ENVIRONMENTAL SUSTAINABILITY INDICATORS IN DECISION-MAKING ANALYSIS ON URBAN REGENERATION PROJECTS: THE USE OF SUSTAINABILITY ASSESSMENT TOOLS

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A topical focus in research and policy shows that sustainability has emerged as one of the most critical aspects of urban regeneration, due to increasing problems related to human population, energy demand and climate change. However, the practical implementation of environmental sustainability is still inadequate. Urban regeneration projects require elaborate decision-making approaches, due to their complex and demanding context. The study explores the potential for established sustainability tools to be used as indicators in decision-making analysis frameworks on such projects. A survey was conducted with 36 expert stakeholders involved in construction projects in the UK. Sustainability assessment tools were viewed by a third of participants as ineffective in evaluating sustainability. Nonetheless, most participants valued universal assessment tools. The findings show that Sustainability Assessment Tools are suitable as environmental sustainability indicators in decision-making analysis for urban regeneration projects, but further development is indispensable in order to resolve the need for greater flexibility and context customization.

Keywords: sustainability, urban regeneration, decision-making, implementation

INTRODUCTION

In the last 50 years, urban regeneration (UR) has become a worldwide phenomenon (UN, 2001) and has received considerable attention from both academics and practitioners, due to the expanding urban decay and deterioration of building stock (Peng *et al*., 2015). Moreover, the increase in human population and its resulting complexities in terms of economic growth (Dixit *et al*., 2010), resources and energy demand, as well as climate change, have highlighted the importance of the sustainability aspect in UR. Gradually, sustainability has advanced from an ecologically focused direction to a holistic context, incorporating social, economic, cultural, physical and environmental aspects (Lee *et al*., 2010). Today, the new form of regeneration sustainability has adopted a long-term, multi-disciplinary perspective that emphasises the balance between economic, social and environmental aspects (Gullino, 2009). Despite the pervasiveness of discourses around sustainability, its practical implementation is still inadequate (Huge *et al*., 2011a). For this gap to be reduced, sustainability must be supported by appropriate decision-making frameworks, following the premise that "at the very heart of every action lies a decision" (Huge *et al*., 2011b). In order to do so, sustainability has to be assessed and measured. However, its holistic and multidimensional nature renders its measurement complex, additionally so, in the early conceptual stages of project design. Despite known

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weaknesses, the indicator system approach, an interconnected set of indicators that share the same purpose, emerges as the most popular and efficient method of sustainability measurement (Peng *et al*., 2015). Exploring the sustainability indicators used in the decision-making of UR projects creates debates and raises questions regarding not only the way in which the indicators are selected but also regarding their efficiency. These questions are closely related to the implementation gap, as the indicators used in decision-making are rarely the same as those used to assess the project after completion (Huge *et al*., 2011a). This analysis addresses one aspect of the gap between theoretical understanding and the implementation of sustainability. Specifically, it explores the potential use of Sustainability Assessment Tools, commonly used to evaluate a project after completion, as the environmental sustainability indicator in the early stage decision-making analysis of UR projects.

LITERATURE REVIEW

Sustainable Development in UR Projects

UR is the process of rehabilitation of the existing built environment through the efficient recovery of buildings and the reuse of urban land (Wang *et al*., 2014). UR projects present additional complexities compared to the rest of construction projects, due to their nature. They are large-scale complex ventures that have a significant development duration, involve multiple stakeholders and are transformational (Flyvbjerg, 2014). These projects present further complexities as they directly and indirectly affect numerous people (Flyvbjerg, 2014).

Sustainable development has been described as the key concept of UR projects due to their long-term effects and vast impact (Zheng *et al*., 2014). Sustainable development may be defined as meeting "the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1985). As stated in the Brundtland report, sustainable development necessarily encompasses three aspects: the economic, the social and the environmental. Even though the term Sustainable Development is characterised by an apparent vagueness and interpretative flexibility (Huge *et al*., 2011b), it is defined by a rather stable set of characteristics. These characteristics may be considered as principles and are the following: equity, which includes intra-generational justice for future generations, interspecies, geographical and procedural equity; dynamics, referring to the constant change of the environment and society, as well as the uncertainties triggered by them; integration of the three sustainability aspects, and normativity (Huge *et al*., 2011b).

Decision-Making Analysis

Decisions constitute selections of solutions that eliminate or reduce uncertainty. Decision-making is a cognitive procedure leading to the selection of a specific option or course of action among other alternatives. While considered a rational process, in reality it is more "fuzzy" as it may be subject to other influencing factors such as ideology, norms, interests and power relationships (Wang and Ruhe, 2007). Decision-making is usually based on the application of evidence-based criteria of selection. These criteria may be qualitative or quantitative. In order to evaluate the criteria, a common measurement framework is needed, denominated as indicator.

Sustainability Indicators

Sustainability performance measurement through the use of indicators is considered a critical step in sustainable development. Consequently, the creation and advancement of sustainability indicators has gained significant attention and importance over the years

(Wheeler, 2000). Egilmez *et al*. (2015) completed a literature review that demonstrates the prevailing themes and indicator categories identified in government reports. The themes comprise global warming, resource consumption, waste generation and quality of air, while the indicator categories incorporate energy and water consumption, air pollution, carbon dioxide emissions, recycling, waste generation, land use, building footprints and transportation. These themes are translated into quantified indicators. Established assessment tools such as BREEAM and LEED are based on a carefully selected system or set of indicators that aim to integrate different aspects of sustainability.

Sustainability Assessment Tools

A review by Walton *et al*. (2005) identified more than 675 sustainability assessment tools. Ten years later, the number of these tools is incalculable (Yigitcanlar and Dizdaroglu, 2015). The tools assess projects of different scales, ranging the from city and neighbourhood level, down to the single building scale. Reviews of these tools show that the environmental components dominate over societal and economical ones (Pope *et al*., 2004). Nevertheless, reviews focused on neighbourhood scale, in which UR projects are assessed, present different results (Berardi, 2012).

Neighbourhood Scale Sustainability Assessment Tools

Research conducted by Komeily and Srinivasan (2015) reveals that the sustainability assessment tools operative on neighbourhood scale encompass aspects of all three dimensions of sustainability. Assessment tools are widely used not only by academics but also by practitioners, for the evaluation of real projects. Some of the most used tools are LEED-Neighbourhood, BREEAM-Communities, DGNB-New Urban District and CASBEE-Urban Development (Ameen *et al*., 2015). There are multiple sources in the literature that praise the objective of these tools and the concomitant increase in awareness that they have facilitated (Kajikawa *et al*., 2011). Nevertheless, there are several authors that question their effectiveness in terms of delivering actual sustainability. Monterotti (2013) argues that these tools do not adequately tackle resource efficiency, renewables and other crucial environmental aspects. He adds that they do not consider any connection between the built environment and its context, and are thus inadequate in the medium- and long term. Ding (2008) proposes that their inflexibility is the major cause for their low performance in practise. This inflexibility may be proven unfavourable in UR projects, as their context is complex and demanding (Lombardi, 2011).

Despite these limitations, the structure of these tools makes their application as indicators valuable in a decision-making context, for a number of reasons. The tools consist of a predetermined, validated, universal set of criteria that attempt to operationalise and measure sustainability. They are used for assessment after completion, however they can be utilized from the early stages of the project to examine its potential performance and how it changes during each design phase. In doing so, the tools offer a potential framework to aid the complex decision making process of early project stages. In addition, the tools yield practical information directly relevant for the future certification of the project, and are compatible with existing operational procedures at governance level. Furthermore, they are accessible and easily comprehensible by all the stakeholders and can be used for comparison with other projects due to the universal structure (Keysar and Pearce, 2007).

Sustainability Indicators in Decision-Making Analysis of UR Projects

The use of sustainability indicators in decision-making analysis is compelling to numerous authors in the context of megaprojects (Waas *et al*., 2014), and more

specifically in UR (Lombardi, 2011) (Peng *et al*., 2015). Various authors have developed decision-making indicator systems that respond to the need of UR projects. Hemphill *et al*. (2004) have focused on the aspect of economy, work, resources, buildings and land use. Ng (2005) in research related to Hong Kong, advanced indicators focused on quality of life, while Winston (2010) utilized location, construction and design indicators in order to assess sustainable housing and regeneration in Dublin. The literature provides diverse valuable references, however decision-making frameworks still present some weaknesses. Most indicators are designed according to specific locations and contexts (Zheng *et al*., 2014), therefore cannot be used for comparison with other projects (Peng *et al*., 2015). Additionally, they cannot be easily understood by stakeholders and decision-makers not familiar with the location. Furthermore, the selection process of the decision-making indicator may be subjective, thus transparency issues emerge (Shen *et al*., 2011). This research explores the use of sustainability assessment tools, a commonly-used universal indicator system, as the environmental sustainability indicator in decision-making analysis, as a possible response to ambiguity, subjectivity and transparency issues, as well as a solution to reduce the gap between design and implementation, created by the use of different indicators in pre- and post-evaluation process.

METHODOLOGY

The conventional research method in sustainability studies is expert consultation through interviews (Laws *et al*., 2004). Although this method can be useful in addressing the multidimensional and uncertain nature of sustainability, there remains a gap on quantitative methods, which seek to measure and offer potential to generalise. In order to thoroughly comprehend respondents' views, studies can use questions that measure both the attitude and its strength simultaneously (Bradburn *et al*., 2004). This study uses a 15-item questionnaire administered via email. In order to measure both the expert's attitude and its strength, closed-ended questions that use five-point rating scales to diminish positivity bias, were used. Furthermore, participants were encouraged to develop their thoughts in the free-format comment section. Participants were experts in the field of sustainability; either currently working at the time of questionnaire completion, or had previously worked – in sustainable development, or they were involved – or had been involved – in research programmes related to sustainable development and UR. They were selected to represent a wide range of the following attributes: field of competence; responsibility and influence; diversity and accessibility (Feleki *et al*., 2016).

Profile of Respondents and Response Rate

The experts were recruited according to the aforementioned attributes. They were working in the following categories of institutions: government, from regional or borough agencies; academia, as university researchers on sustainability-related fields; practitioners, involved in sustainable projects; and policy-makers, in both public and private sectors. In total, 120 surveys were disseminated, with a response rate of 36.6%, which is in line with comparable non-mandatory surveys. The number of the respondents may limit the generalization of the findings of the study. This has been acknowledged in the discussion. The questionnaire was answered by 44 respondents, of which eight were excluded due to failing at the filter question that examined their familiarity with the subject matter of the questionnaire. The remaining 36 participants successfully completed the questionnaire. Of the sample, 8.3% had a Ph.D., 75% held a postgraduate- or professional degree, while 13.9% had an undergraduate degree. Participants were requested to state up to three areas of expertise. The most frequent provided option was

project management (33.3%), the second most frequent was sustainable or environmental design (27.8%) and the third was architecture (25%).

Other areas of expertise included stakeholder management, environmental engineering, building surveying and urban design. At least 38.9% of the respondents had an expertise in environmental engineering, sustainable/environmental design, environmental science, or sustainable development. The sample thus represented a wide range of professional expertise in sustainable development. The majority of participants (94.4%), had used sustainability assessment tools. This information increases the validity of this research as respondents that have worked on the subject of study are likely to have formed more concrete and extensive views (Laws *et al*., 2004). As expected, 85.7% of the interviewees had used LEED and 67.9% had used BREEAM. Few (14.3%) had used Green Star or Protocolo ITACA. This study examined the potential use of sustainability assessment tools as appropriate environmental sustainability indicators in the context of decision-making analysis in UR projects. Additionally, universality versus contextualization and indicator effectiveness, were considered.

FINDINGS

The majority (86.1%) agreed that sustainability assessment tools could serve as an appropriate environmental sustainability indicator, while 13.9% neither agreed nor disagreed. No interviewee expressed any opposition. More than one third of the respondents strongly agreed with the statement, with 46% expressing their views in the optional comment section. More than half of the interviewees (61.1%) agreed that there should exist a universal standardised environmental sustainability indicator − meaning an indicator applicable to all projects, regardless of their location −, while one third of the sample disagreed. Interviewee 1 noted that "there must exist a single international authority in governing environmental and sustainability standards in urban developments and industries", extending the issue from a universal indicator to a universal governance. Around 53% of the interviewees agreed the guidelines for the selection of the environmental sustainability indicator in decision-making should be the same for all the projects, while 38.9% did not support this statement. Interviewee 2 indicated that "Consistency and transparency is absolutely fundamental in standards to provide certainty to developers and planners. Nevertheless a degree of flexibility needs to be built in, for planners to work according to the area".

Turning to the view of the respondents on the effectiveness of sustainability assessment tools in a general context, nearly half of the respondents (47.2%) agreed the result of the sustainability assessment tools truly reflects how environmentally sustainable a project is, while 30.5% disagreed. Numerous respondents supported their negative response. Interviewees 3 and 4 stated that the tools are not focused on the performance on operation, while interviewee 5 commented on their inability to consider the location. Interviewee 6 stated that "tools are well and good, but in practice they are boxes that are just ticked rendering sustainability meaningless". 22.2% neither agreed nor disagreed, while only 19.4% expressed a strong opinion (strongly agreed/disagreed). When questioned whether adapting the tools to the needs of the area of the project (climate, air pollution, traffic, type of area – residential or commercial – etc.), the result of the assessment will more accurately reflect how environmentally sustainable a project is, 86.1% of the interviewees responded positively. Only 5.6% somewhat disagreed.

Exploring whether the environmental indicators used in decision-making processes of UR projects should reflect the specific needs and requirements of the area in which the project is located, 75% of the respondents agreed that every area has different environmental

needs and requirements, such as air pollution, noise pollution and microclimate, while only 19.5% disagreed. This 19.5% consistently agreed that a universal indicator should exist and that the selection guidelines should be the same for all contexts. A large proportion (94.4%) agreed that the environmental indicator used in the decision-making analysis of an UR project should reflect the specific needs of the area where the project is located. Only 2.8% disagreed, one of whom (interviewee 7) stated: "a universal tool should be developed. It should be used routinely and in all circumstances. The acceptable results may be different for different circumstances, but the assessment should be the same", thus supporting that a universal indicator should exist, but the benchmarks used should vary by context.

DISCUSSION

The potential use of sustainability assessment tools as environmental sustainability indicators in decision-making analysis of UR projects was examined. When asked about the general applicability of the rating tools, nearly half of the respondents agreed that they do indeed reflect how environmentally sustainable a project is, but one third disagreed. That is, a third of expert professionals with experience in sustainable construction or development believed that sustainability assessment tools do not effectively evaluate achievement of environmental sustainability, and a further 22% neither agreed nor disagreed. This suggests that sustainability assessment tools are not yet achieving the goal for which they were designed.

However, more than six out of seven interviewees agreed that the adaptation of the tools to the needs of the project area will better reflect how sustainable a project is, which partially contradicts the literature. While a number of studies highlight the advantages of the tools in terms of measuring performance (Ding, 2008), others argue that they fail to adequately assess resource efficiency, renewables and other crucial environmental aspects (Berardi, 2012). Most of those who disagreed with the effectiveness of the tools in this study worked in the sustainable construction sector. These findings are consistent with the research by Schweber (2013), focused primarily on BREEAM, where she found that the more knowledgeable the participants were, the less they perceived highly-rated buildings as green buildings. While the discussion on the tools' effectiveness has been going on for a long time, no clear solution has yet been developed.

The findings of the main part of the study suggest that the respondents support the use of sustainability assessment tools as environmental sustainability indicators in UR projects. Nevertheless, they express conflicting opinions on how they should be applied. Should the environmental sustainability indicator be universal and standardised, and should its selection guidelines be the same for all projects? More than half of the interviewees supported the existence of a universal standardised indicator applicable to all projects, while one third disagreed. This inconsistency is evident in the literature as well. The development of a universal indicator has been considered as critical (Bell and Morse, 2008), due to the large number of existing indicators, their differences and the difficulty in testing their validity (Button, 2002). On the other hand, it is widely supported that indicators, particularly in decision-making, should be location based (UNCSD, 2002). As Sharifi and Murayama (2014) state, "one size doesn't fit all" and customised tools, taking into account context-specific criteria and weightings, have to be applied. This finding along with the fact that more than half of the respondents agreed that the environmental sustainability indicator used in the decision-making process should be selected according to the same guidelines, shows that most of the experts express a need for universality, both in the indicator per se, and in its selection process. Having identical guidelines for

the selection of indicators promotes transparency, thus increases the value and scientific credibility of the result (Dale and Beyeler, 2001). As noted by interviewee 2, consistency and transparency are fundamental aspects of decision-making analysis. However, he/she adds that a degree of flexibility should be embedded in the guidelines. This is consistent with multiple views in the literature that support the development of selection guidelines but point out the need for flexibility (Niemeijer and de Groot, 2008).

Almost all of the respondents maintained that the environmental indicator in decision-making should reflect the different environmental needs and requirements specific to each urban subarea. This finding is consistent with the literature highlighting the importance of location and context (UNCSD, 2002) as well as with the research by Cole (2011) which suggests that these tools should move beyond a focus on the performance of the project as a bounded system. Instead Cole suggests that these tools should concentrate on the evaluation of the project within its proper context. These findings show a tension between answers regarding the indicator's need to reflect context-specific needs and responses related to the universality of the indicator. While almost all respondents agreed that the indicator should reflect the needs of its context, three out of five also endorsed a requirement for a universal standardised indicator that does not consider the location of the project. The format of the questionnaire enabled these apparently paradoxical opinions to be expressed. This finding allows the conflicting need of universality and contextualization in sustainability assessment tools, to emerge. An additional remark by respondent 7 transferred the conflict to the contextualization of the benchmarks instead of the tools, maintaining in this way the pure universality of their structure. Regardless of this tension between universalization and contextualisation, the respondents still acknowledge that the tools can be used as environmental sustainability indicators in UR projects.

With the findings suggesting that domain experts support the use of such tools as indicators in UR, the broader fit of the tools merits consideration. The conflict between contextualization and universality is only one aspect of the tools' broader considerations. The content of the tools presents a broader limitation that regards their applicability on social and economic criteria. The tools partially promote weak sustainability as they fundamentally contain environmental indicators. They lack appropriate assessment of social sustainability (Albino and Dangelico, 2012) and to a degree misrepresent economic sustainability (Berardi, 2012). Thus, the use of the tools in this context may be limited solely to environmental indicators. This significant limitation proposes that for decision-making tools to support strong environmental sustainability they need to assess the environmental, economic and social quote separately. An additional discussion emerges, regarding the competences of the actors that apply and assess the tools. Egan (2004) proposed that in order to deliver sustainable communities, actors should have generic skills and knowledge along with specialist and technical skills. It is evident that each component of sustainability requires a different skillset, thus making the proposition of the use of an all-in-one sustainability indicator potentially inadequate for the complex decision-making in UR. Based on our findings, we propose the use of the tools solely as an environmental indicator alongside with two other indicators regarding social and economic sustainability, acknowledging that all three pillars must be equally represented in the decision making process.

Future study in this area is essential in order to consult beyond the current relatively small sample of experts, and to examine how sustainability assessment tools may respond better to specific location needs without losing their key characteristics, thus their universality and standardization, to promote transparency and consistency. Contextualization could

be addressed through the addition of more flexible elements in the current rigid structure of sustainability assessment tools. Nevertheless, such an "invasion" should be performed with caution, in order not to distort the key characteristic of universality and the advantages that it offers. The less "invasive" way to achieve such contextualization is to customize the assessment benchmarks to location-related values, as suggested by one of the interviewees. In this way, a level of contextualization is achieved without modifying the structure of the tool. Another way to achieve this could be a modular system where the indicator themes are selected dependent on the context. This may require the contribution of the key stakeholders to the selection process. However, this will be possible only if the participation processes are transparent and consistent. An additional way to promote contextualization is the change of the indicator system according to the general characteristics of the location. Indicators may be added or subtracted and weights might vary, according to whether the project is in a developed or developing economy, in an urban, suburban or rural location, with tropical, dry, mild or continental climate, for example. Finally, future research should be focused on identifying means in which social and economic sustainability may be adequately assessed in a decision-making context, in order to promote strong sustainability instead of a weak, environmentally focused one.

CONCLUSION

The use of sustainability assessment tools as the environmental sustainability indicator in the decision-making analysis of UR projects offers a possible response to ambiguity, subjectivity and transparency issues, and as a solution to reduce the gap between theoretical frameworks and implementation of sustainable development. The study explored the views of sustainability experts on this notion. The findings suggest that sustainability assessment tools are suitable as environmental sustainability indicators to decision-making analysis in UR projects. Varying views in the results show that the existence of guidelines and a universal standardised indicator (such as these tools) is desired by most respondents, but at the same time, the tools need to allow flexibility and consider the project's context. The research demonstrates that, as the needs and requirements of the project location vary, they need to be reflected in the set of indicators. This field, however, will benefit from further research. More specifically, research should focus on the applicability of frameworks that allow flexibility in universal standardised tools and on the contextualisation of these tools according to the project's specific needs. Location-related benchmarks, modular selection and diversified sustainability assessment tools are suggested as ways to achieve this. Finally, it is essential to identify social and economic sustainability decision-making indicators to complement the environmental ones and promote strong sustainability.

REFERENCES

Albino, V and Dangelico, R (2012) Green economy principles applied to cities: An analysis of best performers and the proposal of a set of indicators. *In*: *Seventh International Forum on Knowledge Assets Dynamics*, 13-15 June, Matera, Italy.

Ameen, R F M, Mourshed, M and Li, H (2015) A critical review of environmental assessment tools for sustainable urban design. *Environmental Impact Assessment Review*, **55**, 110-25.

Bell, S and Morse, S (2008) Sustainability indicators: measuring the immeasurable? Second Edition. London: Earthscan.

Berardi, U (2012) Sustainability assessment in the construction sector: Rating systems and rated buildings. *Sustainable Development*, **20**(6), 411-24.

Bradburn, N M, Sudman, S and Wansink, B (2004) *Asking Questions: The Definitive Guide to Questionnaire Design for Market Research, Political Polls, and Social and Health Questionnaires*. Chichester: John Wiley & Sons.

Button, K, 2002. City management and urban environmental indicators. Ecological economics, 40(2), 217-33.

Cole, R (2011) Environmental issues past, present and future: Changing priorities and responsibilities for building design. *In*: *Proceedings of the SB11 Helsinki World Sustainable Building Conference*, 18-21 October, Helsinki, Finland.

Dale, V and Beyeler, S (2001) Challenges in the development and use of ecological indicators. *Ecological Indicators*, **1**(1), 3-10.

Ding, G, 2008. Sustainable construction-The role of environmental assessment tools. Journal of environmental management, 86(3), 451-64.

Dixit, M K, Fernández-Solís, J, Lavy, S and Culp, C (2010) Identification of parameters for embodied energy measurement. *Energy and Buildings*, **42**(8), 1238-47.

Egilmez, G, Gumus, S and Kucukvar, M (2015) Environmental sustainability benchmarking of the US and Canada metropoles: An expert judgment-based multi-criteria decision making approach. *Cities*, **42**(Part A), 31-41.

Feleki, E, Vlachokostas, C, Achillas, C, Moussiopoulos, N and Michailidou, A (2016) Involving decision-makers in the transformation of results into urban sustainability policies. *European Journal of Environmental Sciences*, 6(1).

Gullino, S (2009) Urban regeneration and democratization of information access. *Journal of Environmental Management*, **90**(6), 2012-9.

Hemphill, L, Berry, J and McGreal, S (2004) An indicator-based approach to measuring sustainable urban regeneration performance: Part 1, Conceptual foundations and methodological framework. *Urban Studies*, **41**(4), 725-55.

Huge, J, Waas, T, Eggermont, G and Verbruggen, A (2011a) Impact assessment for a sustainable energy future-Reflections and practical experiences. *Energy Policy*, **39**(10), 6243-53.

Huge, J, Waas, T, Verbruggen, A and Wright, T T (2011b) Sustainable development: A bird's eye view. *Sustainability*, **3**(10), 1637-1661

Kajikawa, Y, Inoue, T and Goh, T N (2011) Analysis of building environment assessment frameworks and their implications for sustainability indicators. *Sustainability Science*, **6**(2), 233-46.

Keysar, E and Pearce, A (2007) Decision support tools for green building: facilitating selection among new adopters on public sector projects. *Journal of Green Building*, **2**(3), 153-71.

Komeily, A and Srinivasan, R (2015) A need for balanced approach to neighbourhood sustainability assessments: A critical review and analysis. *Sustainable Cities and Society*, **18**, 32-43.

Laws, D, Scholz, R W, Shiroyama, H, Susskind, L, Suzuki, T and Weber, O (2004) Expert views on sustainability and technology implementation. *The International Journal of Sustainable Development & World Ecology*, **11**(3), 247-61.

Lee, Y, Lim, S and Kim, G (2010) Improvement characteristics shown in holistic regeneration of Ballymun toward sustainable community. *Building and Environment*, **45**(2), 279-86.

Lombardi, R (2011) Conceptualising sustainability in UK urban regeneration: A discursive formation. *Urban Studies*, **48**(2), 273.

Monterotti, C (2013) *Análisis Y Propuesta Sobre La Contribución De Las Herramientas De Evaluación De La Sostenibilidad De Los Edificios A Su Eficiencia Ambiental*. Ph.D. Thesis, Universitat Politècnica De Catalunya, Spain.

Ng, M K (2005) Quality of life perceptions and directions for urban regeneration in Hong Kong. *In*: Shek, DT L, Chan, Y, Keung, L, Paul S N (Eds.) *Quality-of-life research in Chinese, Western and Global Contexts*. New York: Springer, 441-65.

Niemeijer, D and deGroot, R (2008) A conceptual framework for selecting environmental indicator sets. *Ecological Indicators*, **8**(1), 14-25.

Peng, Y, Lai, Y, Li, X and Zhang, X, 2015. An alternative model for measuring the sustainability of urban regeneration: The way forward. *Journal of Cleaner Production*, **109**, 76-83.

Pope, J, Annandale, D and Morrison-Saunders, A (2004) Conceptualising sustainability assessment. *Environmental Impact Assessment Review*, **24**(6), 595-616.

Schweber, L (2013) The effect of BREEAM on clients and construction professionals. *Building Research and Information*, **41**(2), 129-45.

Shen, L, Lu, W, Peng, Y and Jiang, S (2011) Critical assessment indicators for measuring benefits of rural infrastructure investment in China. *Journal of Infrastructure Systems*, **17**(4), 176-83.

UN (2001) *World Urbanisation Prospects*. New York: United Nations

UNCSD (2002) *World Summit on Sustainable Development*. Johannesburg, South Africa: UN Commission on Sustainable Development.

Waas, T, Hugé, J, Block, T, Wright, T, Benitez Capistros, F and Verbruggen, A (2014) Sustainability assessment and indicators: Tools in a decision-making strategy for sustainable development. *Sustainability*, **6**(9), 5512-34.

Walton, J S, El Haram, M, Castillo, N H, Price, A D F, Hardcastle, C and Hardcastle, C (2005) Integrated assessment of urban sustainability. *Proceedings of the ICE - Engineering Sustainability*, **158**(2), 57-65.

Wang, H, Shen, Q, Tang, B-s, Lu, C, Peng, Y and Tang, L (2014) A framework of decision-making factors and supporting information for facilitating sustainable site planning in urban renewal projects. *Cities*, **40**(Part A), 44-55.

Wang, Y and Ruhe, G (2007) The cognitive process of decision making. *In*: Y Wang (Ed.) *Novel Approaches in Cognitive Informatics and Natural Intelligence*. New York: Hershey.

WCED (1985) World commission on environment and development. *Environmental Policy and Law*, **14**(1), 26-30.

Wheeler, S M, 2000. Planning for metropolitan sustainability. *Journal of Planning Education And Research*, **20**(2), 133-45.

Winston, N, 2010. Barriers to implementing sustainable housing in urban areas. *Sustainable Development*, **18**(6), 319-30.

Yigitcanlar, T and Dizdaroglu, D (2015) Ecological approaches in planning for sustainable cities: A review of the literature. *Global Journal of Environmental Science and Management*, **1**(2), 159-88.

Zheng, H W, Shen, G Q and Wang, H (2014) A review of recent studies on sustainable urban renewal. *Habitat International*, **41**, 272-9.