Social sustainability indicators of public construction megaprojects in China

Li, Hongyang; Zhang, Xiaoling; Ng, S. Thomas; Skitmore, Martin; Dong, Ya Hong

Published in:
Journal of Urban Planning and Development

DOI:
10.1061/(ASCE)UP.1943-5444.0000472

Paper for

JOURNAL OF URBAN PLANNING AND DEVELOPMENT

Social Sustainability Indicators of Mega Public Construction Projects in China

Hongyang Li [1*]
Xiaoling Zhang [2]
S. Thomas Ng [3]
Martin Skitmore [4]
Ya Hong Dong [5]

[1] Associate Professor, School of Civil Engineering and Transportation, State Key Laboratory of Subtropical Building Science, South China University of Technology, Guangzhou 510641, China, Email: li.terryhy@yahoo.com (Corresponding author)

[2] Associate Professor, Department of Public Policy, City University of Hong Kong, Tat Chee Avenue, Kowloon, Hong Kong, Email: xiaoling.zhang@cityu.edu.hk

[3] Professor, Department of Civil Engineering, The University of Hong Kong, Pokfulam Road, Hong Kong, Email: tstng@hku.hk, Tel: Int+ (852) 2857 8556; Fax: Int+ (852) 2559 5337

[4] Guest Professor, Research Institute of Complex Engineering and Management School of Economics and Management, Tongji University, Shanghai, China, Email: rm.skitmore@qut.edu.au

[5] Distinguished Professor, School of Environmental Science and Engineering, Qingdao University, Email: yhdonghk@gmail.com

Social Sustainability Indicators of Mega Public Construction Projects in China

(Amount of Words: 8007)

Abstract

The development of mega public construction projects in China has been booming during the last decade and projects of this type are expected to achieve sustainability economically, socially and environmentally. Despite this, their social sustainability level is relatively low and yet to be improved. A potentially important reason is the lack of a comprehensive evaluation mechanism to determine if a mega public project is socially sustainable in the Chinese context. As a prelude to the development of such a mechanism, this paper provides a thorough and comprehensive analysis of the various social sustainability indicators (SSIs) involved from a multi-stakeholder perspective. Different research methods (e.g. literature review and questionnaire survey) are adopted to collect the relevant information, both locally and internationally. The data are then analyzed with various statistical techniques in terms of mean score ranking, tests of Kendall's coefficient of concordance, Spearman's rank correlation, and factor analysis. The results uncover six sets of SSIs, comprising "improved quality of daily life", "appropriate macro policies", "harmonious connections with the surroundings", "unique local identity", "effective public participation" and "others". The work is validated by interviews and the comments raised by the interviewees are reported. The research findings are expected to benefit both the government and construction industry at large for better addressing social concerns when delivering mega public projects in China.

Keywords: Mega projects; China; social sustainability; indicators; factor analysis.

Introduction

Mega projects are defined as "… temporary endeavors (i.e. projects) characterized by: large investment commitment, vast complexity (especially in organizational terms), and long-lasting impact on the economy, the environment and society" (Brookes & Locatelli, 2015). Public projects of this type are normally built with an area of more than 20,000 m^2 and for office, commercial, tourism, science, education, culture, hygiene, communication as well as transportation use (Ling *et al.*, 2014). Despite the increased prosperity of public project provision in China, their overall levels of sustainability are still in question (Li *et al.*, 2016). As evidenced in some recent controversial cases (e.g. the Guangzhou waste-to-energy power plant project, the

Xiamen PX project, the Nu River Dam, and the Yuan Ming Yuan Lake Drainage scheme), the public are dissatisfied with the performance of these projects, especially with their social aspects. The relatively low level of social sustainability of mega public projects in China undoubtedly contradicts the original intention of delivering projects of this type. On the other hand, studies of socially sustainable construction projects are lacking in the Chinese context. According to Zeng *et al*. (2015), although social issues of specific infrastructure projects (e.g. the Qinghai–Tibet Railway) have been proposed, their generality is questionable. A comprehensive evaluation mechanism that can enable project success to be assessed from a social perspective is yet to be devised. The very first step for this is to establish a thoroughgoing index system.

In response, this paper identifies and comprehensively analyzes the various social sustainability indicators (SSIs) of mega public projects in the Chinese context. A brief introduction to the development of Chinese mega public projects and their social performance evaluation is presented next, followed by the description of the research methodology. The results of the literature review, questionnaire survey and validation interviews are then provided. The research findings are expected to benefit both the government and construction industry at large in delivering socially sustainable public projects in the Chinese context.

The Development of Mega Public Projects in China and their Social Performance Evaluation

The development of mega public projects in China

A public project is funded and operated by governments at various levels, and projects of this type are constructed to fulfil public purposes. During the ten years between 2003 and 2012, the total investment in public projects in China was CNY 182.34 trillion (10^{12}) with an average annual increase of 25.07% (National Bureau of Statistics of China, 2013). For Guangdong province, more than CNY 5 trillion was spent on such projects between 2008 and 2012, providing 76.3% of the province's fixed investments during the period (Yi *et al.*, 2014). The largest of these are *mega projects,* defined by the US Federal Highway Administration as major infrastructure projects that cost more than 1 billion US dollars, or projects of a significant cost that attract a high level of public attention or political interest because of their substantial direct and indirect impact on the community, environment, and budgets. Despite their daunting complexity and generally poor performance, they have a "sublime attraction" technologically, politically, economically and aesthetically for engineers and technologists, politicians, business people and trade unions, and designers (Flyvbjerg, Bruzelius & Rothengatter, 2003). China's central government and local governments at various levels have also been fully aware of the regional and strategic significance of mega public projects and their critical role in building a harmonious society.

Evaluating the social performance of mega public projects

Despite increased prosperity and general overall improvements in mega public project provision in China, their sustainability is yet to be improved (Li *et al.*, 2016). While sustainable projects strive to achieve *economic profitability*, *social awareness* and *environmental responsibility* throughout the project life-cycle (Pitt *et al.*, 2009), numerous issues continue to exist for project delivery, such as the emphasis on appearance over usability, relatively low use rate of resource/energy and the dissatisfaction of various stakeholder groups, equity and social/environmental justice, etc.(Lejano and Iseki, 2001; Geurs and Wee, 2004; Feng and Hsieh, 2009; Fischer and Amekudzi, 2011; Cheng *et al.*, 2013). Considering the nature of public projects, their *social performance* may serve as a more important indicator for evaluating overall success. For example, the projects are initiated based on the consensus reached among various relevant groups towards reasonable resource sharing. Representatives of the groups are defined as the project stakeholders – referring to those who can influence the project process and/or final results, whose living environments are positively or negatively affected by the project, or who receive associated direct and indirect benefits and/or losses (Li *et al.*, 2012a, b). Stakeholders of mega public projects in China are increasingly concerned with equity and social/environmental justice during project delivery (Xu, 2013). Numerous project failures resulting from insufficiently addressing these issues throughout the project lifecycle are detailed in the literature (e.g. Morris and Hough, 1993). Such failures occur primarily because the stakeholders have the resources and capability to stop the projects (Atkin and Skitmore, 2008), as evidenced in the recent cases of the Guangzhou-Shenzhen-Hong Kong Express Rail Link project and the Hong Kong-Zhuhai-Macao Bridge project. Both projects attracted unprecedented responses from many groups, including affected residents, the so-called "after 80s" (those after the 1980s), politicians, regulators and professionals, over the issues of family values, costs/benefit distribution, environmental impact, social justice, etc. (Liang, 2010; Fang, 2011).

Vallance *et al.* (2011) identified three major elements of social sustainability, including (1) development social sustainability, which is concerned with meeting basic needs, inter- and intra-generational equity, etc.; (2) bridging social sustainability, emphasizing changing behavior to achieve bio-physical environmental goals; and (3) maintaining social sustainability, associating with social acceptance or what can be sustained in social terms. Dempsey *et al.* (2011), on the other hand, considered social equity and the sustainability of community as the core of the notion of urban social sustainability. Sustainable communities should be safe and inclusive, well planned, built and run, and offer equality of opportunity and good services for all. In this study, social sustainability refers to the satisfaction of the local communities and stakeholders in general towards their social, economic, environmental, and cultural concerns - affected by the assurance

of such conditions as finances, technology, political authority, social organization, and consensus to maintain the conservation practices already established. Worldwide, social sustainability has been evaluated to cover different aspects and stakeholders. The United Nations Environmental Program (UNEP) proposed five stakeholder categories of measurement, including workers, local community, society, consumers, and value chain actors (Benoît & Mazijn, 2009). The social hotspot database (SHDB) includes nearly 150 indicators that cover 22 social themes (SHDB, 2017). Dong and Ng (2015) developed a scoring method to assess the social performance of building construction by considering thirteen indicators of three stakeholders, i.e. (1) workers (freedom of association and collective bargaining, child labor, fair salary, working hours, forced labor, equal opportunities/discrimination, and health and safety); (2) local community (access to material resources, cultural heritage, safe/healthy living conditions, community engagement and local employment); and (3) society (public commitment to sustainability issues).

In addition, indices to assess sustainability have been proposed, including the Environmental Sustainability Index (ESI) by National Aeronautics and Space Administration (NASA) (SEDAC, 2017), the Dashboard of Sustainability by International Institute for Sustainable Development (IISD) (Hardi & Zdan, 2000), the Human Development Index by United Nations Development Program (UNDP, 2015), Rajak and Vinodh (2015), etc.

Today, more stakeholders (or stakeholder groups) are involved constructing mega public projects with rather different or, most of the time, conflicting concerns as compared with more conventional construction projects. Typically, as evidenced in a recent major waste-to-energy power plant project in Guangzhou, an adversarial and confrontational situation between the decision-makers and other stakeholder groups can occur due to their unsatisfied needs (Zhang *et al.*, 2015). Some recent socially controversial cases in China such as the Xiamen PX project (Zhang and Jennings, 2009), the Nu River Dam, the Yuan Ming Yuan Lake Drainage scheme (Moore and Warren, 2006), etc., also indicate the extent of the problem.

Therefore, although the importance of social sustainability of mega public projects is well recognized in China, its current level is far from satisfactory and a comprehensive evaluation mechanism is still lacking (Li *et al.*, 2016). As a prelude to the development of such a mechanism, it is necessary to first identify the indicators involved. In response, this paper provides a thorough and comprehensive analysis of the various social sustainability indicators (SSIs) found in the literature from a multi-stakeholder perspective.

Research Design and Methods Used

Research design

This research was conducted in five steps, comprising: (i) background study; (ii) survey preparation; (iii) conduction of the survey; (iv) data analysis; and (v) validation of results as illustrated in Figure 1. In the first stage of background study, a comprehensive literature review was carried out and social sustainability indicators (SSIs) of mega public projects with high frequency of occurrence summarized. A pilot study and formal questionnaire survey were then organized in stages (ii) and (iii). Responses were solicited on the assessment of the relative importance of the SSIs previously identified. The data collected were analyzed with various statistical techniques (stage iv) and the results obtained validated by experts from the government, industry, academia, the general public, and Non-Governmental Organizations (NGOs) (stage v).

<Insert Figure 1>

Research methods used

This study combines various research methods to collect and analyze information and data on the sustainability performance of mega public projects both locally and internationally. These comprise a literature review and questionnaire survey as well as interviews.

Literature review

In this research, a list of 22 social sustainability indicators (SSIs) of mega public projects was compiled through a comprehensive literature review and content analysis (Lu *et al*., 2002; Chan and Lee, 2008; Jia *et al*., 2010; Li *et al*., 2010; Shen *et al*., 2010; Liu *et al*., 2011; Valdes and Klotz, 2012; Teng *et al*., 2014; Li *et al*., 2015; Hou, 2016; Ahmad and Thaheem, 2017). These comprise: adaptability of development to local needs; availability of local job opportunities; economic benefits to government and local citizens; balanced development of different local economic activities; encouraging stakeholder participation; improved serviceability to the community; harmonization of the proposed project(s) with the local natural setting; project function well with socially acceptable tariffs; prevention and mitigation measures against air, water and noise pollution; conservation of the local cultural and historical heritage; positive influence of project location/land use on society; preservation of local characteristics; suitable project design in terms of aesthetics, density, height and visual permeability; green and sustainable design and construction; ensuring public safety; provision of public open space; practical mechanisms coping with stakeholder conflicts; convenience, efficiency and safety for pedestrian and public transport users; shaped

local identity and international reputation; timely feedback to the participants; well-established stakeholder participatory channels; and reasonable compensation and relocation plan/strategy.

It is also found that, though the impact of equity and justice is receiving increasing attention in China, the generic approaches assessing project social sustainability somehow ignore these fundamental social issues. Comments were therefore sought during the subsequent pilot study and validation interviews.

Questionnaire survey

A questionnaire survey was chosen as the most effective means of collecting the required information since many mega public project SSIs exist and as large as possible sample size is needed for a robust factor analysis. As a result, an initial version of a questionnaire was drafted to evaluate the relative importance of the 22 SSIs identified in the literature review. A 9-point Likert scale was incorporated to facilitate the rating process. A pilot study was conducted to ensure the questions set were intelligible, unambiguous, and easy enough to answer to help determine the time required for completing the exercise. 23 experts from different stakeholder types (government officials, industry practitioners, academics, members of the general public and NGOs) were invited and their feedback helped to improve the questionnaire format and content. For instance, a 7-point Likert scale was recommended since it was thought that potential respondents might have difficulty distinguishing the rating criteria on a 9-point Likert scale. Additional indicators related to macro policies were also added as suggested by the government officials. Moreover, most interviewees believe that issues such as equity and social/environmental justice are already reflected in the established list of SSIs. Their comments, '*effective public participation* (*e.g. constructing stakeholder participatory channels and practical mechanisms for coping with stakeholder conflicts, providing timely feedback to the participants and encouraging stakeholder participation*) *help improve equity and social/environmental justice*', illustrate the point. An information package, briefly explaining public projects and social sustainability concepts, was also prepared to facilitate the participation of respondents.

Two sampling approaches were employed to ensure the survey findings are useful and reliable. These include purposive sampling (for government, industry, academia, and NGO respondents) and random sampling (for the general public). It was also felt that respondents from government, academia and NGO need to have at least two years of working or research experience with public projects or in relevant disciplines or have previously been involved in the social impact assessment (SIA) of at least one project.

Of the total of 990 questionnaires dispatched, 225 (22.73%) valid responses were received through mail, email, fax, or street survey. These include 39 from government

officials, 49 from industry practitioners, 48 from academics, 43 from the general public and 46 from NGOs. The overall response rate and that of each group (20.74% for government officials, 23.44% for industry practitioners, 23.30% for academics, 23.24% for the general public and 22.77% for NGOs) are not uncommon for a survey of this kind and are regarded as acceptable based on the findings of Akintoye (2000).

Validation interviews

To validate the results obtained from the questionnaire survey, semi-structured interviews were considered appropriate, as they allow the researchers to interact more thoroughly with the experts. As a result, 26 experts were purposively selected and invited to participate in interviews. These again comprised representatives from each stakeholder type (government, industry, academia, members of the public and NGOs) (Table 1) and with the same criteria for their selection. The interviewees were asked to assess the results against five criteria, i.e. comprehensiveness, objectivity, reliability, practicality, and generality, according to a scoring scale from 1 ("poor") to 5 ("excellent"). These results, as well as the ways in which the results were interpreted, were discussed at length with the interviewees and have been incorporated into the following sections.

<Insert Table 1>

Results and Discussion

Various SPSS techniques were adopted for data analysis. These methods have been widely used in construction management research, such as in the studies carried out by Yang *et al.* (2009) and Chan and Lee (2008). The mean score of each SSI was first calculated to rank its level of importance. Tests of the Kendall's coefficient of concordance and the Spearman's rank correlation were then conducted to measure the agreement of respondents on their SSI rankings and examine the general similarity of the rankings of SSIs between respondent types (government, industry, academia, the general public and NGOs).

In the next stage, a factor analysis was employed to determine the underlying relationships among the 22 SSIs. Principal component analysis for factor extraction was adopted to categorize the SSIs into a fewer number of groupings. A reliability analysis was also performed at the end to evaluate the internal consistencies of the extracted factors.

SSI ranking

The responses collected were first analyzed by employing the mean score ranking technique. Based on the 7-point Likert scale, the mean score (*MS*) regarding the relative importance of each SSI was calculated by

$$MS = \frac{\sum(f \times s)}{N}, \quad (1 \le MS \le 7) \tag{1}$$

where *s* represents the rating of each SSI as perceived by the respondents, ranging from 1 to 7; *f* refers to the frequency of each score (1-7); and *N* denotes the total number of respondents involved.

Table 2 provides the ranked SSIs. The scale intervals are interpreted as follows: (i) "not at all important" (*mean score* $\leqslant$ 1.5); (ii) "low importance" (1.51 $\leqslant$ *mean score* $\leqslant$ 2.5); (iii) "slightly important" (2.51 $\leqslant$ *mean score* $\leqslant$ 3.5); (iv) "neutral" (3.51 $\leqslant$ *mean score* $\leqslant$ 4.5); (v) "moderately important" (4.51 $\leqslant$ *mean score* $\leqslant$ 5.5); (vi) "very important" (5.51 $\leqslant$ *mean score* $\leqslant$ 6.5); and (vii) "extremely important" (*mean score* $\geqslant$ 6.51). The most important indicator as adjudged by the mean score of the overall respondents was 'Encouraging stakeholder participation' (mean score = 6.50). In total, 18 items were rated as "very important" with mean score ranging from 5.68-6.50. Only 4 indicators fell into the "moderately important" group with "Preservation of local characteristics" the lowest (mean score = 5.29). A consensus seems to be reached among the respondent types regarding the top SSIs. All the five relevant groups considered "Encouraging stakeholder participation", "Well-established stakeholder participatory channels", "Timely feedback to the participants" and "Mechanisms coping with stakeholder conflicts" as the most influential indicators even with slight differences in ranking.

<Insert Table 2>

Test of Kendall's coefficient of concordance

Kendall's coefficient of concordance was analyzed to examine the internal consistency within each of the respondent groups regarding their SSI ratings. The Chi-square value was used as a near approximation since the number of attributes is larger than 7 and that of respondents is larger than 20 (Li *et al.*, 2016). As shown in Table 3, the Chi-square values of all five relevant groups are far above the critical value, confirming the agreement within each respondent type on the SSI ranking. The completed questionnaires were therefore considered valid for further analysis.

<Insert Table 3>

Test of Spearman's rank correlation

Spearman's rank correlation test was then conducted to measure the general similarity of the SSI rankings between the respondent types. The computed values of the Spearman rank correlation coefficient (r_s) are summarized in Table 4. The low significant values achieved are taken to indicate that there is no significant disagreement between the paired groups.

<Insert Table 4>

Factor analysis

Factor analysis refers to the process of identifying a relatively small number of factor groupings for representing relationships among sets of many inter-related variables (Yang *et al.,* 2009). Two issues need to be checked in advanced to confirm the applicability of data collected for factor analysis and these include sample size and the strength of relationship between the various indicators (Pallant, 2013). Pallant (2013) suggests the responses collected should be at least ten times the number of variables (items) involved. This is fulfilled with 225 respondents rating 22 SSIs. Bartlett's test of sphericity (Bartlett, 1954) and the Kaiser-Meyer-Olkin (KMO) (Yang *et al.*, 2009) test were also used for confirming the strength of the relationship among the different variables. As shown in Table 5, the Bartlett's test of sphericity is significant ($p<0.05$) and the value of the KMO index is 0.707 (above 0.7), again indicating the data collected were valid for factor analysis.

<Insert Table 5>

As a result, a five-step factor analysis was carried out (Chan and Lee, 2008) (Figure 2), resulting in a total of 6 components being extracted with eigenvalues larger than 1.0 and accounting for 75.69% of the variance. Table 6 lists the results in detail. A complete description of each factor is given in the next sections.

<Insert Figure 2 and Table 6>

Factor 1: Improved Quality of Daily Life

The first factor "improved quality of daily life" includes six items: convenience, efficiency and safety for pedestrians and public transport users; improved serviceability to the community; ensuring public safety; project functions well with socially acceptable tariffs; positive influence of project location / land use on society and the provision of public open space. The essence of any public project is to serve society at

large and China is no exception. A senior research fellow and an executive director of a NGO however commented during the validation interviews that '*some public projects are built to highlight the achievements of the local government rather than satisfy the needs of the general public*.' A policy advisor of a municipal bureau accepted the criticism and pointed out that the central government and local governments at various levels are devoted to continuously improving the value for money of government spending on public projects so as to avoid these so called "vanity projects" (Dong & Jong, 2012). Representatives of academics as well as the general public later added that practicability is the priority for public projects and recommend that projects of this type (e.g. sports centers) should function differently in order to decrease maintenance costs. Another core issue of mega public project delivery, as suggested by a deputy secretary-general of a provincial bureau, is ensuring public safety, especially in an urban context. The academia contingent agreed and added that projects of this type are expected to play a vital role in improving the resilience of the overall community.

Factor 2: Appropriate Macro Policies

Four indicators: "Availability of local job opportunities", "Economic benefits to government and local citizens", "Adaptability of development to local needs" and "Balanced development of different local economic activities" are grouped here into "Appropriate macro policies". Nearly all the interviewees believe that public projects deliver benefits for city development and *vice versa*. The key premise is the clear position of the city itself and a convention center may not be a universal solution to boom the local economy. In fact, as commented by a university professor, delivering major public projects without considering actual demands may lead to a heavy financial burden to both the local government and people.

Factor 3: Harmonious Connections with the Surroundings

The third component consists of 4 elements comprising "Green and sustainable design and construction", "Prevention and mitigation measures against air, water and noise pollution", "Proper project design in terms of aesthetics, density, height and visual permeability" and "Harmonization of the proposed project(s) with the local natural setting". Various stakeholders can be affected throughout the life cycle of a public project and during its design, construction, operation, and demolition in many different ways. '*Unfortunately, the vast majority of the influences are negative and pollution is definitely one of them*', as alluded to by eight interviewees from the general public and NGO groups. The academics and government representatives responded that public projects should "go green" from both design and operation perspectives. During project delivery, various items are emphasized, such as land saving and the outdoor environment, energy saving and utilization, water saving and resource utilization, material saving and resource utilization, quality of the indoor environment, construction

management, operation management, promotion and innovation. Innovation is highly encouraged when constructing green public projects, as mentioned by four government representatives, '*funds of various administrative levels are available for assisting the import of advanced green technology from overseas countries/regions'*.

Factor 4: Unique Local Identity

Three items are included in this factor relating to unique local identity, namely "Conservation of the local cultural and historical heritage", "Preservation of local characteristics" and "Shaped local identity and international reputation". During the validation interviews, interviewees from both academia and NGOs complained that that the majority of the Chinese cities were similarly built during China's rapid urbanization process and public project delivery is no exception. Incorporating distinct and unique local features in public construction projects remains a challenge for both the government decision-makers and the industry practitioners. As both a director of a municipal commission and a director of municipal research center said, '*unique local identity is the prerequisite to gain international reputation*'. Public projects reflecting local characteristics are rather lacking in China, and incorporating the Chinese elements in project delivery remains a challenge for both the academia and industry practitioners.

Factor 5: Effective public participation

Four indicators comprise the elements of this component regarding effective public participation: "Well-established stakeholder participatory channels", "Practical mechanisms for coping with stakeholder conflicts", "Timely feedback to the participants" and "Encouraging stakeholder participation". All the interviewees agreed that effective participation help in meeting stakeholder expectations as well as dealing with their conflicts. The comment from a deputy director of a provincial research center that '*project social sustainability is nothing without the involvement of relevant groups*' illustrates the point. The industry respondents, on the other hand, admitted that practitioners of the architecture, engineering, and construction (AEC) industry still lack enthusiasm for getting the public involved in delivering projects. As mentioned by an engineering director of a construction company, '*participatory activities may lead to cost increases and time delays*'. One university professor disagreed, however, and further pointed out that, with a mature participatory mechanism, stakeholder engagement will accelerate project delivery and increase the chance of project success. A general manager of an engineering consulting corporation, as well as a member of an environmental group, added that such a mechanism should be comprehensive enough and sufficiently flexible to be applied to public projects with different levels of sensitivity, complexity, and potential impact on the community. It was also suggested that the scope of the public's involvement should be clearly specified, as interviewees from government and industry found it quite difficult to define the "proper" participants

that should be involved, and to balance the perceived tension between the representativeness of participants and the effectiveness of the whole project. Moreover, effective and efficient public participation helps to cope with such issues as equity and social/environmental justice. The prerequisite is that the voices of the poor and the most vulnerable can be heard during the project process, and their inputs can make a real difference to the project outcome. A municipal commission deputy director admitted that previously some participatory exercise in China might be formalistic due to various reasons. '*Today the situation has changed immensely and governments at various levels in China are dedicated to engaging the public as far as possible, especially the socially disadvantaged, in making decisions of different kinds, with construction being no exception'*. These comments are accepted by most academic representatives and the research teams as well. As revealed from the previous study of the research team on stakeholder satisfaction during public participation in major infrastructure and construction projects (Li *et al.*, 2013), the general public, project affected people and pressure groups are all satisfied with the participatory exercise of the urban design of the New Central Harborfront in Hong Kong. By involving the stakeholders (especially the poor and the most vulnerable), the rights of all concerned are respected and equity and social/environmental justice improved.

Factor 6: Other

Only one item belongs to this component, "Reasonable compensation and relocation plan/strategy". It is inevitable that some stakeholder groups will be adversely affected by mega public projects. The core issue, as pointed out by a deputy secretary-general of a provincial bureau, is to provide them with reasonable compensation and a relocation plan/strategy. It is, however, challenging for decision-makers and the victims to reach a consensus on what standards are reasonable or not. As commented by representatives of academia and NGOs, '*compromise is needed for both parties involved to maintain an effective dialogue. The affected groups should understand the sacrifices are unavoidable for the sake of the whole community. The decision-makers, on the other hand, should respect the demands of the affected groups and treat them with patience.*' Two representatives of the public, on other hand, urged that diversified communication channels be established to facilitate dialogues in the less radical manner.

Reliability analysis

Cronbach's alpha was computed to examine internal consistency of the scales under the headings of the SSIs. Chan and Lee (2008) suggested the alpha values should be larger than 0.6 and the results in this research (Table 6) satisfy this criterion and confirm the validity.

Results of the validation interviews

As previously discussed, 26 semi-structured interviews were carried out to validate the survey results. The validation panel members rated all the criteria (i.e. comprehensiveness, objectivity, reliability, practicality and generality) above "4" (where 1 represents 'poor' and 5 denotes 'excellent') on average (Table 7), indicating their satisfaction with the results obtained from the previous stages.

<Insert Table 7>

Conclusions

This paper has identified 22 social sustainability indicators (SSIs) from a comprehensive literature review, and evaluated their relative importance from a multi-stakeholder perspective. The most important SSIs for government officials and the public are 'F2 Well-established stakeholder participatory channels' and 'F1 Encouraging stakeholder participation' respectively. On the other hand, both industry practitioners and academics rate 'F4 Practical mechanisms coping with stakeholder conflicts' at the top of their list. 'F3 Timely feedback to the participants', however, is the principal concern of NGOs. The data collected are also analyzed with such other statistical techniques as Kendall's coefficient of concordance, Spearman's rank correlation, Bartlett's sphericity, and Kaiser-Meyer-Olkin (KMO). The results are positive and the data valid for further analysis. A factor analysis is then carried out, leading to a total of 6 components, comprising the improved quality of daily life, appropriate macro policies, harmonious connections with the surroundings, unique local identity, effective public participation and others. The majority of the results are in line with other previous studies, e.g. Sierra *et al*. (2018) and Almahmoud and Doloi (2015), except for the community engagement factor, which receives more emphasis in this research. This suggests that the Chinese construction industry is progressing towards a more transparent and inclusive manner of decision-making/evaluation.

During the validation interviews, the interviewees confirmed the comprehensiveness, objectivity, reliability, and practicality of the findings. A majority believe, albeit in the Chinese context, the results are applicable to other communities with slight changes of the SSI ratings. Representatives of each stakeholder type also interpreted the results in more detail, with a particular focus on the fifth component; effective public participation, in which all interviewees felt that public participation should be further promoted as an effective and efficient way to better the overall sustainability of public projects. After all, involving the stakeholders (especially the social disadvantaged) is important in coping with such fundamental social issues as equity and justice, when conducted in a genuine manner instead being a mere formality. Encouragingly, as revealed from the validation interviews, Chinese governments at various levels have

been devoted to engaging the public in the decision-making process and the construction industry is no exception. The progress of China towards improved equity and justice in mega public project delivery is recognized by all the interviewees. A remaining issue is balancing the breadth and depth of the participation exercise, and more effort is needed in identifying representative participants to improve the effectiveness and efficiency of the participatory practices in the delivery of mega public projects in China.

Acknowledgments

This work was supported by National Natural Science Foundation of China (Grant No. 71501074) and the State Key Lab of Subtropical Building Science, South China University of Technology, China (Grant No. 2016ZB16).

References

Ahmad, T., & Thaheem, M. J. (2017). Developing a residential building-related social sustainability assessment framework and its implications for BIM. *Sustainable Cities and Society*, 28, 1-15.

Akintoye, A. (2000). Analysis of factors influencing project cost estimating practice. *Construction Management and Economics*, 18(1), 77-89.

Almahmoud, E., & Doloi, H. K. (2015). Assessment of social sustainability in construction projects using social network analysis. *Facilities*, 33(3/4), 152-176.

Bartlett, M. S. (1954). A note on the multiplying factors for various chi square approximations. *Journal of the Royal Statistical Society*, 16(Series B), 396-398.

Benoît, C. & Mazijn, B. (2009). *Guidelines for Social Life Cycle Assessment of Products*. UNEP/SETAC Life Cycle Initiative, Sustainable Product and Consumption Branch, Paris, France.

Brookes, N. J., & Locatelli, G. (2015). Power plants as megaprojects: Using empirics to shape policy, planning, and construction management. *Utilities Policy*, *36*, 57-66.

Chan, E., & Lee, G. K. (2008). Critical factors for improving social sustainability of urban renewal projects. *Social Indicators Research*, 85(2), 243-256.

Cheng, S. J., Zhang, G. X. & Zhang, C. T. (2013). A study of the performance evaluation model of public projects. *East China Economic Management*, *27(02)*, 123-127.

Dempsey, N., Bramley, G., Power, S. & Brown, C. (2011). The social dimension of sustainable development: defining urban social sustainability. *Sustainable Development*, 19(5), 289–300.

Dong, D., & Zhang, Y. C. (2012). Separation of public goods' double value orientations: Resolving dispute over “People-benefit Projects” and “Vanity Projects”. *Journal of Nanjing Normal University (Social Science Edition)*, *6*, 007.

Dong, Y. H., & Ng, S. T. (2015). A social life cycle assessment model for building construction in Hong Kong. *International Journal of Life Cycle Assessment*, 20 (8), 1166-1180.

Fang, Z. (2011) Issues of the Hong Kong-Zhuhai-Macao Bridge project. See http://news.sina.com.hk/news/8/1/1/2364422/1.html (In Chinese) (Accessed 17/11/2017).

Feng, C. M. & Hsieh, C. H. (2009). Implications of transport diversity for quality of life. *Journal of Urban Planning & Development, 135*(1), 13-18.

Fischer, J. M. & Amekudzi, A. (2011). Quality of life, sustainable civil infrastructure, and sustainable development: strategically expanding choice. *Journal of Urban Planning & Development, 137*(1), 39-48.

Flyvbjerg, B., Bruzelius, N., & Rothengatter, W. (2003). *Megaprojects and risk: An anatomy of ambition*. Cambridge University Press.

Geurs, K. T., & Wee, B. V. (2004). Land-use/transport interaction models as tools for sustainability impact assessment of transport investments: review and research perspectives. *European Journal of Transport & Infrastructure Research, 4*(3), 333-355.

Hardi, P., & Zdan, T. J. (2000). *The Dashboard of Sustainability*. Winnipeg: IISD 100 (2000).

Hou, Y. (2016). Establishing Social Impact Assessment Index System of Urban Infrastructure Projects. *Social Perspective*, 6, 227-228. (In Chinese) http://socialhotspot.org/home-about-shdb/. Accessed: February 2, 2017.

Jia, G.S., Yang, F.J., You, R., Hong, B.N., Zhang, J.Q. & Xia, Z.J. (2010). Research on the Assessment Indicator System of Social Impact of Large-scale Construction Project Based on GA-BP Method. *Science & Technology Progress and Policy*, 27(19), 148-152. (In Chinese)

Lejano, R. P., & Iseki, H. (2001). Environmental justice: spatial distribution of waste treatment, storage and disposal facilities in Los Angeles. *Journal of Urban Planning & Development, 127*(2), 51-62.

Li, H. Y., Ng, S.T. & Dong, Y. H. (2016). *Stakeholder Analysis of Sustainable Construction in China*. In Proceedings of 21st International Conference on "Advancement of Construction Management and Real Estate", Hong Kong, China, 1335-1344.

Li, Q., Shi, L.L., Ye, P.F & Li, Z.M. (2010). The Index System of Social Influence Evaluation Adaptable to China's Situation. *Hebei Academic Journal*, 30(1), 106-112.

Li, T. H. Y., Ng, S. T. & Skitmore, M. (2012a). Public participation in infrastructure and construction projects in China: From an EIA-based to a whole-cycle process. *Habitat International*, 36(1), 47-56.

Li, T. H. Y., Ng, S. T. & Skitmore, M. (2012b). Conflict or consensus: An investigation of stakeholder concerns during the participation process of major infrastructure and construction projects in Hong Kong. *Habitat International*, 36(2), 333-342.

Li, T. H. Y., Ng, S. T., & Skitmore, M. (2013). Evaluating stakeholder satisfaction during public participation in major infrastructure and construction projects: a fuzzy approach. *Automation in Construction, 29*(1), 123-135.

Li, T. H. Y., Ng, S. T., Skitmore, M. & Li, N. (2016). Investigating Stakeholder Concerns during Public Participation. *Proceedings of the Institution of Civil Engineers-Municipal Engineer,* 169(4), 199-219.

Li, T. H. Y., Thomas Ng, S., & Skitmore, M. (2015). Modeling Multi-Stakeholder Multi-Objective Decisions during Public Participation in Major Infrastructure and Construction Projects: A Decision Rule Approach. *Journal of Construction Engineering and Management*, 142(3), 04015087-2-04015087-13.

Liang, J. Q. (2010) The express rail link project and the after 80's in Hong Kong. *Southern People Weekly*, 3, 19. (In Chinese)

Ling, F. Y. Y., Ong, S. Y., Ke, Y., Wang, S. & Zou, P. (2014). Drivers and barriers to adopting relational contracting practices in public projects: Comparative study of Beijing and Sydney. *International Journal of Project Management, 32(2),* 275-285.

Liu, Q.L., Chen, G.J. & Zhang, P. (2011). Social Impact Assessment of Large-scale Projects for "Twelve Five-Year Plan". *Development Studies*, 9, 2-5. (In Chinese)

Lu, J.C., Han, G.W. & Zheng, J.J. (2002). A Study on the Social Impact Assessment Index System of City Infrastructure Projects. *Science & Technology Progress and Policy*, Feb., 103-104.

Moore, A. & Warren, A. (2006). Legal advocacy in environmental public participation in China: raising the stakes and strengthening stakeholders. *China Environment Series*, 8, 3–23.

National Bureau of Statistics of China. (2013). *China Statistical Yearbook 2013*. China Statistics Press, Beijing.

Pallant, J. (2013). *SPSS survival manual*. McGraw-Hill Education, London, UK.

Pitt, M., Tucker, M., Riley, M., & Longden, J. (2009). Towards sustainable construction: promotion and best practices. *Construction Innovation*, 9, 201-224.

Rajak, S., & Vinodh, S. (2015). Application of fuzzy logic for social sustainability performance evaluation: a case study of an Indian automotive component manufacturing organization. *Journal of Cleaner Production*, 108, 1184-1192.

SEDAC (2017). Socioeconomic Data and Applications Center (SEDAC), National Aeronautics and Space Administration, United States. Website: http://sedac.ciesin.columbia.edu/data/collection/esi/. Accessed: February 2, 2017.

SHDB (2017). Social Hotspots Database (SHDB). Website:

Shen, L., Wu, Y., & Zhang, X. (2010). Key assessment indicators for the sustainability of infrastructure projects. *Journal of Construction Engineering and Management*, 137(6), 441-451.

Sierra, L. A., Yepes, V., García-Segura, T., & Pellicer, E. (2018). Bayesian network method for decision-making about the social sustainability of infrastructure projects. *Journal of Cleaner Production,* 176, 521-534.

Teng, M.M., Han, C.F. & Liu, X.H. (2014). Index System for Social Impact Assessment of Large Scale Infrastructure Projects in China. *China Population，Resources and Environment*, 24(9), 170-176. (In Chinese)

UNDP. (2015). *Human Development Report 2015 – Work for Human Development*. United Nations Development Program. New York, United States.

Valdes-Vasquez, R., & Klotz, L. E. (2012). Social sustainability considerations during planning and design: Framework of processes for construction projects. *Journal of Construction Engineering and Management*, 139(1), 80-89.

Vallance, S., Perkins, H. C., & Dixon, J. E. (2011). What is social sustainability? a clarification of concepts. *Geoforum*, 42(3), 342-348.

Xu, J. H. (2013). *Social impact assessment of urban public projects*. MSc Thesis, University of Electronic Science and Technology of China. (In Chinese)

Yang, J., Shen, G. Q., Ho, M., Drew, D. S., & Chan, A. P. (2009). Exploring critical success factors for stakeholder management in construction projects. *Journal of civil engineering and management*, 15(4), 337-348.

Yi, H. L., Wang, Y. S. & Li, Y. (2014). Analysing large public project sustainability based on ISM. *Construction Economy*, *5*, 112-115. (In Chinese)

Zeng, S. X., Ma, H. Y., Lin, H., Zeng, R. C., & Tam, V. W. Y. (2015). Social responsibility of major infrastructure projects in China. *International Journal of Project Management*, 33(3), 537-548.

Zhang, D., Huang, G., Xu, Y., & Gong, Q. (2015). Waste-to-Energy in China: Key Challenges and Opportunities. *Energies*, 8(12), 14182-14196.

Zhang, X. & Jennings, E. (2009). *Public participation in environmental policy making in China: a case study*. In Proceedings of the annual meeting of the Midwest Political Science Association 67th Annual National Conference, Chicago, USA.

Table 1 Profiles of the Validation Interviewees

Relevant Groups	***No.***	***Position***	***Organization***
Government officials	1	Deputy Director	Municipal Bureau
	2	Director	Municipal Commission
	3	Policy Advisor	Municipal Bureau
	4	Deputy Secretary-general	Provincial Bureau
	5	Deputy Director	Municipal Commission
Industry practitioners	6	Project Advisor	Real estate Corporation
	7	Engineering Director	Construction Company
	8	General Manager	Engineering Consulting Corporation
	9	General Manager	Architectural & Engineering Design Company
	10	Assistant Manager	Real Estate Corporation
Academics	11	Professor	University
	12	Associate Professor	University
	13	Assistant Professor	University
	14	Senior Research Fellow	University
	15	Director	Municipal research Centre
	16	Deputy Director	Provincial research Centre
The general public	17	The Lay Public	N.A.
	18	The Lay Public	N.A.
	19	The Lay Public	N.A.
	20	The Lay Public	N.A.
	21	The Lay Public	N.A.
NGOs	22	Member	NGO
	23	Executive Director	NGO
	24	Member	Environmental Group
	25	Member	Environmental Group
	26	Member	Environmental Group

Table 2 Mean Scores and Rankings of SSIs of Mega Public Projects

Social Sustainability Indicators (SSIs) of Mega Public Projects	*Government officials*		*Industry practitioners*		*Academics*		*The general public*		*NGOs*		*Overall*	
	Mean	*Rank*	*Mean*	*Rank*	*Mean*	*Rank*	*Mean*	*Rank*	*Mean*	*Rank*	*Mean*	*Rank*
1. Encouraging stakeholder participation	6.33	4	6.41	2	6.54	2	6.58	1	6.61	2	6.50	1
2. Well-established stakeholder participatory channels	6.41	1	6.37	3	6.48	3	6.56	2	6.61	2	6.48	3
3. Timely feedback to the participants	6.41	1	6.33	4	6.38	4	6.53	3	6.70	1	6.47	4
4. Practical mechanisms coping with stakeholder conflicts	6.38	3	6.43	1	6.56	1	6.51	4	6.54	4	6.49	2
5. Harmonization of the proposed project(s) with the local natural setting	6.00	8	6.04	6	6.10	8	6.16	7	6.20	7	6.10	8
6. Green and sustainable design and construction	6.08	7	6.04	6	6.15	6	6.16	7	6.20	7	6.12	7
7. Prevention and mitigation measures against air, water and noise pollution	6.18	5	6.14	5	6.23	5	6.21	6	6.22	6	6.20	5
8. Proper project design in terms of aesthetics, density, height and visual permeability	6.10	6	6.04	6	6.13	7	6.23	5	6.26	5	6.15	6
9. Preservation of local characteristics	5.28	22	5.22	22	5.29	22	5.33	21	5.33	22	5.29	22
10. Conservation of the local cultural and historical heritage	5.38	20	5.33	20	5.38	21	5.40	20	5.39	21	5.37	20
11. Shaped local identity and international reputation	5.51	19	5.27	21	5.40	20	5.49	19	5.48	19	5.42	19
12. Convenience, efficiency & safety for pedestrian & public transport users	5.92	10	5.84	10	5.85	10	5.88	10	5.89	10	5.88	10
13. Project function well with socially acceptable tariffs	5.85	12	5.78	12	5.79	12	5.81	12	5.83	14	5.81	12
14. Improved serviceability to the community	5.90	11	5.82	11	5.83	11	5.86	11	5.87	12	5.85	11
15. Ensuring public safety	5.95	9	5.86	9	5.90	9	5.91	9	5.91	9	5.90	9
16. Positives influence of project location / land use on the society	5.82	13	5.73	13	5.75	13	5.81	13	5.87	12	5.80	13
17. Provision of public open space	5.77	15	5.67	17	5.73	14	5.84	12	5.89	10	5.78	14
18. Adaptability of development to local needs	5.72	18	5.69	16	5.71	17	5.70	16	5.59	16	5.68	18
19. Availability of local job opportunities	5.74	16	5.71	14	5.73	14	5.70	16	5.59	16	5.69	15
20 Economic benefits to government and local citizens	5.79	14	5.71	14	5.73	14	5.67	18	5.57	18	5.69	15
21. Balanced development of different local economic activities	5.74	16	5.65	18	5.67	18	5.72	15	5.61	15	5.68	17
22. Reasonable compensation and relocation plan/strategy	5.38	20	5.39	19	5.46	19	5.09	22	5.46	20	5.36	21

Table 3 Results of Kendall’s Concordance Analysis

	Government officials	***Industry practitioners***	***Academics***	***The general public***	***NGOs***
Number of survey respondents	39	49	48	43	46
Kendall's coefficient of concordance (W)	0.197	0.235	0.252	0.268	0.291
Chi-square value	161.470	241.682	253.937	241.963	280.969
Critical value of Chi-square	32.670	32.670	32.670	32.670	32.670
Degree of freedom (df)	21	21	21	21	21
Asymptotic significance	0·000	0·000	0·000	0·000	0·000

Table 4 Results of Spearman's Rank Correlation Test

Paired Groups										
Government officials VS. Industry practitioners		Government officials VS. Academics		Government officials VS. The general public		Government officials VS. NGOs		Industry practitioners VS. Academics	
r_s	Significant Level	r_s	Significant Level	r_s	Significant Level	r_s	Significant Level	r_s	Significant Level
.978	0·01	.984	0·01	.971	0·01	.969	0·01	.995	0·01
Industry practitioners VS. The general public		Industry practitioners VS. NGOs		Academics VS. The general public		Academics VS. NGOs		The general public VS. NGOs	
r_s	Significant Level	r_s	Significant Level	r_s	Significant Level	r_s	Significant Level	r_s	Significant Level
.952	0·01	.941	0·01	.964	0·01	.957	0·01	.990	0·01

Table 5 Results of KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.707
Bartlett's Test of Sphericity	Approx. Chi-Square	3879.101
	df	231
	Sig.	.000

Table 6 Results of Factor Analysis and Reliability of the Extracted Factors

	Components	*Eigenvalues*	*% of Variance*	*Cumulative %*	*Social Sustainability Indicators*	*Factor Loading (In Descending Order)*	*Alpha Values*
Factor 4	Improved quality of daily life	5.034	22.884	22.884	12. Convenience, efficiency & safety for pedestrian & public transport users	0.951	0.948
					14. Improved serviceability to the community	0.929	
					15. Ensuring public safety	0.914	
					13. Project function well with socially acceptable tariffs	0.898	
					16. Positives influence of project location / land use on the society	0.863	
					17. Provision of public open space	0.761	
Factor 5	Appropriate macro policies	3.071	13.959	36.843	19. Availability of local job opportunities	0.903	0.888
					20 Economic benefits to government and local citizens	0.902	
					18. Adaptability of development to local needs	0.874	
					21. Balanced development of different local economic activities	0.774	
Factor 2	Harmonious connections with the surroundings	2.708	12.307	49.151	6. Green and sustainable design and construction	0.907	0.829
					7. Prevention and mitigation measures against air, water and noise pollution	0.875	
					8. Proper project design in terms of aesthetics, density, height and visual permeability	0.850	
					5. Harmonization of the proposed project(s) with the local natural setting	0.583	
Factor 3	Unique local identity	2.419	10.996	60.146	10. Conservation of the local cultural and historical heritage	0.929	0.865
					9. Preservation of local characteristics	0.863	
					11. Shaped local identity and international reputation	0.847	
Factor 1	Effective public participation	2.168	9.854	70.001	2. Well-established stakeholder participatory channels	0.819	0.681
					4. Practical mechanisms coping with stakeholder conflicts	0.785	
					3. Timely feedback to the participants	0.700	
					1. Encouraging stakeholder participation	0.395	
Factor 6	Others	1.253	5.693	75.694	22. Reasonable compensation and relocation plan/strategy	0.865	N/A

Table 7 Results of the Validation Interviews

Relevant Groups	*No.*	*Comprehensiveness*	*Objectivity*	*Reliability*	*Practicality*	*Generality*
Government officials	1	4	5	5	5	4
	2	4	4	5	5	4
	3	5	4	5	4	3
	4	3	4	4	4	4
	5	4	5	4	4	5
Industry practitioners	6	4	3	4	5	4
	7	5	4	3	5	3
	8	5	3	5	5	3
	9	4	4	3	4	4
	10	4	4	3	5	5
Academics	11	4	4	5	3	4
	12	5	4	5	5	4
	13	4	5	5	4	4
	14	3	3	4	4	5
	15	4	5	5	5	5
	16	4	5	4	4	5
The general public	17	3	5	5	3	3
	18	5	4	4	3	4
	19	3	5	3	3	4
	20	5	3	5	4	4
	21	4	4	3	4	5
NGOs	22	4	4	4	4	5
	23	4	3	4	3	3
	24	5	4	4	3	4
	25	3	4	4	4	5
	26	3	4	5	5	5
Mean		4.04	4.08	4.23	4.12	4.15

Figure 1: Research Process Framework

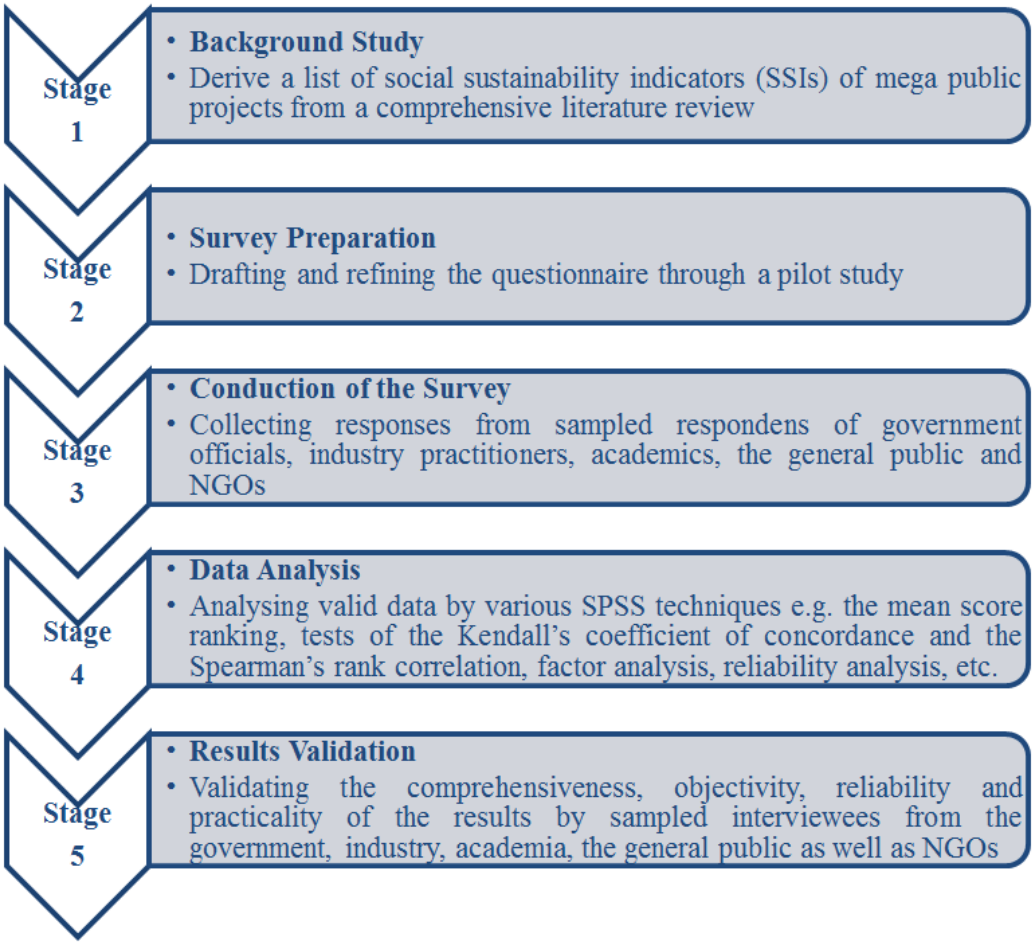
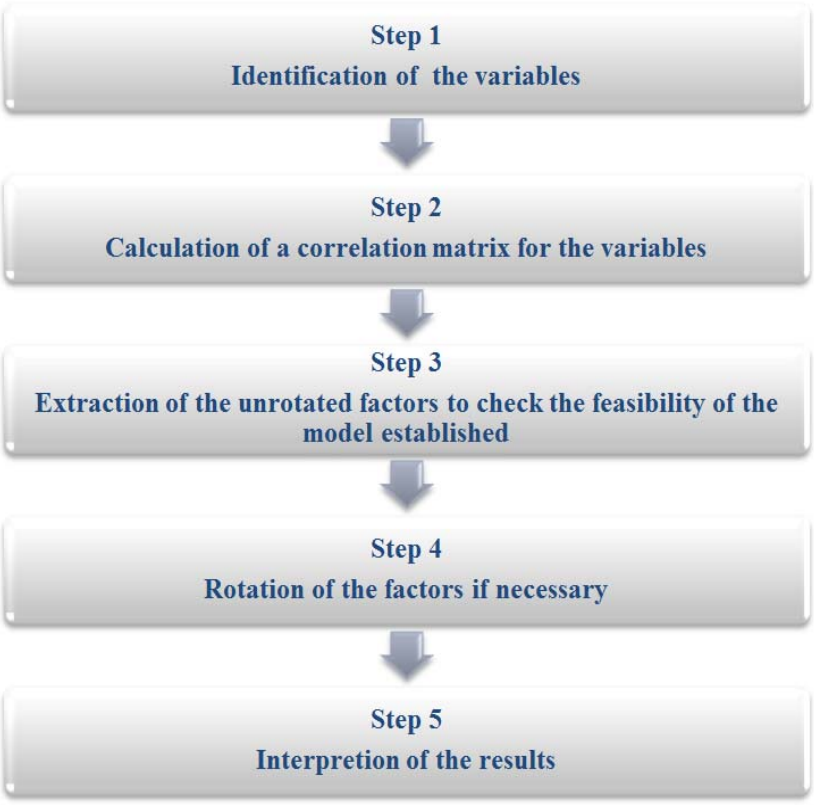


Figure 2: A Five-Step Factor Analysis



Source: Chan and Lee, 2008