom, an American political scientist, described co-production as a process in which public service providers and individuals collaborate to enhance public services. In this partnership, public service agents act as professionals, while people (individuals or groups) contribute to improving the quality and/or quantity of the services that they utilize (Czischke, 2018). Moreover, co-production refers to the effective role of co-management (Pestoff, 2009). This makes co-production a dynamic process involving the people and affecting the place, which reduces the individual approach into three main aspects: who participates, how it works, and where the location is (Pestoff, 2009; Verschuere et al., 2012).

In Europe, co-production was introduced to encourage the active involvement of residents in the development of their own community facilities (Brandsen & Pestoff, 2006). In the United Kingdom, the term referred to a voluntary approach aimed at enhancing public services (Boyle & Harris, 2009; Brandsen & Pestoff, 2006). This concept represents a potential synergy between citizens seeking safer and more effective services, such as healthcare and education, and the ordinary producers of those services, such as police officers, schoolteachers, and healthcare professionals. (Brandsen & Pestoff, 2006; Czischke, 2018; Norström et al., 2020). However, Broadhurst (2022) highlighted that the process of co-production can occasionally be driven by the self-serving motives of individuals seeking to achieve personal objectives. On another note, service providers may exhibit hesitance towards individual participation. This could be due to concerns over power control or skepticism regarding the effectiveness of their contributions in yielding desired outcomes.

The consensus from previous studies is that co-production is not an isolated process but a collaborative one, involving multiple stakeholders residing in the same geographical area, sharing common values, and possessing equal decision-making powers (Czischke, 2018; Pestoff, 2009; Wyborn et al., 2019). This participation delineates the relationship and responsibilities between experts and service users. Nevertheless, the challenges inherent in this process can be alleviated through a collaborative approach (Broadhurst, 2022).

Moreover, co-production has been associated with the concept of social sustainability. This involves community members collaborating to develop a comprehensive understanding based on four pillars: contextual, pluralistic, interactive, and goal-setting (Norström et al., 2020; Zurba et al., 2022).

2.1.3 The link between co-production and co-housing

According to literature, the concepts of co-production and co-housing are interconnected through a multifaceted process that encompasses factors such as location, participants, activities involved, and the nature of decision-making (Pestoff, 2009; Verschuere et al., 2012; Voorberg et al., 2015). Co-production, as previously mentioned, is rooted in the active participation of diverse community members and stakeholders who work together towards shared goals, fostering inclusivity in decision-making processes, mitigating social exclusion, and ultimately leading to an improved environment (Boyle & Harris, 2009; Chambers et al., 2021). This definition aligns with Arnstein's Ladder, a conceptual framework that outlines different levels of citizen engagement. At the apex of Arnstein's ladder (Figure-2), citizens hold full authority over decision-making. Within the context of co-housing and co-production, citizen control signifies the active engagement of individuals in shaping and managing communities (Arnstein, 1969; Contreras, 2019).

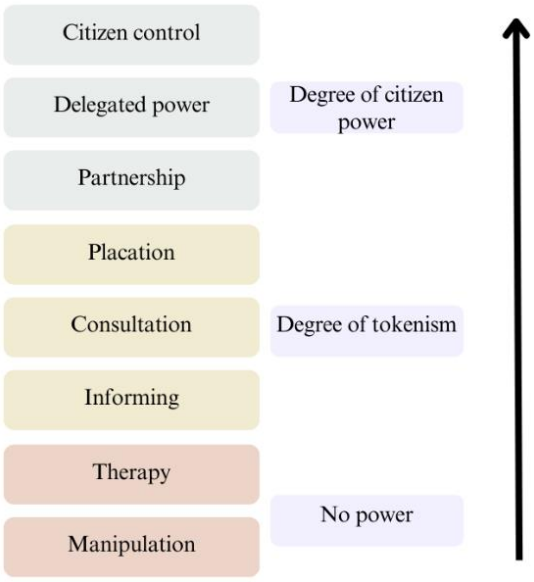

Figure-2. Arnstein's ladder

Source: Author (May-2023) based on literature from (Arnstein, 1969).

Integrating co-production and co-housing can pave the path to a more sustainable community where the well-being of all members is promoted (Choi, 2013; Wyborn et al., 2019). When different community members effectively participate, at varying levels, in the various housing production stages, the successful integration of co-production as a legal public

service for co-housing can be achieved (Czischke, 2018; Tummers, 2017; Williams, J., 2005). However, the degree of success of such integration depends on the type of project, urban context, and implementation timing (Chambers et al., 2021; Norström et al., 2020; Verschuere et al., 2012).

2.1.4 Possible outcomes from co-production and co-housing

Co-production has been recognized in the literature for its significant contribution to sustainability, particularly in the social aspects (Chambers et al., 2021; Norström et al., 2020; Wyborn et al., 2019). It offers equal opportunities to citizens and collaborators, fostering balance, deepening relationships, and building robust networks among community members (Chambers et al., 2021; James, 2020; Norström et al., 2020; Verschuere et al., 2012). Furthermore, co-production instills a sense of belonging and attachment among participants (Mitlin & Bartlett, 2018; Norström et al., 2020). Beyond social development, it also empowers individuals to devise innovative and dynamic solutions, thereby enhancing their technical skills (Brandsen & Pestoff, 2006; Czischke, 2018; Mitlin & Bartlett, 2018; Verschuere et al., 2012).

In contrast, co-housing plays a significant role in shaping residents' lifestyles. It offers a balanced lifestyle between individual and collective living, attracting many individuals (Choi, 2013; Tummers, 2017; Williams, 2005). Additionally, co-housing brings together individuals with shared values, fostering social activism, mutual support, inclusiveness, and environmental and social sustainability (Chiodelli & Baglione, 2014). The gathering of like-minded people and a sense of safety are key attractions that have boosted the popularity of co-housing in the Netherlands (Vos & Spoormans, 2022). Recent studies have also shown that co-housing not only offers social and emotional benefits but also enhances physical mobility and mental health (Choi, 2013).

2.2 Social sustainability

In the pursuit of sustainable development, comprehending social sustainability becomes paramount, especially during transitions involving co-production and co-housing. This section explores the facets of social sustainability at the community level, addressing the third sub-question.

2.2.1 Social sustainability definitions

Social sustainability is a crucial component of sustainable development, aiming to fulfill social and economic objectives while preserving the ability of future generations to meet their needs (Afshari et al., 2022; Corsini & Moultrie, 2021). It encompasses activities that enhance social well-being and address issues such as deprivation and urban degradation (Rogers et al., 2012). The pillars of social sustainability are rooted in fundamental values like equality, justice, participation, social network, safety, and well-being (Dempsey et al., 2011; Murphy, 2012; Rogers et al., 2012; Shirazi & Keivani, 2019). While the triple-bottom-line approach emphasizes the interdependence of social, economic, and environmental dimensions of sustainability (Figure-3) (Melles et al., 2011; Santillo, 2007), measuring and evaluating these pillars together poses a challenge.

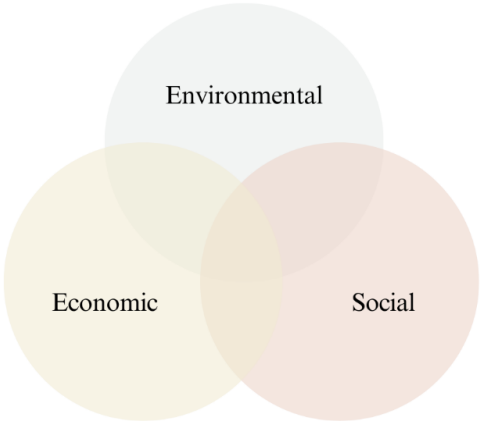

Figure-3. The triple bottom line approach

Source: Author (May-2023) based on literature from (Giddings et al., 2002).

To address this challenge, various conceptual frameworks have been proposed to develop the social, economic, and environmental dimensions separately (Eizenberg & Jabareen, 2017). One such framework is the relationship of overlapping circles, which positions the social perspective as a critical factor connecting the economy and the environment (Figure-4).

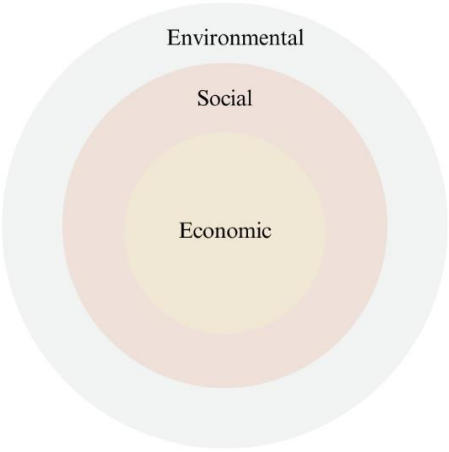

Figure-4. Overlapping circles sustainable development

Source: Author (May-2023) based on literature from (Giddings et al., 2002).

Another framework is the idea of overlapping, which underscores the role of human activities in the economy while operating within environmental boundaries (Figure-5) (Giddings et al., 2002). These frameworks suggest that social sustainability represents a diverse set of social and economic activities that benefit all members of society, regardless of their gender, background, or ethnicity (Shirazi & Keivani, 2019). By recognizing the interplay between human actions, economic systems, and environmental constraints, these frameworks highlight the need for sustainable practices that prioritize inclusivity and equity, ensuring that everyone can reap the benefits of a socially sustainable society (Giddings et al., 2002).

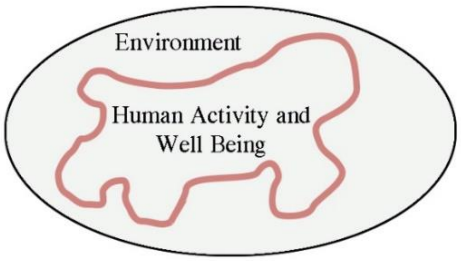

Figure-5. Breaking down the boundaries

Source: Author (May-2023) based on literature from (Giddings et al., 2002).

The concept of social sustainability is closely linked to social equity (Bramley et al., 2009; Dempsey et al., 2011). It fosters social connections among residents, promotes collaboration and civic participation, encourages responsible consumption of resources, and supports sustainable health and wellness (Eizenberg & Jabareen, 2017; Norström et al., 2020; Paidakaki & Lang, 2021; Santillo, 2007). By enhancing social interaction and decision-making, social sustainability contributes to improving the lives of all people (Bolis et al., 2017).

2.2.2 Scale of social sustainability

Delving deeper into the concept of social sustainability reveals that its evaluation is not a one-size-fits-all approach. Assessing its impact requires the use of various scales, and it is crucial to identify one of these scales (Table-1) to define and measure it effectively. By employing these scales, the assessment of social sustainability can accurately capture its multifaceted dimensions.

Reference	Scale	Definition
Shirazi & Keivani, 2019, p. 451	Macro- or micro-scale	"…a socially sustainable environment is a place with a dialectical character. On the one hand, it is a locality where physical qualities and standards (hard infrastructure) are positively perceived, highly valued, and interactively utilised by the inhabitants through sustaining and endurable social practices (soft infrastructure). On the other hand, it is a place where substantial social qualities (soft infrastructure) are sustained, highly valued, and vividly exercised within an urban setting of high physical quality (hard infrastructure)."
Dixon, 2019, p. 23	Micro-scale: neighbourhood	"Social sustainability from a homebuilder's perspective was defined as being (Bacon, Cochrane, and Woodcraft, 2012, p. 9) as ''... about people's quality of life, now and in the future. It describes the extent to which a neighbourhood supports individual and collective well-being. Social sustainability combines design of the physical environment with a focus on how the people who live in and use a space relate to each other and function as a community. It is enhanced by development which provides the right infrastructure to support a strong social and cultural life, opportunities for people to get involved, and scope for the place and the community to evolve.''
Larimian & Sadeghi, 2021, p. 624	Micro-scale: neighbourhood	"In this study, we define a socially sustainable neighbourhood as one that provides residents with equitable access to facilities, services, and affordable housing; creates a viable and safe environment for interaction and participation in community activities; and promotes sense of satisfaction and pride in the neighbourhood in a way that people would like to live there now and in the future."
Zetterberg et al., 2023, p. 795	Micro-scale: neighbourhood	"… Neighbourhoods are a common spatial scale for studying social sustainability and there is a growing focus on social sustainability in urban neighbourhoods for both researchers and policymakers (Dempsey et al.2011)."

Table-1. Scope of social sustainability

Source: Author (May-2023) sources listed in table.

The concept of sustainability has various interpretations, depending on the people and environments involved. However, some commonalities define social sustainability and must be achieved for its successful implementation. Analyzing the definitions provided in Table-1, it is clear that they primarily focus on the present and future aspects of societal progress. Many definitions also highlight the significance of community development. For instance, Dixon (2019) emphasizes the transformative changes within communities, while Larimian and Sadeghi (2021) stress equal participation and satisfaction of community members in improving their surroundings. It is important to recognize that all ethnicities are closely tied to their

respective social and environmental contexts. This connection is evident in the elements of social sustainability, such as inclusive decision-making, interaction, and participation.

To further explore the research scope, Shirazi and Kifani (2019) emphasize the multifaceted nature of social sustainability, which can be implemented at different scales in the built environment. These scales are commonly classified as macro and micro scales, each with distinct approaches. Table-1 provides a comprehensive overview of the differences between these measures. It is worth noting that a significant portion of development activities in the built environment takes place at the "neighborhood" scale, making it a crucial indicator of overall social sustainability within a given context (Dixon, 2019). The concept of a "neighborhood" refers to a connected cluster of buildings where a group of individuals resides within a community context (Dixon, 2019; Stevenson, 2021).

Sustainable communities are closely related to people and affect the daily social practices of their residents. For example, co-housing helps create social cohesion and sustainable behaviour by introducing a diverse mixture of social and economic levels among the residents, additionally to improving equality in the level of educational, gender, and ethnic background of communities (Choi, 2013; Wang et al., 2021). Furthermore, Sanguinetti (2014) argues that co-housing promotes socially and environmentally sustainable lifestyles by enhancing the sense of belonging between residents, the context around them, and the community they live in.

2.2.3 Indicators of social sustainability

Understanding social sustainability necessitates the establishment of quantifiable indicators that link it to tangible outcomes. This study concentrates on a specific geographical area, exploring the interconnections among its residents. It will further develop each principle into measurable indicators, encompassing both tangible and intangible influences (Dempsey et al., 2011). Intangible indicators capture the project's positive impact through interpersonal interactions and daily activities, while tangible indicators underscore the beneficial outcomes of the planning process (Eizenberg & Jabareen, 2017). These indicators of social sustainability can be classified as follows:

a. Equity

Equity, a foundation of social sustainability, requires a variety of institutional requirements that foster fair resource distribution and capability access, thereby enhancing equality and inclusivity in decision-making processes (Bramley et al., 2009; Dempsey et al., 2011; Giddings et al., 2002; Paidakaki & Lang, 2021). It further ensures that all individuals, regardless of their socioeconomic status or personal characteristics, have direct access to services within their localities or nearby areas, facilitated by transportation (Dempsey et al., 2011; McCormick et al., 2013). Moreover, equity demands the active participation of all individuals in decision-making processes that shape their communities (Bolis et al., 2017; Giddings et al., 2002). This engagement in participatory procedures amplifies the significance of fostering inclusivity among community members. Active involvement in community development and organization cultivates lasting memories, reinforcing a profound sense of inclusion and equality, and highlighting the value of each individual's contribution (Stevenson, 2021).

This approach ensures the fulfillment of basic human needs, enhances the quality of life, and empowers individuals to live, work, recreate, and participate in society (Ayala et al., 2019; Larimian & Sadeghi, 2021). The principle of equity is thus integral to social integration and the attainment of social sustainability, with a strong emphasis on inclusion to guarantee that no individual is marginalized or excluded from any activity (Lang, 2019).

b. Sustainability of community

Community is one of the main important elements for measuring the effectiveness of social sustainability. It has several indicators including the following:

(i) Sense of belonging

This enhances the bonding between people and their environment, both physically (place attachment) and socially (community membership) (Stevenson, 2021). Previous studies have emphasized the importance of a sense of belonging in cultivating pride and responsibility toward the community, thereby enhancing social sustainability (Dempsey et al., 2011; Larimian & Sadeghi, 2021).

(ii) Participation and interaction in the community (level of participation)

This indicator is pivotal in assessing social sustainability. Participation signifies individuals' capacity to fulfill their needs and actively engage in decision-making processes. Bramley et al. (2009), Dempsey et al. (2011), and Shirazi & Keivani (2019) have all emphasized the importance of democratic participation and the ability to share interests with others in creating sustainable communities. Social interaction in different activities also plays a crucial role in social sustainability as it bolsters societal belonging (Giddings et al., 2002; Paidakaki & Lang, 2021; Shirazi & Keivani, 2019).

(iii) Sense of safety

In certain urban contexts, the safety indicator can influence residents, encouraging them to engage in various activities that foster trust between residents and expand social networks. These positive experiences can significantly enhance residents' sense of place attachment, which can be measured to ensure that they feel safe among their neighbors. This sense of safety is a crucial factor in promoting social sustainability (Bramley et al., 2009; Dempsey et al., 2011; Eizenberg & Jabareen, 2017; Stevenson, 2021).

(iv) The social network

Social networking can foster sustainable communities by enhancing social connections through knowledge and skill sharing among community members (Cuthill, 2010; Paidakaki & Lang, 2021). This can have a positive influence on individuals' sense of identity, safety, and belonging, thereby contributing to their long-term stability and positive interactions with others (Melles et al., 2011). Furthermore, a strong social network is positively correlated with individual well-being and community harmony (Cuthill, 2010; Dempsey et al., 2011; Eizenberg & Jabareen, 2017; Rogers et al., 2012). Additionally, the benefits of a robust social network can extend to community-level decision-making, benefiting the community as a whole (Dempsey et al., 2011; Eizenberg & Jabareen, 2017; Shirazi & Keivani, 2019).

(v) Stability

Maintaining stability in a community is vital for bolstering social sustainability and facilitating the community's adaptability to changes. The degree of people's participation in communal activities mirrors their connection to the place, which can be social or physical.

Individuals frequently establish connections in the places they have helped shape. This is achieved through interactions with others during the formation of their community, which subsequently heightens their interest in others and their contributions to societal well-being. Ultimately, this leads to the development of a sense of safety and security, thereby strengthening the social network. Over time, these factors significantly contribute to community stability (Bramley et al., 2009; Dempsey et al., 2011).

2.3 Research framework

This study is grounded in a theoretical framework that delineates the relationship between co-production and social sustainability in the context of co-housing. In this framework, co-production is posited as the independent variable, while social sustainability is identified as the dependent variable. This relationship is graphically represented in (Figure-6), drawn from existing literature, which portrays co-production as a powerful tool for promoting equity and social sustainability in urban settings.

By employing an interactive methodology, co-production augments decision-making processes, cultivates trust, and encourages knowledge exchange among community members within the interactive sphere of social networks. Moreover, it plays a significant role in fostering a sense of belonging by addressing individual needs and enhancing the overall quality of life. It is important to underscore that this process is not linear but rather dynamic, shaped by past experiences, and capable of generating both positive and negative effects on social sustainability within the community. Therefore, a thorough explanation is required to fully comprehend this process and clarify the relationship between the two variables, particularly within the context of co-housing.

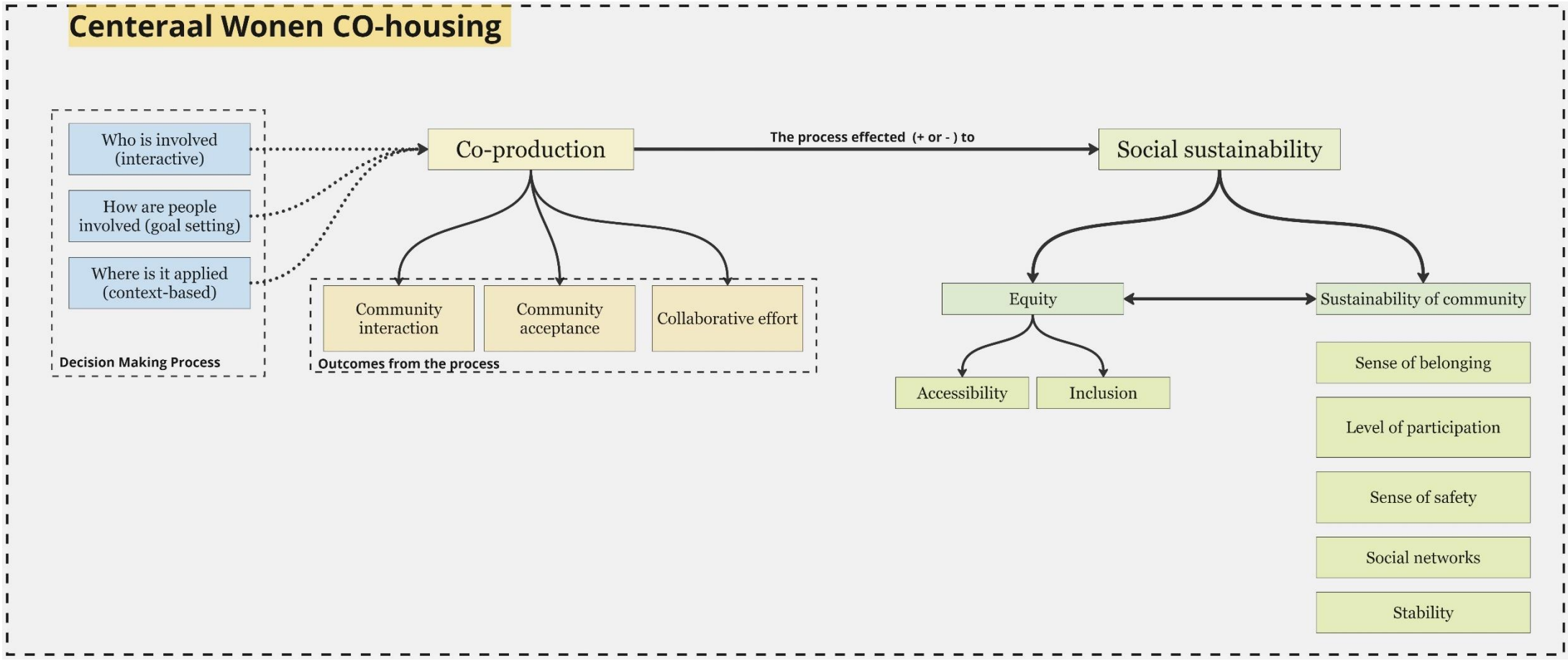

Figure-6. Research framework

Source: Author (May-2023).

Chapter 3: Research design and methodology

3.1 Research strategy

This research employs explanatory analysis to comprehend the motivations behind residents' choice to reside in co-housing, investigate the concept of co-production as a component of the design process previously practiced by residents, and assess how these elements have impacted the project's current status and its potential for achieving social sustainability. The case study of CW was chosen for this investigation, with a primary emphasis on the behavioural aspects of individuals within this resident-led community (Van Thiel, 2014).

The case study approach, in line with social research methodology, and the use of qualitative data, is suitable for this research for several reasons. Firstly, it enables an in-depth explanation of a specific co-housing group that has previously implemented and continues to implement, the co-production approach. Secondly, it aids in determining people's perceptions of the quality of their living environment (Lune & Berg, 2017). Lastly, it allows the researcher to ask detailed questions about specific topics within a particular geographical context (Van Thiel, 2014).

The research will utilize both primary and secondary data sources. Primary sources will comprise interviews and observations of CW residents, while secondary sources will include relevant literature on co-housing and co-production, as well as documents and reports. Ethical considerations will be meticulously observed throughout the research process, and informed consent will be obtained from all participants.

3.2 Data collection

3.2.1 Sample selection and size for primary data collection

This research employs a mixed sampling approach for the unit of analysis, which includes the residents of the co-housing project. Non-probability sampling is used to ensure the sample's representativeness and to select individuals who have strong relevance to the research topic, thereby facilitating the acquisition of new insights into the current situation (Van Thiel, 2014). This sampling approach was chosen due to the limited number of available housing units and the necessity to involve experts who can provide valuable perspectives for the research.

The sample size of 11 participants was determined through random sampling to maximize diversity (Appendix 2-Section 2). This sample size is based on reaching saturation, where new information and insights cease to emerge from additional interviews (Van Thiel, 2014). Participants were selected from each of the four main clusters studied in the project. The sample categories are as follows:

(i) Experts

- An architect involved in the ongoing development of the co-housing project.
- A member involved in the ALV meeting.
- A member of a community organization.

(ii) Residents

- A married couple.
- An elderly individual.
- Singles living alone.

3.2.2 In-depth interview

In this research, an in-depth interview approach was employed for 11 resident interviews. The interviews aimed to investigate the case of co-housing, involving participants who had previously participated in the design process, current residents actively engaged in the project development (Appendix 1-Section 2), and members of an organization dedicated to integrating the community (Appendix 1-Section 3). Moreover, to gain a deeper understanding of the social composition of the residents (Appendix 1-Section 4), an exploratory survey method was utilized during interviews with a diverse sample of 12 residents randomly selected from different clusters.

All interviews were semi-structured and included a series of interconnected closed and open-ended questions, guided by relevant indicators for the research objectives. This allowed participants to express their perspectives, seek clarification, and helped the researcher gain a deeper understanding of the topic (Van Thiel, 2014; Godschalk & Mills, 1966). Each participant was provided with a questionnaire and consent form (Appendix 1-Section 1). The interviews were conducted in English, both face-to-face and online via Microsoft Teams. All interviews were recorded and transcribed following the prior consent of the participants, and all data were anonymized and coded during the transcription process. Privacy and confidentiality measures were strictly adhered to, as indicated in the consent form (Van Thiel, 2014; Godschalk & Mills, 1966).

3.2.3 Secondary data collection

Secondary sources were utilized to supplement the information collected through primary sources with relevant facts and opinions (Van Thiel, 2014). These sources included documents referenced by participating experts explaining the case study process, collected architectural drawings for project analysis, online documents from residents, and past and recent photos (Appendix 2-Section 3).

3.2.4 Observation method

Observational research was conducted to gain insights into the daily lives of co-housing community residents, answering related research questions and addressing corresponding indicators by observing residents' behaviours, activities, and social interactions within their community. Prior approval from the community was obtained to ensure ethical considerations were met (Van Thiel, 2014). The observation process is explained in (Appendix 2-Section 4).

3.3 Validity and reliability

Validity is categorized into two types: internal and external. For internal validity, a mixed-method approach was employed for data collection, involving semi-structured interviews, non-participant observation, and the utilization of primary and secondary data. To reinforce the findings, the analysis results were integrated with relevant literature, employing a triangulation approach that incorporated multiple information sources. Conversely, external validity cannot be generalized as the major findings are specific to this case study (Van Thiel, 2014).

Reliability, on the other hand, concerns the consistency and replicability of research results under similar conditions. To ensure reliability, the researcher documented each step of the data collection process and utilized diverse sources to increase the potential for successfully replicating the study's results. Additionally, pilot interviews and surveys were conducted to further enhance the reliability of the data collection process (Van Thiel, 2014).

3.4 Data analysis strategy

The research utilized Atlas.ti software for analysis, linking textual segments from primary and secondary data as well as observations using specific symbols. The process began with data review and code creation, followed by the identification of relationships among the codes and the interpretation of the findings (Williams & Moser, 2019).

The analysis involved deductive coding using established concepts from the operationalization table, and additional coding was added based on the code tree (Appendix 2-Section 1). These codes provided a more detailed approach to the research (Appendix 2-Section 6).

To gain further insights, a co-occurrence table was created to identify relationships between variables. Some variables were re-contextualized during the later stages of analysis. The findings were visually represented using Sankey diagrams, which effectively highlighted the connections between different codes.

3.5 Limitations and expected challenges

Since the research focuses on investigating the role of residents at CW, it is expected that several extended visits will be needed to conduct interviews with target interviewees and collect comprehensive data. This poses a financial challenge for commuting to the place, as well as a physical burden due to the long hours that need to be spent during each visit. To alleviate this burden, the interviews will be conducted on different days of the week, including weekends, to allow for short breaks in between, facilitating thought gathering and capturing various insights as much as possible.

The research findings are limited by two major points. First, since the interviews are all conducted in English in a Dutch city, the language difference can pose a barrier and restrict the pool of potential interviewees to only those who can speak English. However, it's important to note that interviewees do not need to speak perfect English, as the questions will be simply phrased, with the addition of some translated words if needed. Second, the obtained insights are dependent on the willingness and availability of residents to be interviewed and commit to the agreement. To minimize this effect, flexible interview settings, such as time and place, will be proposed to make the process as convenient as possible for everyone.

3.6 Operationalization

To provide clarification on the sub-variables and indicators derived from the literature (Table-2) and (Table-3) present an overview of concepts of co-production and social sustainability.

Concept - Variable	Sub- Variable	Indicator	Description	Data collection
Co-Production Approach (Independent Variable)	The process of coproduction	Who is involved (interactive)	This indicator will be measured by identifying the different stakeholders involved in the co-production process. This includes residents, architects, experts, and the municipality (Norström et al., 2020; Pestoff, 2009; Verschuere et al., 2012).	Semi-structured Interview / Observations / Document Analysis
		How are people involved (goal setting)	This indicator will be measured by evaluating the scale of residents' active participation in the co-production process. This will be determined by their involvement in various activities such as attending meetings, participating in decision-making, selecting ideas, and upgrading projects (Norström et al., 2020; Pestoff, 2009; Verschuere et al., 2012).	
		Where is it applied (context-based)	This indicator will be measured by identifying locations of co-production activities such as meetings, decision-making, design, and construction. The residents' participation in these activities will also be evaluated to comprehend the co-production process context (Norström et al., 2020; Pestoff, 2009; Verschuere et al., 2012).	
	The outcome from the process of co-production	Community interaction	This indicator will be measured based on the interactions that occur among co-producers during the co-production process. This will involve assessing the outcomes of these interactions, which can range from positive aspects such as the development of trust to negative aspects such as the emergence of conflict or selfishness (Broadhurst, 2022; Czischke, 2018; Norström et al., 2020; Verschuere et al., 2012).	
		Community acceptance	This indicator will be measured by determining the level of acceptance among co-producers during the co-production process. This will be contingent upon the alignment of their needs or financial status (Broadhurst, 2022; Norström et al., 2020; Voorberg et al., 2015; Wyborn et al., 2019; Zurba et al., 2022).	
		The collaborative effort	This indicator will be measured based on the shared efforts and responsibilities among diverse co-producers. This involves evaluating the extent to which these efforts are aimed at achieving common objectives and mitigating individualistic approaches (Brandsen & Pestoff, 2006; Broadhurst, 2022; Chambers et al., 2021; Czischke, 2018; Norström et al., 2020; Wyborn et al., 2019).	

Table-2. Operationalization for the co-production approach

Source: Author (May-2023) sources listed in the table.

Concept - Variable	Sub- Variable	Indicator	Description	Data collection
Social Sustainability (Dependent variable)	Sustainability of community	Sense of belonging	This indicator will be measured by assessing the residents' social and physical connections to their community, including any potential loss of these connections. This includes their feelings of belonging and their social interactions within the community (Bramley et al., 2009; Dempsey et al., 2011; Larimian & Sadeghi, 2021; Stevenson, 2021).	Semi-structured Interview / Observations / Document Analysis
		Level of participation	This will be measured by observing increasing or decreasing the residents' active involvement in community activities and their participation in decision-making processes at different levels (Bramley et al., 2009; Dempsey et al., 2011; Larimian & Sadeghi, 2021; Paidakaki & Lang, 2021; Shirazi & Keivani, 2019).	
		Sense of safety	This indicator will be measured by evaluating the residents' feelings of safety or insecurity within the community and during their interactions with others (Bramley et al., 2009; Dempsey et al., 2011; Larimian & Sadeghi, 2021).	
		Social networks	This will be measured by examining the strength of social connections among residents, the sharing of knowledge and social skills, and the resulting impact on community well-being and harmony. Alternatively, it will assess whether residents prefer isolation or negative interaction between them that affects the strength of the social network (Bramley et al., 2009; Dempsey et al., 2011; Larimian & Sadeghi, 2021; Rogers et al., 2012).	
		Stability	This indicator will be measured by determining the factors that increase or decrease the stay duration in the community (Bramley et al., 2009; Dempsey et al., 2011).	
	Equity	Accessibility	The measurement of this indicator will rely on assessing the ease with which community members can access daily facilities and public resources, as well as the presence of spaces that foster interaction and facilitate collective decision-making (Bramley et al., 2009; Dempsey et al., 2011; Larimian & Sadeghi, 2021; Paidakaki & Lang, 2021).	
		Inclusion	This indicator will be measured by assessing the level of participation of all residents in community decisions, ensuring that no resident is excluded from these processes (Bramley et al., 2009; Corsini & Moultrie, 2021; Lang, 2019; Stevenson, 2021).	

Table-3. Operationalization for social sustainability

Source: Author (May-2023) sources listed in the table.

Chapter 4: Results, analysis and discussion

4.1 The case study of Centraal Wonen

4.1.1 Location

Within the Dutch context, the concept of co-living has primarily emerged through the Centraal Wonen (CW) movement, which aimed to provide alternative living arrangements diverging from traditional housing models. A key feature of this movement is its emphasis on the active involvement of future residents in the design process, ensuring alignment with their specific requirements. An exemplification of this approach can be seen in the CW community built in Delft in 1981 (Photo-1).

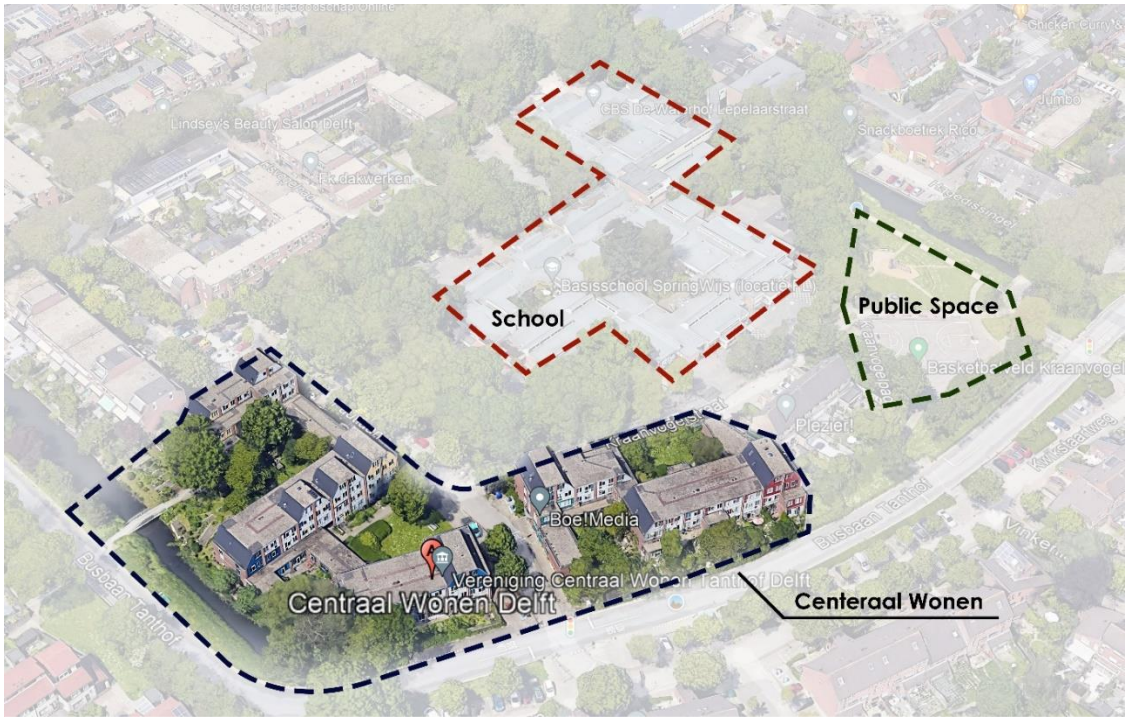

Photo-1. Location of CW

Source: Obtained from google earth and developed by the author (May 2023).

4.1.2 Co-production process

In 1973, the CW started with 15 residents and gradually expanded to form a community of 125 people. Despite their diverse backgrounds and ages, these individuals shared a collective vision to establish alternative co-housing that catered to their specific needs. The primary objective was to ensure housing opportunities for a wide spectrum of individuals, transcending conventional real estate ownership. The residents actively engaged with the housing association (DUWO) and the local municipality of Delft to create an inclusive environment, offering accessible opportunities to all community members, not just the wealthy. The rationale was to foster social inclusion throughout the co-housing project, extending beyond a specific social group.

During the preliminary stages, an extensive engagement process was conducted with the residents to actively gather their input and recommendations on the design aspects (Photo-2). The absence of established guidelines for initiating the project led to inquiries regarding the optimal functionality of the spaces. Consequently, residents engaged in thorough discussions to explore the design's impact on the community, encompassing both private units and public spaces. Additionally, careful attention was given to integrating the project with its surrounding context.

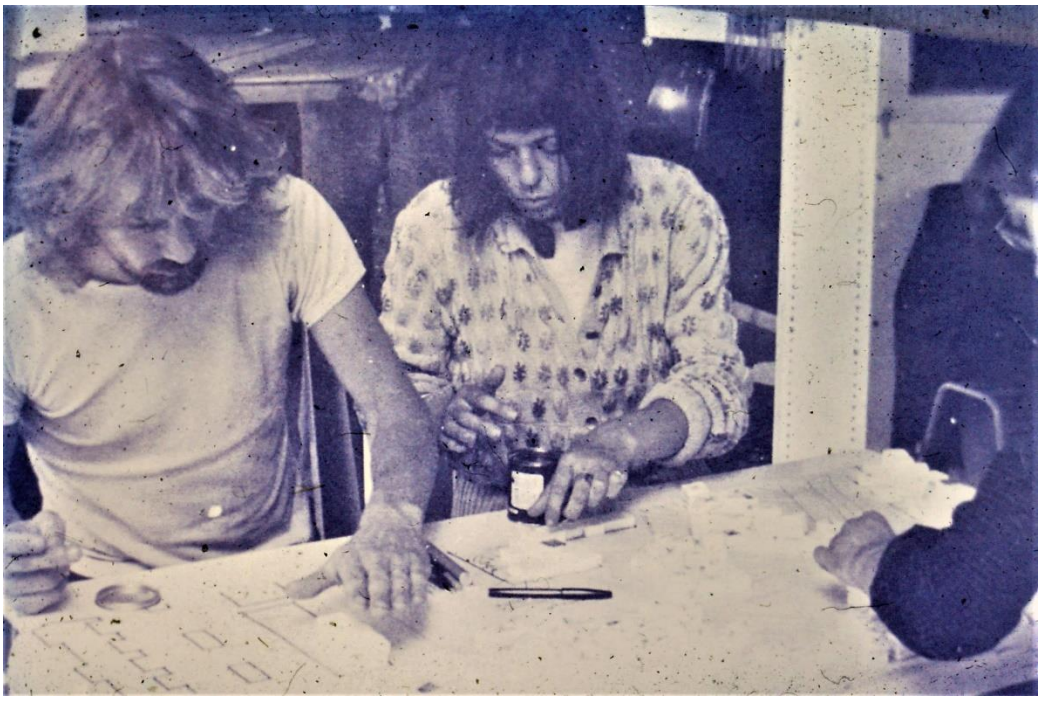

Photo-2. CW residents actively participate in decision-making

Source: Flip Krabbendam (May 2023).

The initial design concept was created by Nikolin Jansen, who conceptualized a ground-floor layout catering to diverse needs (Photo-3). The design included private rooms and common spaces, such as a shared kitchen and communal gardens. Three other residents played key roles within the group: architect Flip Krabendam, journalist Lex Veldwein, and sociologist Cor Langedijk. Krabendam developed a housing design model, identifying necessary modifications in both residential and public spaces. Langedijk engaged potential residents through inquiries to determine their specific requirements and social needs. Lastly, Veldwein focused on publicity to attract residents to the project.

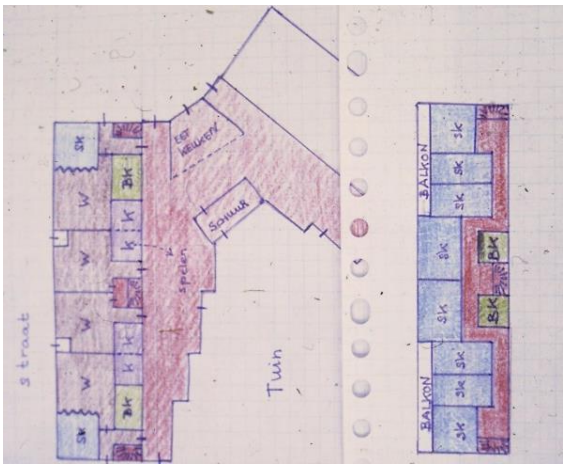

Photo-3. Nikolin Jansen sketch

Source: Flip Krabbendam (May 2023).

All participants embraced the spatial concept of collaborative living, sharing their experiences and ideas concerning co-housing. This concept aimed to transition from public spaces, where all clusters interact, to semi-public spaces for each cluster, and finally to private units for residents. Throughout this transition, equal treatment for all residents in their use of spaces was emphasized, ensuring privacy preservation (Figure-7).

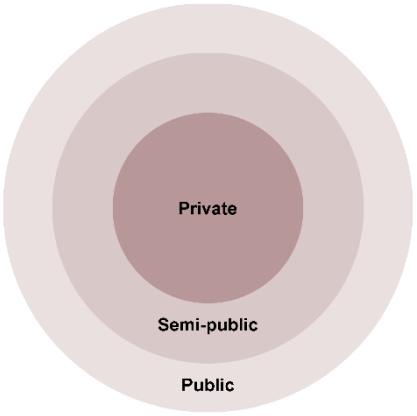

Figure-7. Spatial diagram

Source: Author (May-2023).

Langedijk and Krabendam focused on conducting surveys to determine the optimal capacities of social spaces. They decided that each cluster should accommodate groups of around 30 people, and that shared kitchens should hold 8 to 12 people per cluster. The design process began with the inclusion of common facilities such as gardens, workshops, and laundry rooms to ensure accessibility for all resident clusters. As the design process progressed, participants expressed a desire for a café area to foster interaction with the surrounding neighbourhood (Photo-4).

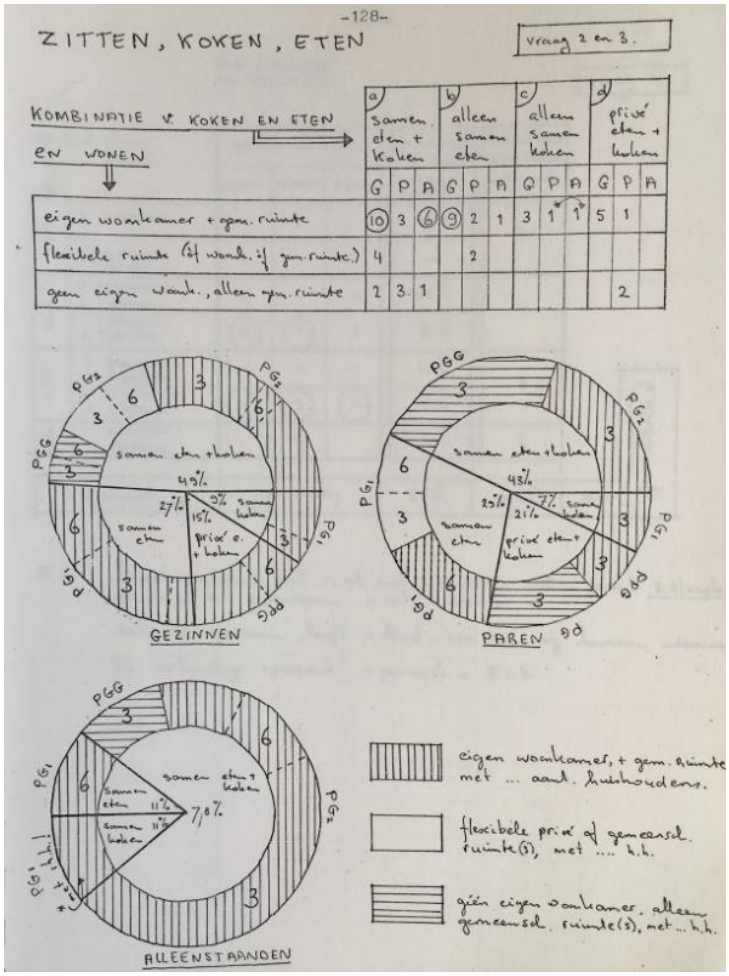

Photo-4. Survey results

Source: Flip Krabbendam (May-2023).

Participants were organized into brainstorming groups to propose alternative housing models, which resulted in the creation of three different forms. One alternative was selected through a voting process (Photo-5). The focus was on the distribution of private, semi-private, and public spaces. The design utilized colors to clearly distinguish between different areas. Yellow was used for the kitchen, living room, and sitting area, while orange represented public spaces such as the laundry facilities, and bike storage. Green was used to indicate private units, which could be flexibly adjusted to suit individual preferences (Photo-6).

Photo-5. Model for Resident Choice

Source: Flip Krabbendam (May-2023).

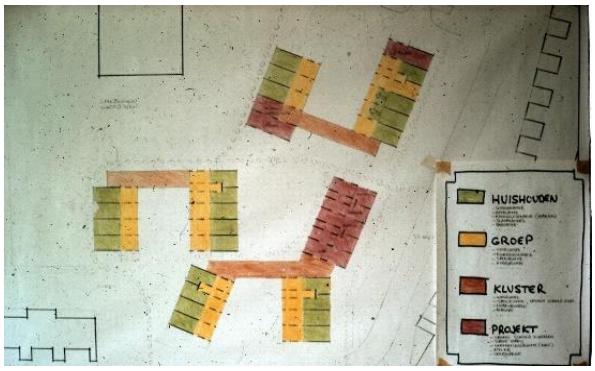

Photo-6. Function color

Source: Flip Krabbendam (May-2023).

Following the consensus on the co-housing design, prospective residents gathered in the café area to participate in the selection units process. They voted to choose their units from four clusters. Interestingly, the blue cluster was initially chosen by only one resident due to some residents' concerns regarding its location. However, the residents actively collaborated and worked together to address these concerns by modifying certain aspects of the blue cluster, resulting in more residents choosing it. In organizing the clusters, the architect adopted an interactive approach by engaging residents in discussions about their preferences. While some residents preferred having larger rooms, others did not, primarily due to financial reasons. This collaborative design process enabled a wide range of preferences to be considered, leading to the development of a flexible design that effectively met the needs of the residents. Eventually, everyone expressed contentment with their final choices (Photo-7).

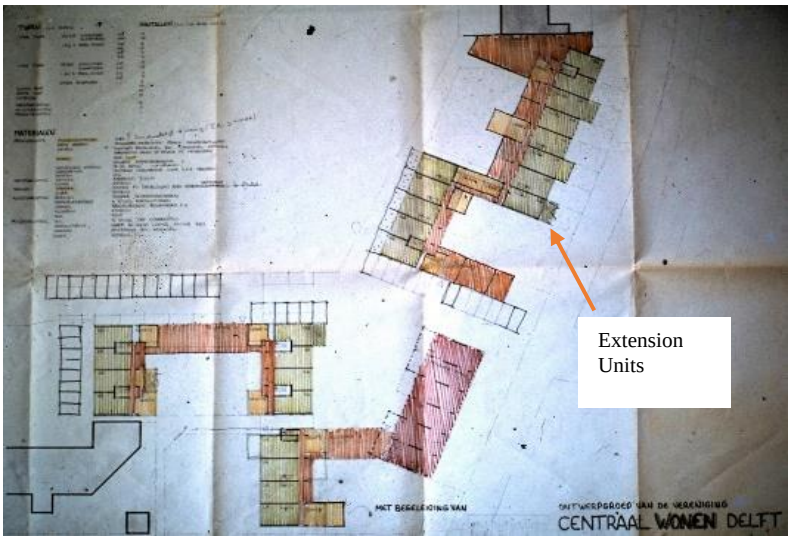

Photo-7. Plan for extension rooms

Source: Flip Krabbendam (May-2023).

In order to facilitate the implementation of the housing project, a 1:1 scale model was utilized at the University of Delft. This approach allowed residents to directly experience the physical dimensions of the spaces and engage in meaningful discussions about room configurations (Photo-8).

"Some residents objected to the presence of columns in the living rooms, as they required a wider space for various activities" (Krabbendam, semi-structured interview, May 2023).

This highlights the importance of the experiential aspect for residents.

"They sought to gain an understanding of how they would live within the co-housing" (Krabbendam, semi-structured interview, May 2023).

Photo-8. Model of 1:1 for co-housing

Source: Flip Krabbendam (May-2023).

After the selection of their units, the process of developing the facade commenced, leading to additional meetings. In this context, the architect played a pivotal role in establishing the preliminary guidelines for the facade, while each resident participated in the design of their section (Photo-9).

"Residents were involved in the design of the facades to create their own perception" (Krabbendam, semi-structured interview, May 2023).

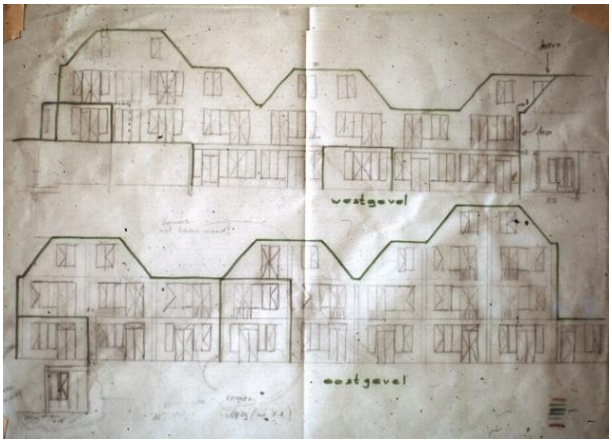

Photo-9. Residents' drawings

Source: Flip Krabbendam (May-2023).

Moreover, driven by a sense of communal responsibility, the local architect residing in the community proposed alternative designs for the public garden at the center of the CW (Photo-10). However, due to insufficient finances, not all residents agreed to the development of the garden. Nonetheless, they acknowledged the possibility of implementing the design at a later point in time.

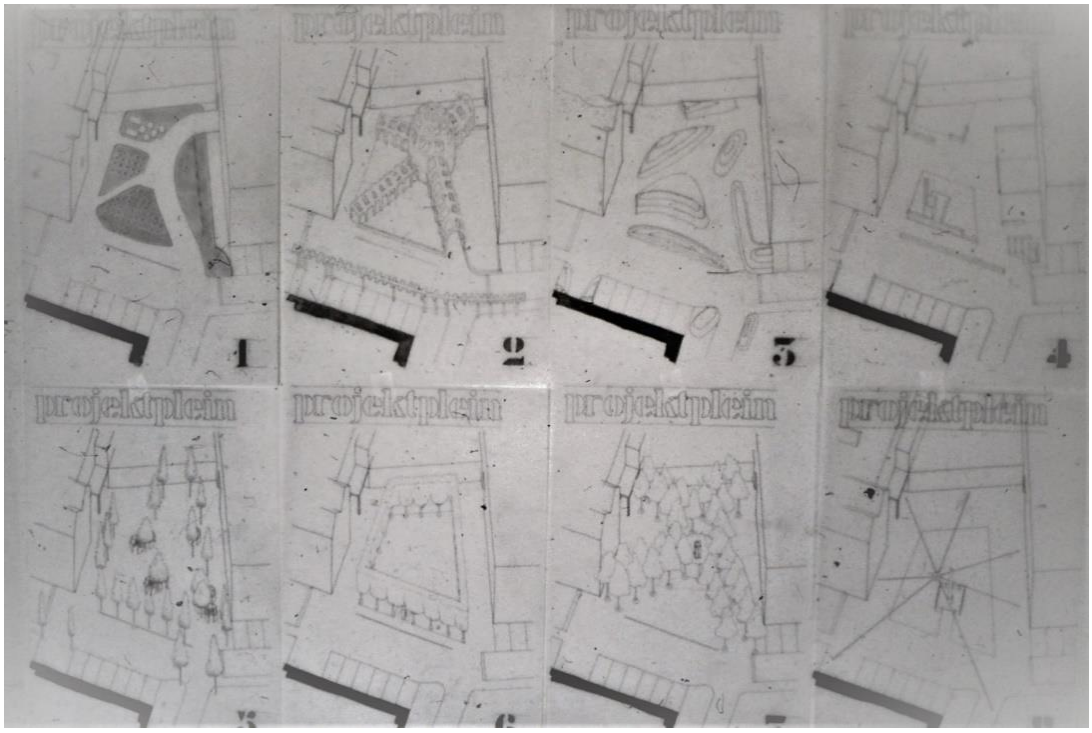

Photo-10. Architect proposals

Source: Flip Krabbendam (May-2023).

Throughout the design process, a consistent communication channel was established between DUWO and the Delft municipality. This involved frequent meetings with active resident participation. As a result, the municipality played a significant role in shaping the project's legal framework through decision-making contributions, comprehensive reviews, and ensuring a favourable project trajectory (Photo-11).

Photo-11. Meeting with Municipality

Source: Flip Krabbendam (May-2023).

"This woman has been actively working in the Delft municipality and participating in residents' meetings to ensure the successful progression of the project" (Krabbendam, semi-structured interview, May 2023).

Notably, the decision-making scope extended to the housing minister, who not only participated in resident meetings but also contributed to formulating proposals for different types of private units in the project.

The subsequent phase of the project, led by architect Henk Klunder, involved diligent monitoring of the construction process by the community. However, upon completion, the residents found the aesthetics of the wooden facades unsatisfactory. To address this, they collaborated on a new design, distinguishing each cluster with a vibrant color. This design was then transformed into a model and discussed in subsequent meetings with the Municipality of Delft and DUWO (Photo-12, Photo-13).

Photo-12. Meeting with Municipality

Source: Flip Krabbendam (May-2023).

Photo-13. New façade proposal

Source: Flip Krabbendam (May-2023).

To sustain the project, biannual meetings are regularly held to set priorities and plan finances. For instance, in these meetings, residents voiced their wish to enhance natural lighting and ventilation in their living spaces (Photo-14), as well as develop communal gathering spots, such as the kitchen, which underwent a redesign to improve accessibility and serviceability (Photo-15).

Photo-14. Maintain facade

Source: Flip Krabbendam (May-2023).

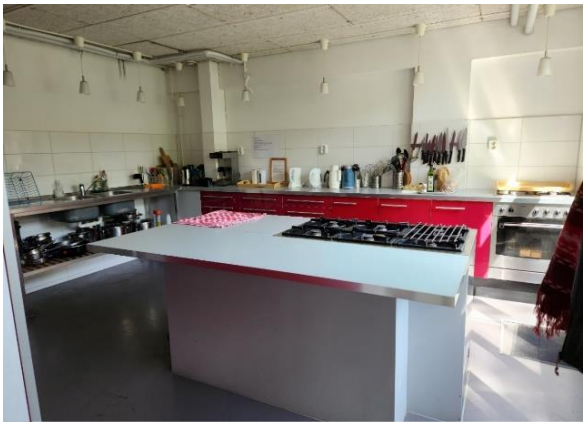

Photo-15. Maintain kitchen

Source: Photo by Author (May-2023).

The most significant change in the project was the transformation of the buildings' facades, prompted by DUWO's acknowledgment of the environmental negative impact of the current concrete materials used in construction. This task was entrusted to Yasser Hassan, an architect and former resident of CW, whose selection was based on his deep understanding of housing requirements, gained from his personal experience as a resident. Through iterative meetings and a resident questionnaire, the drawings were meticulously crafted, reflecting the unanimous approval of the residents.

As final improvements included the incorporation of bird and bat nesting boxes into the facades to protect the local ecosystem, and the retention of ground-floor entrances to promote social cohesion and security. To boost environmental sustainability, residents suggested increasing the facade thickness, enhancing ceiling insulation, and installing ventilation networks. They also proposed the addition of solar panels to cut energy consumption. Furthermore, to preserve the structure's unique color scheme, residents and the architect proposed embedding colors within the windows to highlight the composition of the clusters (Photo-16).

Photo-16. New façade model

Source: https://www.topos.nl/portfolio/centraal-wonen-delft/ (June-2023).

4.2 Data analysis and discussions

This section investigates the correlation between co-production and social sustainability in the context of CW. The interplay among these concepts is examined, with a particular focus on their interrelationships. The data analysis process incorporated multiple information sources, such as primary and secondary data, as well as observations. The Atlas.ti software was employed to interconnect all concepts, following the operationalization framework. The integration of findings from diverse resources facilitated triangulation, thereby enhancing the internal validity of the research due to the congruence of data output. To establish connections between indicators, the analysis utilized co-occurrence tables (Table-4, Table-5) and Sankey charts.

	● The process: How (goal setting)	● The process: Where (context-based)	● The process: Who (interactive)	● Negative Community Acceptance	● Positive Community Acceptance	● Negative Community Interaction	● Positive Community Interaction	● Negative Collaborative Effort	● Positive Collaborative Effort	● Challenges: Environmental	● Challenges: Financial	● Challenges: Social	● Accessibility: Access all resources and facilities	● Inclusion	● Level of participation	● Sense of belonging	● Sense of safety: Resident don't feel safe in CW	● Sense of safety: Resident feel safe in CW	● Social networks: Share the skills and knowledge	● Social networks: Social connections	● Social networks: Well-being	● Stability
● The process: How (goal setting)	0	48	28	3	20	8	55	8	49	7	6	26	6	47	13	18	0	0	12	28	0	1
● The process: Where (context-based)	48	0	22	2	8	4	33	4	20	1	4	10	7	19	6	7	0	0	5	15	0	0
● The process: Who (interactive)	28	22	0	1	8	2	30	3	17	1	5	11	2	16	0	3	0	0	9	8	0	0
●Negative Community Acceptance	3	2	1	0	0	12	1	3	1	1	1	17	2	7	3	5	5	0	1	5	0	2
● Positive Community Acceptance	20	8	8	0	0	0	42	1	23	2	0	16	15	20	19	25	0	11	10	30	13	2
● Negative Community Interaction	8	4	2	12	0	0	0	12	0	5	4	35	0	10	5	10	12	0	0	9	1	3
● Positive Community Interaction	55	33	30	1	42	0	0	3	56	0	2	27	26	37	32	33	0	20	24	48	24	3
● Negative Collaborative Effort	8	4	3	3	1	12	3	0	0	2	2	15	3	2	3	5	3	0	1	6	1	2
● Positive Collaborative Effort	49	20	17	1	23	0	56	0	0	2	1	14	17	36	19	25	0	9	14	38	15	6
● Challenges: Environmental	7	1	1	1	2	5	0	2	2	0	4	5	0	5	1	1	0	0	0	1	0	0

Table 4. Co-occurrence table 1

Source: Author (July -2023) from Atlas Ti.

	● The process: How (goal setting)	● The process: Where (context-based)	● The process: Who (interactive)	● Negative Community Acceptance	● Positive Community Acceptance	● Negative Community Interaction	● Positive Community Interaction	● Negative Collaborative Effort	● Positive Collaborative Effort	● Challenges: Environmental	● Challenges: Financial	● Challenges: Social	● Accessibility: Access all resources and facilities	● Inclusion	● Level of participation	● Sense of belonging	● Sense of safety: Resident don't feel safe in CW	● Sense of safety: Resident feel safe in CW	● Social networks: Share the skills and knowledge	● Social networks: Social connections	● Social networks: Well-being	● Stability
● Challenges: Financial	6	4	5	1	0	4	2	2	1	4	0	8	1	4	0	0	0	0	0	1	0	0
● Challenges: Social	26	10	11	17	16	35	27	15	14	5	8	0	17	20	13	21	15	5	7	28	9	6
● Accessibility: Access all resources and	6	7	2	2	15	0	26	3	17	0	1	17	0	12	19	18	0	10	13	35	20	3
● Inclusion	47	19	16	7	20	10	37	2	36	5	4	20	12	0	11	20	5	3	8	23	2	1
● Level of participation	13	6	0	3	19	5	32	3	19	1	0	13	19	11	0	32	0	15	20	35	18	1
● Sense of belonging	18	7	3	5	25	10	33	5	25	1	0	21	18	20	32	0	4	16	13	53	22	4
● Sense of safety: Resident don't feel safe in CW	0	0	0	5	0	12	0	3	0	0	0	15	0	5	0	4	0	0	0	6	1	1
● Sense of safety: Resident feel safe in CW	0	0	0	0	11	0	20	0	9	0	0	5	10	3	15	16	0	0	3	17	22	7
● Social networks: Share the skills and knowledge	12	5	9	1	10	0	24	1	14	0	0	7	13	8	20	13	0	3	0	20	9	1
● Social networks: Social connections	28	15	8	5	30	9	48	6	38	1	1	28	35	23	35	53	6	17	20	0	34	9
● Social networks: Well-being	0	0	0	0	13	1	24	1	15	0	0	9	20	2	18	22	1	22	9	34	0	4
● Stability	1	0	0	2	2	3	3	2	6	0	0	6	3	1	1	4	1	7	1	9	4	0

Table 5. Co-occurrence table 2

Source: Author (July-2023) from Atlas Ti.

4.2.1 Discussions on the co-production process

4.2.1.1 Co-production Process

This section answers the sub-research question: “How is the co-production approach applied in the co-housing project at 'Centraal Wonen, Delft'?”

(i) Who is involved (interactive)

The CW Delft project is a collaborative endeavour involving a diverse range of stakeholders over a prolonged period. As indicated in the interviews, the primary participants:

1- The government, specifically the Delft municipality and the Minister of Housing.
2- The Housing Association (DUWO).
3- The past and current residents.
4- Experts such as architects, journalists, sociologists, and construction engineers.

The project involved all stakeholders in the development over time. In the past, previous and future residents, as well as experts, actively participated in meetings.

“Previously, we held weekly meetings to generate design ideas and ensure the satisfaction of all parties involved” (Krabbendam, semi-structured interview, May 2023).

These meetings also facilitated regular interactions with the Delft municipality to present proposals.

Currently, residents aged 18 and above convene semi-annually in the General Meeting of Members (ALV) to strategize future development plans and manage finances (Photo-17).

"Decisions made during these meetings encompass aspects such as defining services costs and planning renovations to CW" (R3, semi-structured interview, May 2023).

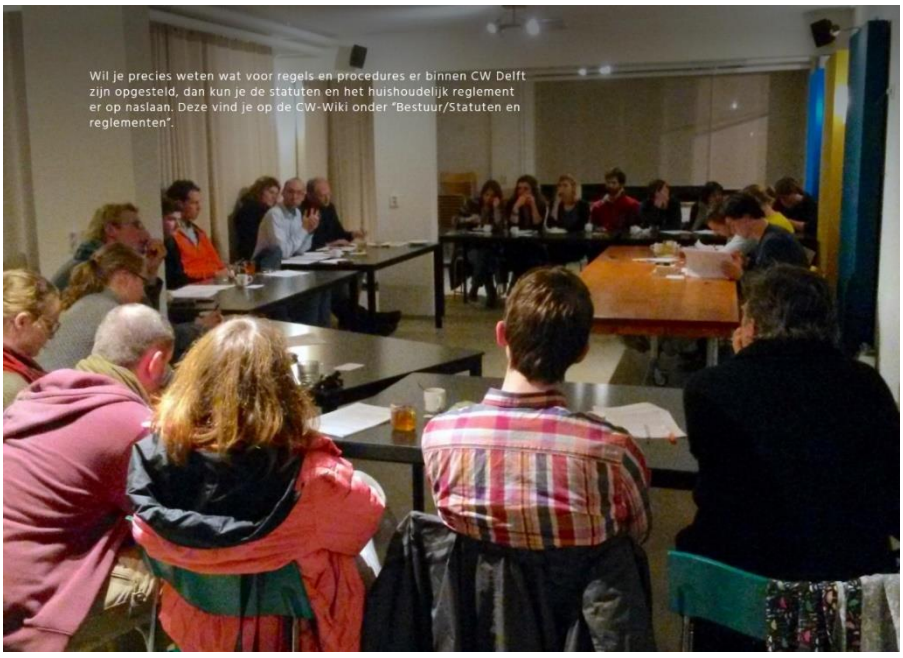

Photo-17. ALV meeting

Source: https://issuu.com/welkomstcommissie/docs/welkomstboekje_centraal_wonen (June-2023).

An example for discussion in this meeting is the transformation of building facades, as explained:

"After defining the facade goals and understanding DUWO's requirements in a meeting, a questionnaire was circulated, with most residents participating. Representatives from each cluster approved the required alternative in the final meeting" (R6, semi-structured interview, May 2023).

Furthermore, all residents are equally involved in the decision-making process when selecting a new resident.

" When units are vacant, we vote for applicants on our website, with all cluster residents participating" (R8, semi-structured interview, May 2023).

(ii) How are people involved (goal setting)

Incorporating diverse experiences through dialogues, collaborative problem-solving, active engagement, and shared decision-making among stakeholders is crucial for establishing a co-production approach in CW. It is important to note that co-production extends beyond goal setting; it involves additional activities that support residents in achieving their goals. This approach fosters equitable and dynamic decisions that take into account changes in residents and prevailing circumstances (Czischke, 2018; Norström et al., 2020; Verschuere et al., 2012).

During the co-production process, residents' differences of opinion are embraced within a spirit of participation and comprehensive understanding.

"Residents' requests for flexible housing unit designs were deliberated and accommodated without causing financial strain for others" (Krabbendam, semi-structured interview, May 2023).

A significant example of collaboration with the local municipality occurred when residents proposed transforming a car park into a vegetable garden.

"Initially, this decision posed challenges due to concerns about increased car numbers. However, the residents were convinced that the priority lay in establishing the garden, and thus their request was accepted" (Krabbendam, semi-structured interview, May 2023).

As residents' needs persistently evolved, the decision-making process adapted accordingly. Despite disagreements, meetings and collaborative efforts among residents consistently yielded positive results through the acceptance of diverse opinions. One resident reflected on the housing development process, stating:

"Differences in decision-making create challenges that strengthen social bonds. We're not just neighbors; we're friends. These challenges must be overcome. For instance, we adapted unused public spaces to cater to our changing needs. Despite initial difficulties, we found a satisfying solution through continued discussions" (R5, semi-structured interview, May 2023).

Residents are encouraged to maintain their active participation in decision-making, as articulated by another resident:

"We convene every first Sunday of the month to discuss our objectives as residents and improve our buildings. The aim of these meetings is to solidify our community bond" (R10, semi-structured interview, May 2023).

(iii) Where is it applied (context-based)

Previously, CW established a system of routine resident meetings, during which roles were allocated to specific task-oriented groups.

"Each group of residents held a distinct notion about the concept of co-housing. They divided themselves into groups, and each group appointed a spokesperson to present their ideas" (Krabbendam, semi-structured interview, May 2023).

As the project advanced, one group, consisting of permanent members, communicated with the municipality to expedite the project's development. Another group worked closely with the architect, using a 1:1 model at the University of Delft, to actively shape the project. A separate group was tasked with ensuring effective intra-resident communication during meetings.

During the construction phase, residents regularly visited the site and continued to make enhancements even post-completion.

"After deciding on the facade design and during its implementation, we discovered issues with its appearance. Consequently, the residents reconvened on-site and proposed alternatives for the facade's shape" (Krabbendam, semi-structured interview, May 2023).

Currently, residents convene in a central meeting area, the café. This location is pivotal in facilitating decision-making, ensuring accessibility for all residents, and promoting inclusivity, as per the survey findings (Appendix 2-Section 5). One resident noted,

"I believe that public spaces are instrumental in facilitating dialogue and the sharing of ideas. Relevant information is typically shared through WhatsApp prior to each gathering" (R9, semi-structured interview, May 2023).

Upon analyzing the co-production process, it is evident that it plays a pivotal role in CW, significantly influencing the outcomes of the process. The extent of resident participation in the process varies, influenced by factors such as where the activity takes place and individual motivations. Despite the potential challenges encountered during this process, they can be mitigated through mutual acceptance and collaborative decision-making. These insights are encapsulated in the co-occurrence table (Table-4, Table-5), which delineates the positive and negative correlations between the co-production process and process outcomes, particularly in fostering community interaction, acceptance, and collaboration. The table also underscores the prominent challenges in this process, with social issues being the most common, followed by financial and environmental challenges.

(Figure-8) offers a graphical representation of the relationship between the co-production process, indicate in yellow, and its outcomes, which are classified as either positive (green) or negative (red). The figure also illustrates the representation of challenges, marked in purple. Importantly, the thickness of the lines in the figure symbolizes the intensity of the relationships between these indicators. A comprehensive analysis of these indicators will be provided in the forthcoming section 4.2.1.2.

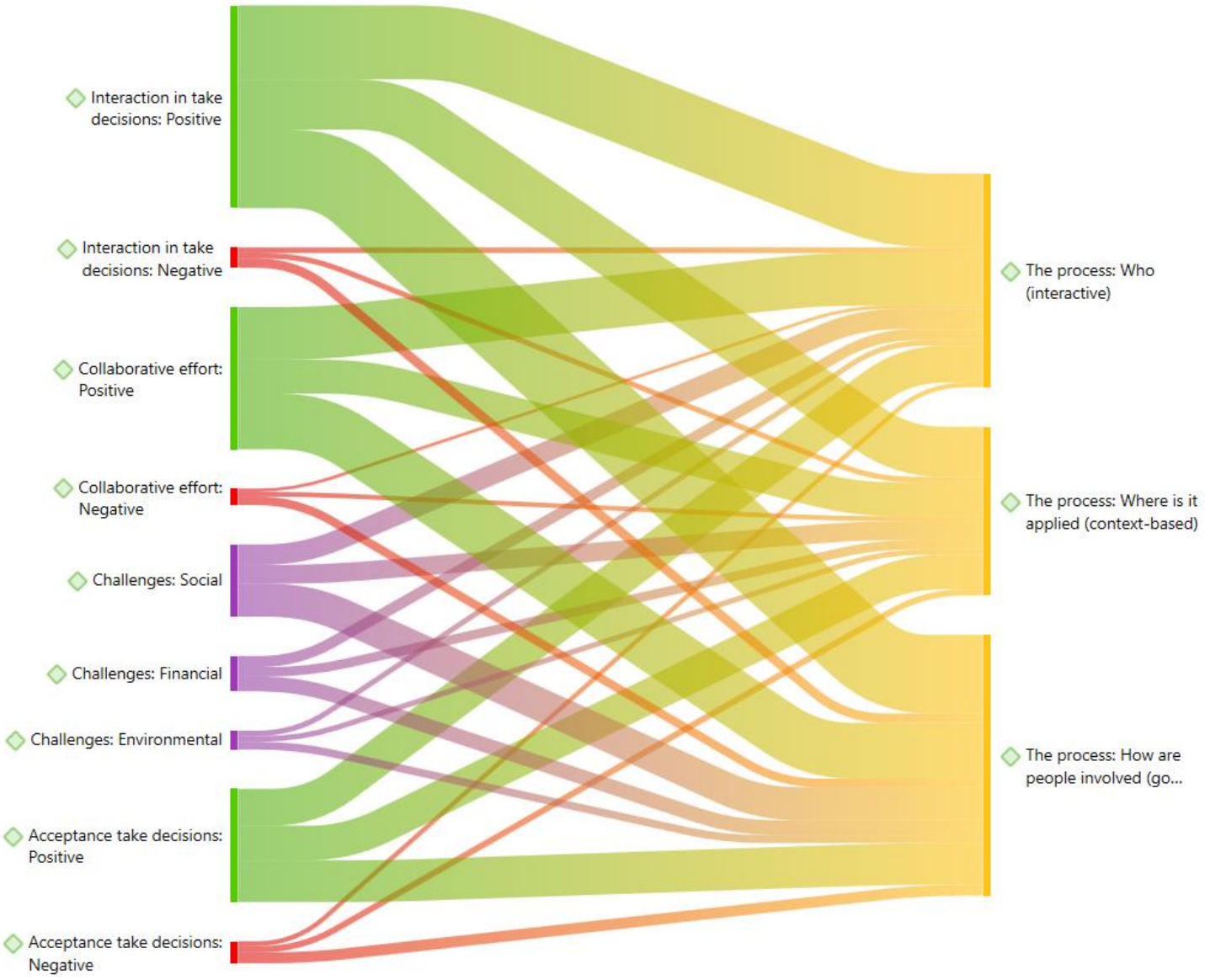

Figure-8. Sankey diagram for relationship between co-production process and co-production outcomes

Source: Author from Atlas.Ti (July-2023).

4.2.1.2 Outcomes of co-production process and challenges

This section tackles the second sub-research question: “How might co-production in co-housing at 'Centraal Wonen, Delft' lead to anticipated outcomes and challenges?”

(i) Community interaction

The project process is examined through the lens of community interaction, segmented into positive and negative aspects. Krabbendam states,

“In the beginning, we agreed that all residents would participate in decision-making. We set up rules together to govern our involvement. This allowed us to actively make design decisions and adjust the building until the units were assigned.”

Furthermore, a current resident elaborated,

"In cases where a member is absent, they are required to delegate authority to another resident to ensure decision-making continuity"(R3, semi-structured interview, May 2023).

Despite the commitment to community participation and fostering interactions for societal progress, challenges persist in decision-making. As one resident notes,

"We consistently convene meetings, although there are some residents who display a negative attitude towards participation, exerting negligible influence on decision outcomes. Nevertheless, we endeavor to continuously motivate them to actively engage in meetings" (R10, semi-structured interview, May 2023).

Table-4 and Table-5 illustrate a strong positive correlation between residents' interaction in the project process and the co-production process. This interaction is closely linked to the collaboration between residents in decision-making, as evidenced by 56 co-occurring codes. The acceptance among residents, indicated by 42 codes, strengthens this connection. The accessibility for all residents to participate in decision-making, represented by 26 codes, and the inclusion of all residents in the process, represented by 37 codes, enhance their level of participation, as shown by 32 codes. This sense of belonging to the community, evidenced by 33 codes, boosts social connections, which are positively correlated with 48 codes.

(ii) Community acceptance

The acceptance process illustrates the degree of community satisfaction concerning the co-production process. This includes both positive aspects that indicate achieved satisfaction and negative aspects that highlight the challenges encountered. As an example, Krabbendam stated:

"During the design exploration, intense discussions among the groups caused initial disagreements. However, by carefully considering alternatives and understanding each group's needs, a mutually acceptable option was chosen.

This emphasizes the importance of continuous interaction and acceptance of designs by residents in the co-production process, which significantly influences design decisions tailored to their needs.

"After meeting with DUWO and learning about the new facade requirements, we held meetings with residents. We presented different design options and incorporated everyone's suggestions into the final alternative, which was unanimously agreed upon." (R3, semi-structured interview, May 2023).

The acceptance process also involves the development of public spaces that align with the community's needs.

"After moving to this community, I suggested improvements to the living room's layout, which were agreed upon by the residents and implemented." (R7, semi-structured interview, May 2023).

Table-4 and Table-5 emphasize the pivotal role of community acceptance in streamlining the co-production process. It shows a positive correlation between community interaction, as indicated by 42 codes, and collaboration among residents in decision-making, as suggested by 23 codes. This correlation is further substantiated by 20 codes, which imply the inclusion of all residents in the process. Furthermore, a robust link is evident between acceptance and its influence on social connections, as demonstrated by 30 codes.

(iii) The collaborative effort

Collaboration is integral to the co-production process, intertwining with social interaction and community acceptance of decision-making. It serves as a measure of social skill development within co-housing contexts. As Krabbendam notes in the design phase,

"As an architect, I established design principles and created models. The sociologist assisted me in developing a questionnaire to understand the residents' needs, and the journalist effectively promoted the building in newspapers. This collaboration greatly aided our efforts".

This collaborative ethos extends to the design of living spaces and communal areas. Krabbendam further states,

"After finalizing the design, we collaborated on the interior details of the building. One resident suggested creating kitchens near the living areas with open windows, allowing us to observe children playing".

The collaboration persists, involving new residents in building modifications. This continuous collaboration disseminates knowledge, sustains the co-production process, and strengthens resident bonds.

"By collaborating in setting our priorities, we develop a deeper understanding of one another" (R6, semi-structured interview, May 2023).

However, collaboration can present challenges. As another resident observes,

"In certain instances, collaborating between residents can be challenging due to varying levels of sociability. Nevertheless, the majority of cases witness harmonious collaboration among everyone involved" (R4, semi-structured interview, May 2023).

The findings from Table-4 and Table-5 suggest that collaboration is an effective outcome of co-production, showing a positive correlation with the co-production process. This is supported by 56 codes for community interaction and 23 codes for community acceptance. The table also indicates a positive relationship between collaboration and increased resident participation, fostering inclusion and a sense of belonging, thereby enhancing social connections (38 codes).

(iv) Challenges

a. Social challenges:

The co-production process inherently involves continuous interaction among community members, particularly during the decision-making stages. This can occasionally result in conflicts due to differing perspectives.

"When the final design was completed, some residents expressed their discontent regarding the limited size of private spaces. Consequently, a proposal was put forth to expand these areas; however, this decision was met with conflict from other residents." (Krabbendam, semi-structured interview, May 2023).

Furthermore, managing public spaces has presented numerous social challenges.

" In the past, a resident associated with an immigrant aid organization regularly used public spaces for gatherings, causing persistent disruptions and numerous problems. (Krabbendam, semi-structured interview, May 2023).

b. Financial challenges:

Financial challenges primarily occur during the development and decision-making stages. For example, a proposal to enhance a central park was met with financial constraints.

"Due to insufficient funding for the park's development, residents were unable to make a final decision, leaving the park's care to the municipality" (Krabbendam, semi-structured interview, May 2023).

Presently, community members actively participate in setting priorities for housing development that align with the budget during ALV meetings. As one resident stated:

"Our group determines the annual budget for building and public space maintenance. If the number of projects exceeds the budget, maintenance becomes optional to prioritize urgent needs" (R8, semi-structured interview, May 2023).

c. Environmental sustainability challenges:

Given that the CW project was constructed in the past, certain materials used did not align with environmental sustainability objectives.

"Previously, concrete was used in the building facades, which had negative environmental implications. As a result, DUWO proposed replacing these facades with environmentally friendly materials" (Krabbendam, semi-structured interview, May 2023).

Moreover, residents collaborated with both the architect and DUWO to address concerns regarding energy consumption within the buildings. Proposals were made to modify the structures, such as increasing facade thickness and installing solar panels on the roofs.

"As a mechanical engineer, when I learned about the need for sustainability improvements in the building, I provided energy-saving solutions" (R5, semi-structured interview, May 2023).

4.2.2 Social sustainability discussions

This section tackles the sub-research question: "What are the elements of social sustainability applied in the co-housing project at 'Centraal Wonen, Delft'?"

4.2.2.1 Community

(i) Social network (Increase social connection)

The social networks within residential clusters are strengthened by the ongoing interaction of residents in the communal areas within the building. In the past, these public spaces functioned as entertainment venues, hosting exhibitions and children's shows (Photo-18).

Photo-18. Social event for children

Source: Flip Krabbendam (May-2023).

Presently, residents gather weekly in semi-public spaces for social gatherings. As one resident articulated,

"I organize weekly parties through our WhatsApp group to strengthen our social bonds. We feel like a family here, and I always enjoy meeting them" (R8, semi-structured interview, May 2023).

Moreover, outdoor parties and various activities are held in the public areas linking clusters, which are instrumental in fostering close relationships among residents from different buildings (Photo-19).

"We coordinate communal events such as sports activities like cycling, walking, or social gatherings" (R5, semi-structured interview, May 2023).

Photo-19. Outdoor Party

Source: Flip Krabbendam (May-2023).

According to Table-4 and Table-5, it is evident that the outcomes of co-production positively influence the enhancement of social connections among residents. This influence permeates both the physical and social dimensions, as demonstrated by 53 codes signifying a sense of belonging. The availability of accessible interaction spaces plays a pivotal role in facilitating these social connections, as corroborated by 35 codes. Nevertheless, it is crucial to recognize that social connections also present challenges, as underscored by 28 codes that highlight instances of negative interactions. These findings are further substantiated by the identification of key interaction areas within the community, visually represented in (Appendix 2-Section 5), and (Figure-9).

Figure-9. Illustration for interaction spaces

Source: Develop by author (July-2023).

(ii) Social network's (Impact on well-being)

In the midst of the COVID-19 pandemic, the community's social network saw significant growth, profoundly impacting residents' overall well-being. Public spaces became crucial gathering points, facilitating physical activities and exercise that improved public health (Bramley et al., 2009; Dempsey et al., 2011).

"The pandemic has enhanced our solidarity. We allocated daily tasks without interaction, using the garden for communal gatherings and physical activities, promoting public health (Photo-20)" (Krabbendam, semi-structured interview, May 2023).

Photo-20. Activities at pandemic

Source: Flip Krabbendam (May-2023).

The community project also prioritized the well-being of the elderly, encouraging active participation from residents and children to eliminate feelings of isolation (Wang et al., 2021).

"Our aim is to foster well-being among the elderly, eradicating feelings of isolation among the elderly, children, and young adults. We are all part of the same cohesive community (Photo-21)" (R2, semi-structured interview, May 2023).

Photo-21. Elderly activity

Source: Member from organization (May-2023).

Additionally, a public space located in the middle of the co-housing area is used for activities such as meditation and yoga, contributing to the mental and physical well-being of the residents (Sanguinetti, 2014) (Photo-22).

Photo-22. Semi-public space for well-being

Source: Author (May-2023).

Table-4 and Table-5 highlight the positive correlation between enhanced well-being and social interaction, supported by 24 codes. The accessibility and use of communal spaces (Figure-10), as indicated by 20 codes, have significantly influenced residents' active participation (18 codes) and fostered a sense of safety and belonging (code 22). The well-being indicator shows a strong positive relationship with social connections, as evidenced by 34 coded instances.

Figure-10. Illustration for communal space

Source: Develop by Author (June-2023).

(iii) Social networks: (Sharing skills and knowledge)

The third dimension of social networking pertains to the exchange of diverse knowledge and skills, a consequence of the residents' varied backgrounds. This is particularly noticeable in the workshop spaces.

"There is a resident here who has a passion for crafting furniture and boats, and he willingly shares his skills with others. Additionally, we are currently creating garden furniture in this space and actively participating in its production (Photo-23)" (R4, semi-structured interview, May 2023).

Photo-23. Furniture for garden

Source: Author (May-2023).

Another instance where the exchange of knowledge and skills took place is in the workshop areas. A resident described the collaboration on renovation, saying:

"These spaces were previously inadequate but have been redesigned and improved through collective effort. Additionally, the residents have installed signs to guide the usage of these spaces." (R6, semi-structured interview, May 2023).

Photo-24. Workshop after development

Source: Author (May-2023).

Importantly, these interactions within public spaces include broader discussions about the residents' work, transcending professional boundaries, and fostering a culture of knowledge-sharing.

"I work as a soil engineer in the municipality of Den Haag. I share my knowledge with others about different types of soil and sustainable practices. I have a neighbor who shares his passion for sustainability, and we frequently meet to exchange knowledge"(R8, semi-structured interview, May 2023).

Table-4 and Table-5 underscore the positive correlation between the enhancement of knowledge and skills among community members and their interactions within public spaces, as substantiated by the survey results (Appendix 2, Section 5). This is evidenced by 24 codes, which underscore the augmentation of knowledge and skills. Additionally, the table highlights the increased level of participation among residents in these activities, as corroborated by 20 interconnected codes.

(iv) Level of participation

The diverse array of activities and numerous public spaces within co-housing have significantly enhanced resident participation.

"From the beginning, we share everything, and this shared living environment fosters a high level of engagement among residents through communal activities such as birthday events" (Krabbendam, semi-structured interview, May 2023).

This ongoing involvement in shaping their living environment has cultivated a robust culture of participation and community commitment.

"We continuously improve the communal areas, such as creating gathering spaces around a piano or billiards table, to encourage resident participation (Photo-25)" (R8, semi-structured interview, May 2023).

Photo-25. Gathering within CW

Source: https://deopenkaart.nl/10-voorbeelden-van-rijker-wonen-door-te-delen/ (June-2023).

Residents also actively contribute to community service initiatives, thereby enhancing communal well-being.

"Residents come here to interact with the elders, help the chef prepare food, and learn cooking techniques (Photo-26). Additionally, they engage in technical activities with them" (R2, semi-structured interview, May 2023).

Photo-26. The resident participates in cooking

Source: Member from organization (May-2023).

Furthermore, one resident highlights the significance of participation and its impact on the residents' responsibility towards their neighbors, stating:

"We have a shared vegetable garden (Photo-27) where residents collectively cultivate and care for plants" (R7, semi-structured interview, May 2023).

Photo-27. Vegetable garden

Source: Author (May-2023).

Moreover, participation is closely linked with residents' sense of physical and social belonging.

"I share my car knowledge and discuss politics with my neighbors, fostering a family-like atmosphere that truly feels like home." (R9, semi-structured interview, May 2023).

Table-4 and Table-5 present data that demonstrate a positive correlation between increased community participation and social connection, supported by 35 codes. This is due to the rise in resident interactions, indicated by 32 codes, and the acceptance and collaboration among all residents in decision-making, represented by 19 codes. These interactions stimulate active participation in activities such as skill-sharing, which is backed by 20 codes, and foster a strong sense of community belonging, as evidenced by 32 codes. The table also underscores the accessibility of facilities for residents, which further promotes their participation, as supported by 19 codes.

(v) Sense of belonging (Physically / Socially)

A profound sense of community belonging was articulated by numerous residents,

"I belong to this community, I consider these residents like my people, and I strive to be an exemplary person among them" (R6, semi-structured interview, May 2023).

The participants emphasized the significance of participating in communal activities and cohabitation in fostering a sense of belonging, even over a brief period.

"Since moving here, I quickly felt a sense of belonging, largely due to the warm and inclusive treatment from other residents" (R11, semi-structured interview, May 2023).

However, it is important to acknowledge that there are instances in which some residents prefer isolation.

"While we endeavor to foster connections and establish social bonds, some residents lean towards solitude. We respect and accommodate these differences without imposing our presence" (R5, semi-structured interview, May 2023).

The findings, depicted in Table-4 and Table-5, highlight a positive correlation between residents' sense of belonging and positive social connections, as evidenced by 53 codes. This correlation can be attributed to increased interaction among community residents, represented by 33 codes, and their collective efforts, represented by 25 codes. However, the table also reveals social challenges, denoted by 21 codes, which stem from some residents' tendency towards isolation or negative interactions with others.

(vi) Residents feel safe within the community

In a broader context, numerous residents emphasized the prevailing sense of safety within the community, attributing this to the ongoing interaction among its members.

"I consistently feel a profound sense of safety when interacting with fellow residents or residing at CW" (R7, semi-structured interview, May 2023).

However, it is crucial to recognize that there may be exceptions. For instance, one resident:

"There is an individual whose unusual behavior engenders a sense of unease. I, along with most residents, avoid visiting their place and limit interaction with them" (R6, semi-structured interview, May 2023).

Despite these exceptions, the overall sentiment among residents is one of safety within the community. This is corroborated by the data presented in Table-4 and Table-5, which reveals a strong correlation (20 codes) between the perception of safety and increased levels of interaction among community members. Interestingly, the data also suggests a negative correlation (15 codes) between social challenges that arise from conflicts among residents and the influence on their sense of safety.

(vii) Stability

The rental housing style in CW leads to the relocation of numerous residents elsewhere. A long-term resident of over twenty years described this situation,

"Regrettably, a majority of the residents choose to move to larger residences to accommodate their expanding families" (Krabbendam, semi-structured interview, May 2023).

Nevertheless, it is noteworthy that several residents express a desire to continue residing within CW.

"Having spent a significant portion of my life here, I am disinclined to relocate to an alternative dwelling. I perceive this place as an integral part of my identity" (R8, semi-structured interview, May 2023).

Community stability is intrinsically linked to the speed at which residents integrate into the community and cultivate a sense of safety with their fellow residents. This idea was expressed by a resident who recently moved to the community,

"Despite having recently relocated, I intend to extend my stay and integrate into this community" (R11, semi-structured interview, May 2023).

According to Table-4 and Table-5, stability is generally positively correlated with community interaction and collaboration, which strengthens the connection among residents, as indicated by the presence of 9 codes. This fosters a sense of safety among residents. However, there are also negative factors that can impact stability. For instance, residents who fail to harmonize with others or those who seek to expand their families may be relocated more swiftly, as evidenced by the presence of 6 codes indicating social challenges.

4.2.2.2 Equity

(i) Inclusion

Active participation in decision-making is a cornerstone of this dynamic community, starting from the initial design phase and extending to the selection of activities within public spaces. As Krabbendam articulates,

"The involvement of residents in all processes of the CW from start to finish, though challenging, yields positive results".

The community thrives on inclusivity, ensuring that no one is excluded from decision-making processes. As one resident expressed,

"We operate collaboratively, without societal segregation. Participation is voluntary, and decisions are made with everyone's consent" (R3, semi-structured interview, May 2023).

Table-4 and Table-5 illustrate a positive correlation between the inclusion of all residents in the co-production process. The data reveals this correlation through 37 codes denoting resident interaction and smooth collaboration (36 codes). Additionally, 20 codes highlight resident acceptance, underscoring the process's capacity to fortify relationships. However, social obstacles can hinder inclusion, as shown by 20 codes suggesting that some residents are not actively involved in the community.

(ii) Accessibility: access to all resources and facilities

Co-housing design is rooted in the principle of utilizing communal spaces, which include semi-public facilities like laundries, workshops, living rooms, and kitchens, as well as public spaces shared with neighbors, such as gardens. Krabbendam elucidates the relationship between the CW and the broader neighborhood, stating,

"This was achieved by linking the central area of the co-housing project to a corridor that connects with the entire district (Photo-28)".

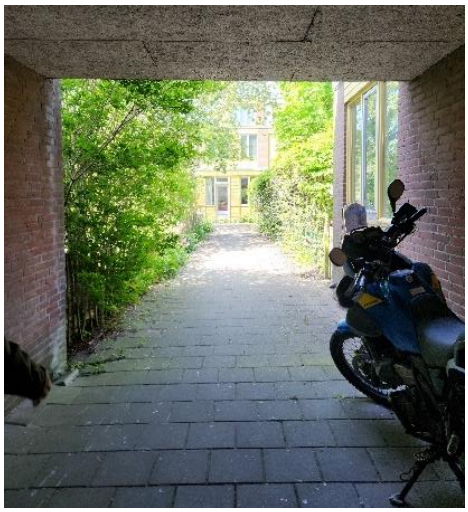

Photo-28. Link between CW with district

Source: Author (May-2023).

Consequently, the accessibility to public spaces within the CW is notably efficient and well-structured. As one resident shared,

"I use the communal kitchen daily as it facilitates interactions with fellow residents" (R4, semi-structured interview, May 2023).

The organization of roles within public spaces, coupled with easy accessibility, engenders a sense of responsibility among residents. As another resident noted,

‘‘The facilities checklist serves as a unifying symbol for all residents, prioritizing and organizing our collective responsibilities in public spaces (Photo-29)" (R9, semi-structured interview, May 2023),

Photo-29. Checklist table

Source: Author (May-2023).

Table-4 and Table-5 present 35 codes signifying the easy accessibility of communal spaces, which enhances the connection between residents participating in various activities or decision-making meetings and increases the level of participation with 19 codes. Furthermore, 26 codes indicate a positive correlation, fostering increased interaction among residents.

4.3 Main discussion, analysis summary

The in-depth analysis of CW highlights the crucial role of co-production characteristics in its formation. The study reveals that the extent of resident involvement in both past and current decision-making processes significantly influences co-production. The participation level is determined by three elements: 'who' participates in decision-making, acting as an influence catalyst, 'how' participation takes place in terms of decision-making processes and goal-setting, and 'where' in terms of the locations of activities and their impact.

Co-production initiatives have led to numerous social opportunities and challenges. Since the project's inception, residents have actively participated in transforming their living environment, encompassing both physical structures and personal relationships. The positive outcomes of co-production include increased equality, inclusion, safety, a sense of belonging, and improved quality of life, contributing to social sustainability. However, co-production also poses challenges, including social difficulties, financial constraints, and environmental issues related to co-housing.

(Figure-11) provides a clear depiction of the relationship between co-production as a process (shown in yellow) and its outcomes, including both positive effects (green) and negative effects (red), as well as challenges (purple). These outcomes significantly impact two key indicators: social sustainability within the community (blue) and equity (brown). The strength or weakness of these relationships is represented by the thickness of the connections.

The study findings suggest that community interaction and acceptance are vital in fostering a positive relationship with social sustainability, as evidenced by the strong connection between them. This connection fosters a positive social network where residents can share knowledge and skills, feel connected, and enhance their overall well-being. The establishment of a system to manage internal relationships during the COVID-19 pandemic is a prime example of this solidarity and high level of participation among community members.

As depicted in Figure-11, co-production positively impacts both the physical and social aspects of the community. It reduces feelings of isolation and positively influences overall well-being, especially through the active participation of the elderly with individuals from different age groups. These activities also contribute to environmental sustainability by replacing car parking spaces with gardens and involving residents in environmentally-friendly initiatives aimed at reducing energy consumption and saving costs.

However, co-production also presents challenges or negative impacts. While it promotes positive outcomes, certain obstacles can hinder the co-production process. Some residents may be hesitant to participate or may feel uncomfortable engaging in activities. Additionally, financial difficulties can arise when managing priorities within the project. Environmental challenges related to the co-housing design, energy consumption, and the temporary nature of co-housing rentals can also impact stability.

Despite these challenges, the Municipality of Delft and DUWO have played a crucial role in monitoring developments and evaluating outcomes with residents. Their involvement has been instrumental in addressing and mitigating the negative impacts and challenges associated with co-production. By actively overseeing the progress and assessing the results, they contribute to the continuous improvement and success of the co-production initiative.

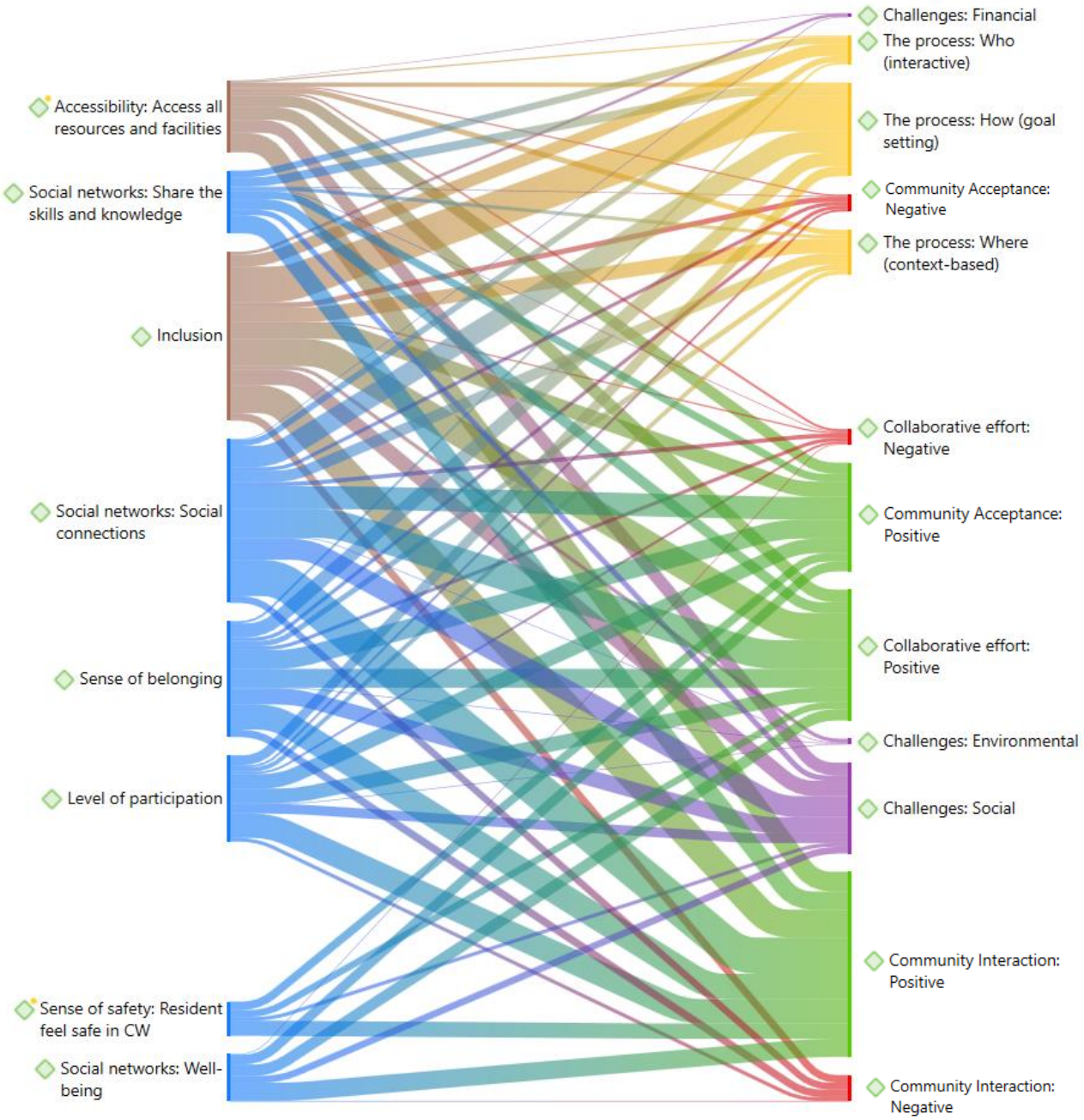

Figure-11. Sankey diagram illustrating the relationship between the co-production process and social sustainability

Source: Author from Atlas.Ti (June-2023).

In conclusion, co-production has emerged as a potent tool in fostering a sustainable and socially stable society with effective management. It has shown its adaptability to changing project requirements over time. Enhanced interaction, inclusive decision-making, knowledge exchange, and stronger social connections have emerged as prominent indicators of successful co-production and social sustainability. Despite the presence of challenges, such as social, financial, and environmental issues, as well as negative interactions and limited engagement, these concerns primarily affect individual residents rather than the collective as a whole. Furthermore, the specific challenges associated with co-production, such as time constraints and financial limitations, have not significantly impacted the social fabric of the community.

Chapter 5: Conclusions and recommendation

5.1 Conclusions

This research investigates a unique case of co-housing, where inhabitants adapt their living spaces to meet evolving needs. This innovative housing model addresses urban issues related to housing development and social disconnection. The study encountered limitations due to a restricted timeframe and commuting difficulties. The findings are confined to insights from English-speaking residents who participated in interviews.

The main research question is: How does the co-production approach of co-housing, as exemplified in 'Centraal Wonen, Delft,' contribute to social sustainability?' This question is further divided into three sub-questions, elaborated in subsequent sections.

5.1.1 RQ1: How is the co-production approach applied in the co-housing project at 'Centraal Wonen, Delft'?

Co-production, a collaborative process involving multiple stakeholders, augments services through collective decision-making (Czischke, 2018; Tummers, 2017). It arises when stakeholders with shared goals intersect within an urban context (Norström et al., 2020). However, co-production can yield negative effects when stakeholders lack initiative or conflicts emerge (Broadhurst, 2022).

Co-housing, alternatively, embodies residents working collectively to satisfy their social, economic, and psychological housing needs, propelled by a shared purpose and inclusivity (Choi, 2013; Corfe, 2019).

In the CW, diverse residents from the past until today collaborate closely with municipal authorities and DUWO for dynamic project development. Despite yielding positive outcomes, challenges arise. Co-production facilitates equitable and inclusive community participation in decision-making processes, benefiting residents. However, increased interaction can lead to divergent opinions and reluctance among some residents due to potential complications. Nevertheless, co-production fosters a sense of belonging and positive interactions, enhancing social connection.

5.1.2 How might co-production in co-housing at 'Centraal Wonen, Delft' lead to anticipated outcomes and challenges?

The process of co-production has shaped the CW, resulting in positive outcomes and challenges. Co-production empowers citizens by providing equal opportunities for engagement in decision-making, creating balance and fostering strong community networks (Chambers et al., 2021; Verschuere et al., 2012). Active involvement not only enhances community participation but also fostering a sense of belonging among participants (Chambers et al., 2021; James, 2020). The positive outcomes of co-production can be attributed to community involvement in the co-housing design and ongoing discussions about their specific needs. Present-day interactions among residents further contribute to these positive outcomes, fostering increased participation and a sense of responsibility within the community (Verschuere et al., 2012).

However, challenges inevitably arise during the co-production process, such as conflicting opinions. These challenges require residents to actively engage and work together to find common ground, known as community acceptance of co-production decisions. The concept of community acceptance allows for flexibility in accommodating diverse needs and prioritizing accordingly (Voorberg et al., 2015). It is important to note that these challenges also play a role in fosters strong social relationships within the community, contributing to the overall idea of social sustainability (Chambers et al., 2021; Norström et al., 2020).

5.1.3 What are the elements of social sustainability applied in the co-housing project at 'Centraal Wonen, Delft'?

The concept of social sustainability originates from societal objectives aimed at meeting their needs (Corsini & Moultrie, 2021). It is closely tied to the co-production process, where sustainable challenges are effectively addressed through diverse collaborative efforts involving various decision-makers within specific contexts. Consequently, social sustainability facilitates continuous learning and fosters interactions among participants (Norström et al., 2020). These elements have significantly influenced the realm of social sustainability in CW, where the community actively participates in goal setting, equitable engagement in decision-making processes, and ongoing interaction with the municipality to voice their perspectives and ensure inclusive access to decision-making.

As a result, these endeavours have had a transformative impact on the community, cultivating a sense of belonging, enhanced commitment to achieving shared objectives, and a focused approach to improving the quality of life within the project. This is achieved through increased resident interaction and addressing challenges. Social interaction has engendered trust and safety among residents, profoundly influencing mutual reliance, social networks, acceptance of differing viewpoints, and the sharing of knowledge and skills. These factors foster a deep-rooted attachment to their place of residence. However, it is crucial to acknowledge the presence of challenges that have also affected social sustainability, including disparities in decision-making processes and a lack of safety among specific residents. These challenges are primarily individual cases rather than reflecting the collective experience of the broader community. The validity of these conclusions is supported by interviews conducted with various participants of interest.

5.1.4 Main research question “How does the co-production approach of co-housing, as exemplified in 'Centraal Wonen, Delft,' contribute to social sustainability?”

The co-production approach of co-housing in CW promotes social sustainability by fostering a strong sense of community and collaboration among residents. Studies by Norström (2020), Verschuere et al. (2012), and Wyborn et al. (2019) support the notion that specific characteristics of co-production influence the development of social sustainability concepts within the community. In CW, residents actively engage in defining, addressing, and achieving their objectives through regular meetings and ongoing collaboration, resulting in the establishment of a strong social network.

Corfe (2019) elucidates that the principles of co-housing resonate with residents' aspirations for an affordable co-living space where they can actively participate in its development and management. The design of communal spaces in CW, which is in line with the recommendations made by Williams (2005), facilitates social interaction while maintaining respect for personal space. These design elements stimulate increased collaboration among residents, particularly in the management of shared spaces.

Regular interaction among residents proves advantageous in problem-solving and collectively addressing challenges. The collaborative ethos of co-production fosters trust and safety within the community. While challenges may arise due to individual irresponsibility or lack of trust, these issues are mitigated through collaboration and continuous interaction, primarily impacting individuals rather than the community as a whole, as underscored by Broadhurst (2022) and Zurba (2021).

Moreover, the design of communal spaces and the active involvement of residents in decision-making processes play a pivotal role in achieving social sustainability in CW. These factors engender a sense of belonging and inclusion within the community, leading to increased communal activities, skill sharing, and active participation.

5.2 Recommendation

This study delves into the impact of resident-led co-housing, facilitated through a co-production process, on meeting residents' needs and promoting social sustainability within the Dutch context. The research seeks to fill a gap in the current academic literature on this subject. It is recommended that further research be conducted to elaborate on this topic and enhance the generalizability of the findings, thereby supporting the positive impact of co-production on social sustainability.

The research concentrates on a specific resident group in Delft, which offers numerous prospects for future research and guidance. Firstly, supplementary research could delve into the participation of individuals in the co-housing design process, with the aim of creating a socially sustainable environment that influences the composition of residents.

Secondly, qualitative research employing a greater number of interviews and discussions could be undertaken within the same framework to augment the data. Comparisons with other cases in diverse regions could be drawn to deepen the comprehension of the influence of co-production on social sustainability.

Thirdly, similar investigations can be carried out to examine the effects of co-production and the achievement of social sustainability within alternative forms of collaborative housing, drawing comparisons with the co-housing approach in Delft.

By exploring these research directions, future studies have the potential to generate new insights into the progression of social development within residential contexts and the dynamic process of meeting residents' needs over time. This contribution will not only enhance the academic discourse but also provide practical recommendations for policymakers, housing developers, and architectural designers.

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Appendix 1: Research instruments

1. Consent Form

Title thesis: Title: Unravelling the Impact of Co-Production on Social Sustainability in Co-Housing: A Case Study of Centraal Wonen, Delft

IHS Making cities work

Consent form

A. Introduction Part:

1- Welcoming the respondent:
Hello, thank you for giving me the time to take part in this interview.

2- Introduction of the interviewer:
My name is Mohammed Sayed. I am a student in the Urban Development and Management program at Erasmus University in Rotterdam.

3- Purpose of the interview:
As part of my thesis research, firstly my research topic is "Impact of social sustainability in co-housing through the process of co-production: A Case Study of Centraal Wonen, Delft"

I want to begin to clarify the concept of my research:
1- co-housing is a collaborative housing model where residents of all come together and engage in decision-making, resulting in a desirable common ground. This approach provides residents with a sense of safety and attachment to the community, increasing support for social networking.
2- In my research, I am exploring the concept of co-production, which involves collaborative decision-making among multiple stakeholders who share the same values and reside in the same geographic area. This process is essential to ensuring that the needs of all parties are met equally and improving the quality of facilities.
3- Finally, I am investigating social sustainability, which is an integral aspect of sustainable development. This concept encompasses a range of activities that promote social well-being and tackle issues and provide positive values such as equality, justice, participation, social cohesion, safety, and well-being.

For that, I am investigating the relationship between residents in cohousing communities. Specifically, I am examining their involvement in the design process of their housing, their ability to meet their needs, and the ongoing development of housing arrangements through co-production. To achieve this, I am choosing the "Centraal wonen" as a case study. Through my research, I aim to determine the positive or negative impact of this approach on residents and whether it contributes to social sustainability.

4- Duration of the interview:
The interview is set to be 35 – 45 minutes, but if you want to talk for longer, we can continue. Also, if you want to stop at any point, just inform me. The interview is split into three sections. The interview begins with Background Questions. Following that, I'll focus more on closed questions you can choose any of the answers to some questions, and you can choose more than one option. In the third part, I would provide you with Open Questions.
I want to highlight that there are no right or wrong replies, and no one will evaluate your word. Today, we want to hear about your experiences as a resident here, as well as what you think about this concept. Today I will be listening to the remarks about your experience. Please let me know if you are uncomfortable answering any questions or if you do not want to answer any for whatever reason. It will not be a problem. This interview is designed to be an educational exercise.

5- Privacy and ethics:
I want to inform you that the results of the interview, in addition to any images you would like to share, will only be used for the thesis research at my university. It will be private and anonymous.

You will not be referred to in any manner that allows the reader to identify you, and a part of the interview will be cited in my research as "R(n), 2023" The outcome will be saved in a secure cloud environment and will be accessible only to me. You may evaluate and approve my interview analysis before submitting at 13 July.

6- **Consent for recording:**
Before we go further, I want to seek permission to record this interview. The recording will assist me in the analysis.

7- **Informed consent:**
The final step before the interview is to inform you of your permission to participate in the interview for educational reasons. If you need to stop at any time or withdraw your consent, please notify me, and the recording will be stopped and deleted. Do you still agree to participate?

Additionally, I give permission to:

I give permission to audio record the interview	Yes:	No:

Participation Name: **Signature:**

Participation Email or phone number:

Researcher signature:

Researcher Email and phone number: 670641mz@eur.nl, +31684606579

Date:

2. Interview guide-residents

A. Warmup questions:

1- Firstly, can tell me about yourself and your background? How many years have you been living here? who else lives with you?

2- How did you get into the Centeraal wonen?

3-What are the advantages or disadvantages here?

4-What are the biggest differences between before living here and now?

B. Open questions:

Coproduction process	The Centeraal wonen project is structured into four clusters, each comprising private housing, shared facilities, semi-public spaces, and public spaces accessible to all clusters. The development of Centeraal Wonen has spanned from the past to the present, prompting the following inquiries: 1- Who: - Who was/is involved in the process of these projects? This can include residents, experts, and the Municipality. You can choose one or multiple parties. - Who was/is ensuring and managing that the process is going in the right direction? - Regarding acceptance: Can you briefly describe the acceptance among participants in the decision-making process? Were/are those decisions considered to align with your needs? - Regarding the collaborative effort: Were those involved in making decisions able to feel a sense of responsibility for this place? 2- How: - Who was/is involved in the process of these projects? This can include residents, experts, and the Municipality. You can choose one or multiple parties. - Who was/is ensuring and managing that the process is going in the right direction? - Regarding acceptance: Can you briefly describe the acceptance among participants in the decision-making process? Were/are those decisions considered to align with your needs? - Regarding the collaborative effort: Were those involved in making decisions able to feel a sense of responsibility for this place? 3- Where: - Can you tell me where you usually meet for these discussions and meetings?

	- Can you tell me where you usually meet for these discussions and meetings? 4- The scale of participation of involvement: - If that person is involved in the design of his or her house / improving their housing condition: - How was or is this achieved? -What challenges were or are encountered? 5- Since you moved here your attitude toward participation in activities: (choose one) -It has increased, and I feel more inclined to participate in improving the quality of living. -It has decreased, and I try to avoid involvement in the process of improvement. -It remains natural. -Other: [Provide details if applicable]

Sense of belonging	1-Do you feel belong in this place as home? - If not so, why? - If yes, can express to me your points that feel at home? 2- Do feel belong to the community? - If not, can describe your negative feeling? - If yes, what are the aspects that you are feeling a sense of community?

Social Network and interaction	1- Can you describe your relationships with your neighbors? - What aspects or values shape the relationships between you and other residents? - Have you encountered any negative barriers in connection with others? - How have your relationships with others changed over time, becoming stronger or potentially weaker? 2- How do the residents in Centeraal Wonen share their knowledge and skills? - Can you tell me if you participate with others in any skills or knowledge acquisition? - Do you have any skills or knowledge that you have shared with others? - Can you explain how these shared skills or knowledge have positively impacted the community? 3- Do you usually engage in activities within the community? 4- Regarding the pandemic period, what has been your experience in Centeraal Wonen?

Level of participation	1- Can you tell me about the activities you participate in here? - How frequently do you participate in activities per month? a) Once b) Twice c) When they are needed d) Other: [Please specify] - Can you discuss the positive and negative aspects of your participation? - Do you usually stay updated with these events? - Who is responsible for organizing these activities? 2- How are your opinions, decision-making, problem-solving, or contributions to enhancing the community taken into consideration? 3- There is any limitation or exclusion for anybody to take his or her decisions?

Sence of safety	1- Do you feel safe within the community? -What aspects or factors related to the residents contribute to your sense of safety? -Are there any specific aspects or behaviors of the residents that make you feel unsafe?

Stability	1- Can you tell me how long you have been residing here? - If long period: a) After these years, are you considering moving outside the place? - b) Has the interaction with others here played a role in your decision to continue staying here? - If short period: a) Do you feel a willingness to extend your stay here? - b) Do you believe that the interaction with others here can further motivate your initiative to continue living here?

C. Ending the interview:

And now, I am finished my interview, thank you very much for your participation in this interview for my thesis, is anything you want to add to the interview?

Thank you so much for your time and effort I appreciate that if you want to add any other information regarding my topic you can contact me directly to me and for now, I will stop the record.

3. Interview guide-member of community organization

	1- How do you create a sense of community and connection among residents, particularly between different age groups? 2- What strategies have you implemented to encourage social interaction and foster relationships between elderly residents and the youth within the community? 3- How do you promote active engagement and participation from all members of the co-housing project, regardless of their age? 4- What measures have you taken to ensure a safe and secure environment within the co-housing community? 5- How do you work towards maintaining a stable and harmonious atmosphere within the co-housing project? 6- Can you share any success stories or examples that illustrate the positive impact of your efforts in enhancing interaction and connection among residents? 7- What challenges have you encountered in your role, and how have you overcome them to ensure the successful integration of different age groups? 8- How do you assess the effectiveness of your initiatives in building a strong community and promoting positive social dynamics? 9- How do you collaborate and coordinate with team members, residents, and external stakeholders to achieve your objectives? 10- What are your future plans and goals for the co-housing project, and how do you intend to continuously improve the sense of community, social interaction, participation, safety, and stability within the community?

4. Exploration survey

Exploration survey:

1- Gender: M - F

2- Age: 10-20 / 20-30 / 30-40 / 40-50 / 50-60 / 60 Above

3- In which locations do people engage in activities such as festivals, celebrations, or informal conversations? (Please indicate the spaces by marking a circle on the provided map.)

4- Can you indicate the location where regular meetings take place by marking a circle on the provided map?

5- Are you actively involved in the activities related to the development of the project?

YES	**NO**

6- If you make decisions concerning the community, are these decisions generally accepted by others?

YES	**NO**

7- Do you share your skills and knowledge with the community?

YES	**NO**

8- Are there specific spaces designated for sharing these skills? (Please mark the spaces on the provided map.)

9- Do you contribute to the ongoing development of the project?

YES	NO

10- Since you moved here, how has your attitude toward participating in activities changed? (Please choose one)

- It has increased, and I feel more inclined to participate in order to improve the quality of living.

- It has decreased, and I tend to avoid participating in activities related to the process of improvement.

- It has remained natural.

- Other: [Please specify]

11- Do you feel secure and safe within the community?

YES	NO

12- When you are away from the community for an extended period, do you inform your neighbors?

YES	NO

13- Do you have a sense of belonging to this community?

YES	NO

14- Do you usually participate in activities within the community?

YES	NO

15- Do you primarily visit your neighbors' homes or gather in common spaces?

YES	NO

16- How many activities do you participate in per month?

-One time

-Two time

-When they are needed

-Another answer:

17- Are you willing to continue living here in CW?

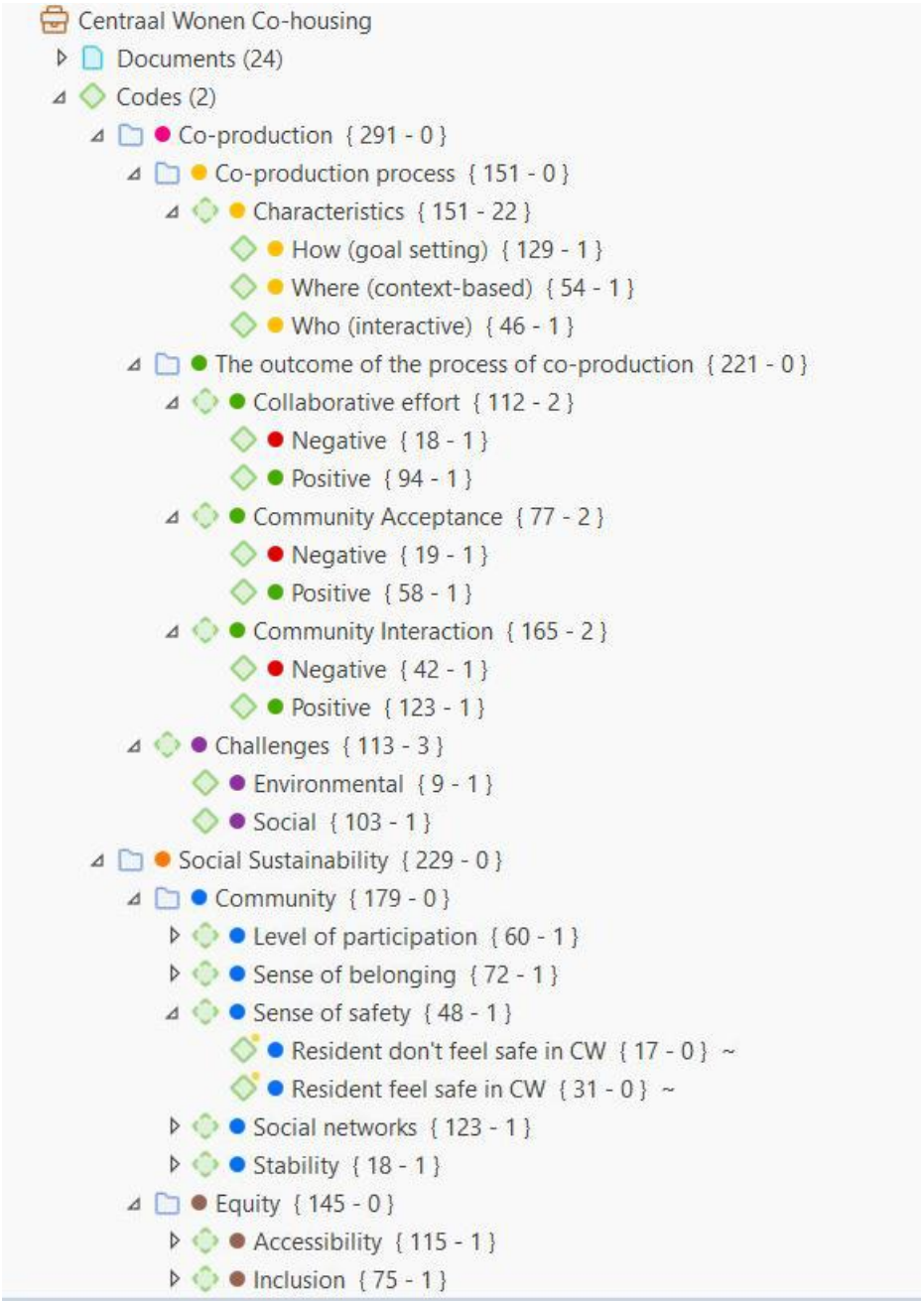
YES	NO

18- Do you consider CW to be a place that can be described as "home"?

YES	NO

Appendix 2: Data samples

1. Code tree:



2. Interviewees' data

Code	Role in community	Interview duration	Interview Location	Date
R1	Mr. Flip Krabendam, an architect and one of the first residents of CW, has been actively involved in the design and development process from its inception to the present day.	Two times: 1- 225 min 2- 65 min	In CW, delft	1- 05/05/2023 2- 16/05/2023
R2	Member of community organization at CW	60 min	In CW, delft	05/05/2023
R3	Resident, Member participate in ALV meetings	40 min	Online via Teams	12/05/2023
R4	Resident	45 min	In CW, delft	16/05/2023
R5	Resident	46 min	In CW, delft	16/05/2023
R6	Resident	37 min	In CW, delft	16/05/2023
R7	Resident	60 min	In CW, delft	16/05/2023
R8	Resident	65 min	Online via Teams	18/05/2023
R9	Resident	40 min	In CW, delft	22/05/2023
R10	Resident	35 min	In CW, delft	22/05/2023
R11	Resident	30 min	Online via Teams	24/05/2023

3. Secondary data list

Code	Document title	Source
Doc.01	CW Website	https://www.cwdelft.nl/contact/
Description	This official website for co-housing in Delft contains a definition of the project, The website describes how the place is managed and what activities are available in the place. Each resident is given a password to access all details related to the building through the website.	
Doc.02	Gemeenschappelijk wone	https://www.gemeenschappelijkwonen.nl/ga/ga112.pdf
Description	This is a magazine specialized in presenting collective living experiences. Co-housing in Delft was explained as a leading example of applying this idea and its social benefits.	
Doc.03	De open kaart:10 examples of wealthier living by sharing	https://deopenkaart.nl/10-voorbeelden-van-rijker-wonen-door-te-delen/
Description	The article describes Centraal Wonen (CW), an older and larger housing collective where over 100 people live together. The concept of CW originated, with the belief that children could benefit from a communal living environment. The housing complex, developed in collaboration with a housing corporation, offers shared spaces at different scales. Residents share kitchens in groups of eight, gardens with thirty others, and general facilities like a café with all residents. While the individual rental properties resemble typical homes, they are interconnected to form four distinct clusters. This arrangement allows residents to enjoy a sense of community while also having privacy. Overall, CW offers a unique living experience that fosters both social interaction and personal retreat.	
Doc.04	De architect: Blog – Communal living: Central Living in Tanthof in Delft	https://www.dearchitect.nl/236668/blog-gemeenschappelijk-wonen-centraal-wonen-in-tanthof-te-delft

Description	The blog discusses Centraal Wonen De Banier, a communal living project in Tanthof, Delft. It focuses on the design aspects, including scale levels, facilities, resident groups, access, and connection with the outside world. The project promotes flexibility, with residents having the opportunity to combine living spaces. It includes common areas like a bar, hobby rooms, and a central outdoor space. The design encourages interaction through connecting doors and corridors. The project aims to prevent isolation and offers a variety of household types. The central area is visible from the public road, and there is a pedestrian route to a nearby shopping center. The blog also mentions the initial idea of residents designing the facade.	
Doc.05	Rethink the City - A practitioner's view Co-housing project in Delft	https://www.youtube.com/watch?v=FfL-TEmv1Kw&ab_channel=RTC1xRethinktheCity
Description	The video titled "Rethink the City: New Approaches to Global and Local Urban Challenges" is an educational video offered by TU Delft. It focuses on the Centraal Wonen in Delft, providing a brief description of its unique design and features. The video includes a virtual tour, showcasing the project's facilities and amenities, and highlights its emphasis on promoting mutual interaction among residents. Overall, it aims to explore innovative approaches to urban challenges through the lens of the Centraal Wonen project.	
Doc.06	Open Rotterdam: VIDEO | Everything is shared in the De Banier residential community in the Agniesebuurt	https://openrotterdam.nl/video-in-woongemeenschap-de-banier-in-de-agniesebuurt-wordt-alles-gedeeld/
Description	The article discusses the emergence of Centraal Wonen projects in the 1970s, which aimed to explore alternative forms of communal living beyond the traditional family unit. The focus was on sharing living spaces, amenities, and even gardens among residents. The article specifically highlights Centraal Wonen Delft, where separate rooms are connected by corridors and stairs, and residents share a kitchenette, living room, and kitchen. Architect Flip Krabbendam and Dr. Darinka Czischke, involved in the project, explains the design process. The article also mentions Centraal Wonen De Banier in Rotterdam, where residents have their own apartments but share a communal garden, bar, offices, workshops, and washing machines. The role of residents in the design process and the challenges of designing for collective living are also discussed.	
Doc.07	Flip krabbendam: Centraal Wonen Delft	https:// flipkrabbendam.nl/cat8.php?pid=60&p=&search https://www.academia.edu/48843139/Philip_Krabbendam_Cohousing_in_the_Netherlands
Description	The article, written by Flip Krabbendam, provides a description of the Centraal Wonen project.	
Doc.08	Welkomstboekje Centraal Wonen Delft	https://issuu.com/welkomstcommissie/docs/welkomstboekje_centraal_wonen
Description	The magazine, created by a resident of CW, provides a comprehensive description of the project and its activities. It offers insights into the daily management and functioning of the CW community. The magazine covers various aspects of the project, including its design, shared spaces, and facilities. It highlights the collaborative efforts of the residents in organizing and maintaining the community, showcasing the unique initiatives and events that take place within the project. Additionally, the magazine delves into the resident-led management structure, illustrating how decisions are made collectively and addressing any challenges that may arise. Overall, the magazine serves as a valuable resource, offering an inside look into the Centraal Wonen project and demonstrating the active involvement and participation of its residents.	
Doc.09	Topos: CW renovative project	https://www.topos.nl/portfolio/centraal-wonen-delft/
Description	Topos office describes the renovation of the facade at Centraal Wonen Tanthof in Delft. The project, commissioned by DUWO, aims to enhance sustainability and improve the building's appearance. The design integrates features like nest boxes, retained ground floor doors, improved drainage, and a natural facade. Yasser Hassan, a former resident and architect at Topos, ensures the interests of the client and residential group are considered. The renovation also includes practical elements such as ventilation grilles, extra insulation, and preparations for solar panels. Overall, the new	

	facade prepares Centraal Wonen Tanthof for the future while maintaining its community-focused approach.	
Doc.10	Co-lab: Corona in Centraal wonen Delft	https://co-lab-research.net/2021/02/12/corona-in-centraal-wonen-delft/
Description	This article explores the experiences of the residents of Centraal Wonen Delft during the Corona pandemic and lockdown. It provides an overview of the cohousing project and how the residents live together in different groups and clusters. The article highlights the challenges faced during the lockdown, such as adjusting to the "intelligent lockdown" measures and implementing subgroups within the clusters. It also discusses the positive aspects of the lockdown, including renewed connections within the clusters and a deeper appreciation for the living environment. The article concludes by reflecting on the lessons learned and contemplating future considerations for cohousing projects in light of the pandemic.	

4. Observation summary for visiting the case study area

First observation 3/5/2023
On my visit to the case study area, I arrived at the project site around 9 am. The project is conveniently located near Delft station, just a 15-minute walk away. Upon reaching the area, I noticed that apart from a Jumbo supermarket, the surroundings were predominantly natural. Adjacent to the project, there was a school, public playgrounds, public spaces, and several seating areas. This setup provides a sense of community and encourages social interactions among residents and visitors. Entering the project, I observed that it was divided into four distinct parts. I accessed the project through an entrance that led to a beautifully planted garden, where some residents were actively engaged in gardening tasks. Once inside the project, I noticed many residents enjoying the public areas. They were engaged in conversations or sharing meals with one another. The weather was sunny that day, and some people were taking advantage of the conditions. One notable aspect of the project was its color scheme, with each of the four parts distinguished by a different color (blue, red, yellow, and green). This colorful arrangement likely adds vibrancy and visual interest to the area. During my exploration, I also came across some residents who were repairing furniture in the public gardens. This observation suggests that the residents take an active role in maintaining and improving their shared spaces, fostering a sense of ownership and community involvement. The central area of the project served as a gathering space for the residents. Situated in the middle of the four buildings, this space was interspersed with a public street. Additionally, an internal path connected the project with the surrounding area, enhancing accessibility and integration.

Second observation 5/5/2023
On the designated day, I had scheduled a meeting with Mr. Philip, one of the participants in the design and one of the oldest residents, as part of my thesis research. Our meeting commenced at approximately 10 am, with the aim of gathering information about the project and conducting observations of people's experiences. Our first stop was the green residential building, where we entered a shared kitchen bustling with activity. Around five individuals were engaged in food preparation while engaging in conversations. Subsequently, we proceeded to Mr. Philip's private house, where we settled down to discuss the project's progress and intricacies.Each resident displayed cherished personal memories, shared artwork, and exchanged ideas with others. Following our discussion, we embarked on an exploration of the project, commencing with the private rooms. Each resident possessed their own personal space, and some individuals had the opportunity to expand their interiors, while others shared communal bathrooms. Continuing our tour, we ventured into the semi-public areas and encountered numerous residents engaged in conversation, dining, or leisure activities. We also visited the storage area, where I observed one resident organizing their personal corner within the public spaces.

Public spaces, particularly those requiring coordination, adhered to specific schedules, which the residents diligently followed. For instance, I noticed a general schedule posted in the bathrooms, assigning cleaning responsibilities to each individual.

Large notice boards were prominently displayed in common areas, disseminating public tasks and outlining the timing of events such as celebrations.

Recreational activities were abundant in the shared spaces, including card games, billiards, and regular musical instrument usage.

The shared kitchens were organized on a semi-daily basis, with residents actively maintaining cleanliness. I witnessed residents collaborating to create artwork on the interior walls.

Each building featured public storage spaces that continuously adapted to residents' needs. On the day of my visit, there were numerous items stored for recycling purposes.

Given that bicycles served as a primary mode of transportation for residents, many storage areas had been converted into bicycle parking lots, complete with two levels and a separate entrance.

In the laundry area, residents displayed meticulousness in scheduling their laundry and availed personal cabinets for storage.

Every residential space featured a small workshop where residents could repair bicycles or household items. Additionally, a large cupboard was designated for storing surplus items not required for general use, such as painting tools.

A corner within the storage areas was dedicated to providing food for the chickens raised in the gardens and for residents interested in fishing. Notably, space names were displayed in Dutch, English, and occasionally Spanish.

Within the green area, residents collectively cared for a chicken farming space.

Nestled within the inner garden of the green area, a barbecue spot existed where residents fashioned furniture from recycled wood and materials. This area was commonly utilized for warmth during the winter season.

In certain private gardens and specific areas, I observed residents pursuing their individual interests. For example, one resident expressed a fascination with soil and its various types, resulting in their garden featuring different soil variations aligned with their work. Some residents with children transformed their gardens into play areas, while others dedicated their spaces solely to agriculture.

Residents with the means had the opportunity to extend and expand their homes, while others did not partake in such modifications.

Adjacent to the yellow buildings within the public garden, residents collaboratively established a jacuzzi area and constructed seating arrangements surrounded by trees.

The cultivated garden I observed featured lush plants ready for harvesting, diligently cared for by resident. The garden maintained a well-organized layout, with designated areas for grains and fertilizers.

A pathway connected the entire neighborhood to the residential area, passing through the cultivated garden and extending into the heart of the shared housing.

We proceeded to visit a gathering area for residents, which had been transformed into an appealing cafe by the residents themselves.

Adjacent to the cafe, a communal public space facilitated various activities. Elderly individuals, young children, and young adults alike convened in this space for drawing or food preparation. I discovered numerous drawings created by the elderly.

In close proximity to this shared space, a relatively spacious room equipped with large mirrors served as a venue for contemplation and yoga practice. The room was entirely white in color.

Subsequently, we entered the expansive communal workshop, which had been meticulously organized. Instructions were provided for each device, detailing its usage and guidelines for maintaining the shared space. Inside the workshop, I encountered furniture crafted by residents for the gardens and a table intended for the communal kitchen.

Residents who owned pets, such as cats and dogs, had made modifications to door openings to allow their animals to move freely.

We then proceeded to the public area within the red zone and discovered that residents collaborated to establish a boxing area and a swing in the garden.

In the red zone, alterations had been made to the public space, with the kitchen area reduced to create a temporary guest room.

In the communal kitchens of the red zone, I noticed that each resident possessed their own small refrigerator, unlike the other kitchens where a large shared refrigerator was utilized.

I witnessed a family preparing their meals in this kitchen and subsequently heading to the public garden with their dog to enjoy their food.

One noteworthy feature in every public space was the presence of musical instruments. However, in the red zone, a library stocked with various piano music collections stood out. Within the workshop of the red zone, residents were actively constructing containers to collect rainwater for irrigation purposes, showcasing their commitment to sustainability.

Third observation 16/5/2023

On this day, I spent nearly 12 hours conducting interviews with people. Therefore, I decided to embark on an experience as if I were one of the residents. I arrived there around 9 o'clock in the morning. I stayed at someone's house for two hours, conducted an interview, and experienced staying in their room. This accommodation was an extension of their living space, which was evident from the inside and appeared larger than the others. It was filled with numerous plants.

We started preparing some food together while standing, and many residents joined us and engaged in conversation. Some of them talked to me about how they manage the kitchen and common spaces. Later, I went to a public space to work. During my stay, around four individuals came to sit with me throughout the day, sharing their work and engaging in conversation.

It became clear to me how these public spaces function. Many residents prefer not to stay inside their homes, so they find themselves working in public spaces. After this period, we started preparing lunch together. Everything was organized, and there were about three of us eating together. Then, we quickly cleaned everything up.

Afterward, I went to sit in the public garden, where one of the new residents, a mechanical engineer, was sitting. They told me a lot about their role in modifying some devices inside the housing to reduce energy consumption. Then, I sat again in the semi-public place and observed how families arrived and how everything was arranged gradually.

This day was after a party had taken place, so one resident took me to explain how the public space is transformed to accommodate parties and how it is returned to its original form afterward. I found that some residents collaborate with each other to fix issues inside the house.

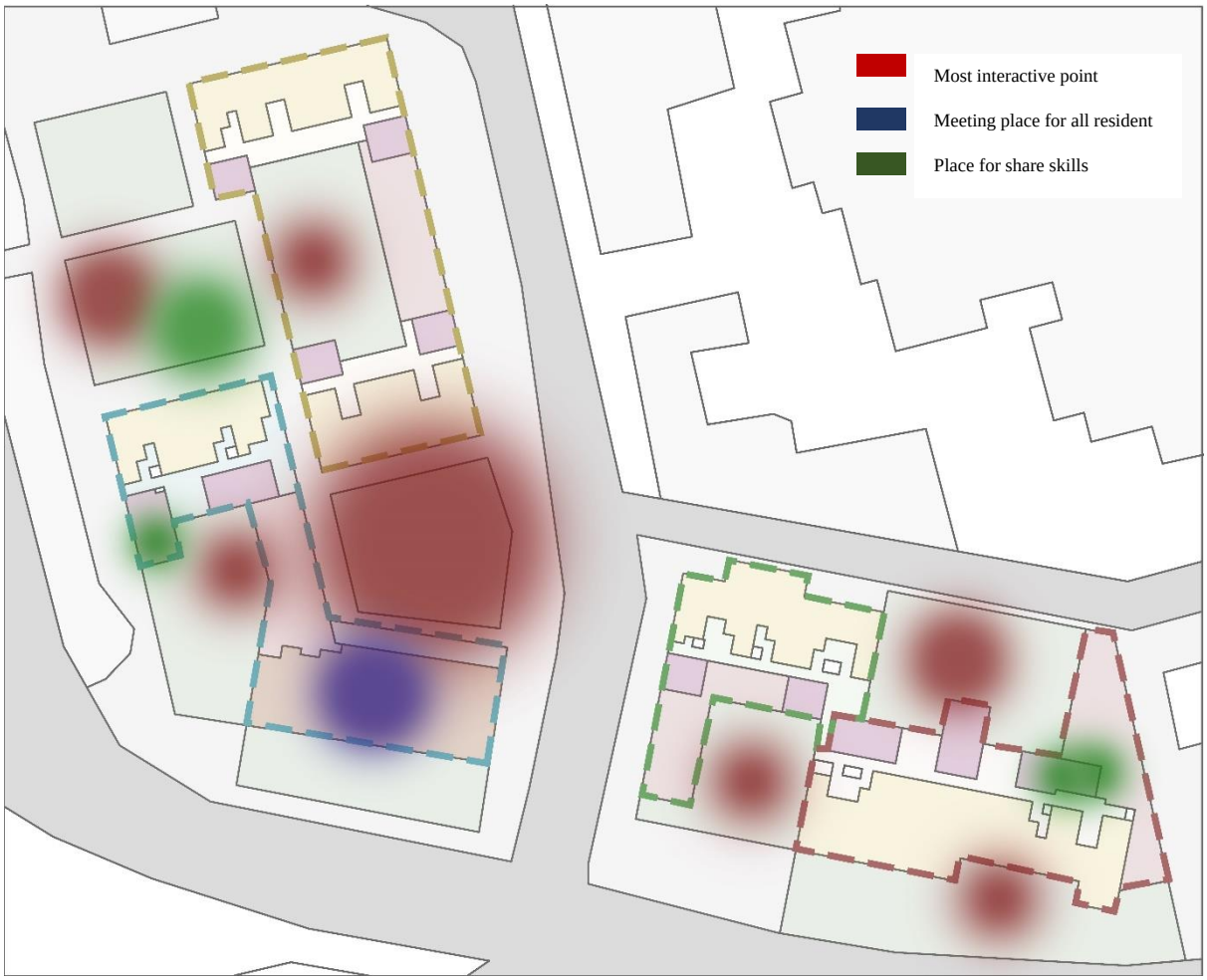
Throughout all these events, there were agreements made with the interviewees, and at the end of each interview, I was invited to meet another person. My tour on this day ended around 9 o'clock in the evening with the last interview."

5. Survey output

3- In which locations do people engage in activities such as festivals, celebrations, or informal conversations? (Please indicate the spaces by marking a circle on the provided map.)

4- Can you indicate the location where regular meetings take place by marking a circle on the provided map?

8- Are there specific spaces designated for sharing these skills? (Please mark the spaces on the provided map.)



Source: Author (June-2023).

6. New indicators list

Old Indicator	New indicator	Description
Community interaction	Positive	Active Participation, Supportive to other, Knowledge Sharing
	Negative	Lack of Engagement, Bad Behaviour, Conflict with others
Community acceptance	Positive	Supportive Networks, Respectful Communication
	Negative	Tension and Conflict, Disagree the ideas
The collaborative effort	Positive	Effective Communication, Shared Goals and Vision, Trust and Mutual Respect
	Negative	Poor Communication, Skewed Goals and Vision, Lack of Responsibility

New Indicator	New Sub-Indicator	Description
Challenges	Social	The challenges that occur in the interaction between the residents for decision-making and the social challenges affecting the social life of the residents.
	Financial	Challenges facing residents in project development.
	Environmental	Challenges that make the building more sustainable and environmentally friendly.

Appendix 3: IHS copyright form

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