



Research article

Revitalizing urban waterfronts: identifying indicators for human well-being

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Abstract: Waterfront cities worldwide have begun the process of regenerating and developing their formerly industrial waterfronts into land uses that reflect a post-industrial economic vision of mixed urban uses supporting a diverse economy and wide range of infrastructure. These revitalization projects require distinct planning and management tactics to determine project-defined successes inclusive of economic, ecological, and human well-being perspectives. While empirically developed templates for economic and ecological measures exist, the multi-dimensionality and subjective nature of human well-being is more difficult to assess. Through an extensive review of indicator frameworks and expert interviews, our research proposes an organizational, yet adaptable, human well-being indicators framework for the management and development of urban waterfront revitalization projects. We analyze the framework through the lens of two waterfront projects in the Puget Sound region of the United States and identify several key factors necessary to developing project-specific human well-being indicator frameworks for urban waterfront revitalization projects. These factors include: initially specify goals and objectives of a given project, acknowledge contextual conditions including prospective land uses and projected users, identify the stage of development or management to use appropriate indicators for that stage, and develop and utilize data sources that are at a similar scale to the size of the project.

Keywords: urban waterfront revitalization; human well-being; indicators; framework; design and management

1. Introduction

Urban waterfronts are critical in the physical and economic development and civic life of cities. As places where people, goods, services, and economy meet, they represent a dynamic edge; spatially reified between land and water they are locations of temporary collection and continual dispersal. For port cities, these crucial sites have supported local and regional economies generating growth both within and outside the cities. Yet, these locations have historically, and continue to be, places of tension and complex geopolitical entanglements; highly sought after and desired by a wide range of urban constituent groups with often dissimilar and contradictory objectives. Continually transforming, the operations and conditions of these places reflect the history of a city, but also must address contemporary issues related to population increase, economic and technological globalization and impacts related to climate change [1-3].

1.1. Urban waterfront revitalization

Historically dominated by uses of industry, manufacturing and shipping both within and near urban centers, intense technological and economic modernization in the twentieth century abandoned many of these once productive spaces, leaving behind large swaths of derelict and degrading land, manufacturing plants, shipping terminals, warehouses, and residential and commercial communities. However, it was also during this time that post-industrial port and waterfront cities worldwide began regenerating and revitalizing their waterfronts, identifying these often dilapidated and underutilized places as critical locations for promulgating urban identity and promoting economic growth. Urban policymakers, planners, and developers recognized the potential of focusing massive investment within waterfronts to increase tax revenues, promote job creation, and advance local tourism opportunities while building greater continuity within the existing urban and social structures of their communities, cities, and regions [4,5].

A prevalent theme in these transformations has been the reclamation of urban waterfronts to accommodate emerging post-industrial economies, and to enable evolving civic agendas as well as new users and activities [6]. Examples of these projects range from the uncovering and re-creation of the Cheonggye River in the urban core of Seoul to the residential and commercial redevelopment of the London Docklands, to the visioning of the Bilbao waterfront on the River Nervion as a regional civic center [7-9]. Many of these waterfront development projects have been hailed as locations of promise, “crucial territorial wedges” for urban growth strategies in the twenty-first century [5]. They have been intended to reestablish or transform abandoned and derelict waterfronts of an earlier time into desirable communities with sustainable urban economies—economies intended to both compete in and support long term civic and regional growth [10,11]. While these visions provide promise in concept the complexity of their realization is difficult to overcome. As Michael Carley describes, “waterfront regeneration and development represents a unique opportunity to structurally and visually alter cities worldwide. The complexity of city-building includes the range of actors and organizations involved and how they interact, including involvement of local communities and the

wider public in the city, both in the process and in benefiting from the resulting places developed” [12].

Early waterfront revitalization projects were driven by the obsolescence and abandonment of vast port, industrial, manufacturing, and shipping lands along shorelines. This has been commonly attributed to emerging technologies in these industries following World War II that enabled greater efficiencies, for example, the construction of larger shipping vessels and the containerization of port activity [13]. Such efficiencies allowed for the centralization of port functions, reducing their overall urban footprint and leading to the deterioration of large areas of waterfront lands. While many of these revitalization projects focused on the rehabilitation of industrial buildings and the creation of public open space and market places, others expanded this approach to include public and private partnerships and incorporate a diverse, yet integrated array of land uses including residential, commercial, and existing water-dependent industries, described by urban planner Rinio Bruttomesso as “an essential paradigm of the post-industrial city” [14].

While there are many examples of urban waterfront revitalization globally, there are also many early attempts thwarted by a lack of political will and public and private capital investment among other reasons [10]. However, since the 1980’s and 1990’s, policy and legislation such as amendments to the federal Coastal Zone Management Act in the U.S. have provided governmental assistance for communities rehabilitating deteriorating urban waterfronts [15]. While this support engages more urban centers and communities in the process they have also initiated trends in waterfront regeneration that reveal an increase in privatization through the location of newly developed high-end housing with supportive infrastructure and commercial development [16]. Such projects have been found to promulgate social polarization and spatial fragmentation along the waterfront [17,18]. While they may provide a significant boost to the local economy, they do not necessarily promote an equitable distribution of goods and services for all people in the surrounding community. Yet, available urban management strategies and policies to counter these trends and build a greater capacity for social sustainability and human well-being (HWB) are being developed. For example, recent waterfront regeneration projects in Antwerp and Rotterdam required the inclusion of affordable housing and the creation of employment opportunities across economic sectors, while enabling and promoting community participation early in the development phase [19].

In order to more adequately identify and understand the conditions created through rapid waterfront development, civic leaders, planners, coastal managers and developers are calling for assessment protocols that incorporate economic, physical, ecological, and human well-being measures to assist in determining the most appropriate strategies for developing healthy urban waterfront communities [20,21]. Economic modeling from the public sector perspective includes job creation/retention, potential tax revenues, and infrastructure burdens, while ecological modeling may include measurements of area open space, percent canopy coverage, and species use [22,23]. However, due to their multidimensional complexity and contextual subjectivity, social and community indicators addressing HWB are more difficult to assign and assess. For these reasons, this research focuses explicitly on developing an indicator framework for HWB that directly relates to urban waterfront revitalization. While recent research has begun to incorporate comprehensive models of assessment that incorporate public health and well-being into models for urban planning, this focus related to waterfront revitalization is nascent and developing [20,24].

This research explores the development of indicators related to HWB in the context of urban waterfront revitalization. Accommodating for the complex issues related to waterfront revitalization

in post-industrial urban centers as well as the subjectivity of well-being measures, we develop and propose an organizational and adaptive framework for assessing waterfront revitalization from a social and HWB perspective, and examine the potential of the framework through two target projects located in the Pacific Northwest of the United States.

1.2. Measuring human well-being

Over recent years there has been increasing academic and professional interest focused on understanding the well-being aspects of society [25-30]. This includes attempts to understand how qualities of the built environment influence individual health and community well-being [31-33].

Human well-being (HWB) is a complex multi-dimensional concept that measures individual and community quality-of-life standards, requiring a deep understanding of the spatial and temporal variability of material (food, water, shelter) and nonmaterial needs (social cohesion, health, and security) within the context of a given location [34-36]. More specifically, HWB is defined by the Millennium Ecosystem Assessment working group of the United Nations to include “the basic material for a good life, freedom of choice and action, health, good social relations, and security” [37]. Building upon this definition, Sowman argues that as an applied condition, HWB is “a dynamic process and a state of ‘being’ that gives people a sense of how their lives are going, through the interaction between their circumstances, activities and psychological resources or mental capacities” [35].

Critical to the concept of HWB is the variability and shifting contingencies across personal, interpersonal, and collective needs that directly influence one another. It is deeply intertwined with the contextual physical, cultural, and technological environment of a given person or community [35]. Further, HWB is understood and expressed individually and is inherently linked to a situational context, reflecting locally influenced factors of geography, culture, social life and standing, as well as age and gender. In other words, HWB may take different forms in different communities and shift through the course of an individual’s life as they mature from child to adult and beyond [38].

The issues and complexities surrounding the topic make it difficult to assess HWB [39]. Any framework developed to measure change in human HWB metrics needs to be flexible and adaptive to shifting contextual and internal biophysical and socioeconomic conditions, yet structured and organized consistently to enable comparison, both spatially and across time [39]. Multiple approaches have emerged. Some focus methods on measures using situational and representative conditions through surveys and interviews to build subjective (i.e., personal reflections on experience) and context-specific understanding [40]. Others rely on more objective measures of HWB such as income, access to education, and physical health in an effort to reduce subjectivity, enabling uniformity and comparative analysis [41]. While these approaches are distinct and provide different results, they can be combined to provide a blended or composite approach [42]. In this regard, frameworks that incorporate a composite set of indices for examining HWB provide for a deeper understanding of a situation or place by resulting in a relative ranking that can then be disaggregated to examine relevance between indicators HWB and physical and economic conditions.

To identify existing HWB frameworks and indicators that would assist in relating HWB specific to urban waterfront revitalization projects, we evaluated several frameworks that engage research in socio-cultural well-being indicators for the built environment, including coastal and riparian

conditions [43-53], comprehensive rating systems and design checklists [54-59], and HWB surveys, evaluators and indicator lists [60-63]. Each was selected so that we could generate a wide representation of methodologies and indicators to measure HWB, and identify measures applicable to the issues and complexities associated with waterfront revitalization.

2. Methods

Utilizing the review of existing literature and HWB frameworks and indices, as well as the conceptual framework, a draft HWB framework for incorporating and assessing socio-cultural, human health, economic and environmental indicators into community re-development and management processes along urban waterfronts was developed. We then initiated a series of stakeholder and expert interviews to develop, expand and refine this indicator framework. The initial framework was created to generate discussion on the benefits and disadvantages of such a framework for assessing HWB in order to develop a refined version of the framework distinctive to urban waterfront revitalization projects. The draft indicator framework was also grounded through the lens of two project examples of waterfront redevelopment in the Puget Sound region of Washington State, U.S.A., one in the second phase of development and one in the planning stages, to iteratively refine the framework to accommodate conditions and variables that emerged when applied to specific locations and projects. We describe the interviews and grounding through the case examples.

2.1. Conceptual framework development

From the initial review of literature and existing HWB frameworks and indicator matrices we identified and adapted a broadly scoped conceptual model for urban waterfronts (Figure 1). The conceptual framework is structured through three primary spheres; HWB, policy and prosperity, and physical and ecological place. Each represents a primary component for framing and describing the contextual conditions of urban waterfronts. Overlaps of components are relationally described through the equitable social environment, viable economic development, and the livable built environment. The model was scoped, developed, and adapted intentionally broad to provide an organizing foundation to frame and focus the interview discussions.

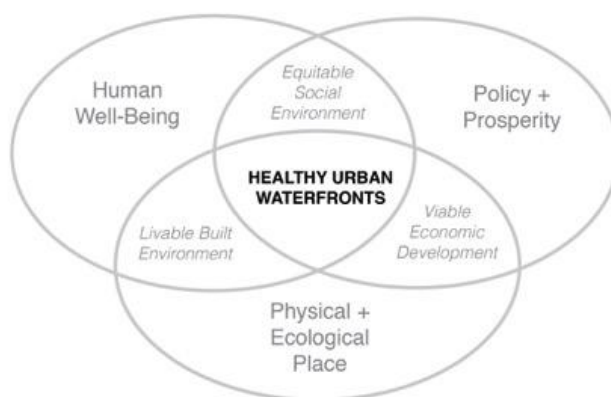


Figure 1. Conceptual framework of healthy urban waterfronts. Adapted from Tacoma Pierce County health department and studio 3MW LLP.

2.2. Interviews

We conducted a series of semi-structured interviews (11) with professionals and experts in HWB indicators and frameworks (4), public health as it relates to the built environment (3), and waterfront development (4). All interviews were conducted in person, or over the phone, or by email after each participant was provided the opportunity to assess the conceptual framework and an early iteration of HWB indicators framework for waterfront revitalization. Interviews were semi-structured to allow participants to evaluate and articulate concepts, issues, and recommendations for the overall approach as well as specific details regarding the use and development of particular indicators.

The interviews were structured in three parts. The initial series of questions asked the participants for an overall impression from their professional perspective, the second series was more specific to the structure and organization of the framework for integrating concepts in HWB and waterfront revitalization, and the third inquired about specific indicators and the data required to measure those indicators. While we initially sought a point of theoretical saturation through the interviews, we quickly came to realize that such a goal was not attainable due to the relatively broad topic of HWB research and the need for any proposed framework to be geographically grounded and contextually focused on existing and projected individuals and communities. However, the interviews did provide significant direction and refinement of the initial framework in order to propose a structure that is adaptive and flexible to site conditions, but uses both objective and subjective measures that are empirically defined, repeatable, and has identifiable sources or methods of collection for the data required.

2.3. Case examples

From the initial set of interviews we assessed the structure of the framework and refined the dimensions, attributes, and indicator measures and evaluated applicability of the framework on two case examples, the Thea Foss Waterway development in Tacoma, Washington and the Bellingham Waterfront district in Bellingham, Washington. These cases were selected to help inform the framework because of their similarity in geographic context and socioeconomic conditions, yet each project is in different phases of development and management with the initial phase of the Thea Foss Waterway project completing construction in 2002 and the Bellingham Waterfront district in an early phase of design and development.

For each case we worked with project managers that were highly familiar with all aspects of their respective projects and had an interest in addressing HWB in their project communities. We then asked them to identify attributes and potential indicators that would be applicable for assessing dimensions of HWB. Their responses were then assessed against the earlier interviews and the refined framework to reframe it from a more theoretical approach for assessing HWB to a grounded and applicable structure for waterfront revitalization projects.

2.3.1. The Thea Foss Waterway development

Waterfront revitalization of the Thea Foss Waterway began in the 1990's when the City of Tacoma bought 11 hectares on the canal's west bank in order to address brownfield cleanup and create economic opportunity (Figure 2). Public participation was deeply embedded in the planning

and design efforts, with over 40 community meetings attracting more than 900 citizens [64]. Aside from sedimentation cleanup and aquatic habitat enhancements, the multi-phased master plan includes public amenities such as waterfront walkways, open space, museums and an education center. These amenities were enhanced by private investment including a mixed-use retail and residential development as well as a collaborative environmental lab and research facility. The first phase of the project was completed in 2002, and development of successive phases is ongoing.



Figure 2. The Thea Foss Waterway development is located on a former industrial canal in Tacoma, Washington. Following environmental cleanup, the site is being redeveloped into a mixed-use private/public urban development. (Photo credit Dane Meyer)

2.3.2. The Bellingham Waterfront district

The Bellingham Waterfront District is a 96-hectare industrial brownfield redevelopment project along the shoreline of Bellingham Bay in Bellingham, Washington. The Waterfront District will be developed into mixed-use urban development over the next 40–50 years as city of Bellingham converts from an urban center dominated by maritime industry into one of service industry, tourism, and dense downtown residential life.

Planning for the waterfront began in 2004 when the Port of Bellingham and the City organized a group of citizens called the Waterfront Futures Group (Figure 3). Following their recommendations, the Port of Bellingham purchased the waterfront property in 2006 and assumed responsibility for remediating contamination caused by the former pulp mill. The Waterfront Advisory Group was then established to facilitate an extensive public participation process, eventually resulting in the December 2013 Waterfront District Sub-Area Plan [65]. Design visions for the waterfront include a waterfront trail, bicycle infrastructure, parks, an ecologically sensitive marina, and a mixed-use neighborhood of commercial, institutional, education, retail and residential land uses. The Bellingham Waterfront District master plan was also a pilot project for the Leadership in Energy and Environmental Design for Neighborhood Development (LEED ND) certification. LEED ND is a United States-based rating system that integrates the principles of smart growth, urbanism and green building into a national system for neighborhood design. It is based on a point system that aggregates to a series of accomplishment stages. Through this system, the Port will be leveraging the Silver

Stage 1 Pre-certified Plan award to attract developers and establish a minimum sustainable living standard for future private development.



Figure 3. Bellingham Waterfront District is a brownfield redevelopment project along the Bellingham Bay and Whatcom Waterway in Bellingham, Washington. The site is to be developed into urban mixed-use. (Photo credit Washington Department of Ecology).

3. Indicator framework for HWB on urban waterfronts

3.1. Systems

As shown in Table 1, the HWB framework is structured along four tiers of assessment. The upper *systems* tier recognizes the need for urban waterfront projects to develop a broad set of assessment indicators that are inclusive of Physical and Ecological Place, Policy and Prosperity, as well as Human Well-Being as developed in the conceptual framework in Figure 1. However, for the scope of this research only the HWB system is expanded upon. One of the reasons that we are focusing on indicators for HWB is that methods for measurable indicators into the economic viability (Policy and Prosperity) and environmental impact (Physical and Ecological Place) of waterfront developments are more developed in other research [22,23]. For the purposes of this research we define the system of Physical and Ecological Place to include empirical and quantitative measures of ecological impact and integrity while Policy and Prosperity include economic and policy oriented measures of regulatory requirements, civic scale cost and benefit, as well as tax and infrastructure burdens at scales that are broader than that of the individual project being assessed.

However, the subjective nature and relatively nascent development of indicators research for HWB adds complexity and the need for deeper evaluation [66]. While strong relationships occur across systems and this framework does include indicators of environmental impact (e.g., percentage of canopy coverage) and economic viability (e.g., number of living wage jobs) those indicators that were selected have direct associations with conditions of HWB.

Table 1. Human Well-Being (HWB) framework for urban waterfront revitalization projects.

ASSESSING SOCIOECOLOGICAL SYSTEMS IN URBAN WATERFRONT REVITALIZATION				
Human Well-Being	Physical + Ecological Place		Policy + Prosperity	
DIMENSIONS OF HUMAN WELLBEING ON WATERFRONTS				
Physical Character + Identity	Livelihood + Prosperity	Social Cohesion	Activity + Access	Experience + Mental Restoration
ATTRIBUTES				
<ul style="list-style-type: none"> Waterfront Land Use (residential / commercial / industrial / open space) Ownership (public / private) Contextual Character (topography / aquatic, terrestrial + urban conditions) Shoreline Related Regulations Civic + Community Identity Unique to the Waterfront 	<ul style="list-style-type: none"> Businesses and Employment on Waterfront Water-related / Water-dependent Industry and Facilities Cost of Living on Waterfront Demographics of Waterfront (income / ethnicity / age / sexual orientation, language) Governance + Regulation 	<ul style="list-style-type: none"> Security of Waterfront (crime) Safety on Waterfront (collision + injury / natural disaster planning) Education Neighborhood Cohesion 	<ul style="list-style-type: none"> Access to Diverse + Active Transportation Options Access to Public Open Space, Recreation + Facilities Access to Health Facilities Access to Water Related Activities Access to Healthy Food 	<ul style="list-style-type: none"> Environmental / Cultural / Historical Literacy on Waterfront Waterfront Sensory Experience + Stimulation Temporal Changes of Waterfront Experience of Nature
INDICATORS				
<ul style="list-style-type: none"> % distribution per land use category % public / private ownership % tree + vegetation coverage on waterfront % slope to shoreline presence of regulations and guidelines for development on waterfront water, soil + air test results complying with waterfront ecological + human health standards locally sourced aquatic foods meeting health regulations presence of district signage and wayfinding # of civic, cultural heritage, historic + educational facilities and landscape elements on waterfront (museums, community centers, music halls, sports venues, amphitheaters etc.) % area of places for active recreation (playgrounds, play fields, multi-use paths) % cost of waterfront development dedicated to public art, landscape and public space 	<ul style="list-style-type: none"> # of living wage jobs on the waterfront by industry category diversity of employment opportunities on the waterfront by industry category # of maritime/ water dependent operations affordability of businesses on waterfront (shops, restaurants, services etc.) # of opportunities for local food production (community gardens, farmer's markets etc.) median household income of residents and employees resident poverty rates % income spent on transportation for residents + employees on waterfront % income spent on housing for waterfront residents # of homeless and presence of homeless services % diversity of residents + users on waterfront (ethnic, age, income, sexual orientation, language) % of waterfront residents who feel represented by community + government leaders % of waterfront residents who vote presence of a maintenance or long-term sustainability plan + funding strategy 	<ul style="list-style-type: none"> # of crimes per 1000 residents + users % violent crimes on the waterfront presence of safe lighting, visibility and sight lines along waterfront presence of a natural disaster, extreme weather + terror emergency prevention + response plans presence of an emergency response plan (fire, police, medic) # of transportation accidents on waterfront per # of residents + users # of workplace accidents on waterfront per # of employees level of educational achievement for waterfront residents + users # of schools + childcare facilities within 1 km of waterfront per child resident/user # of neighborhood groups + neighborhood-based events on waterfront # of religious institutions within 1 km of waterfront presence of project community outreach + public participation average # of days/year residents participate in activities with family and/or friends # of heritage/culturally-based events held annually on waterfront and # of participants for each 	<ul style="list-style-type: none"> # of public transportation options within ½ km of the waterfront # of sidewalks + bike paths/infrastructure on waterfront average block length + street width on waterfront traffic + pedestrian counts on waterfront (peak + off-peak hours) ADA accessibility of public infrastructure + facilities # of opportunities for dining + drinking, groceries + fresh produce, shopping, errands, parks and recreation, healthcare, and entertainment on waterfront linear meters of accessible public shoreline # of opportunities for public to experience waterfront activities (aquatic recreation, restoration + industry) # of infrastructural elements supporting water dependent activities (docks, shipyards, boat launches, kayak rental etc.) # of public restrooms # of publicly accessible points for sustenance fishing + harvesting 	<ul style="list-style-type: none"> # of cultural heritage, environmental and historic programs on waterfront # of stewardship opportunities on waterfront and # of participants for each noise levels on waterfront light pollution levels complying with ecological + human health standards cleanliness levels + presence of public solid waste, recycling + composting infrastructure on waterfront public accessibility of waterfront views # of users per public seating # of areas with coverage from elements (tree shade, canopies, pavilions etc.) diversity of materials, plants and facades in view of public realm # of seasonal experiences on waterfront (festivals, holiday lighting, fall color, aquatic migration viewing, temporary installations etc.) # of public performance arts opportunities annually visitor satisfaction levels # of water touch points

3.2. Dimensions

The second tier includes five dimensions of HWB. These dimensions offer an organizing structure for understanding the scope and specifics of HWB research that build from the Millennium Assessment [43] definition regarding the provision of the basic material for a good life. Each of the five dimensions represents a distinct component of HWB in the context of urban waterfronts. While Physical Character and Identity and Livelihood and Prosperity are related to the systems Physical and Ecological Place and Policy and Prosperity respectively, they are included because the indicators used in this framework focus on the immediate built environment and represent measures of individual well-being and prosperity as opposed to broader civic, environmental, and social health.

3.3. Attributes

The attributes define and describe the topical areas that comprise the dimensions. They serve to structure the scope of the dimensions tier as they relate to urban waterfronts. The attributes listed are not exhaustive, but offer key considerations based upon the contextual conditions and goals and objectives of a specific project, and were refined through application of the framework through the case examples. For example, the bulleted descriptors for the dimension of Activity and Access highlight the public accessibility of a wide range of infrastructure from the immediate waterfront to diverse transportation options to the availability of healthy foods. With the dimension of Social Cohesion safety and security, education, and neighborhood development serve as discreet topical descriptors that directly contribute to HWB, however certain aspects, such as education, may not be as important depending on projected land uses. This adaptability enables project stakeholders and managers to identify and determine the most appropriate attributes of HWB for a given project.

3.4. Indicators

The fourth, and most detailed tier, indicators, is offered as potential measures that are specific to the attributes. The indicators provided are either physical, life, or regulatory in orientation. Physical Indicators, often difficult to change after the project is built (e.g., % public waterfront), assess the constructed environment of the waterfront. Life Indicators are associated with the actions and livability of people and their relationship to this place, and are better for measuring the impact the waterfront has on HWB after the project has been built and the community is an active participant in the space (e.g., # of cultural activities). Regulatory Indicators, are those which likely would not be able to be changed by the actual waterfront development (e.g., # of residents who feel represented by community leaders), however were included because of their importance to collective community well-being. These are included to understand the larger picture of HWB on the waterfront. Each of these types of indicators also includes an integrated combination of objective and subjective measures that support and inform the other. Where objective measures offer a discreet understanding of a specific indicator, the indicators such as visitor satisfaction levels can provide a more subjective understanding for how the project is functioning in relation to HWB.

While the indicators provided are all grounded in empirical assessments of human health and well-being it is critical to comprehend and incorporate contextual knowledge regarding which stage of development the framework (planning and design, construction, or post-development management)

is being developed for, and the dominance and distribution of land uses in the revitalization project (ranging from mixed residential to open space to industry). The specific indicators included in a project assessment should be selected and measured based on the particular and contextual conditions of the project. In this, stakeholders engaged in the process need to determine which indicator measures are of priority, assign value, and set standards for measurement based on the goals, objectives, and conditions of the project [67]. The values ascribed to these selected indicators should arise from empirical research, professional experience, regulatory requirements, as well as community and stakeholder interests and needs. The indicators included are value-less, with the understanding that values should be assigned based on weighing 1) project context and type of waterfront revitalization project, 2) community identified goals and local/cultural ideas of HWB, 3) regulatory standards, 4) professional experience and knowledge, 5) empirical evidence and built environment research on HWB, and 6) common sense and intuition. By allowing the community process to establish values and HWB thresholds, the approach can be flexible to different cultural contexts and enable communities to define and engage with the concept of HWB on their terms.

4. Results

The iterative stakeholder and expert interview and case example approach enabled the development of a HWB indicator framework for urban waterfront revitalization projects that is flexible, transparent, and encompassing. The interviews provided opportunities to identify measures that were more subjective, related to the experiential and sensory assessment of waterfront development based on conditional and situational experiences of individuals, while the application with the case examples expanded the framework to be more inclusive of objective measures that could be easily repeated such as changes to income, public access, and the relative costs used for the management of public open space.

4.1. HWB framework development

The extensive evaluation of the literature, the comprehensive rating systems and design checklists, and HWB surveys, evaluators, and indicator lists provided a basis for which to develop an HWB indicator framework that is specific to urban waterfront revitalization. Building from the core definition of HWB provided by the Millennium Ecosystem Assessment working group set the conditions for identifying the specific dimensions for HWB addressed in the framework. The interviews with professionals and experts in HWB and waterfront redevelopment further developed the conceptual structure of the framework, initiating an iterative assessment of attributes and indicators that address the core issues of HWB as they apply to the complex entanglements of environmental, political, and social issues related to waterfront development.

4.2. Applied findings

The examination of the HWB framework within the applied conditions of the case examples, provided discreet examples for how the framework could not only assist in the early planning phases of a given project, but be further applied during later stages and subsequent phases of development. With more than a decade of active planning and community engagement, the project managers for

both examples agreed that a detailed indicators framework for HWB offered perspectives that had not been previously considered by the planning team. Further, they identified value in how the HWB framework organized the dimensions and attributes of HWB to provide structure for long term and systematic integration and assessment of HWB attributes. They understood this structure as valuable in determining successful management practices and future planning projects that give greater consideration for public use and interests.

More specifically, the HWB framework would assist focusing their efforts for policy development regarding waterfront development practices. For example, utilizing the indicators to assess the benefit and constraints for offering incentive-based private investment based on public services and access to the waterfront would have been beneficial in earlier stages of the project. For the Thea Foss Waterway project that is well into its second decade of development they identified the dimensions of Livelihood and Prosperity and Social Cohesion as key components to ensuring economic viability and the production and maintenance of community character through tenant and public perception and use surveys. For the Bellingham Waterfront District project, many of the attributes--particularly those listed under Physical Character and Identity and Livelihood and Prosperity—were similar to those examined through the LEED ND documentation, the other dimensions and associated example attributes could provide direction for assessing individual and community perspectives of the redevelopment project.

For both cases, the primary critique of the HWB framework was in the quality and availability of data that translate across community to individual scales. Further, they argued for a more detailed description of the methods used to assess the proposed indicators as well as the potential costs associated with conducting such studies. Allocations within the budget for these projects did not support empirical research that is not mandated through policy and regulatory agencies. As public/private partnerships the development commissions have limited staff and monetary resources for conducting such research. Funding for data collection and integrated public health research would need to be prioritized early on if a deeper understanding of HWB for a given project is to be reached.

Through the detailed evaluation of both projects, the project managers determined that the HWB framework could be a useful tool for assessing HWB in theirs and other waterfront redevelopment projects. For these projects, the value of the adaptive framework model was understood as reaching beyond a formulaic and systematic approach for assessing HWB. When adjusted for context specific conditions the HWB framework provides a valuable foundation for leveraging public funds, directing private development, and establishing policy goals incorporating measures of HWB in addition to the more traditional economic and environmental measures of success. However, the actual adoption and implementation of the framework would present political and administrative challenges including the time and effort needed to develop and apply the framework, identify data and methods for its assessment, and conduct long term evaluations.

5. Discussion

The HWB framework is designed to be flexible for all phases of a waterfront project, from initial planning through design and construction, to evaluation and adaptive management. While the attributes and indicators of the HWB framework are loosely defined to allow for the contextual specificity of individual waterfront revitalization projects, the overall structure provides a

foundational focus for planners, designers, managers and decision-makers to intentionally consider HWB in waterfront revitalization.

Through the process of developing and assessing the HWB framework it was affirmed that there is need for such tools to assist individuals, communities, policy makers, and program managers in setting and evaluating HWB project goals and objectives [32,36]. While urban waterfront revitalization projects are often driven by economic and environmental factors, understanding the dimensions of HWB and quality of life within these projects is crucial for their long-term success [10].

However, identifying the way in which this need is translated into an actionable assessment framework is challenging. This research identified several points that are critical for any proposed framework and method devised to assess the complexity of HWB issues. First, the approach must be adaptable to the bio-physical, social, and political context of the project and context. For each project, indicators must be selected with a discreet understanding of quantity, quality, cultural relevance, affordability and proximity necessary for understanding HWB. Ideally data measured would be objective (e.g., crime statistics) and subjective (e.g., perception of crime) to allow for a more comprehensive understanding of HWB [32].

Users must be careful to draw appropriate conclusions in relation to the scale at which data is collected. Inappropriate use of well-being data is common, since HWB is best understood at the individual level; however data is often collected at the population or community level [42]. Users must also understand that these measures are indicators of HWB and the actual impact the waterfront project has on HWB must be directly collected to determine actual health and well-being outcomes [24]. To accomplish this, project teams must conduct longitudinal studies to monitor and adaptively manage to fully understand the impact of HWB on the waterfront.

The HWB framework was developed to stimulate dialogue regarding HWB on waterfronts and to act as a top-down guideline to be paired with a community process for determining goals, objectives, values, and priorities. It is a first step towards understanding the impact that waterfront revitalization projects have on HWB, and discovering ways to manage these projects to maximize HWB potentials. The framework allows communities to begin to understand the complex connections between the built environment and HWB and could help link the project team to other HWB programs and public services (e.g., efforts of public health departments). Lastly, as described by the project managers from the case examples, the framework and data collected through the indicators are helpful in policy development and determining long-term management strategies to assist in meeting project goals focused on HWB.

Further, while the indicators may be viewed as conceptual goals, they are most useful if data are collected to measure project performance. If a community has limited resources, existing data may not be available, and project partners may have difficulties collecting new data. For example, the Thea Foss Waterfront Development project leaders speculated that while the framework may have contributed to more defined project goals around HWB, the team likely would not have had the budget, time or staff to determine whether the project achieved these goals. Setting aside funding for research and evaluation or connecting with project partners such as universities or public health departments is necessary at the beginning of the project.

6. Conclusion

As coastal and port cities continue to seek opportunities to revitalize and redevelop their waterfronts to accommodate civic and community desire to inhabit these spaces, greater demands are being placed on planners, developers, managers and community leaders to develop projects that are not only economically beneficial and ecologically sustainable, but also equitable, inclusive, and reflective of community needs [3,12,14]. While the context surrounding each project is distinct, there are physical and social commonalities between waterfronts that support their evaluation as a discreet urban condition [11,68]. Yet, while indicator frameworks offer the potential to assess relationships between HWB and project planning, development, and management on the waterfront, there are several requirements necessary to ensure that the framework serves to provide meaningful information and is effective at engaging and assessing the issues that are important for project stakeholders.

The first is the contextual distinctiveness of each waterfront and project. Developments along the waterfront support a broad range of urban land uses from residential to industrial, commercial to public open space as well as mixtures of ownership from solely private or public to complex spatial and operational partnerships between public and private entities, each serving distinct interests. With these range of land uses obviously comes a wide diversity of users. Any framework that assesses HWB must be flexible and inclusive to accommodate the diversity, needs, and wants of users, but also to have the capacity to evolve over time as user demographics and concerns or interests change. If not carefully considered, the selection of indicators used to address a particular project may result in trade-offs with unintended consequences that ultimately reduce the quality of HWB for a given project.

Further, the community, project planners and designers have different perspectives of and goals for HWB than long-term managers and public officials [69]. Any framework therefore must account for different phases of the redevelopment process. For example, physical character and identity attributes may be more important in the planning and design phases of a project as they are often difficult to alter once constructed. Additionally, it is important to understand the scale at which the data being used to assess indicators is collected, and if that scale is appropriate to the project. For example, if human health data are being collected at the city-scale, it is inappropriate to use these data to assess project-scale trends in health.

Evaluations into the use of this indicator framework to assess HWB need to be cognizant of the challenges presented by this work so that it reflects an inclusive and equitable understanding of HWB for a given project. There is great potential in this approach to generate information and understanding about waterfront development that will greatly improve the way that waterfronts are revitalized and serve post-industrial cities and communities.

Acknowledgements

This research was supported through a grant from the Korea Maritime Institute, Office of Government Policy Coordination, Republic of Korea

Conflict of interest

All authors declare no conflicts of interest in this paper.

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