Functional sustainability indicators

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A B S T R A C T

Sustainability indicators (SIs) are not just traditional performance metrics but are value laden pathways to supporting urban development. This paper presents a functional classification for SIs. The following six classes are used to illustrate the various functions of SIs: (F1) Political and Operational; (F2) Problem Recognition and Awareness; (F3) Justification; (F4) Monitoring Control and Reporting; (F5) Normative Guidance; (F6) Communication and Opinion Forming. The Houston Sustainability Indicators (HSI) program was used as a heuristic case study of how the functional classification could be applied. F1 was illustrated by carefully choosing geographic boundaries for the study. F2 was highlighted by careful review of the socio-economic persons in the Food Desert. F3 was demonstrated by a look at issues of calculating population growth totals and also setting standards for access to parks. F4 was illustrated by a look at Employment figures. F5 was highlighted by a look at affordability in Houston. Lastly F6 was explained by a look at income inequality. This paper is intended to strengthen the importance of sustainability in development planning, through the illustration of key functions for SIs.

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1. Introduction

Sustainability indicators (SIs) are value laden measures of development performance designed to measure and calibrate progress toward sustainable development goals. We have seen the proliferation of a range of types of programs (Maclaren, 1996; Tanguay et al., 2010). Some of the various names for SI programs are ‘Indicators’, ‘Metrics’, ‘Indicator Reports’, ‘Community Indicators’, ‘Existing Conditions Reports’, ‘State of Place Reports’, ‘Health Assessment Reports’, etc. The problem is that the range of types and lack of common content among the reports, suggests that agencies could benefit from guidance on what is expected from SI programs. This lack of standards also highlights a need to develop a functional classification regarding the intended use and/or resource opportunity of the SIs to help to determine the requisite components of the programs.

Functional classification is here defined as the discrete framing of outcome values and purposes through which SIs can be classified. Basic to this process is the recognition that sustainable development involves inclusion of several principles, frameworks and objectives such as the Brundtland Commission definition of sustainable development; the Brundtland Commission report, ‘Our Common Future’ (WCED, 1987); the program of action, titled ‘Agenda 21’, with its 27 principles and 39 different themes in the four major areas of social and economic development, conservation and management of natural resources; strengthening the roles of major groups; and implementation for sustainable development (UNCED, 1992). It becomes necessary then to determine how performance measures can be characterized within sustainable development in a logical and meaningful manner, through for instance the functional classification designed in this paper.

This paper develops a functional classification of SIs, which may be helpful to standardize the many and varied programs planned or under development. The basis for the functional classes, are key citations from various sources on the outcome values and purposes of SIs. Results from the case study of the Houston Sustainability Indicators (HSI) program, will be used to support definitions of the functional classes. It is hoped that the functional classes developed in this paper would be useful for agencies and researchers to further the knowledgebase on developing SI programs, which meet the intent of sustainable development.

2. Background

2.1. Performance measurement and sustainable development

Using urban performance data to drive public policy can be beneficial through explicit inclusion in policy or through three other methods. Those are improving technical capacity, empowering views through enhanced reliability of facts and changing the terms
of normative discourse on topics in urban policy (Innes, 1988). Scholars have suggested quotes, such as the preceding by Innes (1988), which could be used to develop functional classes for SIs for as long as data has been used to drive public policy. The use of measurement systems for tracking performance became widespread in the US starting in the 1990s. At that time strategic planning and results oriented management was being implemented and improvements were recognized in the public sector (Osborne and Gaebler, 1992; U.S. Congress, 1993). Performance measurement has a singularly defined focus on positivist1 roots. It is defined as “...the regular measurement of results (outcomes) and efficiency of services or programs” (Hatry, 2006, p. 3). However, although singularly defined, the functions of performance measurement programs can be manifold (Innes, 1988). Recently we have had major successes in all levels of government with implementing performance measurement programs.

The theoretical justification for the use of performance measures can be found in the positivist approach to theory, which is a focus on empirical quantitative analysis. However although SIs depend on empirical analysis, in terms of producing forecasts and trends toward sustainability, they are also accompanied by a deterministic blueprint for achieving sustainability based on concern for explicit balance between social, economic and environmental forces. This substantive concern for ethics and public policy can be considered value laden determinism, as opposed to physical determinism (Bohl, 2000; Fainstein, 2000). Herbert Gans argues that these types of concerns are more intrinsic to the development of human settlements than physical determinism (Bohl, 2000).

The 1970s and 1980s were focused on debates between positivist scientific analysis and materialist political economy. Then the surge of ideas from the 1990s was a move from logical positivism toward a substantive concern for ethics and public policy (Fainstein, 2000). Therefore we can see that sustainable development practitioners have had their paradigm for value laden determinism since the 1970s when the idea originated. It was not until late 1980s when value laden determinism for sustainable development was codified in the form of the Brundtland commission report (WCED, 1987). The entire premise for sustainable development was built around adding value2 to the practice of development.

2.2. SI definition, principles, frameworks, criteria

The Brundtland Commission report released in 1987 codified the term Sustainable Development (WCED, 1987). At the Earth Summit in 1992, another document was developed, which established a program of action for sustainable development. The program of action, titled ‘Agenda 21’, is preceded by a declaration, which presents 27 principles of sustainable development. It also outlines 40 different themes in the four major areas of social and economic development, conservation and management of natural resources; strengthening the roles of major groups; and implementation for sustainable development. Chapter 40 of the program of action calls for the development of Sustainability Indicators (United Nations, 1992).

The first set of 134 SIs were published in 1996 by the UN Department of Economic and Social Affairs (UN DESA) with a national level focus of developing a central list of indicators to enable country to country comparisons. These indicators were organized using a framework to capture interrelationships between the indicators. The framework used was the driving force-state-response method (DSR). It is important to point out that employing a framework was the initial basis of selecting indicators since characterization was the fundamental basis for selecting indicators (UN, 1996). After consultation and testing between 1996 and 1999, another framework called the Theme/Sub-theme (TST) framework was recommended to more fully capture policy issues and main issues related to sustainable development. This set of 58 indicators was organized as themes and sub-themes under the four separate pillars of social development, economic development, environmental development and institutional development (UN, 2001). The most current iteration of national level indicators contains 96 indicators, with 50 considered core indicators. The TST framework is still recommended, but division of indicators among the four pillars (social, economic, environmental, institutional) is no longer included (UN, 2007). Other types of frameworks include capital frameworks, accounting frameworks, aggregated indicators, and goal-indicator frameworks.

While work was being conducted at the international level, to develop a suite of SIs that could be adopted by all countries, other efforts were being conducted to both define and develop SI programs for local level application (Elger and Krueger, 2012). The focus was on developing the ideal indicator based on defined criteria of each indicator (Harger and Meyer, 1996; Hart, 1999; Innes and Boorer, 2000; Holman, 2009). Work has been contributed to developing indices to better understand findings and to simplify reporting (Mori and Christodoulou, 2012). Another path of research is focusing on the process of developing indicators such as stakeholder integration and rationally ordered procedures (Bell and Morse, 2008; Maclaren, 1996; Moussiopoulos et al., 2010; Magee and Scerr, 2012). Yet another focus is analysis of requisite components of indicator programs (Portney, 2002; Berke and Manta-Conroy, 2000).

For the purpose of this research, one can summarize most of the literature on SI to-date as focused on the figurative anatomy/structure of SIs (Singh et al., 2012). Therefore a focus on the figurative physiology/function of SIs is suggested as a major determining factor in deciding how indicators should be selected (Brugmann, 1997b). There has not been much work done on the figurative physiology of SIs, aside from concluding or framing approaches to studies directed toward figuratively anatomically focused SI research (Hezri and Dovers, 2006; Yli-Viikari, 2009). For example most research papers on the topic conclude or begin with well crafted statements on why SIs are important and how they could be useful. It is precisely the referencing of these statements that forms the basis for the development of the functional classification presented in this paper. Statements such as, Innes’ (1988) three points on the beneficial aspects of using data to drive public policy, will be developed in the form of a functional classification for SIs in this paper.

Section 3 of this paper outlines the development of the functional classification for SIs. Following this discussion, Section 4 presents findings and experiences from the Houston Sustainability Indicators project as a case study to highlight application of the various functions of the presented classification system. Section 5 concludes the paper and contextualizes the findings in the literature.

1 Positivism is the term given to the philosophical position that emphasizes data and scientific methods. In the 17th century the work of Francis Bacon provided the foundation for this tradition. In the 18th century, John Locke and David Hume and George Berkeley were the primary exponents of this philosophy.

2 This value can be defined as equal consideration of social, economic and environmental impacts.

3 The term driving force represents human activities, processes, and patterns that impact on sustainable development either positively or negatively. State indicators provide a reading on the condition of sustainable development, while response indicators represent societal actions aimed at moving toward sustainable development.
Table 1
Functional classification table of sustainability indicators.

<table>
<thead>
<tr>
<th>Intrinsic (governance)</th>
<th>Extrinsic (general public)</th>
<th>Leadership functions</th>
<th>Knowledge increase functions</th>
<th>Capacity assessment functions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Political &amp; operational</td>
<td>Problem recognition &amp; awareness</td>
<td>Communication &amp; opinion forming</td>
<td>Justificatory</td>
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<tr>
<td></td>
<td>Normative guidance</td>
<td>Communication</td>
<td>Monitoring, control &amp; reporting</td>
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</tbody>
</table>

3. Functional classification development and discussion

This paper takes the approach that in seeking to develop indicators with maximized impact, there should be recognition that the function of selected indicators should be a major determining factor. With this function in mind we can select different indicators to serve various functional purposes (Levett, 1998; Hezri and Dovers, 2006; McCool and Stankey, 2004; Yli-Viikari, 2009). The paper illustrates six discrete functions that can be used to classify indicators to meet the needs of stakeholders.

In the performance measurement literature, consistent top level support, knowledge increase, and organizational capacity are the three drivers of effective measurement systems (Melkers and Willoughby, 2005). These three drivers can be used to characterize discrete functions of SI programs. Top level support can be considered a political function since this is the basis for setting work programs and focus. Knowledge increase is one of the more exciting functional opportunities. Hezri and Dovers (2006) calls this the Conceptual use of indicators as users become enlightened. Thirdly, improved organizational capacity is a separate function, since it is essential to understand improvements or failures to maintain our organizational systems. Hezri and Dovers (2006) calls this the Instrumental use of indicators.

Indicators can be characterized as having intrinsic and extrinsic value. The intrinsic value can be defined as characterization of the internal structure being measured. The extrinsic value appears where indicators may also report characteristics about other systems or other elements in an environment (Bossel, 1999). This paper sets up a dichotomy of interests between ‘leaders/organizational interests’ versus the ‘general public/public commons’. This differentiation can also be classified as a ‘top-down vs bottom up’ approach (Singh et al., 2012). It should however be noted that today top down leadership includes not only government entities but powerful non-profit groups and strong advocacy groups, along with business stakeholders, therefore the term governance is used to refer to this leadership group. Leaders and organized groups are citizens and hence the line is not always as blurred with regards to the pursuit of the public interests. Conducting stakeholder analyses serve as good efforts to understand needs and drivers for varying groups (Dalal-Clayton and Bass, 2002; Sommer, 2000). This paper takes the position that any group with an internal reporting structure (government, business, NGO, etc.), will be oriented more toward intrinsic considerations, since they have political directives, that over-ride the decisions of individual actors representing those organizations.

The sensitivity to intrinsic and extrinsic dichotomy as expressed by Bossel (1999) can be represented by rows in a classification table. Where intrinsic functions are those pertaining to leadership and organized stakeholders. The extrinsic functions would be those pertaining to individual citizen involvement and management of the commons. The three drivers suggested by Melkers and Willoughby (2005) could be presented as columns in our table. This would suggest that we would have similar functions for intrinsic/leadership objectives and for extrinsic/individual citizens or ecosystem objectives, thus creating a $2 \times 3$ matrix of functions. Table 1 presents the six identified functions for our classification system.

Intrinsic and extrinsic functions are herein described as the importance of SIs to the internal interests of governance groups versus public needs and wants. This difference is important to recognize in developing indicator programs, since different actors maintain different interests in the realm of public policy (Sommer, 2000). The fact that public servants have internal efficiency goals, which at times may complicate objective alignment with public policy goals, should not be recognized as a disparagement of public officials (Martin, 2004). If public servants are hired to manage and improve ‘wicked problems’ such as crime, oft times but not exclusively, the goal of reduction in the numbers may not be met and may not reflect poor performance on the part of the public servants. Performance measurement and SI programs should serve the dual function of indirectly improving government operational efficiency and accountability [intrinsic] (Brugmann, 1997a); as well as recognizing public goals and aspirations [extrinsic] (Pinfield, 1997). Yli-Viikari (2009), refers to this difference as the need for management tools versus informative tools.

3.1. Intrinsic function – Political & operational

Using data to drive public policy can be proven to be beneficial through explicit inclusion in policy (Innes, 1988; Brugmann, 1997b; Bell and Morse, 2008). SIs are used to serve political and operational functions. On the operational gamut they are useful for goal oriented objectives (Backhaus et al., 2002). The political function of SIs is challenging, in many cases, since sustainable development represents a vast holistic concept bridging social, economic and environmental concepts; intergenerational considerations; and the need to consider both local and extra-local impacts and effects.

There is not a great deal of evidence of success in linking indicators to policy uptake in the literature (Holman, 2009). In general, new information and policy is difficult to capture since knowledge is oft times linked to areas already known and accepted (Yli-Viikari, 2009). Indicators that are designed for institutional accountability and plan evaluation are considered the most result-oriented types of SI projects (Brugmann, 1997a). In effect, the opportunity created by the more standard performance measurement for government accountability, creates the established justification for measurement. Following this more traditional justification of conducting performance measurement, the opportunity for incorporating more value laden sustainability indicators can be integrated (Terry, 2008).

The focus here for classification purposes is recognition that the political leadership is a separate actor in the process of developing indicators and brings to the table a different perspective and set of needs, which should also be considered and incorporated in successful SI programs (Hezri and Dovers, 2006). The policy environment of leadership will affect how indicators programs are viewed and developed. Rydin et al. (2003) refers to this as recognition of the governance environment. In addition, contemporary public–private partnership agreements expands the notion of leadership and brings a wider array of non-state actors to direct policy making (Hezri and Dovers, 2006). Some indicators should be selected to serve the political function of representing the interests of the governance bodies, which are represented by several different organizations with their own internal goals.

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3.2. Intrinsic function – Problem recognition & awareness

Slis support problem recognition and awareness through knowledge increases (Backhaus et al., 2002; Brugmann, 1997b). Ideally bringing separate systems, represented by balance between the economic, social and environmental considerations, into a holistic framework for policy evaluation is a needed and ideal function for policy makers (Yli-Viikari, 2009). Units of government routinely operate independent of each other. The paradigm of sustainable development is an opportunity to facilitate discussions between economic development departments and environmental departments for full-cost accounting such as the use of the Genuine Progress Indicator (GPI) instead of the Gross Domestic Product (GDP) for national accounts.5 Opportunities for establishing horizontal relationships and reflective policy to support those created entities are made possible by the instrumental utilization of this function of Slis (Hezri and Dovers, 2006; Holden, 2006).

This function also serves to highlight the value of ecosystem complexity and the need to recognize methods for constructing models to elicit comprehensive feedback through indicators. Indicators should be selected to serve a problem recognition and awareness function, which in turn provides the basis for better public policy (Bell and Morse, 2008; Bossel, 1999; Tasser et al., 2008; Niemeijer and de Groot, 2008).

3.3. Intrinsic function – Justificatory

Indicators can serve to explain, predict, and justify approaches to the achievement of goals for the development of human settlements (Neuman, 2005). Establishing a clear link between indicators and decision outcomes is important (Yli-Viikari, 2009). It is somewhat easier to establish clear links between indicators-outcomes and policy synergies on indicators relating to engineering themes, such as transportation, water, and infrastructure (Keirstead and Leach, 2007). This is why efforts such as the U.S. Green Building Council’s LEED for Neighborhood Development (LEED ND) performance measures will go a long way on establishing more contemporary formal precedents for place based determinism. LEED ND has established a precedent for providing generic indicators defined to create enhanced livability and to minimize environmental impact for communities (U.S. GBC, 2009). On the national level, the United Nations Commission for Sustainable Development has made also available a suite of generic indicators for national policy improvements (UN, 2007).

The administrative feature of this function is to enhance organizational capacity for implementation purposes. Indicators should be specifically selected to serve the function of justifying governance positions. This includes resource needs, organizational improvements, employee motivation, and operations control (Holzer and Yang, 2004).

3.4. Extrinsic function – Normative guidance

The important difference here between this extrinsic function and the intrinsic function of internal political directives is that the former is meant to recognize the function of empowering the general public, while the latter intrinsic function is meant to recognize integration of internal political directives from the leading governance units participating in an indicators program. Addressing the goals, visions and aspirations of the general public is a very important function of SI programs (Neuman, 2005). Striving to unencumber this from the political directives of the leading organizations and governmental units is an important goal.

Kaiser et al. (1995) offer a five point classification of goals to aid in reaching consensus among different stakeholders as follows: Mandated, Legacy, Generic, Needs and Wants. Dividing stakeholders into groups more suited to address certain types of goals helps to increase the possibility that contributions from various perspectives are included in final outcomes. In the functional classification presented in this paper, the Mandated goals would be the responsibility of the intrinsic political function of the governance leadership. Legacy goals could be contributed by either the knowledge development function of intrinsic or extrinsic stakeholders, since these goals are reserved for those who have legacy knowledge as procedural experts or senior citizens. The Generic goals would be represented by organizational leaders, under the intrinsic Justificatory function. The Needs and Wants would be contributed to by the extrinsic function of normative guidance from the citizen stakeholders. The opportunity for citizens and the general public to contribute understanding of their Needs and Wants to indicators systems is a clearly separate and important function of indicators (Sawicki, 2002). Establishing an indicators system with different indicators to serve different functions, as presented in this paper, is one way to ensure that different stakeholders can have their interests represented with less fear of dilution from competing interests.

3.5. Extrinsic function – Communication & opinion forming

Slis support Communication and Opinion Forming and strategic design for problem solving (Backhaus et al., 2002). Empowering views through changing the terms of normative discourse are exceptional benefits from well-developed SI programs (Innes, 1998; Bell and Morse, 2008; Magee and Scerri, 2012). Gabin et al. (2003) characterize these benefits to public participation as ‘intangible’ as opposed to ‘direct policy connections’ or actual inducement of measureable change.

Communication and Opinion Forming may have higher degrees of importance in places with strong advocacy agendas to promote sustainable development in light of weak government support (Pinfield, 1997; Brugmann, 1997b). Considerations to develop more robust indicators according to this function include: fostering communication and plurality of information; and understanding the social and cognitive processes that affect public choices (Yli-Viikari, 2009).

Indicators of this Communication & Opinion Forming function are more geared toward collaborative learning processes rather than direct policy drivers (Innes and Booher, 2000a,b). In the policy arena, indicators developed under this function are more of a conceptual utilization to effect policy. Since the intended stakeholders here are the community or non-state actors, enlightening and informing views is the goal. The process of uptake would thus be lengthy and conceptually based on this potential to influence action over time (Bell and Morse, 2008; Hezri and Dovers, 2006).

3.6. Extrinsic function – Monitoring, control & reporting

Indicators are useful for monitoring, control and reporting (Backhaus et al., 2002). The notion that governments owe measurable performance to their constituents is a responsibility enabled through the use of Slis (Brugmann, 1997b; UN General Assembly, 2012). In one study of indicator development in Vancouver, public participants considered the monitoring and reporting of trends, actions and relationships as more important than the potential of increased knowledge from Slis (Holden, 2011). In a separate study in Finland interviewees on the beneficial use of indicators for a project expressed similar benefits from having data simply reported, without policy implications. In this particular function there is beneficial

5 The GPI starts with personal consumption expenditure then makes reservations for negative effects of economic activity ignored by GDP such as spending on rebuilding from storms (Dalal-Clayton and Bass, 2002).
use to simply having better access to data and improving data quality (Yli-Viikari, 2009).

Indicators developed around this function should be defined by individual citizens and hence reflect local uniqueness. However, there is the tendency to adopt standardized indicators to fit this purpose as with its counterpart on the intrinsic side. On the intrinsic side (representative of the leading governance interests), generic indicators make sense since the need is to have clear benchmarks tied to production or process units. Uniqueness is really not an issue for governance benchmarks. However, on the extrinsic side (representative of individual citizens and public commons), there is a need to report indicators and make data available that reflect local idiosyncrasies (Elgert and Krueger, 2012).

Fig. 1 illustrates the identified functions for SIs. Three of the functional classes illustrate indicator functions representative of governance bodies, those are: Political & Operational; Problem Recognition & Awareness; and Justificatory. The complementary three extrinsic functional classes, representative of the general public are: Normative Guidance, Communication & Opinion Forming and Monitoring, Control, and Reporting. These groups of functional classes are not mutually exclusive, there are meant to offer a reliable classification standard to present several functional benefits of SI programs. The process of organizing stakeholders for consensus on ideal SIs should not have to be some form of conflictual consensus shrouded in antagonistic appearances (Mouffe, 2000). The process in reaching consensus could be ameliorated by grouping interests according to various functions that indicators can serve.

4. Houston Sustainability Indicators program

The Houston Sustainability Indicators program (HSI), will be the case study used to illustrate the definitions and application of the functional classes. The HSI was developed to support sustainable development in the City of Houston, which is the largest city in the US with no articulated vision, goals or comprehensive plan. To date there has been just one other major sustainability effort conducted in the region through the regional council of governments (COG), which received federal funding to develop a regional sustainable communities plan. The regional plan for sustainable communities developed by the Houston Region COG does not address sustainable development of the City of Houston very well since there is no major focus on the City of Houston. The City of Houston although the largest and most populous city in the region, contains one third of the total regional population, but only 5% of the land area in the region, which is 12,500 square miles. Despite obvious economic and populous strengths of the City of Houston, the regional COG is not politically governed to address the dynamics of the City of Houston as the priority in the region. One reason is because the board of directors of the COG is composed of 35 elected officials representing the 13 counties and 105 cities in the region and has adopted more of a mandate for equal distribution of resources among members on a per municipality basis. Houston would have to retain one third of all appointed board members to the aforementioned regional boards to have regional representation commensurate with its population size. The existing form of governance of the COG may be a key contributor to the sprawl type development prevalent in the region, since funding is distributed evenly across the region, as opposed to a focus on the major population concentration.

Houston is a majority-minority city leading the way to what we can expect for the entire US in the near future in terms of demographics (Economist, 2009). The racial and ethnic demographic mix in Houston is 44% Hispanic, 26% White, 23% African American and 7% of the population from other racial/ethnic groups. As of the 2010 census the White group was 300,000 persons smaller and the Hispanic group was 640,000 persons larger than compared to 1980 numbers (U.S. Census Bureau, 2011). Houston has the highest violent and property crime rates among the largest cities in the country (U.S Census, 2007). The poverty rate is 23% and the median household income is $42,355. The average household spent 46% of their income on housing and transportation costs (King, 2012). This city is going through a tremendous demographic change; crime and poverty are high. Incomes are low on average and people spend a tremendous amount of their income on housing and transportation costs. It is not clear that the average Houstonian understands these major issues since popular media primarily focuses on housing prices without regard for incomes and or focuses on job numbers without regard for the pay scale of those jobs or the fact that the job numbers are most often reported for the Houston metro area and not just for the City of Houston (Brennan, 2012; Mulvaney, 2014) (Fig. 2).

Houston also has a very expansive and aging infrastructure, with unstable surface conditions due to land subsidence from a history of too much ground water extraction. A recent assessment of infrastructure conditions rated all systems ‘C’ or ‘D’ except for wastewater, which was rated an ‘A’ (ASCE, 2012). Flooding risk, which is an annual natural hazard affects 26% of the city and 17% of the population, who are located directly in the flood zone. The value of homes potentially at risk in the event of this type of incident is estimated at $18.5 billion (King, 2012). Perhaps the most unclear development factor is the governance of the city, which operates without a set of visions or goals and no comprehensive plan to guide development. A comprehensive assessment and characterization of development performance, using SIs could greatly assist with understanding the capability of sustainable development in this city (Fig. 3).

The HSI was developed on the campus of Rice University to assist with the characterization of sustainable development in Houston and to support the long term monitoring of development performance. Now in its fourth year, the program has published three SI reports looking at city level performance over time and projected into the future and also at the performance of major districts within the city (SCS, 2013).

The HSI utilizes the TST framework and has identified themes and sub-themes based on the ‘Big Ideas’ that Houstonians rally around. These ‘Big Ideas’ were identified from various sources such as a popular annual survey of opinions and aspirations of Houstonians; local media articles; and discussions and meetings.
with several experts and citizens throughout the city. Indicators were selected based on the definition of sustainability, principles, framework, criteria and functions presented in this paper. Data was collected and analyzed from various sources ranging from federal, state, and regional to local agencies. Experts were convened among several workshops to review the data, assign ratings for trends toward sustainability, and suggest policy to improve the indicators. Reports were then developed illustrating and discussing the findings, presenting background relevance to sustainability of each indicator and presenting policy options for improving the indicators.

The HSI reports have achieved major public impact with feature stories on the cover of the leading local newspapers (Sarnoff, 2013); feature interviews on major local television stations; headline news features on local radio outlets such as National Public Radio (NPR); and consultation requests from elected officials, business executives, and local non-profits. This public impact in itself hints to the value of the HSI program to supporting sustainable development in Houston.

4.1. Intrinsic function – Political and operational indicator functions in Houston

At the very first stakeholder meeting of experts for the HSI project, the question of project scale and boundaries was a dominant and contentious issue. It was concluded that the HSI should be
developed to capture the various levels of governance overlapping the city and highlighting the issues that may be found at various levels of geography such as neighborhoods, communities and city-level dynamics. The response was to collect data at the smallest unit of analysis possible to be able to prepare reports representative of the vertical levels of governance in the city. The first two HSI reports\(^9\) were focused on the Houston municipal boundary. The third report focused on the eleven council districts within the city, measuring performance at the levels of elected officials.\(^10\) A fourth report is compiled at a lower level of geography, which is the community level.\(^11\)

Preparing a sustainability report at these various levels of government was an important political strategy for three reasons. First it addressed the recognition that most people are now living in cities and play a key role in consumption and generation (WHO, 2013). Secondly, we were able to prepare reports representative of the various interests of stakeholders without having to develop three completely different sets of indicators. Third, it presents the basis, for comparison between neighborhoods within the city and to other cities around the country, which again helps to contextualize the performance of the local area.

### 4.2. Intrinsic function – Problem recognition and awareness indicator function in Houston

The opportunity for incorporating the indicator function, problem recognition and awareness comes from the fact that the HSI is a comprehensive program containing many themes. Indicators such as Poverty, Unemployment, Education, Environmental Justice, Food Deserts and Transportation are included. One specific example for illustration of this function is that of the indicator Food Deserts. The Food Desert problem in Houston can be classified in two parts. The first is that of the market vs the consumer problem and the second is a racial/ethnicity problem of access to large supermarkets. Almost 40% of Houstonians or 796,000 live in a Food Desert.\(^12\) A real estate periodical reported that Houston is enduring a grocery store market squeeze since the margins are low and competition is high (BISNOW, 2013). The article suggests that large supermarkets do not necessarily recognize Food Deserts as problems easily solved under current business models. The problem here is that large chains locate to capture customers from spatially wide market sheds. However from the perspective of the consumer, the wide area shed needed by the large chains runs counter to improved accessibility (Table 2).

The above table highlights the second problem of the racial/ethnic disparity of access to large supermarkets in Houston. When income and race/ethnicity are considered in addition to distance the results show quite similar racial/ethnic patterns compared to the total city. Except for the African American community, which is over-represented by 6 percentage points in the Food Desert. When an overlay of the food desert with areas of moderate incomes\(^13\) was performed, further details are identified. First 40% of persons drop out of the food desert, which shows that the food desert significantly affects persons of higher income as well (313,000 persons). Secondly African Americans, who are 23% of the total population make up 38% of the moderate income food desert and Whites who are 26% of the population are only 11% of the moderate income food desert. This racial disparity is shown more acutely when the food desert and low income\(^14\) areas are overlaid. Low income areas make up 35% of the total food desert. African Americans make up 43% of the population in these areas and Whites make up 7% of the population.

As a result of publication of the HSI report, we were consulted by an elected official to assist with a project to alleviate the Food Desert problem. Our findings showed that: (1) Hispanic ethnic groups are not affected by the Food Desert very significantly different to their share of the total population in Houston. (2) African Americans are over-represented in Food Desert areas in Houston especially among the poor to moderate income cohorts in the African American community. (3) The total food desert in Houston affects a significant number of higher income groups as well. This consultation demonstrated clear success in the HSI project supporting policy development in Houston. We were able to do so by identifying and visualizing indicators to specifically represent the function of Problem Recognition and Awareness of the Food Desert in Houston.

### 4.3. Intrinsic function – Justificatory indicator function in Houston

Local governments, such as those in places that challenge deterministic planning, such as Houston, can utilize SIs to help explain, predict and justify their chosen policy approach to tackle development in the city. This is one of the main functions of planning theory (Neuman, 2005). Following are two areas in which HSI was able to exemplify this Justificatory function. Again this function is inclined to be useful to represent the interests of the governance driving the indicators program. The first example is through the Population Growth Indicator and the second is through the Access to Parks indicator.

HSI calculated the average annual growth and intercensal population estimates for each year between 1980 and 2040. These data are not calculated by any public agency for the City of Houston at this time. Population growth projections are also not calculated specifically for the City of Houston since control totals are derived from the surrounding counties by the regional COG. This is a major issue for cities surrounded by strong suburban growth, since over-prediction of growth numbers in the city would be inevitable (COH, 2011).

\(^9\) Blackburn (2011) and King (2012).
\(^10\) King (2013).
\(^11\) King (2014).
\(^12\) Here defined as 1 mile from a major supermarket selling fresh fruits and vegetables.

\(^13\) Income less than or equal to 120% of median Household for the city. Moderate income was under $52,948.80 for Houston in 2011 (US Census Bureau, ACS 5Yr – 2007–2011).
\(^14\) Income less than or equal to 80% of median Household for the city. Low income was under $35,299.20 for Houston in 2011 (US Census Bureau, ACS 5Yr – 2007–2011).
Table 3
Houston Sustainability Indicators.

<table>
<thead>
<tr>
<th>Theme</th>
<th>Subtheme</th>
<th>Indicator</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social indicators</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Social demography</td>
<td>Population growth</td>
<td>Population growth</td>
<td>6 – Reporting</td>
</tr>
<tr>
<td></td>
<td>Education</td>
<td>Education attainment</td>
<td>3 – Justifactory</td>
</tr>
<tr>
<td></td>
<td>Community involvement</td>
<td>Voter participation</td>
<td>5 – Opinion forming</td>
</tr>
<tr>
<td>Poverty</td>
<td>Inequality</td>
<td>Income inequality</td>
<td>6 – Reporting</td>
</tr>
<tr>
<td></td>
<td>Poverty level</td>
<td>Poverty rate</td>
<td>2 – Problem recognition</td>
</tr>
<tr>
<td></td>
<td>Healthcare delivery</td>
<td>Health coverage</td>
<td>2 – Problem recognition</td>
</tr>
<tr>
<td>Livability</td>
<td>Cost of living</td>
<td>Affordability</td>
<td>4 – Normative guidance</td>
</tr>
<tr>
<td></td>
<td>Quality of life</td>
<td>Accessibility of public spaces</td>
<td>3 – Justifactory</td>
</tr>
<tr>
<td></td>
<td>Health &amp; nutrition</td>
<td>Food deserts</td>
<td>4 – Normative guidance</td>
</tr>
<tr>
<td>Economic indicators</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Economic development</td>
<td>Employment</td>
<td>Employment status</td>
<td>6 – Reporting</td>
</tr>
<tr>
<td></td>
<td>Macroeconomic performance</td>
<td>Primary jobs/green jobs</td>
<td>4 – Normative guidance</td>
</tr>
<tr>
<td></td>
<td>Earnings</td>
<td>Income</td>
<td>5 – Opinion forming</td>
</tr>
<tr>
<td>Consumption &amp; production</td>
<td>Waste generation &amp; management</td>
<td>Waste generation</td>
<td>2 – Problem recognition</td>
</tr>
<tr>
<td></td>
<td>Energy use</td>
<td>Energy consumption</td>
<td>2 – Problem recognition</td>
</tr>
<tr>
<td>Transportation</td>
<td>Access</td>
<td>Access to public transportation</td>
<td>5 – Opinion forming</td>
</tr>
<tr>
<td></td>
<td>Demand</td>
<td>Vehicle miles traveled</td>
<td>2 – Problem recognition</td>
</tr>
<tr>
<td></td>
<td>Mode</td>
<td>Travel choice</td>
<td>5 – Opinion forming</td>
</tr>
<tr>
<td>Environmental indicators</td>
<td>Atmosphere</td>
<td>Ambient pollutants</td>
<td>3 – Justifactory</td>
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<tr>
<td></td>
<td>Air quality</td>
<td>Greenhouse gas emissions</td>
<td>3 – Justifactory</td>
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<td></td>
<td>Climate change</td>
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<td>Fresh</td>
<td>Water quality</td>
<td>Water pollution</td>
<td>3 – Justifactory</td>
</tr>
<tr>
<td>water</td>
<td>Water demand</td>
<td>Water use</td>
<td>2 – Problem recognition</td>
</tr>
<tr>
<td>Land</td>
<td>Water resources</td>
<td>Water availability</td>
<td>2 – Problem recognition</td>
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<td></td>
<td>Flooding</td>
<td>Floodplain expansion</td>
<td>4 – Normative guidance</td>
</tr>
<tr>
<td></td>
<td>Land cover</td>
<td>Land cover change</td>
<td>2 – Problem recognition</td>
</tr>
<tr>
<td></td>
<td>Classification</td>
<td>Jobs/housing balance</td>
<td>3 – Justifactory</td>
</tr>
</tbody>
</table>

By including and calculating population growth at the city of Houston level, HSI was able to make available this data, since the City was actually not calculating its own growth rate, but was relying on regional estimates from the regional planning agency. The problem with the City of Houston approach is that the average annual regional growth rate from 2010 to 2040 of 1.7% is higher than the City of Houston average annual growth rate of 1.3%. The regional forecast for 2040 is predicting an additional 120,000–130,000 persons each year for a total of 3.7 million people by 2040. HSI predicts a more modest growth of approximately 46,000 persons per year and 1 million more persons by 2040 within the City of Houston.

The second indicator to illustrate this justificatory function is Access to Parks. The City of Houston Parks Department used the HSI data as third party justification in meeting its goals for park access. The Houston level of service standard regarding park access is stated in terms of size of the park per population. There is no distance or ideal spatial definition for the coverage area. The HSI data and the Trust for Public Land (TPL) data on park accessibility defined by ½ mile radius was used by the Houston Parks Department to illustrate other ways in which Parks access could be defined. Houston has 44% of the population within ½ mile to a park using the HSI data and 45% of the population within ½ mile using the TPL data. The HSI data uses a Euclidian radius of ½ mile while the TPL data uses the road network. This example demonstrates how indicators can both reflect legislated performance standards or justify performance in areas for which there is no standard, to demonstrate the benefits of developing such a standard.

4.4. Extrinsic function – Normative guidance indicator function in Houston

Perhaps the most important benefit of implementing an SI program is the extrinsic ability to empower stakeholders in normative guidance on the achievement of goals for the development of human settlements (Neuman, 2005). This is also the primary function of SIs, which separate them from traditional performance metrics. Performance metrics are usually developed to measure discrete thematic areas in development such as transportation, air pollution or housing performance. Goals for performance measurement are usually linked to clear benchmark targets. SIs however, are primarily developed to meet the integrity of the definition of sustainable development (WCED, 1987) and the principles as embodied in the manifesto for the paradigm (UNCED, 1992). This normative capability empowers the general public to express their aspirations, values and goals.

The HSI program was based on the ‘Theme-Sub-Theme’ framework of indicators development. This framework allowed for heavy loading of themes, which were identified as a representation of the big issues and aspirations, which affect Houstonians. Subthemes were then identified to captured smaller yet related concerns and then indicators were identified. This framework worked well for this project since there were no city level goals to follow and hence no centrally agreed upon suite of aspirations representing the interests of Houstonians. The following table presents the indicators selected for the HSI program (Table 3).

The Employment sub-theme was a good example to illustrate the function of Normative Guidance in the study. The Houston MSA was the fastest growing metro area, in terms of population, between 2000 and 2010. Between 2009 and 2013 the GDP increased by 22%, which was double the national average (The Economist, 2015). HSI provided a municipal level snapshot and disaggregation of the metro level data. We found that in a comparing Unemployment across the three decades of 1990, 2000, and 2010, that Unemployment dropped between 1990 and 2000 by a little less than a percentage point. This municipal level trend was very similar to the experience of the disaggregated White cohort and the Hispanic Cohort. However the African-American cohort experienced a 3 point reduction in unemployment. By 2010, however, the unemployment rate shot up by 2.4 percentage points. The Hispanic rate increased by less than a percentage point. The White rate increased by 2 percentage points and the African American rate increased by

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15 HAGC 2014 Q4 Forecast.
16 HSI 2012.
5 percentage points. This disaggregated analysis shows that the African American population in Houston has the most unstable position with regards to job security in comparison to the other racial and ethnic groups. It also shows that the economic base for the Hispanic population remained strong enough to withstand the recession which occurred in the latter years before 2010. The results from this Indicator shows that as Houston continues to grow, emphasis needs to be placed on ensuring job stability/equality for the African American cohort.

4.5. Extrinsic function – Communication & opinion forming indicator functions in Houston

The communicative model theory emerged as a response to the scientific rational model, which was used primarily for forec- casts and program evaluations. The top-down planning nature of the rational model was ameliorated by a more discursive struc- ture involving all stakeholders (Fainstein, 2000). SI programs satisfy the communicative model although programs should be evaluated uniquely based on scale. Local plans will include citizen stake- holders and primarily units of government (UN, 1993). Regional and national plans may only involve governmental and non- governmental organized groups.

Most studies utilize the Internet to publish SIs, this gives citi- zen stakeholders the ability to efficiently access the data and also to engage in the program. Some indicator programs develop intern- al and external web portals. Where the general public has access to some components of the data while local government staff has access to physically update and monitor progress on internal goals. The second option acts as a feedback loop to government staff, who can use the data to improve their technical capacity (Intrinsic func- tion – Justificatory). The first option represented under this extrinsic function of Communication and Opinion Forming is promoted by organizations such as the National Neighborhoods Partnership (NNIP). NNIP is an umbrella organization that has organized indica- tor programs around the country and strives to encourage programs to make data available to the benefit of the general public. HSI is a provisional member of the NNIP and was recently contacted to act as local data provider for the local office of Local Initiatives Support Services Corporation (LISC).

Without adequate communication of results, sustainability reports become ‘shelved’ or relegated to background study mate- rials for other plans. Serving as background material is just one of the functions of SI reports. However indicators such as Affordability serve the function of Communication and Opinion Forming very well.

Houston has been recently marketed as the capital for afford- ability (Brennan, 2012). However, when comparing cities in the country with more than 250,000 people, on transportation costs combined with housing costs, Houston ranks 26th for affordability. In Houston 46% of income goes to housing and transportation costs – 30% for housing and 16% for transportation. Philadelphia was the most affordable with 33% of income going to housing combined with transportation costs; New York was 4th with 37%; Chicago was 14th with 42%; and Los Angeles was 51st with 52% of income going to housing and transportation cost. By including data on trans- portation costs and comparing to other cities, this data changes the terms of discourse and opinion forming on affordability in Houston (Rudick, 2013).

4.6. Extrinsic function – Monitoring control and reporting indicator functions in Houston

In the HSI community comparison report, city council districts were used as the unit of analysis since elected officials directly gov- ern these districts. The city council district elected representa- tives are also the avenue through which the largest public investment vehicle in the city is administered, which is the Capital Improve- ment Plan (CIP). This is a five year plan, updated annually to cover all infrastructure and capital costs in which elected officials compete for funding projects in their various districts. The HSI was the first comprehensive report developed in the city to address the state of development within and between each district. This fact has given the report broad public relevance within the city as reflected by the scores of media references, including front page of the local newspaper, and features on prominent radio and television stations (Sarnoff, 2013; Rudick, 2013).

The HSI project is the first comprehensive sustainability report developed in Houston, and also the first comprehensive report on development performance. This objectivity is important to be able to address key points in making indicators data useful and available. Those key points may be defined as: providing disaggregated data; comparisons to benchmarks; explanations as to data performance successes or failures; and presentation clarity in user friendly for- mats (Hatry, 2006).

Since the publication of the HSI reports, many data requests were received from community organizations asking for informa- tion to help them address dynamics in their communities. Indicators data on Income Inequality are frequently requested.

The top 20 percent of wage earners increased at a fast rate between 1990 and 2000 and then dropped between 2000 and 2010. This steep increase between 1990 and 2010 was not reflective in the median income of the city as a whole, which is indica- tive of income disparity in the city. The top 20 percent median household earnings dropped between 2000 and 2010 but this drop did not have a noticeable impact on the median income in the city. This suggests an income disparity between the top 20 per- centile and the rest of workers. The median household earnings of the top 20 percentile were approximately $140,000 in 2010. The median household income in the City of Houston was approxi- mately $43,000 and the median household income of the bottom 20 percentile was approximately $10,000.

5. Conclusion

Sustainability indicator programs are distinct from performance metrics since they are value laden with the potential to perform the six functions presented in this paper. Those functions are: Political and operational; Problem recognition and awareness; Justificatory; Monitoring, control and reporting; Normative guidance; and Commu- nication and opinion forming. These value laden functions should be considered and addressed in the initial stages of setting up SI pro- grams since their use can enhance the opportunity for the pursuit of deterministic goals, values and aspirations of the public, while ameliorating contentious discourse between stakeholders.

Over the last 17 years we have seen a tremendous increase in the perceived utility of sustainable development as a paradigm for all sectors of society. Governments, businesses and civic society have adopted the values embodied in sustainable development as suit- able to meet their needs. Indicators for sustainable development are also being development to measure the state of development and identify gaps in development services. However some local gov- ernments simply present these indicators as background studies secondary to the sustainability plans being developed. Thereby they fail to engage the full benefit of utilizing SIs and to avail themselves of the wealth of benefits more robust programs can actualize. This highlights a gap in misconception as to how SIs should be used and ultimately the functions they can play. Understanding of various functions of SIs aside from solely performance metrics should help to correct that gap. It is hoped that the research presented in this paper can serve to support local governments and civil society to continue pursuing the important work of sustainable development.
In developing this proposed functional classification we hope to also offer local governments the confidence to identify and develop their own SI programs appropriate for their unique settings. We recommend referring to best practices, not to copy indicators used in other places, but to perhaps learn from the process others have been through. Locally developed indicators may be more useful than standardized indicators packaged by consultants. The process of selecting from the gamut of standardized indicators is a normative decision making process and as such should be based on a transparent opportunity for all stakeholders to participate for the indicators to be considered representative of the area under study (Elgert and Krueger, 2012; Magee and Scerri, 2012).

The HSI project has had support and participation from local government offices and a large list of development experts in Houston. Participation ranged from representation on expert working groups to develop consensus reports and sustainability strategies; to participation on expert panels to dialog on sustainability in Houston. The Parks Department and the Planning Department are both consulting with us on strategies for their individual Master Planning and General Planning respectively. Additionally, elected officials have consulted with our Food Desert strategies. This type of involvement addresses the importance of having participation by local government officials in SI work. It also demonstrates the success of HSI in developing indicators that embody multiple functions which represent the interests of many and varied stakeholders (Bruggmann, 1997a).

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