Visualization Technology-Mediated Civic Engagement in Community-Driven Landscape Design: An Analysis & Evaluation of Pre-Built Design Outcomes

by

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Abstract

Engaging diverse stakeholders in decision making around the design and planning of public space is critical to building more sustainable, socially-just communities. Technology-mediated civic engagement can empower residents to interactively design the environment to meet community-specific needs which can lead to myriad positive environmental, economic, and social outcomes. This project proposes a model to evaluate the outcomes of a technology-mediated civic engagement method using a new software in the context of public space design and planning and tests the evaluative model with a case study. Visualization based decision support systems are being developed to provide non-professionals with tools to design their own landscapes. Land.Info is a decision support system that aids the design of sustainable open space by combining realistic 3D visualizations with data indicating the social, ecological and economic performance of a site that updates in real-time as users alter their design. However, at this point there is a lack of objective methods to evaluate design outcomes from these types of decision support systems (DSS). The overall aim of this practicum is to create an evaluation model to assess the potential socio-cultural impacts of pre-implementation design outcomes created using Land.info as a community-engagement open-space planning tool in a participatory setting. This paper has three main parts. The first part discusses and conceptualizes the nature of visualization and technology-mediated civic engagement. The second draws from existing evaluation models to create and explain a new model inclusive of features supporting workshop design goals. The final part discusses the value and limitations of the created evaluation model and suggests directions for further development and research.

Table of Contents

List of Figures

Figure

List of Tables

Table

List of abbreviations and terms

1. Public - community, citizens, local people
2. Participation - influencing decisions, addressing conflicts, ensuring public official accountability (Arnstein, 1969)
3. Landscape Visualization - a computer-generated representation of a landscape
4. Participatory Design - (In landscape architecture and planning) A process that engages a group of individuals in shaping open space (Sanders & Stappers, 2008).
5. Technology-mediated - used to source, analyze, visualize and share information and create solutions to address a problem (Desouza & Bhagwatwar, 2014)
6. Open Space - defined as areas and networks of varying scales that benefit communities ecological, social, and other health benefits (Meyer 2010). In the context of this project, open spaces refer to parcels of land that are designed and manage for a specific use.
7. DSS – decision support software
8. ECN – Eastside Community Network

Chapter 1. Introduction

1.1 Theoretical framework

This practicum develops a pre-built design evaluation model and discusses its application in a case study of a series of workshops led by a team of University of Michigan Dow Sustainability Fellowship recipients in collaboration with the Eastside Community Network, a Detroit-based nonprofit community development organization. The research uses quantitative and qualitative methods to assess design outcomes from a visualization technology-mediated of civic engagement process using the Land.info decision support software (DSS), in the conceptual landscape design of a vacant parcel. The first part of this report details the need for effective community engagement tools to support open space design and explains the broader benefits of collaborative design practices. The second part reviews existing technology-mediated community-driven design tools used by planners and introduces Land.info as a novel decision support tool. The third section develops and operationalizes a model of pre-built design evaluation to compare the socio-cultural benefits of designs created using Land.info in a participatory design setting.

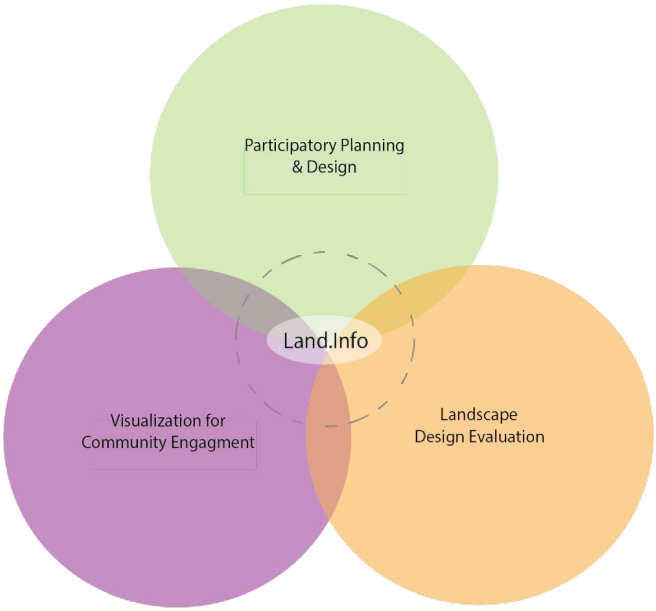

Figure 1. Theoretical framework and approach for practicum includes Landscape Design, Participatory Design, and Visualization for Community Engagement

The evaluation draws on several fields: landscape architecture, community planning, environmental education, and environmental justice. The framework centers on technology-mediated planning and design and participatory design theory through which Land.info as a technology mediated community engagement software is assessed. The topics of inquiry framing the study are:

- Visualization for Community Engagement
- Participatory Planning and Design
- Landscape Design Evaluation

1.1.1 Key Concepts

- Technology-mediated community engagement is a powerful tool for landscape architecture and planning professions
- Interactive visualization software provides a common visual language that can communicate sometimes abstract concepts among many people
- Effective technology-mediated community engagement using Land.info is dependent upon its accessibility and standardized facilitation methods
- A combination of design evaluation methods allow for informed qualitative comparison of design outcomes generated in landscape visualization software

1.1.2 Research question

What methods of evaluation can be used to assess the socio-cultural benefits of pre-built designs created using technology-mediated civic engagement software?

1.1.3 Objectives

- To develop an objective evaluation model measuring the socio-cultural benefits of proposed designs
- To conduct a deductive evaluation of design outcomes produced during engagement workshops that used Land.info DSS

Chapter 2 - Literature Review

2.1 The Importance of Civic Engagement

There is growing understanding about the connection between well-designed parks and public spaces and the health, wellness, and sustainability of a community (Carmona, 2019). The landscape is the matrix that connects humans to the environment and to each other. Publicly accessible lands such as parks, gardens, reserves, arboreta, playgrounds, monuments, and golf courses are environments at the confluence of human interaction with one another and the natural world. The design of these public open spaces is determined by built environment professionals: city planners, landscape architects, developers, engineers, and other specialized professions centered altering the landscape. Improving the quality of public lands and human connection to them requires decision making that incorporates a variety of perspectives and supports public interest. Bringing community members together in the creation of public open space is important in the development of sustainable communities as the consequences of planning and design efforts affect landscapes and stakeholders at a variety of scales well beyond the contractual scope of work (Brown & Jennings, 2003). Civic engagement contributes valuable information to a project of public benefit that can lead to more impactful, sustainable solutions to some of the most pressing environmental, economic, social, and political issues facing communities today. As a result, there are growing efforts to increase civic engagement in planning and design.

Civic engagement conducted by planners and landscape architects takes many forms including community meetings, workshops, surveys, events, mapping, and model building with the goal of influencing spatial change that best serves unique community needs. A well-designed civic engagement process shifts some of the power into the hands of residents and stakeholders by enhancing opportunities for their involvement in design and planning of open space (Arnstein, 1969). Residents and professionals collaborating to define community design goals and priorities enhances the outcomes of public space planning and design project. Community goals can be realized through a combination of knowledge, skills, and values gained when these diverse perspectives are integrated into the process (Conner, 2019). Pairing civic engagement with technology can support the efficiency and effectiveness of these processes.

2.2 Technology-Mediated Civic Engagement

The use of technology-mediated civic engagement is growing in the design and planning industries as it supports additional modes of interaction and

communication in public engagement endeavors. Civic engagement using virtual worlds more directly connects people to communities and public spaces and sparks dialogue that supports evaluation and modification of these environments (Gorden & Koo, 2008). Web-based methods of engagement enable more widespread outreach, tapping into a broader sampling of stakeholders and requiring less time and money than traditional forms of civic engagement.

Using technology to facilitate engagement first involved shifting conventional methods to digital platforms (e.g. surveys). Despite the use of traditional engagement methods in digital formats, the complexity of information and understanding required in design and planning is difficult to communicate to lay-citizens in these engagement activities. For this reason, the adoption of visualization and other technology-centered methods can help to simplify the complexity of spatial design by communicating in visual space. New visualization technology allows everyday people to “see” themselves, their cities, and their changing environments in powerful ways (Foo, 2018). Using technology, residents can contribute meaningful input without being subjected to the levels of complexity that become a part of the conversation during many public engagement methods.

2.3. Visualization as a Medium to Enhance Civic Engagement

Civic engagement can greatly benefit from the integration of visualization as it allows for a clearer understanding of the spatial environment in question and supports more conversation around a space (Salter et al., 2009). Visualization tools assist non-designers in communicating ideas by using a variety of techniques that include sketching, mapping, model making, photography, Geographic Information Systems (GIS), and computer assisted visualization (Sutton & Kemp, 2006).

Visualization technology to support urban design and planning projects benefits from its versatility in platform, meaning it can be used in both in-person and web-based civic engagement settings. Visualization technology-mediated civic engagement can incorporate both qualitative and quantitative metrics, such as the air quality impacts of tree plantings and perceived safety of a place, which support more informed decision-making for its improvement. Conveying benefits and incentives of plans using visual means provides for easier communication of ideas between involved parties like designers, planners, residents, developers, and businesses (Goodspeed & Hackel, 2017).

Using methods of visualization in public engagement enables residential inquiry in different forms and supports dialogue around novel design solutions for a local site (Sutton & Kemp, 2006). Residents can feel more empowered

by seeing the impacts of change in their communities using visualization methods. This means that incorporating visualization into technology-mediated civic engagement practices can enhance these methods and assist in developing effective design outcomes using a communicative medium that doesn't require extensive industry knowledge to understand.

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2.4 Participatory Design

A form of civic engagement called participatory design stems from environmental movements of the 1960's in support of democratic engagement of communities in making decisions to support the health of the environment (Bartlett, as cited in Hester Jr. 1987; Sanoff, 2000; 2015). Participatory design aims to bring together diverse perspectives in an iterative cycle of learning for both participants and researchers that takes the form of conversation, co-learning, reflection, and action to support structural and cultural change (Sutton & Kemp, 2006). Inclusion of diverse stakeholders and perspectives in the design and planning process helps to empower participants in shaping their communities.

Effective participatory design requires interdisciplinary and transdisciplinary approaches that allow for discourse and iterative creation of open space among users (Meyer, 2011). Participatory engagement practices help decision makers and users better understand the complex context within which the design takes place and supports designer and participant knowledge that leads to idea creation and concept development (Sanders & Stappers, 2008). In this practice, the end users are considered experts of their experience offering important information to the design process that otherwise not available to design professionals (Sanders & Stappers, 2008). Designed and implemented correctly, the participatory design process benefits all stakeholders involved and contributes to positive environmental and social outcomes.

Storytelling is the primary form of knowledge sharing from community members engaged in participatory settings (Cumming & Norwood, 2012). When stakeholders contribute their stories to the participatory design process, it assists in creating more social connection and cohesion, enabling more empathy for fellow stakeholders impacted by land use change. Urban design and planning projects that incorporate participatory design can foster the development of creative parks and public spaces that serve the unique

interests of local stakeholders, enhance their sense of ownership of a space, and support the most use of the space to enhance the community.

2.5. Visualization & Technology-Mediated Participatory Civic Engagement

Convening community members in participatory settings to create open spaces using visualization software tools enables the inclusion of unique local perspectives, preference, and creativity to inform the development of place-based sustainable public spaces. Visualization used in participatory settings can enhance the process by facilitating dialog around the visualized change. The transformational power of dialogue in participatory design contributes to consensus building and collaborative learning (Sheppard, 2005). When proposed changes can be visualized and discussed, there is more transparency in the design process. Stakeholders can both contribute useful information to the design and more clearly understand why decisions are made. The effectiveness of visualization to communicate change is powerful. Tools that enable community members to create and visualize are essential to developing effective technology-mediated civic engagement practices. 3D visualization has also been shown to be effective in empowering citizens to challenge dominant planning and design processes (Lindquist, 2007). Using realistic visualization in civic engagement around expected landscape changes, landscape planning and design can be more effectively communicated with the broader public and the public can provide feedback from a more informed perspective.

2.6. Evaluation and Existing Technology-Mediated Engagement

In studies evaluating the performance of landscapes as a result of civic engagement in their design, results showed increased park usage, sense of ownership, and self-organized monitoring and management of a transit design and linear park called the Boston Southwest Corridor (Crewe, 2001). This extensive civic engagement effort was aimed at reducing the detrimental impacts of highway construction on effected neighborhoods. The process enhanced the outcome of the corridor design.

Sacramento California's Council of Government's (SCAG) Scenario Planning Model (SPM), implemented in 2016, is an example of technology mediated planning and information sharing process tapping multiple stakeholders (Goodspeed & Hackel, 2019). An analysis of this model resulted in recommendations for its improvement and wider adoption in planning practice. Suggestions for optimizing the model included utilizing a similar participatory design process in all outreach methods, as to avoid lack of

representation from any involved work groups. A successful technology-mediated civic engagement process will employ a consistent participatory design process that allows for the most accurate comparison of civic engagement results from differing stakeholders.

Kounkuey Design Initiative (KDI) is a non-profit community development design/build firm whose design process centers upon community engagement. KDI uses a community-driven photography technique that directs participants to take pictures of the community to help to orient the design team and support relationship-building between the designers and community members (de la Pena et al., 2017). This process also helps to identify important sites for design interventions within the communities they work. KDI's exemplary interactive engagement methods and photography is an example of how different forms of visualization can be incorporated into various parts of the participatory design process.

Boone (2015), used cell phones as a method of technology-mediated civic engagement in a landscape architecture project in North Carolina. Cell phones were provided to community members to take pictures, audio, and video to document place-based stories that supported park enhancement of a historically African American community, Chavis Park. The media developed by participants was then geo-referenced to an interactive map to share results with the broader community. This civic engagement method employed mobile technology and visualization to contribute to site analysis, goal development and prioritization for a community enhancement project. This use of technology is an example of how different forms of technology can be incorporated into civic engagement around design and planning for the built environment and how the broader community can engage with the information collected.

Senbel and Church (2011) have experimented with the use of six visualization mediums with residents involved in a densification plan of Vancouver. Of those mediums, the ability for participants to interact with 3D visualization tools to shape their desired outcomes can enhance participant's feelings of empowerment to change their communities. The ability to interact with a visualization tool is essential to its most impactful use in civic engagement methods. Interactive visualization is more engaging and improves the ability for residents to convey design ideas as they are more adaptable the individual as opposed to static visualizations that can limit the level of participant input.

A pilot program in Boston, Massachusetts employed the use of the virtual world, Second Life, to engage residents in dialogue about their communities and contribute ideas to support their improvement (Gordon & Koo, 2008). In this model, residents created an avatar navigate a virtual depiction of their community, deliberated with other residents about the space and any virtual changes made to it. The opportunity to implement changes and discuss them during the design and planning process using an existing web-based visualization environment is an example of technology-mediated civic

engagement. Second Life pilots some important features for the most effective civic engagement around design that can be further enhanced to support this process.

2.7 The Problem

Traditionally-used civic engagement practices have lacked opportunity for community members to contribute meaningful information during early phases of open space planning and development projects (Sheppard, 2005). Lack of engagement in the design and planning of a park or public space may result in reduced frequency of its use which impacts the positive community benefits associated with these spaces. Participatory engagement during the early phases of a design and planning project can create more positive outcomes.

Civic engagement practices are time intensive and costly requiring extensive planning and a range of engagement methods to ensure optimal public participation. Additionally, attracting stakeholders representative of the community during community meetings and other in-person activities limits participation because it often requires volunteering time and travel to the engagement location (Desouza & Bhagwatwar, 2014). Technology-mediated practices for design and planning present opportunities to streamline the time-intensive and costly civic engagement process and increase the number of stakeholders contributing to a project.

Traditional tools (e.g. drawing, photographs, models, and maps) used in civic engagement in landscape architecture and planning lack the capability for sophisticated analyses of the design and the widespread access to internet and mobile devices have made the adoption of technology in public participation a more common part of planning practice (Goodspeed & Pelzer, forthcoming). Advancements in technology and digital visualization present an opportunity to reimagine participatory design practice and develop more widespread and efficient methods to engage residents in open space design and planning.

Though technology mediated civic engagement tools are used in urban design and planning practices today, there are limitations on the scale of their use. In land use planning, there are models of successful technology-mediated design and planning tools, but these are not intended for small-scale analysis (Goodspeed & Hackel, 2017) meaning there exists a gap in accessible site-scale design software that can support collaborative design. Additionally, many of these digital tools require specific engagement formats, such as community meetings because they are time intensive and require specialized knowledge and training to use (Goodspeed & Hackel, 2017). Optimizing visualization technology-mediated civic engagement therefore requires a platform that is easy-to-use and versatile to best improve its adopted use in the fields of design and planning.

Though visualization presents a promising medium for engaging diverse stakeholders in the planning and design process, there are limitations to its communicative capacity. Digital tools are not a full-proof engagement method as they often lack the ability to facilitate meaningful interaction with other participants and the information depicted (Al-Kodmany, 2001). Additionally, visualization is not a substitute for the experience of real landscapes and practitioners must temper the expectations of software users when using these tools (Nassauer, 2015). Incorporating quantification of landscape performance benefits with visualization software can support more informed decision-making not limited to the visual appearance of the space. Using visualization software that quantifies landscape performance benefits in a participatory setting can guide the design process and help to navigate the limitations that exist around visualization in civic-engagement practices.

Communities that do not have the capital or resources, financial, social, and political, are often excluded from decision making and planning of their own spaces (Gorden & Koo, 2008). Mobile engagement methods and visualization technology-mediated engagement can improve access to information for residents regarding local design and planning projects and can increase the number of stakeholders involved in the process. Extensive efforts are required to organize civic engagement focused around participatory design that are representative of the community. The depth of public engagement processes is typically limited by resources available to the organizing body (community organization, municipality, etc.). Public participation in landscape architecture and planning engages a range of stakeholders, including marginalized groups, to garner needs, interests, and values around open public space. The representative diverse perspectives in a collaborative design process support the creative of different strategies and approaches that may have not been considered without the presence of local knowledge and participation. More accessible civic engagement methods around design and planning support inclusion of sometimes marginalized populations in these processes.

The use of visualization software in decision making around collaborative open space design is a new practice that requires evaluation of its impact. Due to the complexity of landscape design, optimizing designs to maximize these public benefits require methods of evaluation that consider both qualitative and quantitative metrics. The software evaluated in this practicum, Land.info, currently features tools to calculate environmental performance metrics such as air quality improvement, stormwater infiltration rates and cost to support the evaluation of designs created in the software, but it does not include features to analyze socio-cultural impacts such as aesthetics, perceived safety, and elements that support social interaction. Since both environmental and social performance are important in the success of an open space, several evaluation models were used to inform the development of an assessment method for evaluation of designs created in Land.info. The methodology was evaluated in a case study using the ECN workshops.

2.8 Design Evaluation Techniques

Many models of built environment design proposal evaluation are led by a panel of reviewers, in some cases with diverse roles in the project representing various expertise, and in others an appointed group of expert designers. In these models, reviewers are consulted about a design and tasked with providing feedback to enhance it. The critiques of this method are that it tends to be very subjective (dependent upon the review panel), it is time intensive, and costly (Carmon, 2019). Land.info can enhance efficiency of public engagement around open space design using visualization, and so efficiency in design evaluation is an important part of developing the software. Since creating a panel of reviewers to evaluate design outcomes is not an optimal way of providing objective assessment, several other models of evaluation were explored, namely The Gehl Institute's Twelve Quality Criteria (reference), the Six Axial Model (reference), Sustainable Sites Manual (reference), and the Center for Neighborhood Technology's (CNT) 'Value of Green Infrastructure' publication (reference). These models have been created based on a set of indicators and rankings to assess the publicness, quality, and socio-cultural provisions of a landscape and will be briefly described in the next section.

The socio-cultural benefits of public green space are difficult to quantify. Literature on this topic is still limited and is not extensively agreed upon (Center for Community Technology, 2010). This makes quantification of socio-cultural impacts difficult in communicating the holistic benefits of public landscapes to the public and decision makers responsible for their creation and improvement. Evaluation of the community improvements that fall under 'socio-cultural', or community livability, include measures of aesthetics, options for recreation, noise pollution reduction, and community cohesion. As previously mentioned, there is no straightforward measure and valuation of these benefits within a designed landscape. The development of an evaluation system that includes these elements is vital to creating public spaces that provide the most beneficial community outcomes and address socio-cultural benefits assessment.

Noting these gaps in knowledge, this practicum provides evaluation of designs resulting from the visualization technology guided participatory design workshop pre-implementation. The project is limited in its capacity to evaluate the impact of a design post-implementation because of the short timeframe in which the project was conducted. This practicum contributes to the advancement of a Land.info as a software that can be used in participatory site-scale scenario planning by evaluating its use in a participatory design workshop setting and drawing from literature to support evaluation of socio-cultural design outcomes.

Chapter 3. The Socio-Cultural Model for Pre-Built Design Evaluation

Developing an objective evaluation model measuring the socio-cultural benefits of proposed designs in alignment with workshop goals began by reviewing existing models used to evaluate the meta dimensions of socio-cultural inquiry that align with the goals of the ECN workshops.

Predominate community needs revealed through the workshop are the following:

Goals defined by Eastside Community Network:

- Space for social gathering
- Space for events (farmer's markets, community meetings, birthday parties, etc.)
- Designated recreation activities due to proximity to a major thoroughfare (no basketball)
- Low maintenance
- Cost of installation between $50,000-$75,000

Goals defined by Workshop Participants

- Intergenerational activity space
- Fountains and water features
- Shaded areas
- Seating

The Socio-Cultural Model for Pre-Built Design Evaluation was informed by several evaluative methods centered on the workshop goals of: A) providing intergenerational social gather space, B) creating a low-maintenance landscape, C) affordable within the budget scope of the organization, D) providing opportunities for recreation, and E) including the specific features requested. The following evaluative methods were adapted to measure these design goals. Table 1 describes each evaluation tool and the indicators associated with them:

1) **The Six Axial Model:** Developed by Mantey (2017) the Six Axial Model of Assessment of Publicness contains three dimensions and indicators of publicness: 1) Diversity; of activities & of users 2) Management; type of management and limitations of access or use, 3) Accessibility; financial and spatial barriers (Mantey, 2017). The Six Axial Model was developed based on evaluation models: the 'cobweb model of Van Melik, Van Aalst, and Van Weesep (2007), the 'tri-axial model of Nemeth and Schmidt (2010), the Star Model of Varna and

Tiesdall (2010), the 'OMAI' model of Langstraat and Van Melik (2013), the 'spider' diagram of CABE'S Spaceshaper (2007), and the 'Place diagram' of Projects for Public Spaces (PPS) (Mantey, 2017). The 'cobweb' model is centered upon criteria that define a secure public space (surveillance and loitering deterrents) and themed public space (events and businesses that attract people) (Van Melik et al., 2007). The 'tri-axial model' considers ownership, users, and management of a space (Nemeth and Schmidt, 2010). The 'star' model also consider ownership but also includes control, civility, animation, and physical configuration (Varna and Tiesdall, 2010). The 'OMAI' model address ownership, accessibility, and inclusiveness (Langstraat and Van Melik, 2013).

The Six Axial Model also includes 'spider diagrams' developed by The Commission for Architecture and the Built Environment (CABE), a government advisor of architecture, urban design, and public space aimed at bringing 'excellence to the design, management, and maintenance of parks and public space in our towns and cities' (CABE, 2007). CABE's Spaceshaper is an accessible workshop toolkit designed to measure the quality of a public space including access, use, other people, maintenance, environment, design and appearance, community, and you. Project's for Public Spaces 'Place Diagram' evaluated sociability, access and linkages, uses and activities of a space, and comfort and image. The Place Diagram assists in judging the quality of a public space as good or bad based on its defined set of indicators. Measures of 'publicness' of a landscape do not fully account for the myriad socio-cultural benefits associated with these spaces. Providing these features within a public landscape can improve the quality of life for residents and are important to quantify.

2) **The Gehl 12 Quality Criteria:** developed by Jan Gehl at the Royal Danish Academy of Fine Arts, School of Architecture, evaluation model was to assess the qualities of public space (Gehl & Svarre, 2013). These criteria comprise a list of indicators that are indicative of the quality of public space by addressing characteristics related to human comfort. The list allows for easy comparison of public spaces and was chosen to evaluate the designs generated in Land.info due to their focus on the features of public space that enhance their social value. It includes assessment for aesthetic qualities, recreation, mobility, and features that support social interaction. Traditionally, the Gehl 12 Quality Criteria are evaluated on a 3-point scale indicating whether these criteria are met using 'yes', 'no', or 'in between' (Gehl & Svarre, 2013).

   The first principle of the Gehl 12 Quality Criteria: protection from cars, noise, rain, and wind is critical for a public space to be regularly used. The design site on Mack Avenue needs a protective barrier along Mack Avenue to support use of the space. Designs containing some

sort of barrier, fence or vegetative receive a ranking of yes, no, or neutral on the Twelve Criteria Scale. The second principle: elements that support use of the space such as walking, standing, sitting, seeing, and conversing are important to encourage use of the space. Designs containing elements such as paths, benches, and clear sight lines receive a ranking of yes, no, or neutral on the Twelve Criteria Scale. The third principle: positive aesthetic experiences that support sensory experience in the landscape help visitors to feel more comfortable in a space. Designs containing elements such as garden beds, or interesting features such as fountains and sculptures, receive a ranking of yes, no, or neutral on the Twelve Criteria Scale.

3) **The Center for Neighborhood Technology (CNT's)** Characteristics such as aesthetics, recreational opportunities, reduced noise pollution, and community cohesion are examples of socio-cultural benefits associated with well-designed public spaces (Center for Community Technology, 2010). CNT has outlined an evaluation method to assess some of these benefits based on the presence of trees in communities and the correlated increase in property value, recreational value and associated cost benefit, reduction and noise pollution, community cohesion, and provision of urban agriculture opportunities. The publication also supports quantifying the anticipated property value gains resulting from the number of trees planted in the public space design (based on the size small, medium, and large trees), and utilizes the User Day Methodology, which translates the number of vegetated acres into an estimated monetary value.

   The costs and benefits of trees planted in the public space draws from 2010 USDA research report, 'Northern California Coast Community Tree Guide Benefits, Costs, and Strategic Planning', referenced in CNT's 'Value of Green Infrastructure' publication. This research is derived from models calculating the benefits of trees against the cost of their maintenance (planting, pruning, irrigation, administration, pest control, liability, cleanup, and removal) based on the size of tree (McPherson et al., 2010). The monetary value considers the following: increased community aesthetics, heat street reduction, water quality and aquatic ecosystem improvements, wetland creation and enhancement, poverty reduction from local green jobs, energy savings and carbon footprint reduction, air quality improvement, and construction- and maintenance related disruption (Stratus, 2009). The 'Community Livability' indicators included in this evaluation are supplementary to the design goals identified by ECN and stakeholders.

4) **Sustainable SITES** is a comprehensive system used to create sustainable land development projects by practitioners in built environment professions to ensure optimal design for ecologically resilience and sustainable communities (Calkins, 2011). Sustainable

SITES guide the design, construction, operations, and maintenance of a landscape and, unlike the other evaluative models, focuses upon a holistic criterion based around ecosystem services. The system considers vegetation, soils, water systems, materials and resources, energy systems, and cultural systems all as important elements in the creation of sustainable landscapes. Specific criteria related to design maintenance and monitoring were extracted from the Sustainable SITES manual to create a list of indicators through which to evaluate the anticipated maintenance requirements of the most sustainable design outcomes (Stratus, 2009).

Evaluating the anticipated maintenance and monitoring of a landscape design, as informed by the SITES manual, includes reviewing the physical configuration of the garden. A site that contains complex plantings with cleanly defined edges and geometric shapes will require more maintenance than a garden that contains more simplistic plantings and organic shapes (Calkins, 2011). In creating planting groupings and layout for a site, designers should also consider that naturalistic plantings may require maintenance approaches from individuals more knowledgeable of native species management. For this reason, the scales defined to evaluate maintenance include level of complexity of plant groupings (high complexity of plantings requires more maintenance than low complexity) and the form of plant groupings (geometric plantings may require more maintenance than organic forms). The evaluation also considers native versus non-native plantings, where native species will require less maintenance than non-native. Presence of composting or yard waste facilities on the site are also considered when evaluating the level maintenance required.

Waste generation and removal must also be considered when evaluating the maintenance requirements of a design. The amount of waste generated, types, and quantities, dictate the level of maintenance required on the site. The most informed way to evaluate waste management requirements of a site requires monitoring waste volumes and types post-implementation. Since that information is not available pre-implementation, the waste management evaluation will consider the number and types of waste receptacles of the design proposals.

Table 1: Combined evaluation criteria of the Six Axial Model, Gehl 12 Quality Criteria, Sustainable SITES Manual, and CNT 'Community Livability'

Evaluation	Indicators
The Six-Axial Model of Assessment of Publicness	
Scale 1 (Private) - 4 (Public)	Diversity: of activities, of users
Scale 1 (Private) - 4 (Public)	Management: type of management & freedom of access, use, and behavior.
Scale 1 (Private) - 4 (Public)	Accessibility: Financial Barriers, Spatial Barriers
Gehl 12 Quality Criteria	
Protection	
Y/N/In between	Protection against traffic
Y/N/In between	Protection again harm by others
Y/N/In between	Protection against unpleasant sensory experience
Comfort	
Y/N/In between	Options for mobility
Y/N/In between	Options to stand and linger
Y/N/In between	Options for sitting
Y/N/In between	Options for seeing
Y/N/In between	Options for talking and listening
Y/N/In between	Options for play, exercise, and activities
Enjoyment	
Y/N/In between	Scale
Y/N/In between	Opportunities to enjoy the positive aspects of climate

Y/N/In between	Experience of aesthetic qualities and positive sensory experiences
Sustainable SITES Maintenance & Monitoring Criteria	
Scale 1 (Geometric) - 4 (Organic)	Site Layout & Form
Scale 1 (Non-native) - 4 (Native)	Plant Composition
Scale 1 (Complex) - 4 (Simplistic)	Plant Grouping Complexity
Y/N/In between	Presence of compost/yard waste structure
Scale 1 (Numerous) - 4 (Few)	Trash & Recycling
Select CNT 'Value of Green Infrastructure' Community Livability Criteria	
Small, Medium, and Large Tree (dollar value)	Annual Property Value Gains (1 tree)
Vegetated Area (acres)	User Day - Recreational Value

Indicators from the referenced evaluation models were aligned with the workshop design goals:

A) **Providing intergenerational social gather space** draws from the Six-Axial Model and the Gehl 12 Quality Criteria in measuring publicness and quality of public space. Diversity of activities (Six-Axial Model) affords opportunities for individuals of varying ages and abilities to enjoy the space. Opportunities to walk, stand, sit, talk, listen, see; protection against crime and violence (overlapping day/night uses and lights); protection against unpleasant sensory experiences (sound barriers); opportunities to enjoy the positive aspects of climate (provision of shade); and scale (size of space), are indicators drawn from the Gehl 12 Quality Criteria that inform the quality of a public space, or measures that inform a public spaces' optimal use by a variety of people.

B) **Creating a low-maintenance landscape** draws from the Six-Axial Model and from the Sustainable SITES Manual. Types of management (private vs. public sector) indicate the 'publicness' of a site according to the Six Axial Model. The remaining measures that qualify a site as low-maintenance come from the Sustainable SITES Manual and relate to the physical configuration, planting complexity, planting composition, presence of waste receptacles, and yard waste/composting facilities.

C) **Affordable within the budget scope of the organization** as defined by the clients, this is a numeric value within the budget scope of the organization. ECN indicated a scope between $50,000 and $70,000. This number was calculated as an estimate within the Land.info software. Property value gains extracted from the CNT 'Value of Green Infrastructure' Community Livability publication were included in this section to address monetary benefits to the surrounding community.

D) **Providing opportunities for recreation** measurement draws from the Gehl 12 Quality Criteria indicators of 'opportunities for recreation', 'positive sensory experience' and 'protection against traffic'. These indicators are associated with optimal recreational use of a public space. In addition, the CNT 'User Day' Value was included in this section to address the quantified health and wellness benefits available to residents as a measure of the size of the recreational space on the site.

E) **Including the specific features requested** is a flexible part of the evaluation that ensures that specific requested features are included in assessing designs. ECN staff and workshop participants specified that the inclusion of water features and seating were important in the final design of the site.

Table 2: Final criteria for evaluation of designs generated in the workshops

Indicator	Metric	Methods
ECN Design Goal 1: Intergenerational Social Gathering Space		
Diversity	# of activities Accessibility	Six-Axial Model
Opportunities to walk	Room for walking, no obstacles, accessible for everyone	Gehl 12 Quality Criteria (Modified)
Opportunities to stand	Attractive zones for standing	Gehl 12 Quality Criteria (Modified)

Opportunities to sit	Zones for sitting, benches	Gehl 12 Quality Criteria (Modified)
Opportunities to talk & listen	Low noise levels	Gehl 12 Quality Criteria (Modified)
Opportunities to see	Lighting	Gehl 12 Quality Criteria (Modified)
Protection again crime and violence - feeling secure	Overlapping day & night functions presence of lighting	Gehl 12 Quality Criteria (Modified)
Protection against unpleasant sensory experiences	Rain/snow Heat/cold	Gehl 12 Quality Criteria (Modified)
Opportunities to enjoy the positive aspects of climate	Sun/Shade Heat/coolness	Gehl 12 Quality Criteria (Modified)
Scale	Buildings and spaces designed to human scale	Gehl 12 Quality Criteria (Modified)
ECN Design Goal 2: Low Maintenance		
Management Type	Scale 1-4 (1 - privately managed to 4 - publicly managed)	Six-Axial Model
Site Layout & Form	Scale 1 (Geometric) - 4 (Organic)	Sustainable SITES Manual

Plant Composition	Scale 1 (Non-native) - 4 (Native)	Sustainable SITES Manual
Plant Grouping Complexity	Scale 1 (Complex) - 4 (Simplistic)	Sustainable SITES Manual
Presence of compost/yard waste structure	Y/N/In between	Sustainable SITES Manual
Number of Trash/Recycling Receptacles	Scale 1 (Many) - 4 (Few)	Sustainable SITES Manual
ECN Design Goal 3: Affordable		
Cost	Dollar Value	Calculated in Land.info
Property Value Gains	Dollar Value	CNT 'Value of Green Infrastructure' Community Livability (select criteria)
ECN Design Goal 4: Opportunities for Recreation		
Opportunities for play and exercise	Invitations for creativity, physical activity, exercise, and play	Gehl 12 Quality Criteria (Modified)
Positive sensory experience	Trees, plants, water	Gehl 12 Quality Criteria (Modified)
Protection against traffic - feeling safe	Protection for pedestrian's barrier present	Gehl 12 Quality Criteria (Modified)
User Day - Recreation Opportunity	Dollar Value	CNT 'Value of Green Infrastructure' Community Livability (select criteria)
Design Goal: Contains specific features		
Fountains & Water Features	Present (Y/N?)	Evaluator identified
Shade	Present (Y/N?)	Evaluator identified

Due to the differing measurement methods used in the Six Axial Model (4-point scale), the Gehl 12 Quality Criteria (3-point scale), and the Sustainable

SITES manual (no scale) a new model was created to normalize the evaluation method to make all criteria comparable across the two scales. Each Indicator was ranked on a 4-point scale, from 'Not Present' to 'Good'. Indicators used in the referenced models that used 'yes', 'no', and 'in between' evaluations were adapted to the 4-point scale where 1 indicates 'no', 2-3 indicate 'in-between', and 4 indicates 'good'. Indicators drawn from the CNT 'Value of Green Infrastructure - Community Livability' measures are scored separately, as they are not based on a scale of 1-4.

Table 3: Socio-Cultural Model of Pre-Built Design Evaluation Scorecard

Goal	Indicator	1 - Not Present	2 - Poor	3 - Average	4 - Good
Intergenerational Social Gathering Space	Diversity of activities				
	Opportunities to stand				
	Opportunities to sit				
	Opportunities to talk and listen				
	Opportunities to see				
	Protection against crime and violence				
	Protection against unpleasant sensory experiences				
	Opportunities to enjoy the positive aspects of climate				
Low Maintenance	Management type				
	Site Layout & Form (geometric - organic)				
	Plant Composition (non-native - native)				

	Plant Grouping Complexity (complex - simple)				
	Number of Trash/Recycling Receptacles (many - few)				
Affordable	Cost				
Opportunities for recreation	Opportunities for play and exercise				
	Opportunities to walk				
	Positive sensory experience				
	Protection against traffic				
Specific Features	Fountains & water features				
	Shade				
***Additional Community Livability Measures**	**Indicator**	**Small Tree ($5.32)**	**Medium Tree ($12.67)**	**Large Tree ($27.69)**	**Total**
	Annual Property Value Gains				
	Indicator	**Acre/year ($951.40)**			
	User Day Value				

*Not specified in ECN & Stakeholder identified design goals

3.1 Methods

In partnership with the Eastside Community Network (ECN), a non-profit community development organization, five interdisciplinary master's student's representative of landscape architecture, urban planning and urban design,

information science, civil engineering, and business coordinated a conducted a series of mixed-method engagement workshops centered on 3D Visualization in support of collaborative design of a vacant lot in Detroit. Workshops were designed to engage residents in a unique series of iterative design activities to reimagine the vacant parcel as an activated community public space. Three workshops were used in the process of familiarizing participants with the goals of the workshop, gaining an understanding of participant goals and values related to open space, and maximizing contact with residents given the limited scope of the project. The team facilitated a series of three workshops with eighteen community leaders to create a suite of design options for the vacant lot that met design goals for this open space. Data were collected through surveys, screen recordings of designing with the software, observation of participants in the workshop, and site photographs collected by the participants. Results of the surveys from the workshops are elaborated in Kwon et al (2019).

The general workshop framework is discussed below in section 3.1.1 as it informs the final design outcomes of each of the workshops. The evaluative method developed to assess the design outcomes created in the workshops is addressed in section 3.3.

3.1.1 Workshop Methods

Workshop 1 - Site Introduction and Design Priority Identification

Workshop one was inspired by traditional participatory design and planning methods to introduce residents to the site and site analysis process. The group convened over dinner, residents were introduced to the research team and project, visited the design site, and engaged in several visioning activities. The first of visioning activities was a co-photography exercise, or site-analysis, in which teams of 3 participants were tasked with taking 3 pictures: one showing their favorite aspect of the site, one with a part of the site that needs improvement, and one that showed something unexpected about the site that the team discovered. The second of the visioning activities was created for individual brainstorming. During this exercise residents were asked to use drawings and words to answer questions about what they would like to see happen on the site (in terms of activities and landscape features) and what they did not want to see on the site.

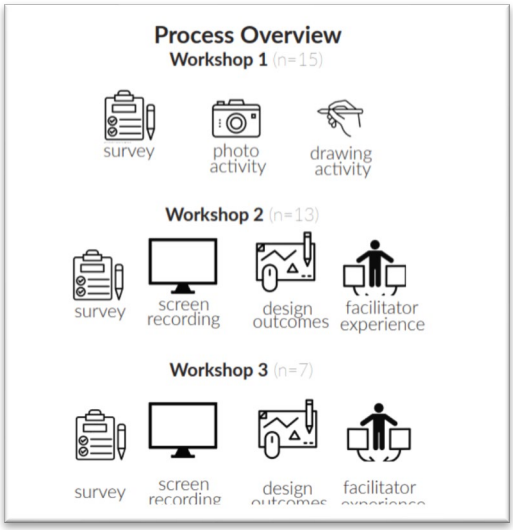


Figure 2. ECN Series of 3 Workshops Process Overview: Structure & Data Collection

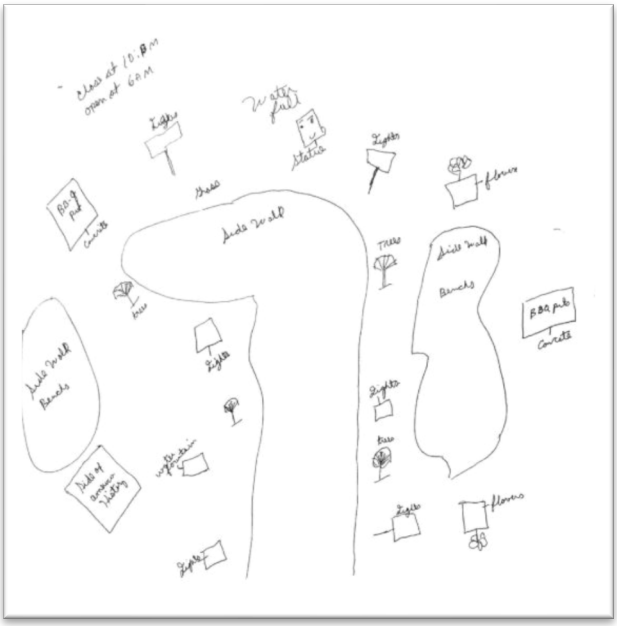


Figure 3. Participant sketch created during the Sketching and Goal Articulation activity of Workshop 1. Sketch includes signs, lights, wall features, gardens, trees, and sculptures to inform the design using Land.info.

These activities helped to familiarize the research team and participants with the site and design priorities for the subsequent workshop design sessions. Participants were asked to rank design priorities that were extracted from these activities and use the priorities in the design process in Land.info.

Workshop 2 - Design using Land.info with Creative Freedom

Workshop two was developed to introduce the participants to the Land.info software. Teams of 3-4 participants were led by a landscape architecture student in designing the site using Land.info. The workshops were set up to create an iterative design process by mixing up participant design teams and matching them with a different landscape architecture student facilitator. The goal of this process was to encourage the creation of different designs and support dialogue between different workshop participants to result in differing design outcomes. Each participant was a part of 3 different design sessions. There were no restrictions for the designs created during this workshop. Participants were encouraged to use complete creative freedom during the design sessions, keeping in mind the priorities and goals identified during the first workshop, but did not need to consider parameters such as cost or specifically identified programmatic elements.

Workshop 3 - Design using Land.info and Defined Design Objectives

The third workshop was design similarly to the second workshop, iterative design sessions using the Land.info software. In this workshop, a specific design goal was to be considered in each of the design sessions. The design sessions were focused on creating a public gathering space that provided opportunities for socializing and events and defined price range.

Chapter 4. Results and Discussion

4.1 Design Results

4.1.1 Workshop 2 Design Outcomes

Workshop 2 resulted in 14 total designs. The designs were informed by criteria articulated by the workshop participants in the first workshop which included intergenerational activity space, fountains and water features, shaded areas, and seating. The top design according to the created evaluation are shown below and the remaining designs can be viewed in Appendix A.

The highest and lowest rated designs according to the evaluation model are shown in Figures 4-11 and Tables 4 and 5. The remaining designs can be viewed in Appendix A. Design A was rated highest because the diversity of activities it affords its users, covered areas for use during varying weather conditions, shade, seating, lights along pathways and use a fence as a barrier between Mack Avenue and the site.

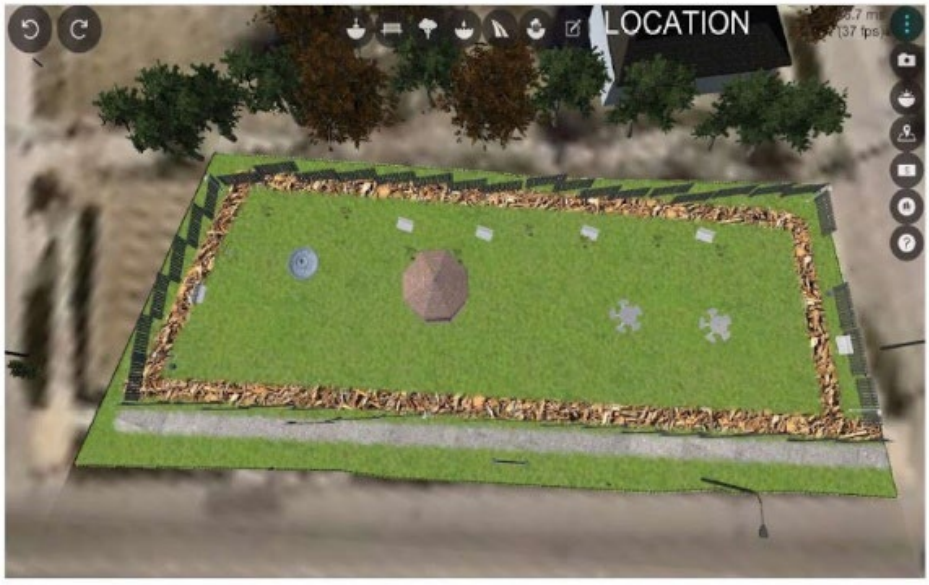


Figure 4. High-Ranking Design Outcome A from Workshop 2. Received a score of 69/80.

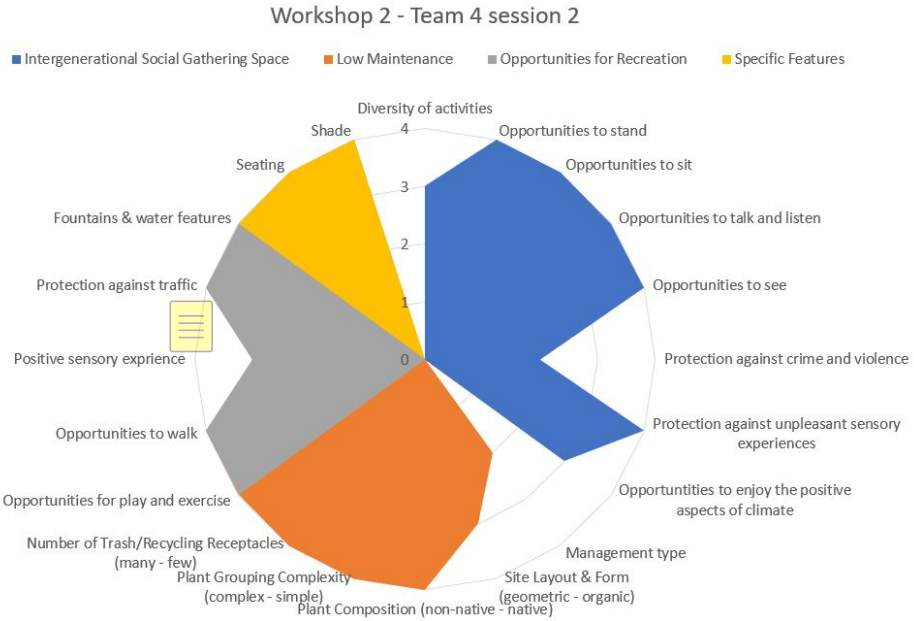


Figure 5. Radar Diagram Evaluation of High-Ranking Design Outcome A from Workshop 2. Received a score of 69/80

Figure 6. Perspective 1 from High-Ranking Design Outcome A Workshop 2.

Figure 7. Perspective 2 from High-Ranking Design Outcome A Workshop 2.

Figure 8. Perspective 3 from High-Ranking Design Outcome A Workshop 2.

Table 4. Scorecard from High-Ranking Design Outcome A Workshop 2.

Goal	Indicator	1	2	3	4
Intergenerational Social Gathering S	Diversity of activities			3	
	Opportunities to stand				4
	Opportunities to sit				4
	Opportunities to talk and listen				4
	Opportunities to see				4
	Protection against crime and violence		2		
	Protection against unpleasant sensory experiences				4
	Opportuntities to enjoy the positive aspects of climate			3	
Low Maintenance	Management type		2		
	Site Layout & Form(geometric - organic)			3	
	Plant Composition (non-native - native)				4
	Plant Grouping Complexity(complex - simple)				4
	Number of Trash/Recycling Receptacles(many - few)				4
Opportunitiesfor recreation	Opportunities for play and exercise				4
	Opportunities to walk				4
	Positive sensory experience			3	
	Protection against traffic				4
Specific Features	Fountains & water features				4
	Seating				4
	Shade				4
*Additional Community Livability Measures	**Indicator (Tree Size)**	**Sm$5.32**	**Med$12.67**	**Lrg$27.69**	**Total**
	Annual Property Value Gains		101.36		101.4
	Indicator	**Acre/year ($951.40)**			
	User Day Value				$380.56
Affordable	Approximate Installation Cost				$33,000
Total Score					69

The lowest rated design according to the evaluation model are shown in Figures 12-14. This design was rated lowest because the lack of diversity of activities afforded to users, limited covered areas for use during varying weather conditions, lack of features that provide shade, limited seating, limited lighting along pathways posing higher risk for safety, and lack of a barrier between Mack Avenue and the site.

Figure 9. Low-Ranking Design Outcome B from Workshop 2. Received a score of 46/80.

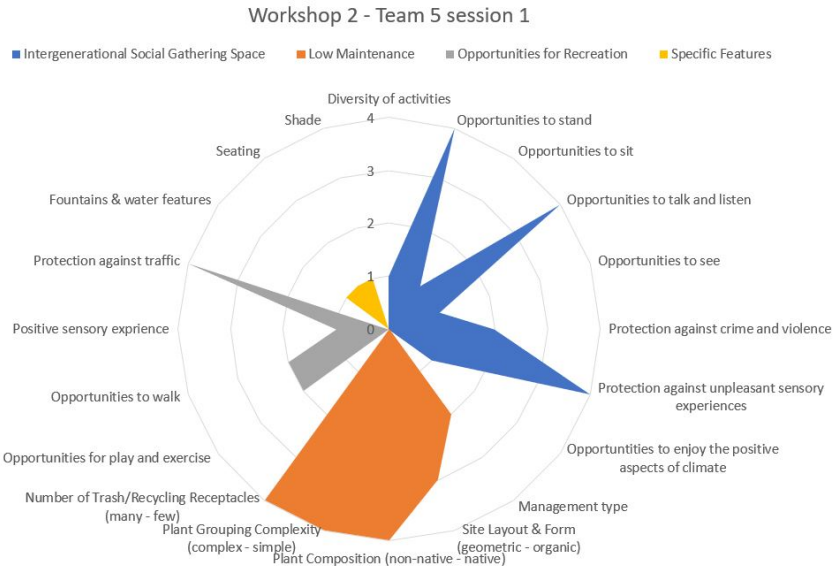


Figure 10. Radar Diagram Evaluation of Low-Ranking Design Outcome B from Workshop 2. Received a score of 46/80.

Figure 11. Perspective 1 from Low-Ranking Design Outcome B Workshop 2.

Table 5. Scorecard from Low-Ranking Design Outcome B Workshop 2.

Goal	Indicator	1	2	3	4
Intergenerational Social Gathering Spa	Diversity of activities	1			
	Opportunities to stand				4
	Opportunities to sit	1			
	Opportunities to talk and listen				4
	Opportunities to see	1			
	Protection against crime and violence		2		
	Protection against unpleasant sensory experiences				4
	Opportuntities to enjoy the positive aspects of climate	1			
Low Maintenance	Management type		2		
	Site Layout & Form(geometric - organic)			3	
	Plant Composition (non-native - native)				4
	Plant Grouping Complexity(complex - simple)				4
	Number of Trash/Recycling Receptacles(many - few)				4
Opportunitiesfor recreation	Opportunities for play and exercise		2		
	Opportunities to walk		2		
	Positive sensory experience	1			
	Protection against traffic				4
Specific Features	Fountains & water features	1			
	Seating	1			
	Shade	1			
*Additional Community Livability Measures	**Indicator (Tree Size)**	**Sm$5.32**	**Med$12.67**	**Lrg$27.69**	**Total**
	Annual Property Value Gains				0
	Indicator	**Acre/year ($951.40)**			
	User Day Value				$380.56
Affordable	Approximate Installation Cost				$16,000
Total Score					46

4.1.2 Workshop 3 Design Outcomes

Workshop 3 resulted in 6 total designs. The designs were informed by criteria articulated by the Eastside Community Network in the first workshop which included space for social gathering, space for events (farmer's markets, community meetings, birthday parties, etc.), designated recreation activities due to proximity to a major thoroughfare (no basketball), low maintenance, cost of installation between $50,000-$75,000.

The highest rated design according to the evaluation model are shown in Figures 12-15 and Table 6 and the remaining designs can be viewed in Appendix B. This design was rated highest because the diversity of activities it affords its users, covered areas for use during varying weather conditions, shade, seating, lights along pathways and use a fence as a barrier between Mack Avenue and the site.

Figure 12. High-Ranking Design Outcome C from Workshop 3. Received a score of 66/80.

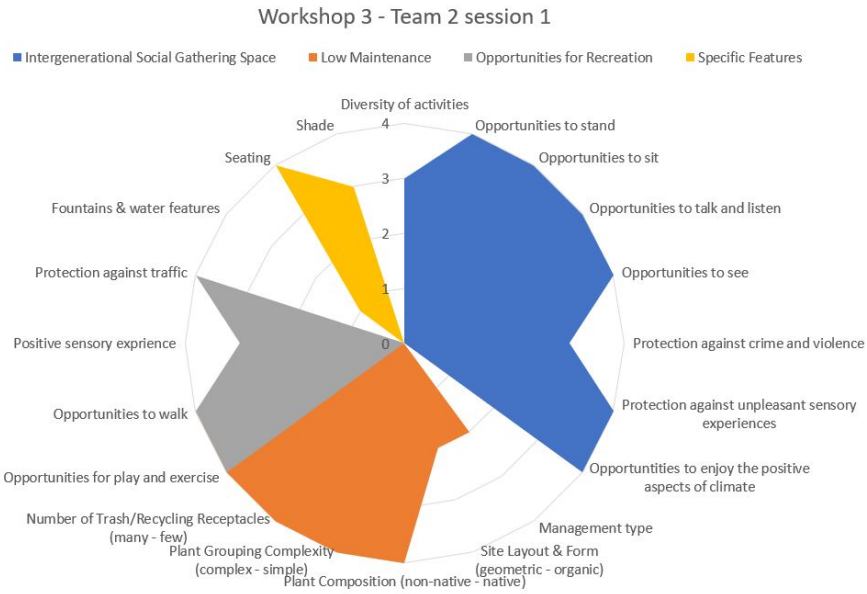


Figure 13. Radar Diagram Evaluation of High-Ranking Design Outcome C from Workshop 3. Received a score of 66/80.

Figure 14. Perspective 1 from High-Ranking Design Outcome C Workshop 3.

Figure 15. Perspective 2 from High-Ranking Design Outcome C Workshop 3.

Table 6. Scorecard from High-Ranking Design Outcome C Workshop 3.

Goal	Indicator	1	2	3	4
Intergenerational Social Gathering S	Diversity of activities			3	
	Opportunities to stand				4
	Opportunities to sit				4
	Opportunities to talk and listen				4
	Opportunities to see				4
	Protection against crime and violence			3	
	Protection against unpleasant sensory experiences				4
	Opportuntities to enjoy the positive aspects of climate				4
Low Maintenance	Management type		2		
	Site Layout & Form(geometric - organic)		2		
	Plant Composition (non-native - native)				4
	Plant Grouping Complexity(complex - simple)				4
	Number of Trash/Recycling Receptacles(many - few)				4
Opportunitiesfor recreation	Opportunities for play and exercise				4
	Opportunities to walk				4
	Positive sensory experience			3	
	Protection against traffic				4
Specific Features	Fountains & water features	1			
	Seating				4
	Shade			3	
*Additional Community Livability Measures	Indicator (Tree Size)	Sm$5.32	Med$12.67	Lrg$27.69	Total
	Annual Property Value Gains			83.07	83.07
	Indicator	Acre/year ($951.40)			
	User Day Value				$380.56
Affordable	Approximate Installation Cost				$45,000
Total Score					66

The lowest rated design according to the evaluation model are shown in Figures 16-18 and Table 7. This design was rated lowest because it lacks a barrier between Mack Avenue and the site, includes a basketball court (exclusively undesired by the client), and doesn't provide diversity of activities to support engaging intergenerational site-users.

Figure 16. Low-Ranking Design Outcome D from Workshop 3. Received a score of 53/80.

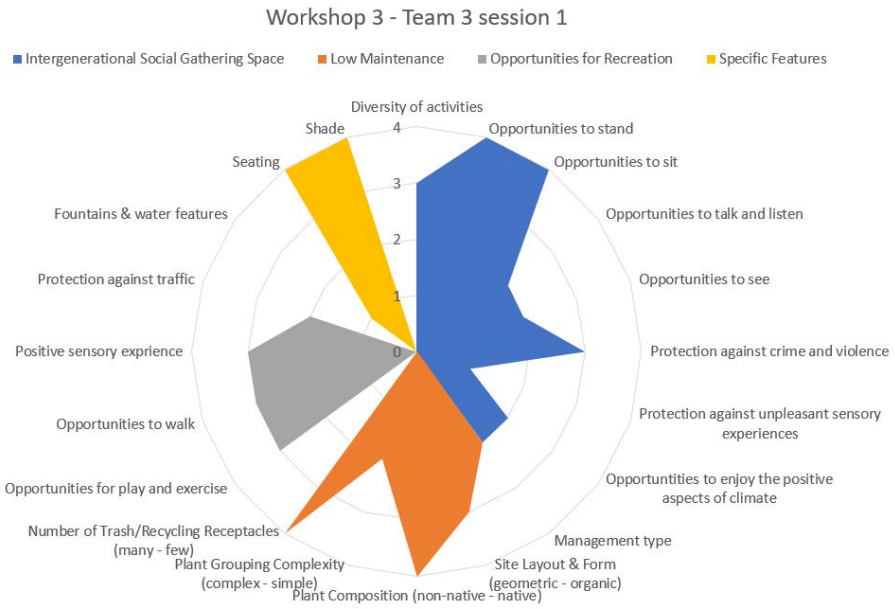


Figure 17. Radar Diagram Evaluation of Low-Ranking Design Outcome D from Workshop 3. Received a score of 53/80.

Figure 18. Perspective 1 from Low-Ranking Design Outcome D Workshop 3.

Table 7. Scorecard from Low-Ranking Design Outcome D Workshop 3.

Goal	Indicator	1	2	3	4
Intergenerational Social Gathering Spa	Diversity of activities			3	
	Opportunities to stand				4
	Opportunities to sit				4
	Opportunities to talk and listen		2		
	Opportunities to see		2		
	Protection against crime and violence			3	
	Protection against unpleasant sensory experiences	1			
	Opportuntities to enjoy the positive aspects of climate		2		
Low Maintenance	Management type		2		
	Site Layout & Form(geometric - organic)			3	
	Plant Composition (non-native - native)				4
	Plant Grouping Complexity(complex - simple)		2		
	Number of Trash/Recycling Receptacles(many - few)				4
Opportunitiesfor recreation	Opportunities for play and exercise			3	
	Opportunities to walk			3	
	Positive sensory experience			3	
	Protection against traffic		2		
Specific Features	Fountains & water features	1			
	Seating				4
	Shade				4
***Additional Community Livability Measures**	**Indicator (Tree Size)**	**Sm$5.32**	**Med$12.67**	**Lrg$27.69**	**Total**
	Annual Property Value Gains			166.14	166.14
	Indicator	**Acre/year ($951.40)**			
	User Day Value				$380.56
Affordable	Approximate Installation Cost				$58,000
Total Score					**53**

4.3 Discussion

The resulting design evaluation allowed for an assessment of design outcomes in line with the defined goals of ECN and the workshop participants. The evaluation measured important design features that support these goals including intergenerational use of the space, provision of recreational opportunities, low-maintenance, and cost evaluation. The additional community livability measures add an ancillary metric that conveys the larger potential community benefits of the designs in relation to the health and wellness of residents and surrounding property value gains.

The Socio-Cultural Model for Pre-Built Design Evaluation draws from previous work of Mantey (2017), Gehl and Svarre (2013), CNT (2010), and Sustainable SITES (2011). The model is an attempt to measure socio-cultural Impacts pre-design implementation in line with project-specific goals. The attempts to create an objective model through the creation of this evaluation resulted in a method that is still inherently subjective due to the possible difference in weighting of indicators as perceived by the reviewer. Differing perceptions of indicators such as ‘positive sensory experience’, ‘protection from unpleasant sensory

experience', and 'protection from crime and violence' may be evaluated differently depending upon the reviewer.

Designs received scores based on the developed evaluation that do not account for the differing goals of Workshop 1 and Workshop 2. Workshop 1 allotted freedom of creativity, with no restrictions on design inclusions and Workshop 2 encouraged creation of a multi-functional public gathering space with opportunities for recreation. Overall, the top design from Workshop 2 received a higher score (69) than the top design from Workshop 3 (66).

This model can benefit from being operationalized with organizations leading design and stakeholders involved in the participatory design process. Participatory design outcomes may differ significantly if the evaluation method is provided before the design process, which could lead to more similar designs. Utilizing the evaluation method within a panel of reviewers can still be beneficial in supporting discussion and review of designs though indicators subject to reviewer's opinion may pose barriers in coming to a most objective final result.

Pairing the Socio-Cultural Model for Pre-Built Design Evaluation with other metrics related to landscape performance available within the Land.info software can create a more robust evaluation system overall. Measuring the environmental performance of design features and potential socio-cultural impact may assist in navigating some of the subjectivity present in this model.

Chapter 6. Conclusions and future research

6.1 Conclusions

Evaluating design outcomes from visualization technology-mediated civic engagement practices requires a multi-faceted approach that considers socio-cultural, ecological, and economic outcomes. There are many challenges to civic engagement practices including its time and resource consumptive nature. Effective visualization technology-mediated civic engagement practices must incorporate methods that allow for engagement of diversity representative of the community in question and provides an evaluative method that enables more objectivity in assessing design quality.

The objectives of this practicum were to develop an evaluation model measuring the socio-cultural benefits of designs created in Land.info and to conduct a deductive evaluation of the final design outcomes from the workshops. The created evaluation model draws from several existing models measuring publicness and quality of public open spaces. It aggregates design indicators into a scorecard that allows for a more objective approach to evaluating the socio-cultural impacts of design as compared to the commonly used review panel that has a tendency toward subjectivity. Operationalizing this model in future workshops to evaluate design outcomes and comparing the results to measures of landscape performance present in the Land.info software can create a more robust evaluation system that accounts for both environmental and socio-cultural impact, which are both important in evaluating landscape design.

This practicum centers upon the pre-implementation phase of design which enables more room for adjustment and optimization of a design instead of evaluation after its installation. The results show that a scoring system can be developed to assist in measuring design goals based on specific design indicators. Designs that score low in certain indicators may then be altered to more adequately satisfy the project's goals. Land.info has the potential to break down barriers of communication between organizations working on planning and design projects given its use of visualization and metrics to guide the decision-making process.

6.2 Future research

Understanding the impacts of Land.info require much more extensive research regarding the appropriate platform, facilitation, and evaluation process. Embedding Land.info as an engagement tool, with multiple trained staff from allied professional offices, could assist with the increasing the adoption of this tool in open space planning and design processes (Goodspeed & Hackel, 2017). Piloting the software in partnership with different organizations and varying disciplines will allow researchers to better understand its most appropriate use.

In the current iteration of Land.info, there exist several barriers to achieve optimal community engagement outcomes. The first, a facilitation methodology must be more clearly defined for future applications of Land.info in participatory design settings. Second, the user interface and hardware with which the software is currently available impacts who uses it. Third, the evaluation process should be operationalized to better understand the best methods of use. Continued research should delve into varying methods of facilitation, interfaces, and evaluation processes.

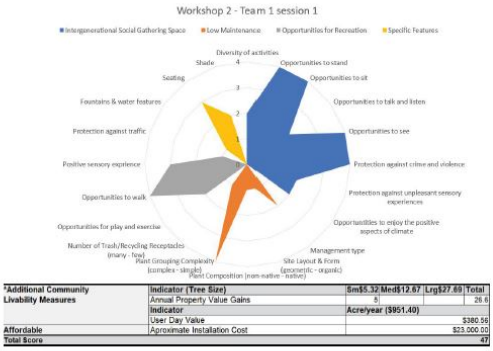
Though the process and outcomes of community engagement using Land.info were promising, there is little research that exists around the use of media to support learning, behavior change, and capacity building (Reed et. al 2018). Conceptual influence, though considered an impact should be supported by additional types of impact that are achieved through public engagement. Further research needs to the entire process from pre- to post-implementation of open space design to better understand the outcomes of the community engagement process.

The limitations of visualization reside within the lack of transparency within power structures that make decisions regarding design and planning (Senbel & Church, 2011). Improved transparency regarding data sources and design decision making must be researched in more depth to understand if visualization technology-mediated civic engagement tools pared with evaluation modes are able to provide more transparency related to the decision-making process.

The diversity of engaged stakeholders in technology-mediated participatory design settings is dependent on ability and discluding these individuals hinders the creation of truly equitable open space creation (Oswal, 2014). Stakeholders with sensory impairments, such as visual impairments were not included in this study. Continued research should engage appropriate diversity of individuals representative of the community and consider factors such as age, race, ethnicity, and disability.

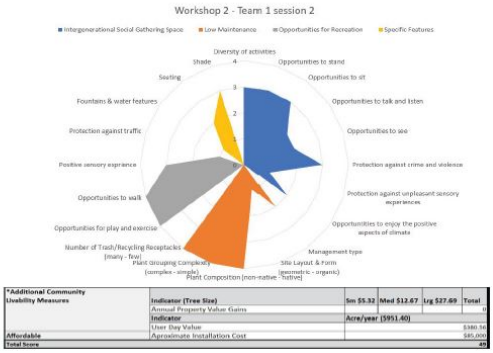
Appendix A. Workshop 2 Designs

Figure 2.1.1 Team 1 Session 1



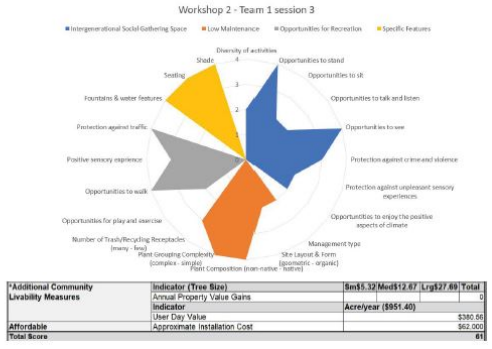
*Additional Community Livability Measures	Indicator (Tree Size)	$m $5.32	Med $12.67	Lrg $27.69	Total
	Annual Property Value Gains		5		26.6
	Indicator	Acre/year ($951.40)			
	User Day Value				$380.56
Affordable	Aproximate Installation Cost				$23,000.00
Total Score					47

Figure 2.1.2- Team 1 Session 2



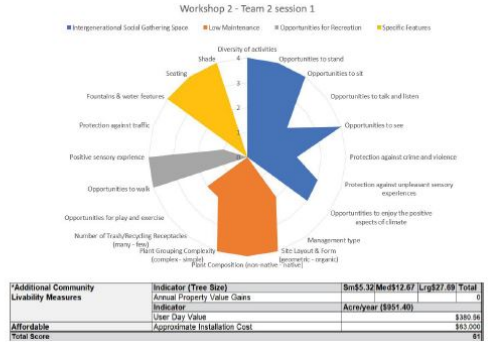
*Additional Community Livability Measures	Indicator (Tree Size)	$m $5.32	Med $12.67	Lrg $27.69	Total
	Annual Property Value Gains				0
	Indicator	Acre/year ($951.40)			
	User Day Value				$380.56
Affordable	Aproximate Installation Cost				$85,000
Total Score					49

Figure 2.1.3- Team 1 Session 3

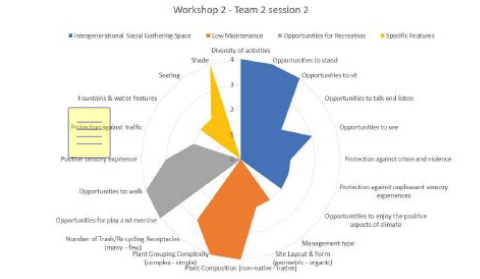


*Additional Community Livability Measures	Indicator (Tree Size)	$m $5.32	Med $12.67	Lrg $27.69	Total
	Annual Property Value Gains				0
	Indicator	Acre/year ($951.40)			
	User Day Value				$380.56
Affordable	Approximate Installation Cost				$62,000
Total Score					61

Figure 2.2.1- Team 2 Session 1

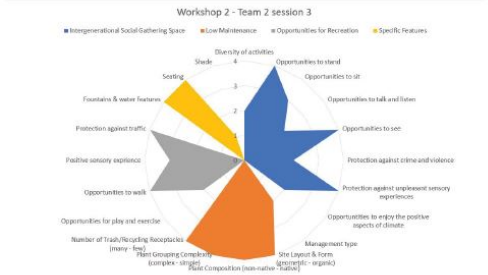


*Additional Community Livability Measures	Indicator (Tree Size)	$m $5.32	Med $12.67	Lrg $27.69	Total
	Annual Property Value Gains				0
	Indicator	Acre/year ($951.40)			
	User Day Value				$380.56
Affordable	Approximate Installation Cost				$63,000
Total Score					61



*Additional Community Livability Measures	Indicator (Tree Size)	Sm$5.32	Med$12.67	Lrg$27.69	Total
	Annual Property Value Gains	69.16		387.66	406.8
	Indicator	Acre/year ($951.40)			
	User Day Value				$380.56
Affordable	Approximate Installation Cost				$61,000
Total Score					55

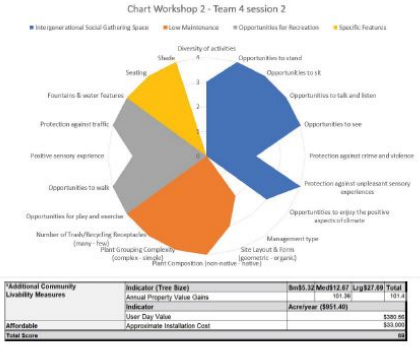
Figure 2.2.2 Team 2 Session 2



*Additional Community Livability Measures	Indicator (Tree Size)	Sm$5.32	Med$12.67	Lrg$27.69	Total
	Annual Property Value Gains		38.01		38.01
	Indicator	Acre/year ($951.40)			
	User Day Value				$380.56
Affordable	Approximate Installation Cost				$55,000
Total Score					51

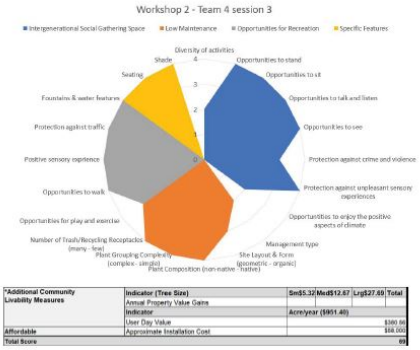
Figure 2.2.3 Team 2 Session 3

Figure 2.4.2- Team 4 Session 2



*Additional Community Livability Measures	Indicator (Tree Size)	Sm$5.32	Med$12.67	Lrg$27.69	Total
	Annual Property Value Gains		101.36		101.4
	Indicator	Acre/year ($951.40)			
	User Day Value				$380.56
Affordable	Approximate Installation Cost				$50,000
Total Score					65

Figure 2.4.3- Team 4 Session 3



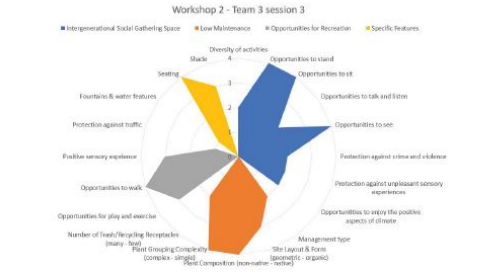
*Additional Community Livability Measures	Indicator (Tree Size)	Sm$5.32	Med$12.67	Lrg$27.69	Total
	Annual Property Value Gains				
	Indicator	Acre/year ($951.40)			
	User Day Value				$380.56
Affordable	Approximate Installation Cost				$68,000
Total Score					69

Figure 2.3.1- Team 3 Session 1

*Additional Community Livability Measures	Indicator (Tree Size)	m5.32	Med$12.67	Lrg$27.69	Total
	Annual Property Value Gains		15.96		$4.91
	Indicator	Acre/year ($951.40)			
	User Day Value				$380.66
Affordable	Approximate Installation Cost				$26,000
Total Score					51

Figure 2.3.2- Team 3 Session 2

*Additional Community Livability Measures	Indicator (Tree Size)	m5.32	Med$12.67	Lrg$27.69	Total
	Annual Property Value Gains		25.34		0
	Indicator	Acre/year ($951.40)			
	User Day Value				$380.66
Affordable	Approximate Installation Cost				$32,000
Total Score					53



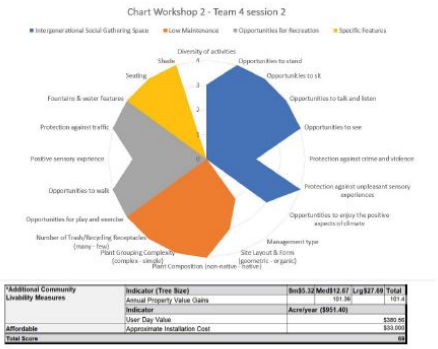
*Additional Community Livability Measures	Indicator (Tree Size)	m5.32	Med$12.67	Lrg$27.69	Total
	Annual Property Value Gains		63.35		63.35
	Indicator	Acre/year ($951.40)			
	User Day Value				$380.66
Affordable	Approximate Installation Cost				$66,000
Total Score					54

Figure 2.3.3- Team 3 Session 3

*Additional Community Livability Measures	Indicator (Tree Size)	m5.32	Med$12.67	Lrg$27.69	Total
	Annual Property Value Gains				0
	Indicator	Acre/year ($951.40)			
	User Day Value				$380.66
Affordable	Approximate Installation Cost				$24,000
Total Score					57

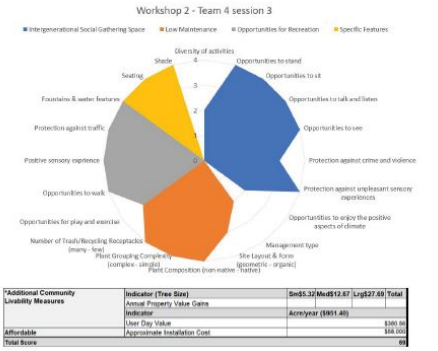
Figure 2.4.1- Team 4 Session 1

Figure 2.4.2- Team 4 Session 2



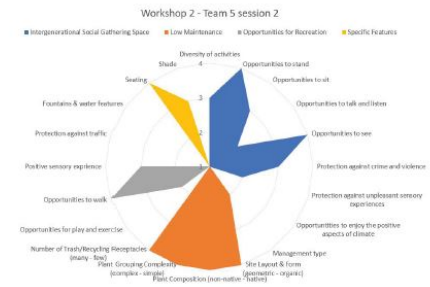
*Additional Community Livability Measures	Indicator (Tree Size)	Sm$5.32	Med$12.67	Lrg$27.69	Total
	Annual Property Value Gains		101.36		101.4
	Indicator		Acre/year ($951.40)		
	User Day Value				$380.56
Affordable	Approximate Installation Cost				$33,000
Total Score					69

Figure 2.4.3- Team 4 Session 3



*Additional Community Livability Measures	Indicator (Tree Size)	Sm$5.32	Med$12.67	Lrg$27.69	Total
	Annual Property Value Gains				
	Indicator		Acre/year ($951.40)		
	User Day Value				$380.56
Affordable	Approximate Installation Cost				$68,000
Total Score					69

*Additional Community Livability Measures	Indicator (Tree Size)	Sm$5.32	Med$12.67	Lrg$27.69	Total
	Annual Property Value Gains				
	Indicator		Acre/year ($951.40)		
	User Day Value				$380.56
Affordable	Approximate Installation Cost				$16,000
Total Score					40

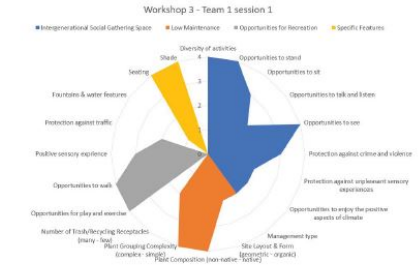


*Additional Community Livability Measures	Indicator (Tree Size)	Sm$5.32	Med$12.67	Lrg$27.69	Total
	Annual Property Value Gains		$0.68		
	Indicator		Acre/year ($951.40)		
	User Day Value				$380.56
Affordable	Approximate Installation Cost				$20,000
Total Score					55

Figure 2.5.1- Team 5 Session 1

Figure 2.5.2- Team 5 Session 2

Appendix B. Workshop 3 Designs



*Additional Community Livability Measures	Indicator (Tree Size)	Sm$5.32	Med$12.67	Lrg$27.69	Total
	Annual Property Value Gains	10.64	25.34		35.98
	Indicator	Acre/year ($951.40)			
	User Day Value				$380.56
Affordable	Approximate Installation Cost				$58,000
Total Score					66

Figure 3.1.1- Team 1 Session 1

*Additional Community Livability Measures	Indicator (Tree Size)	Sm$5.32	Med$12.67	Lrg$27.69	Total
	Annual Property Value Gains		88.69	110.76	199.5
	Indicator	Acre/year ($951.40)			
	User Day Value				$380.56
Affordable	Approximate Installation Cost				$105,000
Total Score					57

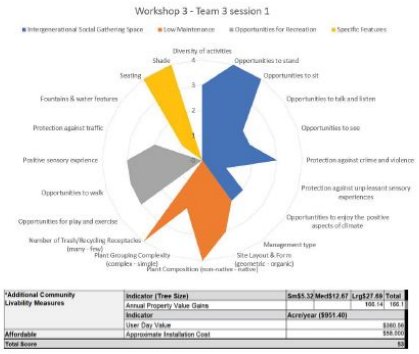
Figure 3.1.2- Team 1 Session 2

Figure 3.2.1- Team 2 Session 1

*Additional Community Livability Measures	Indicator (Tree Size)	Sm$5.32	Med$12.67	Lrg$27.69	Total
	Annual Property Value Gains			83.07	83.07
	Indicator	Acre/year ($951.40)			
	User Day Value				$380.56
Affordable	Approximate Installation Cost				$45,000
Total Score					66

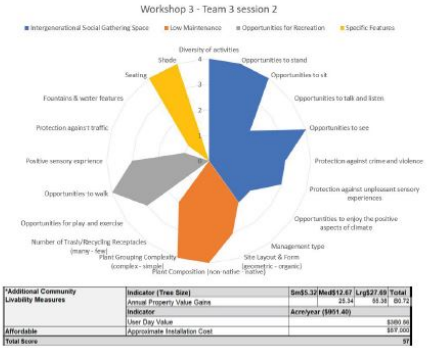
Figure 3.2.2- Team 2 Session 2

*Additional Community Livability Measures	Indicator (Tree Size)	Sm$5.32	Med$12.67	Lrg$27.69	Total
	Annual Property Value Gains		$0.00	22.82	273.2
	Indicator	Acre/year ($951.40)			
	User Day Value				$380.56
Affordable	Approximate Installation Cost				$48,000
Total Score					69



*Additional Community Livability Measures	Indicator (Tree Size)	m5.32	Med$12.67	Lrg$27.69	Total
	Annual Property Value Gains			100.14	100.1
	Indicator	Acre/year ($951.40)			
	User Day Value				$380.56
Affordable	Approximate Installation Cost				$88.000
Total Score					93

Figure 3.3.1- Team 3 Session 1



*Additional Community Livability Measures	Indicator (Tree Size)	m5.32	Med$12.67	Lrg$27.69	Total
	Annual Property Value Gains		25.34	55.36	80.70
	Indicator	Acre/year ($951.40)			
	User Day Value				$380.56
Affordable	Approximate Installation Cost				$87.000
Total Score					97

Figure 3.2.2- Team 3 Session 2

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