ALMA MATER STUDIORUM - UNIVERSITÀ DI BOLOGNA

DIPARTIMENTO DI SCIENZE E TECNOLOGIE AGRO-ALIMENTARI

CAMPUS DI BOLOGNA

CORSO DI LAUREA MAGISTRALE IN

SCIENZE E TECNOLOGIE AGRARIE

Curriculum Tecnico-economico e gestionale

SOCIAL RETURN ON INVESTMENT TO CAPTURE SOCIAL IMPACTS: AN APPLICATION TO THE CASE OF HORTS AL TERRAT IN BARCELONA

Tesi in

POLITICHE AGRO-AMBIENTALI E BIOENERGETICHE

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Anno Accademico 2022/2023

Sessione unica

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ABSTRACT

The constant growth of urbanization that has occurred in recent decades has affected various aspects of urban life by making food systems (FS) more complex, non-transparent, and more vulnerable to external shocks. For this reason, future-proof, sustainable, and climate-resilient FS are required to ensure sustainable and healthy diets by promoting circularity, resource-use efficiency, and community empowerment.

City-regions have been identified as the geographical scale for generating efficient and sustainable FS. City Region Food Systems (CRFS) strengthen links between urban centers, peri-urban, and rural areas to provide essential public goods and socioeconomic benefits and enhance resilience and sustainability by ensuring accessible, affordable, and safe nourishment. Withing the CRFS, rooftop agriculture (RA) has gained attention globally and it emerges as a crucial element for local food production and shortening supply chains.

The assessment of impacts that CRFS initiatives (CRFSi) generate remains challenging. Among various methodologies, the Social Return on Investment (SROI) approach is promising. SROI is able express in monetary form the value of social, environmental, and economic outcomes, whether these already have a financial value or not.

This thesis focuses on the application of SROI to assess the impacts of "Horts al Terrat" project, a CRFSi in Barcelona, that performs RA by including people with physical and mental disabilities in cultivation activities with soil-less systems. The findings highlighted the advantage of SROI of measuring impacts in monetary terms, facilitating communication and understanding of results from various stakeholder categories. On the other hand, the study highlighted the high degree of arbitrariness that affects the accuracy and comparability of the results obtained from the analysis of different CRFSi. In order to overcome the limitations of the SROI methodology, it is proposed to include stakeholders in the indicators selection process to identify those that actually express the generated impacts in order to allow consistent and precise quantification of outcomes.

1. INTRODUCTION

The global population is steadily increasing, leading to a rise in urbanization. By the end of the first decade of the 21st century, urban regions hosted more people than rural ones for the first time (Batty, 2015). It is projected that 68% of the world's population will live in urban areas by 2050 (Ritchie & Roser, 2018), causing rural populations to decline due to migration for political, economic, and environmental reasons (UN, DESA, 2015). This shift results in larger urban areas, widening the gap between production and consumption zones, increasing reliance on external resources and global food supply chains (Scoones, 2009). Urbanization impacts various aspects of quality of life, affecting fresh food access, social connections, economic opportunities, health, and education. Moreover, the concept of urbanization represents a significant shift in how people view food since nowadays most people no longer directly participate in the production of their food or, to a great extent, with its producers (Jennings et al., 2015). This makes supply chains vulnerable to external shocks, as highlighted by events like the COVID-19 pandemic and the start of the conflict in Ukraine (O'Meara et al., 2022; McGreevy et al., 2022). To address these challenges, the European Commission's "Food 2030 pathways for action" seeks resilient and sustainable food systems (FS), promoting circularity, efficiency, and community empowerment (Directorate-General for Research and Innovation, 2020). Such systems could ensure reliable access to nutritious food, even during shocks, while combating poverty and inequality.

City-regions have emerged as key elements in generating sustainable FSs (Jennings et al., 2015; Dubbeling et al., 2017; Blay-Palmer et al., 2018). The idea of City Region Food Systems (CRFS) is about strengthening the connections between urban centers and the surrounding peri-urban and rural areas in order to supply important public goods and socio-economic benefits (Blay-Palmer et al., 2018). This approach fosters accessible, affordable, and safe food by considering ecological, social, and economic links within defined geographical regions, making city-regions pivotal in building resilient and sustainable FSs (Blay-Palmer et al., 2021).

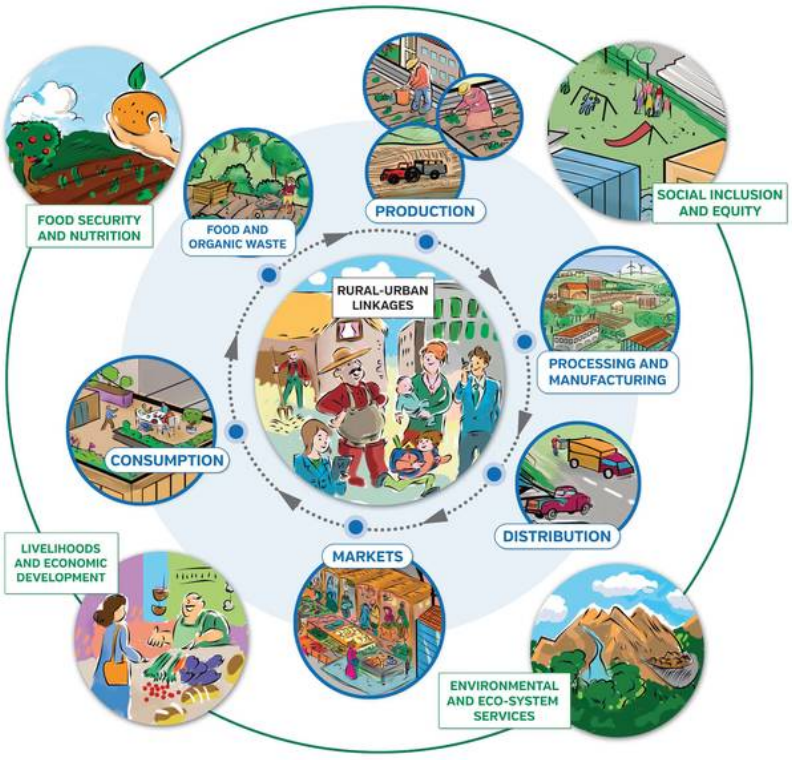

Figure 1: The CRFS approach (source: Food and Agriculture Organization of the United Nations)

Variability characterizes CRFS, shaped by factors like urban center size, FS type, and culture (Jennings et al., 2015). Generally, within a CRFS, urban agriculture (UA) is a remarkable element capable of producing fresh food within cities, shortening supply chains, and generating social benefits. UA is defined as production in households or on plots in urban or peri-urban areas and it includes the cultivation of horticultural products, and other specialized crops (e.g., medicinal, and ornamental plants), wood production, animal husbandry, beekeeping, and aquaculture (Orsini et al., 2013). UA is also promoted as a healthy, social, community-led practice for the city's residents which also raises awareness of agricultural principles, improves physical and mental health, and builds community (Orsini et al., 2020). In fact, the most relevant aspects of the UA lie in its integration within urban socioeconomic and ecological systems, utilizing resources like land and labor, influencing urban conditions, and addressing issues such as food security and poverty (Mougeot, 2000; Dubbeling et al., 2019). In the context of creating sustainable CRFS, UA plays a leading role by shortening food distances, reusing urban organic waste, mitigating urban heat island effects, improving diets, ensuring food security, reducing vulnerability of people at risk of social exclusion (RSE), and fostering community development (Orsini et al., 2020).

UA can take different forms within the city context depending on the availability of space and the functions for which it is practiced. One type of urban agriculture that has received great interest in the past decade and is spreading around the world is rooftop agriculture (RA) (Appolloni et al. 2021) (*Figure 2*). RA is based on more or less complex growing systems (from simple bins or containers to hydroponic systems) in order to take advantage of city rooftops to create growing spaces. RA initiatives have varied from one another in terms of spaces used for cultivation, involved stakeholders, and goals. Among the objectives of RA initiatives, social goals such as unifying a neighborhood, creating a social and shared space, improving the food security of a family or community, and generating jobs and income are very common (Nasr et al., 2017).

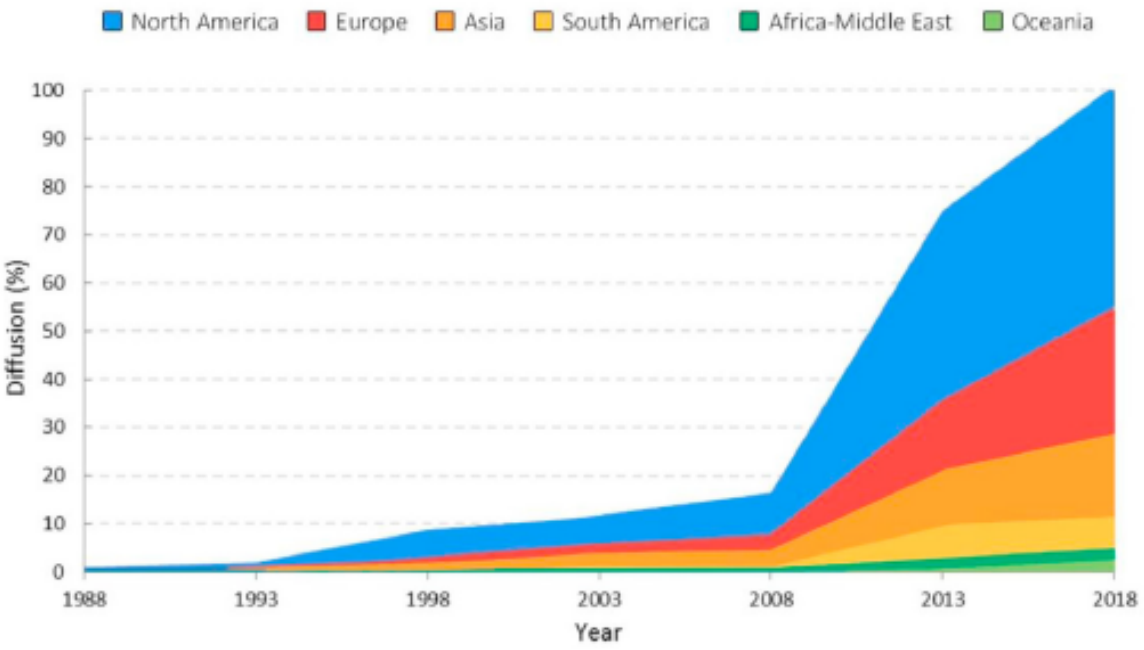

Figure 2: Spread of RA in the world (Appolloni et al. 2021)

In fact, RA can be used as a foundation for implementing social agriculture (SA) within the urban context. SA falls under the broad umbrella of Green Care, which represents all activities aimed at generating social value that rely on natural elements such as horticultural therapy, animal-assisted therapy, therapeutic gardening, nature walks, etc. (Berget et al., 2010; Haubenhofer et al., 2010). SA represents an approach to agriculture that prioritizes social, cultural, and environmental values over economic goals and seeks to create a more sustainable and equitable FS. Typically, SA targets groups at RSE namely those who are susceptible to the social process that pushes individuals to the margins of society and prevents them from participating fully due to personal poverty, lack of necessary skills, lifelong learning opportunities or discrimination (Directorate-General for Employment, Social Affair, and Inclusion, 2011). SA makes efforts to promote social inclusion and poverty reduction of people

at RSE through vocational training or employment opportunities and also promote community strengthening and development (Elings et al., 2022). The beneficial social effects that RA is able to generate have been widely pointed out by various authors (Ilieva et al., 2022; Triguero-Mas et al. 2020; Specht et al., 2017; Orsini et al., 2013; Poštek et al., 2021; Wang & Pryor, 2019; Elings et al., 2022) and shown in *Table 1*.

Table 1: Beneficial social effects of RA

Effect	Description
Health	RA has effects on participants' physical health through improved diet quality and increased consumption of a greater variety and quantity of fresh vegetables, but also thanks to these spaces as a place for physical activities for some groups (e.g., the elderly). Effects have also been found on the mental health of gardeners, who report higher self-esteem and mental well-being and experience less depression and stress. Finally, RA has effects on food and nutrition security in that it provides, especially to low-income communities, greater access to fresh, local, and healthy food.
Education	RA is able to generate increased food and environmental awareness through learning how, where, and who grows food. The goal is to better understand the food production chain and the importance of seasonal and local produce, but also to spread food awareness and consciousness. Of course, participants also have the opportunity to gain new job skills in RA and learn new practical skills in food production.
Community recreation	Places where RA takes place provide new spaces for communities where different groups of people can meet and spend time. In addition, the presence of rooftop gardens enhances the aesthetic value of the neighborhood.
Urban improvement	Utilization of vacant city spaces, creation of rooftop multifunctionality, and reduction of the heat island effect by increasing the livability of cities are the main effects that RA has on the urban context. A particularly important effect of RA is the increase in urban resilience, as food production within the city guarantees food security even in the face of severe weather disasters, economic crises, and social unrest.
Social empowerment	RA improves users' and residents' life satisfaction and participation in community life. Rooftop gardens serve as a meeting point for the residents and help foster social cohesion in terms of problem-solving networks. The creation of rooftop gardens also makes it possible to provide new employment opportunities and improve the economic condition of people who, thanks to the provision of free or low-cost fresh food, have greater economic availability for other consumer goods.
Social integration	RA empowers and enhances the living standards of people at risk of marginalization. RA is also a foundation for social network formation that enables people to carry out an active social life and make new acquaintances and friendships. Finally, RA is a key tool for the social integration of disadvantaged people or marginalized communities, as it encourages and eases their engagement in society and improves their living conditions.

Although welfare creation by rooftop social farming is known, the social impact assessment of rooftop SF's well-being creation lacks universally recognized methodologies for consistent

quantification. Over time, numerous instruments have been developed for measuring the effects produced by socially impactful activities proposed by international organizations, financial institutions, trade associations, and academia (Zamagni et al., 2015). To date, over 100 methodologies for evaluating social impact are cited in the literature (Perrini et al., 2020) categorized by researchers (Maas & Liket, 2011; Nicholls, 2012; Grieco et al., 2014; Bengo et al., 2016) based on purpose of the evaluation (screening, monitoring, reporting, evaluation), impact typology (holistic, people, social, environmental, economic), time frame (prospective, ongoing, retrospective), approach (process methods, impact methods, monetarization), perspective (individual, corporation, society) and data typology (qualitative, quantitative, quali-quantitative).

Among these approaches, the Social Return on Investment (SROI) stands out as a widely used procedure to assess impacts in social initiatives (OECD, 2021). SROI is an outcomes-based measurement tool that helps organizations understand and quantify the social, environmental, and economic value they are creating. Developed from traditional cost-benefit analysis and social accounting, SROI is a participative approach that can express in monetary terms the value of a wide range of outcomes, whether these already have a financial value or not. SROI is a highly helpful instrument, especially in organizations that do not generate financial income, as it makes it possible to express social and environmental factors in monetary terms by using outcomes, indicators, and financial proxies. The main reasons why SROI analysis may be preferable to other social impact assessments methodologies are: the integrated approach that considers both positive and negative effects and their costs; the use of an economic valuation that expresses social impact in monetary terms; the co-investigation of stakeholders to learn about opinions and perspectives; simple and effective communication of social impact to stakeholders.

For these reasons, this master's thesis aims to conduct a SROI analysis to evaluate the impacts of a CRFS initiative (CRFSi) of the city of Barcelona called "Horts al Terrat" project. This initiative carries out social RA with the inclusion of people with physical and mental disabilities in cultivation activities with soil-less systems. SROI's positive attributes, its use at European and regional (Catalunya) levels to evaluate social agriculture initiatives (Basset, 2023, Tulla et al., 2018; Tulla et.al, 2020), and its capability to evaluate investment, justify its selection. The SROI index will be used for both internal and external purposes within the organization. On the one hand, the SROI index will be used for the organization to quantify and understand the social value it is able to generate, but also to identify which are the key activities and stakeholders so that it can focus its efforts on maximizing social impact. On the other hand, the SROI can be used by investors (Municipality of

Barcelona) an element of evaluation of the investment made in the “Horts al Terrat” project. Finally, the application of the SROI methodology also aims to highlight limitations in measuring social impacts.

2. MATERIALS AND METHODS

2.1 City Region Food System initiative case study description

The "Horts al Terrat" project was born in 2016 from the collaboration between the Municipality of Barcelona and the Municipal Institute of Persons with Disabilities (IMPD, Institut Municipal de Persones amb Discapacitat) to offer training in horticulture and social inclusion to people with disabilities together with other groups (children, youth, the elderly, etc.) from the local area. Since 2020, the Catalan company Tectum Garden took part in the project with the task of managing the activities that are carried out in the rooftop gardens and deal with the operation and maintenance of soil-less systems. This start-up was born out of the Sostenipra research group at the Institute of Environmental Science and Technology (ICTA-UAB) of the Autonomous University of Barcelona with the aim of bringing agriculture closer to the places where people live to promote consumption of fresh and healthy vegetables, but also to develop environmental and social effects that urban agriculture can catalyze. The "Horts al Terrat" project has an educational (working with people with disabilities), environmental (reuse and utilization of space), civic (opening a public space), innovative (sustainable production of vegetables), and social (crop surpluses are given to canteens and food banks) dimension. The specific objectives of this CRFSi case study of Barcelona are shown in *Table 2.*

Table 2: "Horts al Terrat" project goals

Social dimension	Develop the autonomy and learning of adults with intellectual and physical disabilities, who are the recipients of the gardens.
	Promote participants' interpersonal skills with each other and with people from other associations.
	Create gardens accessible to people with physical and sensory disabilities.
Urban environment	Install gardens based on the soil-less growing technique on the roofs of municipal buildings to increase vegetable production within the urban context.
	Take advantage of disused urban spaces.
Food safety	Produce fresh and healthy vegetables to be donated to social canteens to strengthen the food security of people at risk of social exclusion.
	Develop short supply chains.

To date, Horts al-Terrat is being participated by 120 people with varying degrees of mental and physical disability from different associations. The project is composed of seven gardens installed on the roofs of public buildings in the municipality of Barcelona, but the goal is to install a garden in each of the city's ten districts (*Figure 3)*. Cultivation is conducted using soilless soil-less farming techniques with drip fertigation systems, to avoid adding too much weight to the roofs of the buildings (*Figure 4*). Various vegetables, including beets, lettuce, spinach, cucumbers, zucchini, peppers, and tomatoes, are grown using this system, with an average production of 11 kg/m2. The harvest is distributed among the participants, but 80% of the vegetables are donated to social canteens and food banks in neighboring areas that provide them to people on RSE in healthy meals [1]. Thus, the project not only fulfills the social function of employing people with disabilities, but also succeeds in providing food for people at RSE and shortening the city food chain.

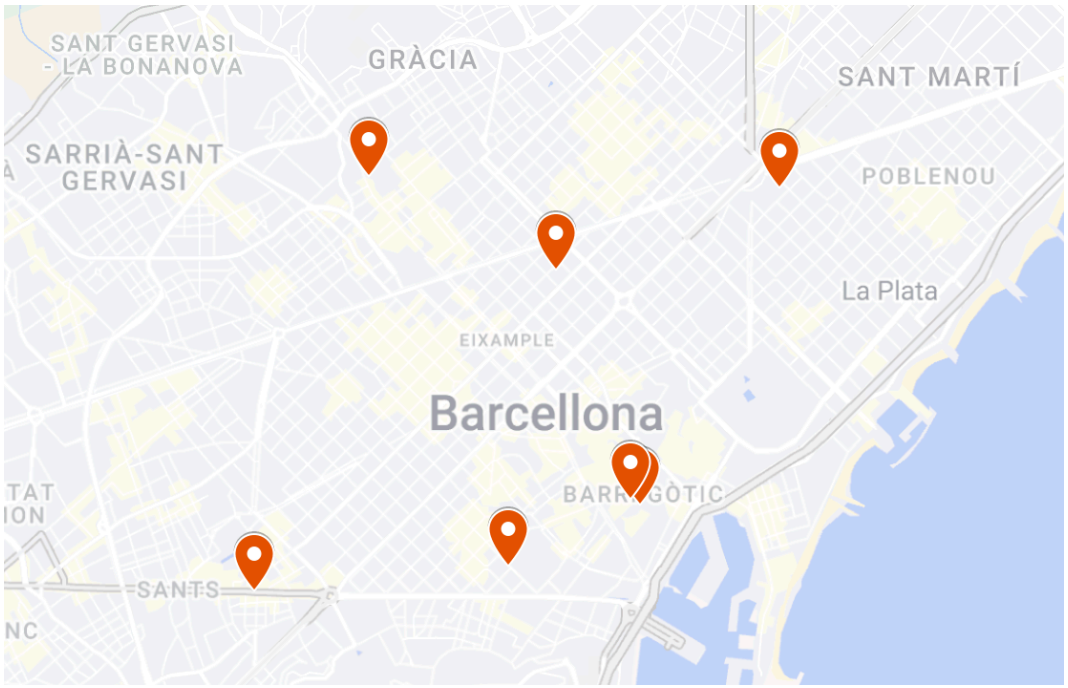

Figure 3: Aerial image of the location of the 7 gardens of "Horts al Terrat"

[1] A healthy meal provides adequate nutrition, without excess, of health-promoting nutrients and substances and avoids the consumption of health-damaging substances from the perspective of a diet that promotes health and prevents disease (Neufeld et al, 2023).

Figure 4: Rooftop soil-less growing system (source: Municipality of Barcelona)

2.2 Social Return On Investment (SROI) analysis

The social impact that Horts al Terrat has on rooftop gardeners has already been analyzed from a qualitative point of view by Triguero-Mas et al. (2020), who pointed out that this project has had a significant impact on the participants' physical well-being, relationship development, social inclusion, and personal development. To deepen the analysis of the social impact that "Horts al Terrat" is able to generate towards all its stakeholders, it was decided to carry out a quantitative analysis using the methodology of SROI analysis.

In the case of Horts al Terrat, an evaluative SROI is calculated since the project has been in place since 2016. In order to express the social return of an activity in monetary terms, the SROI methodology is achieved into six steps (Nicholls et al., 2012) (*Figure 5*):

1) Goal definition and stakeholder mapping

At this stage the purpose, the activities to be analyzed, and the time frame of the analysis are defined. Subsequently, stakeholder mapping is carried out to identify and analyze the stakeholders involved and their level of influence, interest, and importance. In this study, the main purpose of the stakeholder mapping is to identify stakeholders involved in the "Horts al Terrat" project and, among them, identify key stakeholders to be included in the SROI analysis. To identify and analyze stakeholders involved in the project, the Net-Map tool (Schiffer & Hauck, 2010) was used. Net-Map is a low-tech and low-cost social network analysis tool that merges characteristics of social network analysis and power mapping to help individuals and organizations visualize and analyze complex social networks. Net-Map involves drawing a network map, which is a graphical representation of the relationships between actors in a particular network to better understand the levels of participation of each of them. The steps of the Net-Map stakeholder analysis are:

- Identify stakeholders: the first step in stakeholder mapping is to identify all the stakeholders involved in the project or program. This includes individuals, groups, organizations, or institutions that can affect or be affected by the project.
- Categorize stakeholders: first, the linkages among stakeholders (resources, expertise, authority, support, and time) are defined. Then, based on the typology and numbers of linkages and level of interest and influence, stakeholders are classified.
- Select stakeholders: the main categories of stakeholders to be included in the SROI analysis are selected depending on the number of linkages and their influence in the organization.
- Define stakeholder goals: stakeholder objectives are investigated in order to define the purpose of the SROI analysis, predict its potential outcomes, and define the system boundaries of the analysis.

2) Mapping outcomes

An impact map is produced to provide information regarding the organization's inputs, outputs, and outcomes. Inputs represent the factors that stakeholders bring to the initiative activities, e.g., time, money, or space. Outputs are the results of the activities and outcomes are the changes generated towards the stakeholders as a result of carrying out the activities. Therefore, the impact map fulfills two functions in SROI analysis: identifying the costs sustained to generate the outputs of a project/initiative and highlighting the potential outcomes that the project aims to achieve. The values of these two factors will subsequently be related to calculate the SROI index.

3) Evidencing outcomes and giving them a value

Indicators are developed as units of measurement for quantifying outcomes in order to understand the magnitude of change. Indicator data may already be available or may need to be obtained through stakeholders' involvement. After that, the duration over time of the outcomes is defined, as some may be closely related to the activities, but others may last even after the end of the activities. Last, a monetary value is assigned to the outcomes (monetization) through financial proxies that describe the value that stakeholders obtain from the outcome.

4) Defining the impact

In this phase, four parameters are applied to assess whether the considered outcomes are the result of the project/initiative activities. The parameters used are deadweight, displacement, attribution, and drop-off. The deadweight provides a coefficient to estimate the extent of an outcome if the activity had not taken place. The displacement provides a measure of the influence of a realized outcome on other outcomes, but it is not commonly applied in SROI analyses. The attribution defines the portion of the outcome that is generated by other organizations/initiatives. Lastly, the drop-off provides an estimation of the annual reduction in the value of multi-year term outcomes, which are those that continue to occur even after the end of activities. In this way, the true social impact of the project/initiative can be monetized by avoiding overestimates and increasing the accuracy of measurement.

5) SROI calculation

To calculate NPV (Net Present Value) and SROI (Social Return on Investment), the costs and benefits (social value) of each year of project/initiative activity are discounted using a discount factor. NPV is a financial measure of the profitability of an investment and represents the difference between the present value of social impact and the present value of inputs. SROI index is calculated as the ratio of the value of social impact to the value of inputs. In addition, the payback period is calculated to determine how long it takes for the benefits to exceed the costs. Finally, to assess the robustness of the results obtained, a univariate sensitivity analysis is performed to simulate the effects of changes in the most influential variables in the estimate.

6) Returning, using, and integrating

In this last stage, communication of SROI analysis results to stakeholders takes place in the clearest and most transparent way possible. Following the study aim, the index obtained can be used both for

internal and external purposes. In the first case, the organization can exploit the SROI to maximize social value creation within its activities, while in the latter it can provide a snapshot of the social impact generated by a RA initiative involving people with disabilities.

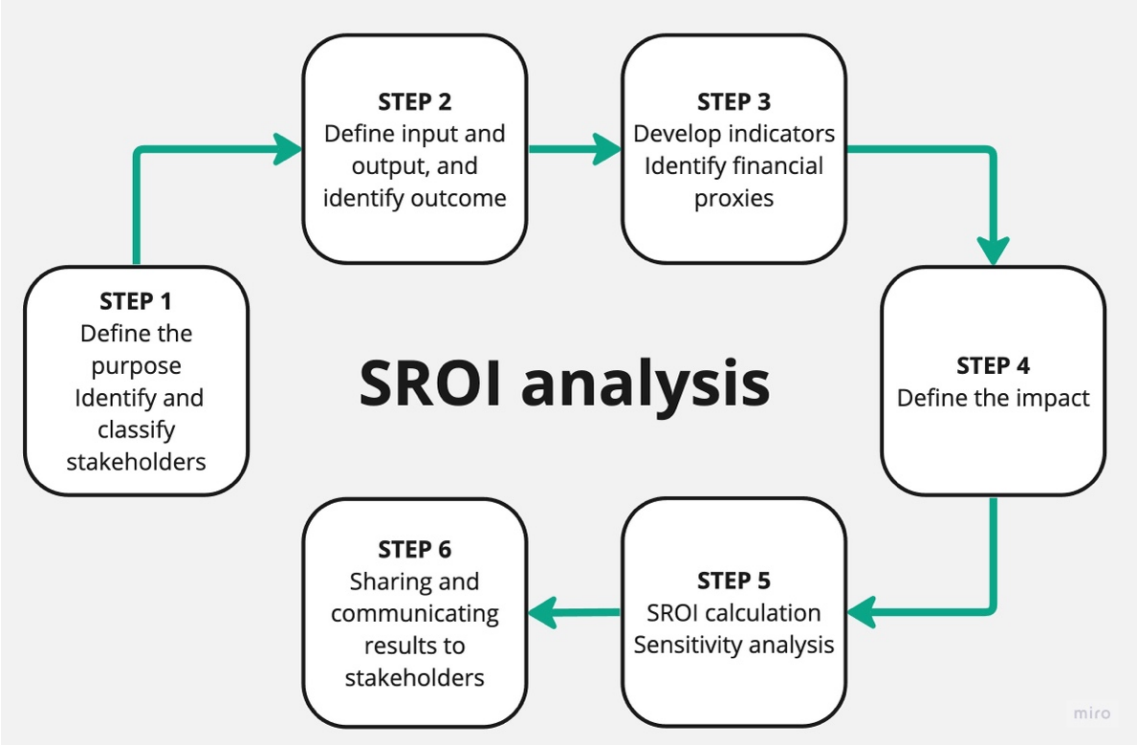

Figure 5: Social Return On Investment steps (source: author)

SROI analysis provides several benefits and opportunities for non-profit organizations. SROI assigns monetary values to social impacts, using a common unit of measurement that allows transparent and clear results communication and interpretation by a wide range of stakeholders. Moreover, the stakeholder engagement approach allows for robust social impact data and insight into the value that stakeholders attribute to the organization's activities. Finally, from the investors' point of view, the SROI index can be used as a tool for benchmarking potential investments to support decision-making processes (Rauscher et al., 2012).

On the other hand, some limitations and weaknesses are presented (Damtoft et.al, 2023). Due to the subjective nature of social aspects, the selection of indicators, financial proxies, and coefficients of impact attribution parameters can be characterized by a significant arbitrariness degree. Moreover, a major limitation of this methodology is the comparability of the results, which is only possible if certain conditions are met. In fact, comparison is possible only between projects and initiatives that operate within the same specific environment, as this affects the way of acting and the objectives of the organizations. Strictly speaking, a scientifically reliable comparison of SROI indicators is only

possible within the same organization assessed over time, while limited comparability is possible between projects and programs managed under similar general conditions. Despite this, similarity was observed between the SROI indices of similar initiatives operating in distinct contexts (Rauscher et al., 2012). If these conditions are met, the SROI analysis can make a valuable contribution to comparing similar projects or organizations in defined geographical region (Nicholls et al. 2012).

3. RESULTS AND DISCUSSION

This section presents the outcomes of each methodological step of the SROI analysis conducted for the "Horts al Terrat" project. As previously mentioned, to date, “Horts al Terrat" consists of 6 rooftop gardens with different sizes and characteristics. For the SROI analysis, the social impact of one representative rooftop garden was analyzed. The representative installation is the soil-less system located in carrer de Valencia above the roof of the Institut Municipal de Persones amb Discapacitat (IMPD, Municipal Institute of Persons with Disabilities). This rooftop garden has an area of 140 m^2 and carries out social activities for 20 disabled people. The social impact of the project was measured over a time horizon of 10 years, which represents the lifespan of the soil-less system required to carry out the cultivation activities of the project.

3.1 Stakeholder mapping

Net-Map is a method that excels in visualizing and making explicit various phenomena that characterize an organization by developing a map in which various stakeholders are highlighted and connected to each other by lines of different colors that represent the different types of relationships among them. For this analysis, the mapping of stakeholders using the Net-Map method represents the first step for the development of the SROI analysis, as it has allowed for the identification of stakeholders of the "Horts al Terrat" project, and among them, those to include in the analysis. (*Figure 6*)

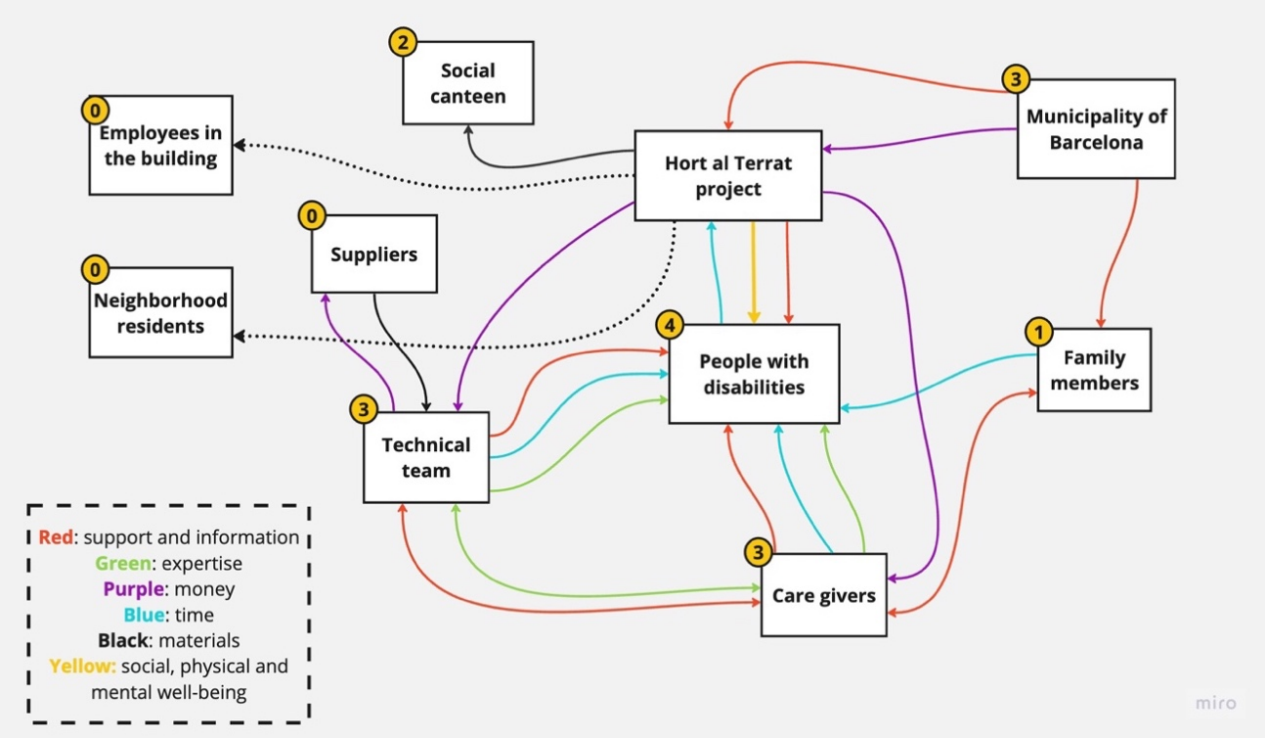

Figure 6: Net Map of the "Horts al Terrat" project

Before drawing the Net-Map, a preliminary identification of the stakeholders of the project was carried out. This phase allowed for the identification of stakeholders who are directly involved in the activities carried out by the "Horts al Terrat" project, the beneficiaries, and those who are not included in the project, but still influence or are influenced by it. Among them, six flows of resources were identified: skills, time, money, support and information, materials, and social, physical, and mental well-being (*Table 3*).

Table 3: Description of Horts al Terrat's stakeholder connections

Connection type	Description
Support and information	Flow of information ta stakeholders in order to increase the effectiveness of the project in improving the well-being of people with disabilities
Expertise	Knowledge that the stakeholders bring to the project. Mainly, the technical team provides the expertise for the soil-less system's functioning and vegetable cultivation, while the caregivers bring the necessary competences to help and support people with disabilities
Money	Monetary flows related to the project. The money invested by the Municipality of Barcelona (main funder) goes into the project for the creation, operation, and maintenance of the soil-less system
Time	Actors' commitment and dedication within the project
Materials	Flow of inputs provided by suppliers and vegetables (output) produced
Social, physical, and mental well-being	Main aim of the project towards people with disabilities

As shown in *Figure 6*, the Net-Map also includes stakeholders who are influenced by the project without participating as "Employees in the building" and "Neighborhood residents." Since they are indirectly influenced by the project by connections that are not fundamental and necessary for the life of the project, their connection line is represented with a dotted line.

The Net-Map method also defines the influence or power relationships that each actor has in the project, in order to identify key stakeholders. In this study, stakeholder influence was quantified using numbers from 0 to 4. A score of 0 was assigned to stakeholders who are not involved in the project activities, while scores from 1 to 4 were assigned to stakeholders involved in the project based on their number of connections and their contribution to the social value generation of the project. By assigning influence degrees to each stakeholder also system boundaries can be set for the SROI analysis. Indeed, the stakeholders to be included/excluded from the analysis were chosen on the basis of their degree. Only stakeholders who scored 0 in their degree of influence were excluded because they were not directly involved in the project. How each stakeholder influences or is influenced by the project and the reason for their inclusion/exclusion from the analysis are listed in *Table 4*.

Table 4: Included and excluded stakeholders of the Horts al Terrat project

Included stakeholders	Project involvement	Inclusion criteria
Disabled people	Stakeholders expected to benefit most from the project	The aim of the project is to generate well-being and social inclusion for disabled people
Technical team	Professionals providing technical expertise in managing soilless farming systems	Their knowledge is necessary for the operation of the system and therefore for the project
Care giver	Professionals who accompany and support disabled people during activities	Their knowledge is needed to help the disabled and technicians in cultivation
Municipality of Barcelona	It is the funder of the project and provides free space for gardens on the roofs of public buildings.	Provides the necessary funds to carry out the project
Social canteen	It receives vegetables and provides them in meals to people at risk of social exclusion	Through the provision of healthy meals to people at risk of social exclusion is generating social impact
Family members	They are the actors closest to people with disabilities	They are indirectly affected by improving the welfare of their disabled children
Excluded stakeholders	**Project involvement**	**Exclusion criteria**
Supply providers	They provide the material for building and maintaining the system (plants, substrate, pesticides, fertilizers).	They do not contribute to the generation of social value
Employees in the building	They work in public buildings that hosts the rooftop gardens	They do not fit within the boundaries of the analysis system.
Neighborhood residents	Rooftop gardens give the neighborhood a better appearance	They do not fit within the boundaries of the analysis system.

After identifying the stakeholders to be included in the SROI analysis through the Net-Map, the expected changes were hypothesized for each included stakeholder. This stage allowed to make predictions about the project outcomes, which will then be validated in subsequent stages through data collection. The expected changes for each stakeholder are listed in *Table 5.*

Table 5: Expected changes for each included stakeholder

Stakeholder	Expected changes
Disabled people	The exercise of gardening is closely related to physical and mental well-being. Participants in the rooftop project are able to make more connections and socialize more. The rooftop project also exposes them to new ways of autonomy, such as reaching the garden by public transportation. Finally, cultivation activities are associated with improved social relationships, self-awareness, self-esteem, and problem solving (Triguero-Mas et al., 2020).
Technical team	The project enables them to have access to a job and a salary resulting in social security. Working closely with care givers and people with disabilities allows them to gain new knowledge and experience in caregiving. In addition, working and contributing to a social project produces a sense of satisfaction and motivation
Care givers	The project enables them to have access to a job and a salary resulting in social security. Working closely with the technical team allows them to gain new knowledge and experience in agriculture. In addition, working and contributing to a social project produces a sense of satisfaction and motivation
Municipality of Barcelona	Through project funding, it is able to shorten the food chain by fostering the development of CRFS. In addition, it creates a social agriculture initiative within the city center by making it easier for users to reach the site and facilitating transportation by public transport
Social canteen	Through the production of rooftop gardens, they receive a steady supply of fresh, healthy vegetables that are served in meals offered to people at risk of social exclusion.
Family members	The improved well-being of disabled children also has an impact on their behavior at home which results calmer and more manageable. As a result, family members have to spend less time in caring for their children and thus have a lower emotional burden and a quieter life

3.2 Impact Map

To define the Impact Map, the inputs provided by each stakeholder for the project implementation were identified. A financial value was assigned to each input, with the exception of the "time" input. Indeed, the time that disabled people devote to cultivation activities cannot be assigned a financial value, as the project aims to produce benefits through social farming, rather than generating paid employment opportunities. The same logic can be applied to the time devoted by the parents of people with disabilities since they are also indirect beneficiaries. Finally, the time that the social canteen staff devotes to bringing vegetables from the rooftop gardens to the plates of people on RSE cannot be assigned a monetary value either, since it is voluntary work.

The inputs with monetary value are those provided by the workers (technical team and caregivers) and the Municipality of Barcelona, which is the project's funder. The total investment that the Municipality of Barcelona makes for a 140 m² rooftop garden is € 60,000.00, distributed over 10 years. The initial investment for the soil-less system installation is € 30,000.00. The maintenance and operation cost of the system is € 250 m²/year, totaling €3,000.00 per year. Finally, the salary of the technician is € 880.00/year, while the two caregivers have a wage of €440.00/year each. The total value of the inputs related to labor is € 1,760.00/year. It is important to highlight that the "Horts al Terrat" project does not pay for the space occupied by the soil-less systems since it is offered by Municipality of Barcelona.

The value of the inputs for each stakeholder is reported in *Table 6* and their percentage distribution is shown in *Figure 7*.

Table 6: Stakeholders input into the "Horts al Terrat" project (data source: Tectum Garden)

Stakeholder	Input	Value	10 years value
Disabled people	Time	0 €	0 €
Technical team	Time, effort, and commitment (waged)	10 €/h * 88 h/year * 1 technician	8.800,00 €
Care givers	Time, effort, and commitment (waged)	10 €/h * 44 h/year * 2 care givers	8.800,00 €
Municipality of Barcelona	Money	30.000 € initial investment + 3.000 €/year	60.000,00 €
	Space	0 €	0 €
Social canteen	Time	0 €	0 €
Family members	Time	0 €	0 €
Total investment			77,600.00 €

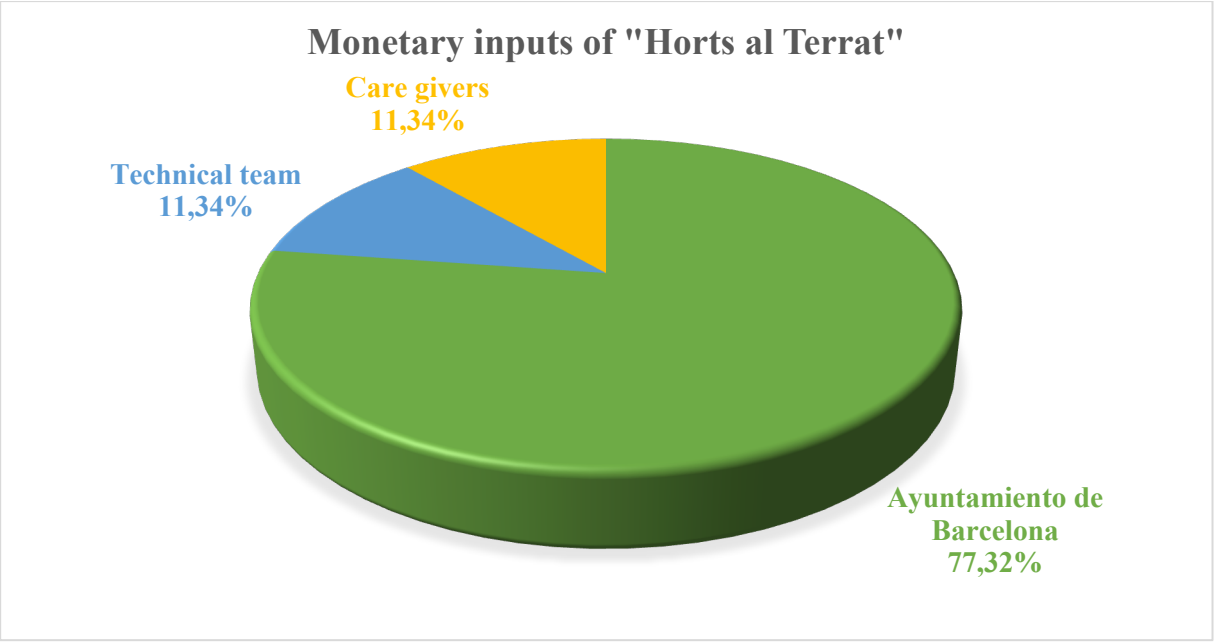

Figure 7: Distribution of monetary inputs of "Horts al Terrat" among stakeholders

3.3 Outcomes, related indicators, and financial proxies

According to the expected changes for the included stakeholders, it was possible to define the outcomes generated by the project. Regarding people with disabilities, the definition of outcomes was supported by the study of Triguero-Mas et al. (2020) and stakeholder interviews. Next, the outcomes were assigned indicators to quantify them and financial proxies to assign a monetary value. A limitation of the SROI methodology was found at this stage. Indeed, the absence of guidelines for the selection of indicators and financial proxies gives this step a high degree of subjectivity.

For this reason, the indicators from Tulla et al. (2020) and the City Region Food System Indicator Framework (Carey et al., 2017) were adopted to reduce the degree of arbitrariness in the analysis and to allow the results to be compared with the regional context of Catalonia (Tulla et al., 2020) and other CRFS (Carey et al., 2017). In addition, some outcomes initially identified were excluded from the calculation of social impact according to their nature and the availability of indicators in the literature.

The economic-environmental outcomes were excluded as they do not fulfill the system boundaries of this SROI analysis, which includes only impacts related to the social sphere of the "Horts al Terrat" project. In addition, outcomes for which the indicators reported in the reference bibliography needed to be complemented were excluded. Their inclusion in the SROI analysis would have decreased the degree of comparability of results with other studies. Despite this, it is important to note that "Horts al Terrat" also generates environmental and economic impacts. Some examples of economic impacts excluded from the analysis are the increase in market value of buildings hosting rooftop gardens and the creation of cultivable area within the city. The respective proposed indicators were "Average sales price increase of buildings with rooftop gardens" (proposed by the author) and "Increase in total agricultural surface area in the city" (Carey et al, 2017). Otherwise, an environmental outcome is represented as the reduction in CO_2 emissions due to the shortening of the supply chain of social canteens, which was assigned the indicator "Reduction of equivalent CO_2 emissions" (proposed by the author).

Other outcomes were not included in the social value calculation to avoid double counting. The outcome "Improved social well-being" of people with disabilities was initially included with the potential attribution of indicators like "Number of people who increased interpersonal relationships" (Tulla et al., 2020) or "Regular attendance of voluntary or local organizations" (Trotter et al., 2014).

Despite this, Triguero-Mas et al. (2020) report that urban RA improves the social relationships of people with disabilities, but they also point out that the causes of improvement can be diverse and difficult to represent with a single indicator. Therefore, due to the complex nature of social well-being and its correlation with mental and physical well-being (already included in the analysis), the outcome "Improved social well-being" was excluded from the analysis.

Also, the outcome "Short supply chain development'" was excluded to avoid double counting of the outcome value. In fact, this outcome and the "Healthier meals" outcome of the social canteen relate to the same amount of vegetables produced in the rooftop gardens and both base their financial proxy on the average selling price per kg of vegetables in Spain (Ministry of Agriculture, Fisheries and Food of Spain, 2021). Despite this, the vegetables produced in the rooftop gardens are actually donated to social canteens, so it was preferred to include in the analysis their value under the outcome "Healthier Meals" while excluding "Short supply chain development."

The financial proxies attributed to the indicators were obtained from the reference bibliography or from Tectum's own data. The outcomes included in the analysis with their associated indicators and financial proxies are shown in *Table 7.*

Table 7: Indicators, financial proxy, and value of gross outcome impact

Stakeholder	Outcome	Change indicator	Financial proxy	Value	Number	Gross impact
Disabled people	Improvement of physical health	Number of people whose well-being and physical health have improved (1)	Annual registration with a gym/daily entrance fee (1)	597,84 €	20	11.956,80 €
	Greater mental health	Number of people whose mental health status has improved (1)	Cost of a therapy session (1 time x month x user) (1)	50,00 €	20	12.000,00 €
	Acquisition of skills in agriculture	Number of people who have acquired new personal and work skills and abilities (1)	Average training cost: horticulture (1)	285,71 €	20	5.714,20 €
Technical team	Salary and job security	Monetary amount that workers receive for their work (1)	Salary of technical team staff (4)	880,00 €	1	880,00 €
	Acquisition of skills in care giving	Number of people who have acquired new personal and work skills and abilities (1)	Average training cost: social care (1)	285,71 €	1	285,71 €
Care givers	Salary and job security	Monetary amount that workers receive for their work (1)	Salary of care givers (4)	440,00 €	2	880,00 €
	Acquisition of skills in agriculture	Number of people who have acquired new personal and work skills and abilities (1)	Average training cost: horticulture (1)	285,71 €	2	571,42 €

Municipality of Barcelona	Increased use of public transport	Number of people who use public transport more (1).	10-trip ticket cost x 4 months (1)	34,05 €	20	681,00 €
	Short (local) supply chain development	Annual volume of food produced by the system (2)	Average selling price (5)	2,05 €	1542 kg (4)	---
Social canteen	Healthier meals	Number of healthy meals (3)	Vegetable ration cost (average price per kg * 0,150 kg/ration) (5)	0,31 €	10280 meals	3.161,10 €
Family members	Less time to devote to disabled children	Number of hours that families no longer spend caring for with people with disabilities (1)	Cost of one hour of Home Help Assistant (1)	7,51 €	880 h	6.608,80 €
					Total annual gross impact	36.130,23 €

1) Tulla, A. F., Vera, A., Guirado, C. & Valldeperas, N. The Return on Investment in Social Farming: A Strategy for Sustainable Rural Development in Rural Catalonia. Sustainability 12, 4632 (2020).

2) Carey, J., Dubbeling, M. & Foundation, R. City Region Food System Indicator Framework. (2017).

3) Proposed by the author.

4) Tectum Garden own data.

5) Ministerio de Agricultura, Pesca y Alimentacion de Espana. Datos anuales del panel de consumo alimentario en hogares. (2021).

3.4 Actual social impact calculation of "Horts al Terrat"

To quantify the effective social value generated by the project over its 10-year lifespan, the value of the outcomes was calculated by applying the deadweight, attribution, and drop-off coefficients. All three coefficients are expressed as percentages.

Defining the value of the coefficients is another critical point of the method because the social benefits generated by CRFSi are intangible and therefore difficult to estimate (Solórzano-García et al., 2019). The authors also reported that in the SROI analyses considered in their work, a variety of criteria were used to define the coefficients, among which, according to Damtoft et al. (2023), the use of control groups is the method that is most likely to provide analytical values. Despite this, this stage remains a source of arbitrariness in SROI analysis. In this SROI analysis, the coefficient values were estimated through stakeholder interviews and by applying a precautionary approach.

The value of the coefficients and their assignment to each outcome is displayed in *Table 8*. Three different percentages were applied for the deadweight based on the specific characteristics of each outcome and the evaluation of the project's effects in the territorial context of its implementation: 1) 100% for the social canteen's food supply outcome, as in the absence of the project, the canteen would have sourced from another supplier to continue its activities; 2) 50% for the "Salary and job security" outcome, considering that the workers, in the absence of the project, could potentially find employment in one of the many SA initiative in the Barcelona metropolitan area (Guirado et al., 2017); 3) 30% for those changes that the project has contributed to, but could have also occurred without its presence.

For attribution, no coefficient was applied for outcomes entirely generated by the project. The only outcomes to which an attribution coefficient was applied were "Improvement of physical health" and "Greater mental health". Triguero-Mas et al. (2020) reported that participation in urban rooftop gardening projects is linked to an improvement in individuals' quality of life. Nevertheless, quality of life depends on many interrelated factors, and therefore the effect of a single activity, such as horticultural therapy, is complex to isolate from others and quantify (Damtoft et al., 2023). Therefore, to avoid overestimating the actual mental and physical well-being generated by "Horts al Terrat," a precautional attribution coefficient of 50 % was applied.

For the drop-off, a percentage of 60% was estimated only for outcomes related to the acquisition of new skills. The acquisition of new skills is related to the performance of activities, but over time, the

activities remain the same, so the learning decreases every year (data obtained from participants interviews). In this study, a duration of the outcome of 3 years was considered; therefore, for the first year, the full value of the outcome was considered, and for the remaining years, the value was decreased by 60% compared to the previous year. The other outcomes do not have a drop off because the benefit does not produce effects over time and ceases with the interruption of project activities.

Table 8: Estimates of the percentage values of the coefficients of deadweight, attribution and drop off.

Stakeholder	Outcome	Deadweight	Attribution	Drop off	Impact
People with disabilities	Improvement of physical health	0%	50%	0%	59.784,00 €
	Greater mental health	0%	50%	0%	60.000,00 €
	Acquisition of skills in agriculture	30%	0%	60%	6.239,91 €
Technical team	Salary and job security	50%	0%	0%	4.400,00 €
	Acquisition of skills in care giving	30%	0%	60%	312,00 €
Care givers	Salary and job security	50%	0%	0%	4.400,00 €
	Acquisition of skills in agriculture	30%	0%	60%	623,99 €
Municipality of Barcelona	Increased use of public transport	30%	0%	0%	4.767,00 €
Social canteen	Healthier meals	100%	0%	0%	- €
Family members	Less time to devote to children with disabilities	0%	0%	0%	66.088,00 €
Total impact					206.614,89 €

3.5 SROI calculation

After calculating the monetary net value of each change, the social value and costs were defined for each year of the 10-year time horizon. These values were discounted to the initial time using a social discount rate (SDR) set at 3.5% (Nicholls et al., 2012) . *Table 9* shows the calculations to quantify the SROI.

Table 9: Calculations of SROI and payback period.

Year	Present Social Value	Present Cost	NPV	SROI	Payback period
0	- €	30.000,00 €	- 30.000,00 €	---	- 30.000,00 €
1	23.713,85 €	4.599,03 €	19.114,82 €	0,69	- 10.885,19 €
2	20.335,48 €	4.443,51 €	15.891,97 €	1,13 (+0,44)	5.006,78 €
3	18.652,08 €	4.293,25 €	14.358,83 €	1,45 (+0,32)	19.365,61 €
4	17.379,96 €	4.148,07 €	13.231,89 €	1,69 (+0,24)	32.597,50 €
5	16.792,23 €	4.007,79 €	12.784,44 €	1,88 (+0,19)	45.381,94 €
6	16.224,38 €	3.872,26 €	12.352,12 €	2,04 (+0,16)	57.734,05 €
7	15.675,73 €	3.741,32 €	11.934,41 €	2,18 (+0,14)	69.668,46 €
8	15.145,63 €	3.614,80 €	11.530,83 €	2,29 (+0,12)	81.199,29 €
9	14.633,46 €	3.492,56 €	11.140,90 €	2,39 (+0,10)	92.340,18 €
10	14.138,61 €	3.374,45 €	10.764,16 €	2,48 (+0,09)	103.104,34 €
Total	173.257,74 €	69.587,04 €	103.104,34 €	2,48	

The investment is able to generate a Net Present Value (NPV) of €103,104.34 during its useful life of 10 years. The SROI (Present Social Value/ Present Cost) of the Carrer de Valencia rooftop garden in the "Horts al Terrat" project is €2.48 for every euro invested. As shown in *Table 9*, the annual increase in SROI decreases over time due to the effect of discount rate and drop off.

The payback period of the investment, which is the time required for the sum of the revenues to exceed the sum of the costs, is only 2 years because the project generates a significantly higher social value compared to the annual management costs, especially in the early years.

In order to highlight the impact generated by "Horts al Terrat" towards each stakeholder an analysis of the distribution of impact among stakeholders was carried out. As shown in *Table 10*, most of the social value is generated towards people with disabilities (61.12%) since they are the stakeholders expected to benefit most from the project, as assumed during the stakeholder mapping. Family members are the second category of stakeholders in terms of social value generated (31.83%) as they benefit from the improved condition of their children.

Table 10: Value of social impact and SROI for each stakeholder category

Stakeholder	Present social value	SROI	% impact
People with disabilities	105.555,13 €	1,52	61,12%
Technician	3.956,08 €	0,06	2,29%
Care givers	4.252,86 €	0,06	2,46%
Municipality of Barcelona	3.964,53 €	0,06	2,30%
Social canteen	- €	0,00	0,00%
Family members	54.962,78 €	0,79	31,83%
Total	172.691,38 €	2,48	100,0%

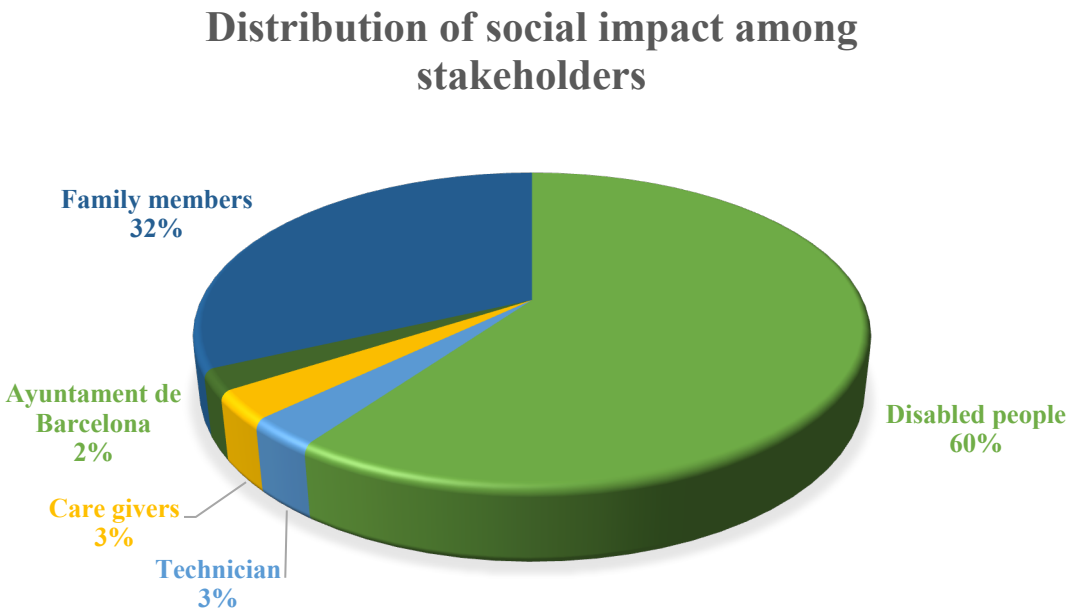

Figure 8: Distribution of the impact of "Horts al Terrat" among stakeholders

3.6 Sensitivity analysis

From the results of the impact distribution analysis, it can be inferred that the generation of social value in the project depends mainly on two variables in the analysis: the number of people with disabilities involved and the number of annual hours they spend in the project. Although family members are the second category of stakeholders in terms of generated social value, the value of their social impact is also dependent on the number of hours their disabled children spend in the rooftop vegetable gardens. However, it is important to note that this impact is an indirect effect of the participation of people with disabilities in the "Horts al Terrat" project. Based on these two variables, a sensitivity analysis was conducted.

By analyzing the effect of varying the number of people with disabilities participating in the activities, it has been observed that each user contributes € 8,025.90 to the NPV and 0.12 points to the SROI.

Based on this data, the minimum number of people with disabilities to be included in the activities to achieve economic viability (NPV > 0 and SROI > 1) for the project has been calculated. It has been observed that the minimum number of disabled people to be included is 8, as below this value, the NPV becomes negative and the SROI falls below 1. Conversely, an increase in the number of

participants would result in an increase in the NPV and SROI. For example, by increasing the number of users per year by 10 (from 20 to 30), there would be an increase of + €80,258.96 in NPV and +1.15 in SROI (NPV = €183,363.29; SROI = 3.64).

This increase would involve adding 2-3 users to each group of people with disabilities without requiring an increase in the working hours of the technical team and caregivers. However, if the increase exceeds 10 users, it will lead to an increase in operating costs due to the need to hire technicians and caregivers (stepped variable cost) (*Figure 9*).

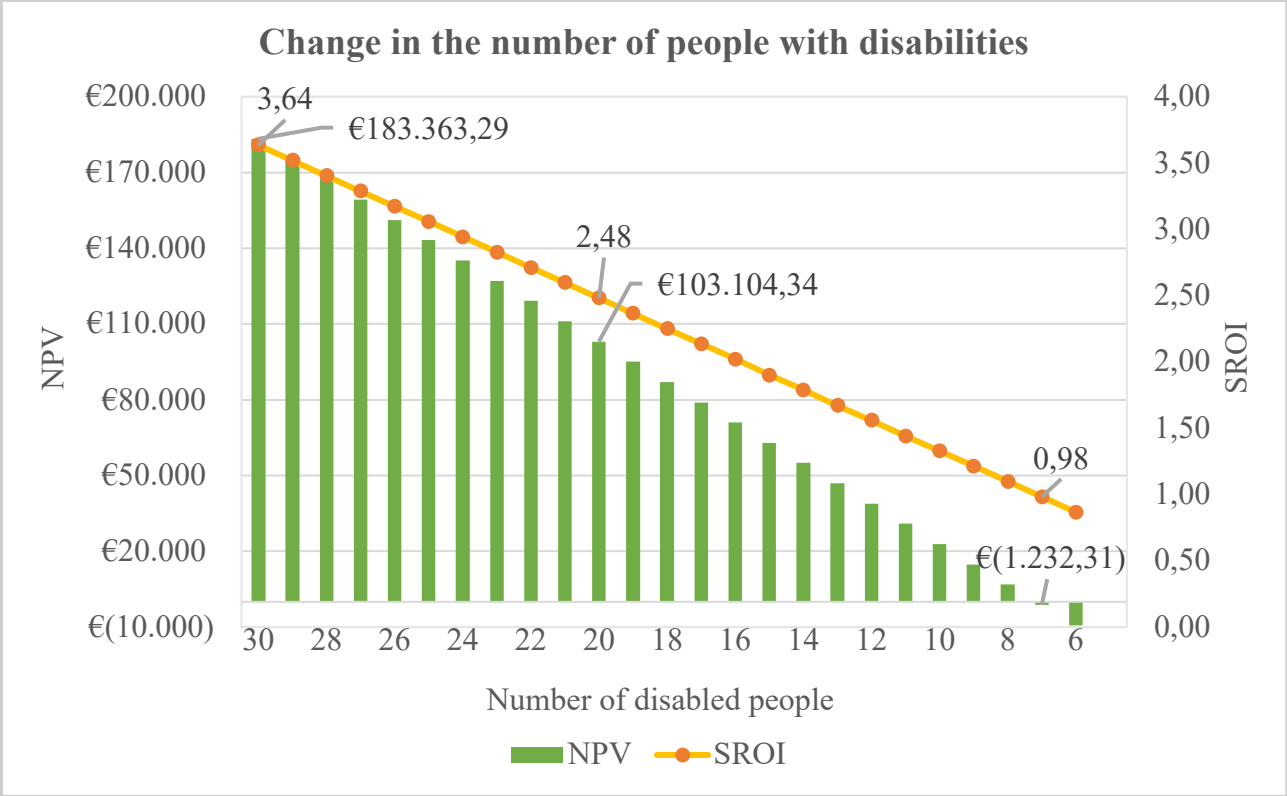

Figure 9: Effect of variation in the number of disabled individuals on NPV and SROI

Otherwise, the variation in the number of annual hours spent by each disabled person in the rooftop gardens also affects the working hours of the technical team and caregivers since their presence is required during the activity hours. Furthermore, the variation in the number of annual hours per disabled person also impacts the value of their outcomes, those of the project staff (technical team and caregivers), and the outcomes of family members.

With an equal number of disabled people (20), the reduction in the number of annual hours per user that the system can support while still generating social value is approximately – 68,19% (from 44 to

around 14 hours). Conversely, increasing the annual hours per person by just one hour results in an increase of €3,477.62 in NPV and 0.04 in SROI. Therefore, to increase the social value generated by the project, an increase of 50% in annual hours (from 44 hours/disabled person/year to 66 hours/disabled person/year) would yield an NPV and SROI of €179,703.98 and 3.34, respectively (+€76,599.65 NPV and +1.15 SROI). (*Figure 10*)

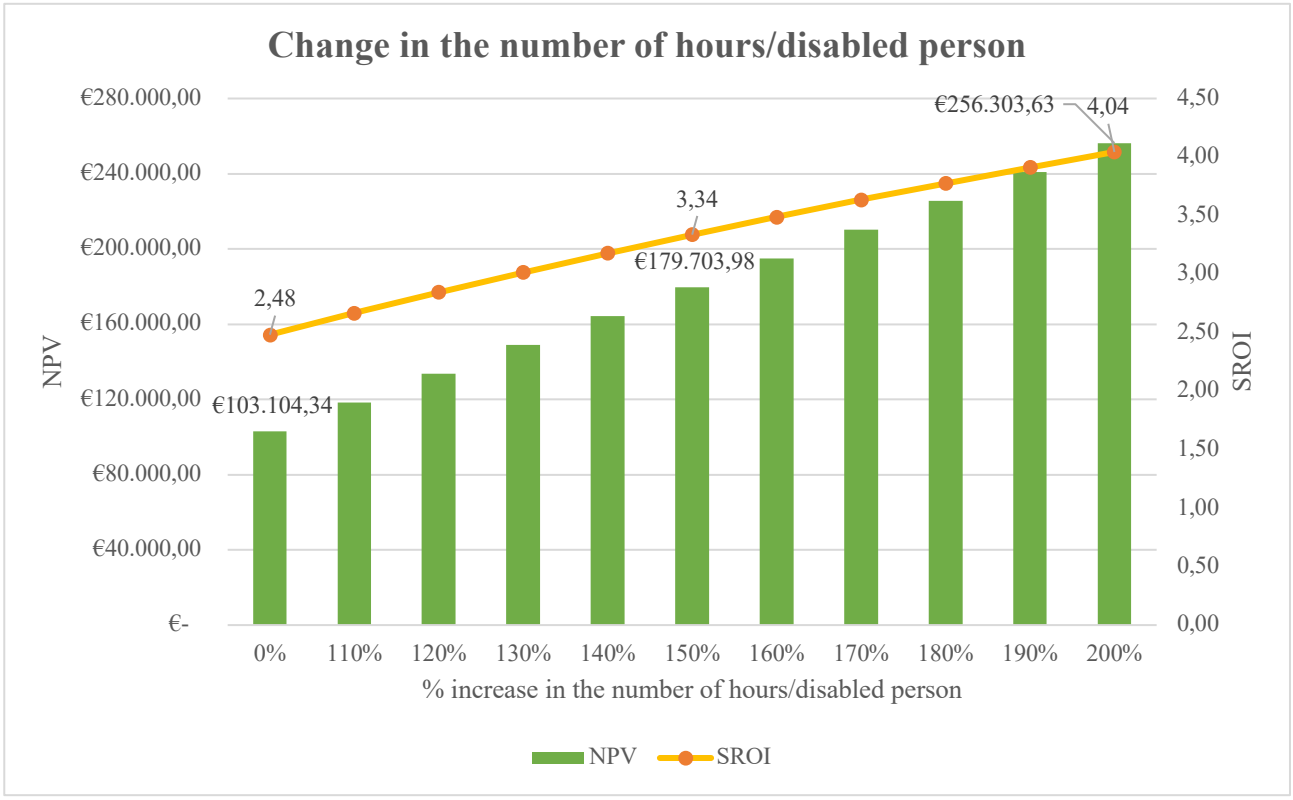

Figure 10: Effect of variation in the number of annual hours per disabled person on NPV and SROI

4. CONCLUSIONS

In recent years, there has been an increasing interest in the research on sustainable and efficient FSs that aim to meet the supply of goods while generating socioeconomic benefits. Among these, CRFS have been identified as an approach that can enhance the connection between urban centers and surrounding peri-urban and rural areas, creating a resilient and sustainable structure capable of producing safe, nutritious, and accessible food. To demonstrate and measure the sustainability and benefits of these FSs, tools for impact assessment are required.

Among the various available methods, SROI analysis has emerged as a promising methodology for evaluating the social and economic impacts of CRFSi, as it enables quantification and evaluation of the social value generated by projects and initiatives related to FSs, providing an economic perspective on their effectiveness and sustainability. Through the use of SROI, it is possible to measure the impacts that CRFSi can have on the three spheres of sustainability, especially on the social one. The application of SROI analysis in this thesis work to measure the impact generated by the "Horts al Terrat" project in the city of Barcelona has enabled the identification of its strengths, limitations, and potential improvements.

Due to the main strengths of this methodology, SROI analysis has high potential in assessing social impacts of CRFSi. SROI's principal advantage lies in its capacity to quantify impacts in monetary terms which facilitates comprehension of results across a broad spectrum of stakeholders and comparability to other monetary values. This efficacy was also evident during the communication phase of the analysis results of this thesis work, where stakeholders readily understood the findings. Furthermore, the utilization of monetary language enables the SROI index to function as an economic tool for comparing investments or measure the profitability of previous investments. In the present analysis, the index provided Tectum Garden and Municipality of Barcelona with a means to assess the efficacy of the investment in "Horts al Terrat," which would have been difficult to evaluate given the project's lack of monetary revenue generation. Simultaneously, the index was utilized by Tectum Garden to identify the main factors contributing to social impact generation, and thus improve the focus of their efforts.

However, limitations were encountered during the analysis with respect to the degree of arbitrariness involved in some steps of the SROI methodology. As mentioned in the previous chapter, the selection of indicators and financial proxies is not supported by guidelines or reference databases.

Consequently, the choice of these elements relies on the judgment of the analysis executor, introducing a certain degree of arbitrariness that hinders result comparability. In this analysis, indicators and financial proxies derived from literature were employed to enhance comparability with other regional SF initiatives and CRFSs. Nevertheless, in absence of supporting tools for the selection of indicators and financial proxies the accuracy of impact measurement and results comparability will be always strongly affected.

Therefore, to overcome these limitations, adopting a participatory approach in the indicator selection process is recommended. Expanding stakeholder involvement beyond data collection stages would allow for the identification of indicators and financial proxies that effectively represent the generated impact in monetary terms. To achieve this, representatives from each category of stakeholders involved in SF initiatives at the regional level should be identified to form focus groups. Through collaborative discussion, focus group members would be tasked with identifying one or more suitable indicators for quantifying the impacts generated by projects. The resulting indicators would be integrated into a toolkit for indicator selection in SROI analyses, enabling consistent and precise quantification of specific outcomes. This approach would facilitate the comparison of impacts across different SF initiatives at the regional level, highlighting activities that have the greatest potential to generate social value in a given territory.

In conclusion, the encountered limitations and the obtained results from this thesis work confirm the lack of depth in assessing the social impacts that CRFSi can have within territorial FSs (Brouwer et al., 2020; El Bilali et al., 2021). More accurate measurement of social impacts is needed to conduct sustainability assessments that precisely quantify the all-round impacts of CRFSi. This would help to identify hotspots on which focus efforts to increase the positive impacts of these initiatives and accelerate the transition to more sustainable and resilient territorial FSs.

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ACKNOWLEDGEMENTS

I would like to thank my supervisor Prof. Matteo Vittuari for the educational experience that allowed me to improve my academic knowledge and abilities. I also extend my thanks to Dr. Anna Niero who supported me in writing the thesis with valuable advice. My appreciation also goes to Dr. Pietro Tonini (UAB Universitat Autònoma de Barcelona) who assisted me in carrying out the SROI analysis and organizing the thesis work. Finally, I would like to thank Tectum Garden for granting me the opportunity to undertake my final internship at their company.