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SOCIAL SUSTAINABILITY CONSIDERATIONS DURING PLANNING AND DESIGN: A FRAMEWORK OF PROCESSES FOR CONSTRUCTION PROJECTS

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SOCIAL SUSTAINABILITY CONSIDERATIONS DURING PLANNING AND DESIGN: A FRAMEWORK OF PROCESSES FOR CONSTRUCTION PROJECTS

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ABSTRACT

With increased awareness of issues such as global resource shortages and climate change, sustainability efforts are becoming more common in the construction industry. While these efforts often consider economic and environmental factors, a truly sustainable construction project also needs to include such social considerations as its impact on the surrounding community and the safety, health, and education of the workforce. For the construction industry, social sustainability requires integrating processes for improving safety, health and well-being over the project life cycle. However, an empirical and comprehensive framework defining these social sustainability processes in construction projects has yet to be clearly delineated.

To address this need, this study identifies these processes and categorizes them into a framework for integrating and evaluating social considerations in construction projects. These processes focus on the planning and design phases because they offer the greatest potential for influencing project performance. A concept mapping research method was applied to identify and categorize social sustainability processes based on the input of 25 experts from academia, industry and government. These experts contributed to process identification and then clustered and rated the processes based on similarity and importance, respectively. Multidimensional scaling and hierarchical cluster analysis was applied to organize the experts' input into six categories defining social sustainability in construction projects: Stakeholder Engagement, User Considerations, Team Formation, Management Considerations, Impact Assessment, and Place Context.

The primary contribution of this research to the knowledge in the field is the expert-based social sustainability framework. Practitioners can benefit from the framework, which will enhance existing sustainability assessment methods and help address the challenge of developing truly sustainable projects. This framework also provides educators with a tool to teach students about social sustainability for construction projects. While this research advances understanding of social sustainability for construction projects, the framework was not validated for every type of construction project and construction project stakeholder. Given the differences between construction projects and between stakeholder perspectives, future research to validate the framework with other expert groups would be useful. In addition, future research suggested by this project could include the development of metrics based on the processes included in the framework. Beyond the framework itself, a secondary contribution to the field is the method for applying the concept mapping research method in the construction industry.

DEDICATION

To Mima

ACKNOWLEDGMENTS

My research journey required the guidance of many. Over last past three years, a dedicated group of people helped me to develop this study. First, I would like to express my deepest gratitude to my advisor and mentor, Dr. Leidy E. Klotz, for his guidance through this research project and the Ph.D. Program. Since our first meeting, he saw in me a future collaborator, encouraging me to select a research topic that is not only fundamental to the industry and academics but also fit my professional goals. He also has served as valuable resource, helping me to attend relevant conferences and to network with other well-known experts.

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CHAPTER 1

CONTEXT AND SCOPE OF THE RESEARCH

For true sustainability in the construction industry, there is a need to identify and organize processes for social sustainability. Addressing this need, this research categorizes these processes in a framework to serve as guide to enhance social sustainability in construction projects. To do so, this study determines various processes that should be considered during the planning and design phases of a construction project based on expert knowledge. The purpose of this chapter is to introduce the context of the problem, the goal and the objectives of this research, the overall research method, and the outline of the document.

1.1 Background

Sustainable development considers the interdependence and balance among economic, ecological, and social pillars (WECD 1987, UNCED 1992, CIB 1999). This sustainability agenda has led to efforts in the U.S. construction industry to address the economic and environmental considerations through efficient energy use and waste reduction as well as enhancing the comfort of end-users and safeguarding the environment (Kibert 1994, Kibert *et al*. 2000, Smith 2003, Kibert 2005, Fowler and Rauch 2006, Tulacz 2008, ENR 2009, USGBC 2009). However, a truly sustainable construction project also needs to include social considerations such as the project's impact on the surrounding community and the safety, health, and education of the workforce. Integrating these considerations will improve both long-term project performance and the quality of life for those impacted by the project (Liddle 1994).

1.2 Problem Statement

Since the *Brundtland Report* in 1987, there has been an increasing awareness that the construction industry must support the sustainable development agenda by including social considerations throughout the entire construction project life cycle: planning, design, construction, operation, and deconstruction (Vanegas 2003, Trinius 2005, Boyle *et al*. 2010). In addition, the need for expanding the conceptualization of construction projects has been encouraged by broadening the vision of the research topics related to construction (Levitt 2007). This vision includes focusing on social sustainability processes that need to be addressed and integrated based on a life cycle perspective. To have the maximum impact, these processes must be considered early in the life cycle, during the planning and design phases.

However, an empirical and comprehensive framework defining these social sustainability processes in construction projects has yet to be clearly delineated. The social sustainability concept is defined in different ways, depending on the stakeholder's perspective and phase during the project life cycle. In other words, stakeholders may see social sustainability as having different levels of importance and value it accordingly. The definition of social sustainability that guides this research considers this concept as a series of processes for improving the health, safety and well-being of current and future generations (Mihelcic *et al*. 2003, Dillard *et al*. 2009).

1.3 Research Questions

To develop an empirical framework defining social sustainability in construction projects, this research identifies various processes of social sustainability which are then categorized based on expert knowledge. This categorization will allow for the developing of an empirical framework for evaluating social considerations during the planning and design phases of construction projects. Specifically, this research addresses the following questions:

- What social processes should be included during the planning and design phases of construction projects?
- How do expert construction project stakeholders from a range of professional areas organize and prioritize the social sustainability processes during the planning and design phases?

In general, construction project stakeholders are those who will be affected, both positively and negatively, during the different phases of a construction project (Pearce 1999). This study recognizes two categories of stakeholder affected by the development of a project: internal (owners and tenants) and external (designers, contractors, and communities groups). The typical stakeholders involved in each phase of a construction project life cycle is discusses in Section 2.2.2.

1.4 Goal and Objectives

The goal of this study was to develop an empirical framework identifying processes of social sustainability that should be considered during the planning and design phases of construction projects. The following objectives were accomplished in pursuit of this goal:

- **Identify background information on social sustainability related to construction projects.** This identification relied on a review of literature, providing the antecedents necessary to recognize these perspectives and identifying processes for representing them. To synthesize the background information, this research began at the broad level of sustainable construction and social sustainability and then focused on the project life cycle and the stakeholders' views.
- **Adapt and apply a research method for developing a framework based on expert knowledge from different perspectives.** The concept mapping research method was adapted to categorize social sustainability processes. This approach combines quantitative and qualitative methods to facilitate the understanding and analysis of overall expert judgment. Adapting this method to the needs of this project structured the collection of data allowing for the generation of an appropriate framework.
- **Develop a conceptual framework that creates awareness of social sustainability processes that should be incorporated during the planning and design phases of construction projects.** Application of the concept mapping method generated a series of maps, which served as the baseline for the conceptual framework. These research results guided the development of this framework by analyzing the interrelationship among processes and categories.

- **Identify implications and future research opportunities.** The general framework proposed is expected to increase awareness about key social categories of sustainability. Particular attention was paid to areas providing future research opportunities.

Four general steps were followed to accomplish these goals: reviewing of previous knowledge about social sustainability, gathering data from experts by through the concept mapping method, analyzing the results obtained from the cluster analysis, developing a framework, and identifying the implications of this study including the future research made possible.

1.4.1 Literature Review

This step identified the primary social perspectives of social sustainability related to the construction industry, focusing on articles published in peer-reviewed journals. In addition, other sources were reviewed such as research books and on-line publications. A preliminary list of categories and concepts of social sustainability were identified during this stage to help understand the social sustainability concept in the context of construction projects. Based on the literature, social sustainability was divided into four conceptual areas: Community Involvement emphasizes public constituencies in governmental and private decisions; Corporate Social Responsibility considers the accountability of an organization in caring for all of the stakeholders affected by its operations; Safety through Design ensures worker safety by eliminating potential construction/operation safety hazards during the design phase; and Social Design focuses on improving the decision-making process of the design team and the intended use of the project by the final users (Valdes-Vasquez and Klotz 2010a). A full discussion of these preliminary categories can be found in Chapter 2. This literature review was then used to guide the final selection of processes generated by the experts and the interpretations of the concept mapping findings.

1.4.2 Adaptation of Concept Mapping Method

For the purpose of this research, a traditional quantitative hypothesis-testing experimental design[1] was not suitable since there is not enough numerical data to formulate meaningful hypotheses, particularly for a topic that is approached from different perspectives by the industry. Hence, the selection of significant independent and dependent variables is limited at this point.

To develop the conceptual framework that is one of the products of this research, the concept mapping method was adapted. This method integrates structured group processes such as idea generation, sorting, and rating tasks with sophisticated multidimensional scaling and cluster analyses to determine a well-defined quantitative set of results (Kane and Trochim 2007) such as the categorization of social sustainability processes in construction projects. Details of this method are presented in Chapter 3. In addition, this conceptual categorization is based on expert knowledge without the use of forced classifications that may introduce individual bias. Following this integrated

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[1] Hypothesis testing research investigates a phenomenon in terms of a relationship between an independent and dependent variable (Robson 2002).

research approach enhances in confidence in this study by ensuring that the various social sustainability processes and their categories were determined.

1.4.3 Concept Mapping Results and Analysis

This study offers several findings on the role of the social sustainability processes in construction projects. Using an expert-based research method, 50 processes were identified based on the judgment of the 19 experts who participated in the idea generation step. These processes, which enhance the definition of social sustainability in construction projects, served as units of analysis that were sorted by a total of 16 experts, ten of whom participated in the idea generation step.

After analyzing this sorting by based on Multidimensional scaling and cluster analysis, the following categorization was determined:

- Stakeholder Involvement
- User Considerations
- Team Formation
- Management Considerations
- Impact Assessment
- Place Context.

A full discussion of this expert-based social sustainability framework and subsequent rating of these processes can be found in Chapter 4. The experts also rated all the processes at a high level of importance. In addition, the analysis of the resulting concept maps drove the development of a practical guide, i.e. a synthesized representation of social sustainability in construction projects. This guide includes three areas -- Approach, Assessment and Desired Results. The aim of this guidance is to provide an effective representation of the social sustainability concept for practitioners and academics.

1.4.4 Limitations, Implications and Future Research

Discussion of the limitations of this study as well as the implications can be found in Chapter 5. In particular, the primary limitation of this study is that the empirical framework is based on the sorting and rating of 16 experts. Given the differences between construction projects and between stakeholder perspectives, future research to validate the framework with other expert groups would be useful. In addition, the categorization of social sustainability processes serves as important scaffolding for future discussion among those organizations and institutions that aim to assess a comprehensive sustainable construction project. This chapter concludes with opportunities for teaching the social sustainability concept and increasing the knowledge about concept mapping method are provided in this chapter. The general recommendation is to implement new teaching approaches to foster the learning of social sustainability in, for example, civil engineering programs. Finally, future research was identified, one area of further study being to establish metrics based on the processes included in the framework.

1.5 Reader's Guide

The rest of this document describes in detail the research steps to develop this framework. Figure 1.1 is a graphical representation of the outline of this study beginning with the theoretical phase moving to the empirical one and finishing with a general conceptualization of social sustainability processes in construction projects.

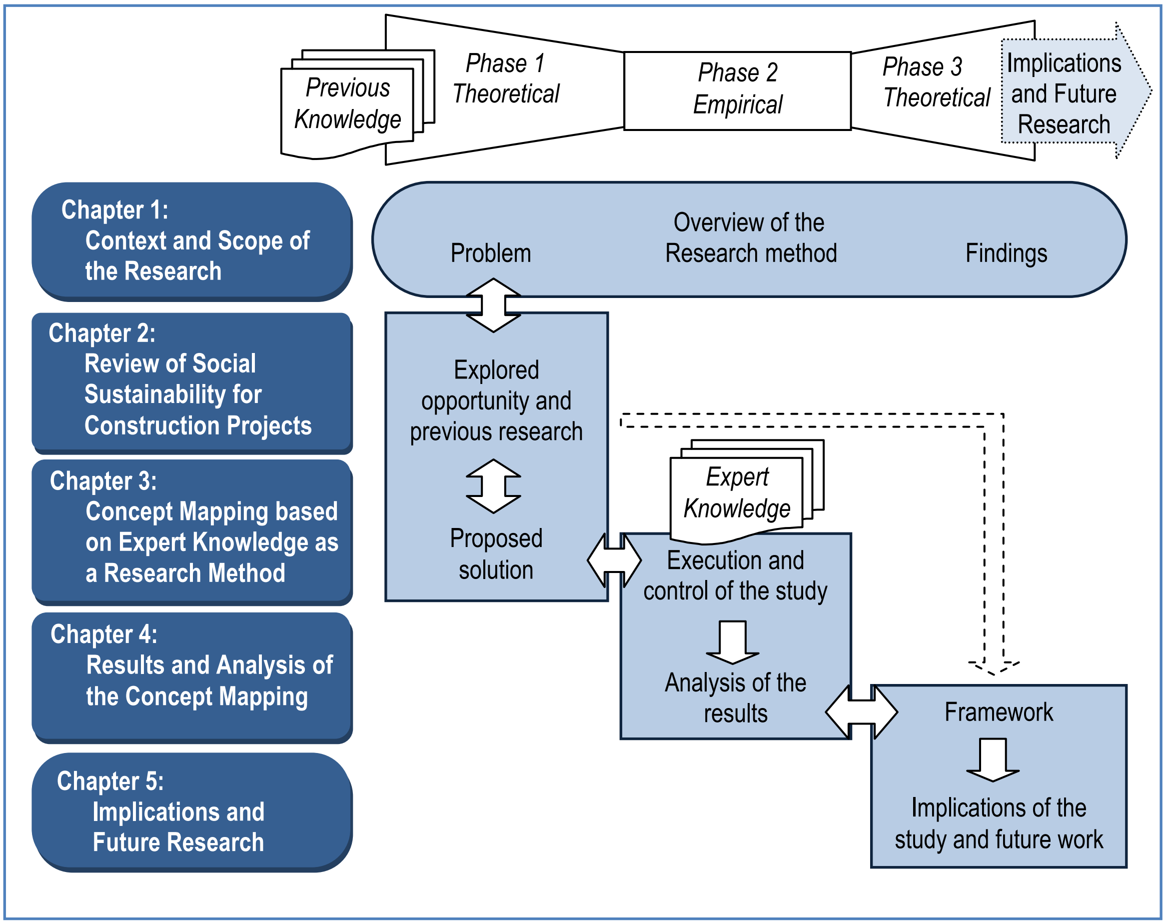

Figure 1.1 Outline of the Dissertation

The theoretical phase begins with the need to identify social sustainability processes and the categorization of them, which is introduced in Chapter 1. In addition, this phase includes the understanding of the previous knowledge presented in Chapter 2 by examining how the construction industry conceptualizes social sustainability. This literature review was synthesized into four perspectives of social sustainability in construction projects, establishing the necessity for developing a conceptual framework based on expert knowledge from a range of professional areas representing various stakeholders.

The empirical phase includes how this expert knowledge is captured using the concept mapping method presented in Chapter 3. This chapter provides the details of the research method, the execution of the study and the qualifications of the experts as well as an introduction to the various concept maps determined during the analysis of the results. Then, in Chapter 4 the results and their analysis are introduced by presenting the final cluster solution that includes the six clusters of Stakeholder Involvement, User Considerations, Team Formation, Management Considerations, Impact Assessment, and Place Context. In addition, the validity of the results is discussed.

In the last phase of the research, the researcher proposes a conceptual model based on the six cluster solution and informed by the literature review. This model is introduced in Chapter 5. In addition, a discussion of the implications of this research and future studies that will support the work of academics and other industry professionals is presented in this last chapter.

CHAPTER 2

REVIEW OF SOCIAL SUSTAINABILITY FOR CONSTRUCTION PROJECTS

This chapter provides an overview of social sustainability in construction projects. To account for the varying perspectives of social sustainability in the body of existing literature, this overview is organized into four areas: Community Involvement, Corporate Social Responsibility, Safety through Design, and Social Design. In this chapter, the point of departure for this research is introduced by showing the need to categorize social sustainability processes into a general framework for construction projects based on an expert-based approach.

2.1 Strategy for Reviewing the Literature

This study began by selecting peer-reviewed articles in journals from both construction academics and practitioners. The selection of journals was based on the recommendations from Chau (1997) and Björk and Bröchner (2007) who analyze the quality of journals based on factors such as readership and performance. In addition, other sources of literature were included based on their relevance to the topic. The articles include those published in journals such as: *Construction Engineering and Management (JCEM), Construction Management and Economics (CME), Architectural Engineering (AE), Environmental Science and Technology (EST), Building Research and Information (BRI), Journal of Professional Issues in Engineering Education and Practice (JPIEEP),* and *the Journal of Green Building (JGB)*. This review selection focused on the fifteen year period from 1994 to 2009 since the current concept of sustainability was introduced by the *Brundtland Report* in 1987 and it was further developed in *Agenda 21* in 1992, followed by the introduction of the *sustainable construction* concept in the U.S. in 1994 during the *First International Conference on Sustainable Construction* (Hill and Bowen 1997, Bourdeau 1999).

Within the selected references, articles were retrieved using keywords appearing in the title and abstract of the paper. Keywords used were *sustainable construction, sustainable development,* and *sustainability* because these terms are the most comprehensive for addressing the ecological, social, and economic aspects of a project (Kibert 2005). Another filter used to select papers included keywords unique to the focus of this research such as *social sustainability*, *corporate responsibility*, and *community engagement*. While these terms for social sustainability do not fully define this concept, they are some of the more relevant terms as discussed by Herd-Smith and Fewings (2008).

A brief review of the abstracts of these papers was conducted to exclude articles without a social sustainability focus or content. This study also limited the articles to those from Western culture, specifically North American or European. Figure 2.1 presents the general approach used to begin the literature review. While the author strived to ensure that no concepts are missing, those that are should be captured in the empirical phase of the research which involves incorporating expert knowledge from industry, academia and government institutions in the U. S.

Identification by keywords	Screening by social content	Eligibility by location	Result:
No. articles identified through data base screening:	No. of articles screened:	No. full text included for eligibility:	40 articles as initial input to begin the synthesis
23 *Construction Engineering and Management (CEM)*	9 CEM	9 CEM	
39 *Construction Management and Economics (JCME)*	10 JCME	3 JCME	
9 *Architectural Engineering (AE)*	1 AE	1 AE	
20 *Environmental Science and Technology (EST)*	3 EST	2 EST	
47 *Building Research and Information (BRI)*	6 BRI	5 BRI	
25 *J. Prof. Issues in Eng. Educ. and Practice* (JPIEEP)	8 JPIEEP	6 JPIEEP	
39 *Journal of Green Building* (JGB)	18 JGB	12 JGB	

Figure 2.1 Diagram of Selection of Articles to Begin the Literature Review

The 40 articles considered as initial input for this synthesis were examined by reading those that reported discussions of social sustainability, considering such criteria as project life cycle phases, contribution of the papers, and stakeholder perspectives. The rationale for using this systematic selection process was to obtain an unbiased overview of the different perspectives of social sustainability based on the fact that construction projects are developed from a multi-disciplinary background, by different organizational levels, in multiple stages or phases, and at various geographical locations (Betts and Lansley 1993).

This approach helped develop the researcher's general understanding of the various perspectives and emerging themes of research in social sustainability. However, the approach was less helpful for identifying specific processes for social sustainability in the construction industry. To address this issue, additional references beyond the initial 40 articles were sought.

2.2 Social Sustainability in the Construction Industry[2]

Social sustainability is fundamentally about people. In the construction industry this concept is defined in different ways, depending upon the stakeholder's perspective and where it is applied during the project life cycle. For instance, during the planning and design phase, one focus involves estimating the impact of construction projects in relation to where users live, work, play, and engage in cultural activities (Burdge 2004). These estimates are normally embedded in the environmental impact assessments required by government agencies. It is during these early phases that community involvement approaches such as public hearings are used by external stakeholders and governmental agencies to influence design decisions (Solitare 2005). Community experts indicate that while these social benefits maybe intangible to developers, they are strongly as financial and environmental ones (Hammer 2009).

Another focus of social sustainability, this one from the perspective of construction firms, relates to the application of corporate social responsibility practices (Lamprinidi and Ringland 2008), which consider how the organization can meet the needs of stakeholders affected by its operations (Kolk 2003). Designers, government agencies and construction companies advocate for worker safety by eliminating potential safety hazards from the work site during the design phase (Gambatese 1998, Gambatese *et al*. 2008, Schulte *et al*. 2008). Other researchers describe social sustainability as the engagement among employees, local communities, clients and the supply chain to ensure

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[2] Some of the discussions presented in the following sections of this chapter are part of the paper Valdes-Vasquez, R. and Klotz, L. (2010a) published in the International Journal of Environmental, Cultural, Economic and Social Sustainability.

meeting the needs of current and future populations and communities (Herd-Smith and Fewings 2008), a definition that more fully reflects the different perspectives of the stakeholders of a project. Generally, the sustainability literature suggests that safe and healthy living and working conditions are important components of social sustainability along with the impact of the project on the local community through its life cycle (Benoit and Mazijn, 2009). Social sustainability also relates to such aspects required to improve the decisions during the design phase as transparency (Kaatz *et al*. 2006, Klotz *et al*. 2009).

As this discussion implies, the concept of social sustainability has various interpretations in the industry. Stakeholders may see it as having different levels of importance and value it accordingly. Thus, rather than a clear and agreed upon focus of social sustainability in the industry, it is an evolving concept of interest, dependent on the perspective of the stakeholder. In general, even though this concept has different level of importance based on the principles from the *Brundtland Report* (1987), *Agenda 21* (1992) and *Agenda 21 on Sustainable Construction* (1999), researchers suggest that social sustainability should focus on the processes needed to achieve better living conditions (Mihelcic *et al.* 2003, Dillard *et al*. 2009).

In this literature review, social sustainability is conceptualized as a series of processes that improve safety, health, and well-being during the life cycle of projects, considering need of both current and future stakeholders. Integrating these views and considering the entire project life cycle can provide a more inclusive understanding of this concept for the construction industry than a specific definition allows. Before introducing the perspectives of social sustainability in construction projects, the next two subsections provide a short overview of the social impacts during the construction project life cycle as well as the various stakeholders in construction projects, both of which play a key role in the social sustainability construct proposed in this study.

2.2.1 Social Impacts During the Construction Project Life Cycle

Typically, each construction project is comprised of five sequential phases: planning, design, construction, operation/maintenance and renovation/deconstruction. The project life cycle begins with an idea or concept during the planning phase, continuing with the analysis of the feasibility of the project objectives and scope; this analysis is based on the physical and nonphysical constraints (Vanegas 2003). The results of this phase are the requirements describing the intentions of the owner seeking to build the project (Pearce 1999).

Design, the second phase of the construction project life cycle, is where the project is transformed from concept to construction documents (Pearce 1999), consisting of the detailed drawings, specifications and models. It is in this phase that Social Impact Assessment (SIA) processes and techniques are incorporated to estimate in advance the consequences of the proposed project at the community level. Some of these consequences include the formation of the community attitude, the project's influence on the population and future infrastructure needs. These initial assessments serve as baselines for further monitoring of the impact associated to the project (Burdge 2004). In addition, the social life cycle assessment of products/materials should be determined in this phase by analyzing the future impact of these products/materials during construction and operation (Benoit and Mazijn 2009).

As a result, the decisions made during these two phases have a significant impact on the performance of the construction project, which can have positive and negative social impacts in the users and the surrounding communities. Figure 2.2 represents this concept. As the figure indicates, it is much easier to influence a project's performance during early phases when the cost of making changes is relatively lower than during the later phases of the project such as construction and operation.

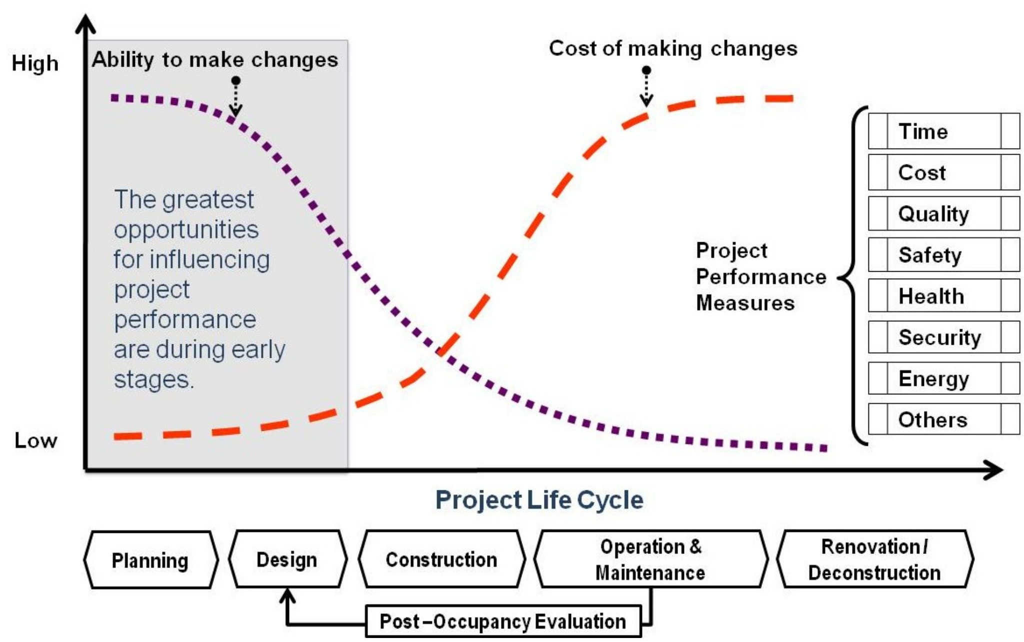


Figure 2.2 Influence of Decisions for the Project Life Cycle

While the majority of the opportunity to influence social impacts occurs during planning and design, the majority of the social impacts resulting from construction projects occur during the next three phases. Particularly, during the construction, or building phase, the elements that should be considered include site disturbance, indoor environment quality, construction recycling and resource reuse, and construction health and safety (Vanegas 2003). The construction workforce and contractors can be affected by poor planning and design. For instance, Dai *et al*. (2007) investigated the negative effects of poor engineering drawings on construction labor productivity. Owners also report that poor quality design documentation increases complaints about and disruptions of the construction processes (FMI/CMAA 2010). Previous research has also found a link between a project's design and the number of construction site injury and fatality incidents (Haslam *et al*. 2003, Gibb *et al*. 2004, Behm 2005, and Gambatese *et al*. 2008).

At the community level, potential adverse impacts of construction projects include prolonged closure of road space, air/water pollution, noise, and damages to current community infrastructures (Gilchrist and Allouche 2005, Surahyo and El-Diraby 2009). These temporary impacts should be monitored according to the plans developed based on the SIA of the project (Burdge 2004). At the user level, Vanegas (2003) emphasizes the social impacts of a poor commissioning process such as the loss of productivity of the users in a facility because the assembled systems (i.e. HVAC system) were not properly verified and documented, leading to higher operation and maintenance costs as a result of inefficient energy or water use.

The operation and maintenance phases, which are by far the longest part of the life cycle, focus on fulfilling the needs for which the project was designed, including activities such as cleaning, minor repairs or updating of project components with shorter life cycles than the project itself, e.g. carpets (Pearce 1999). In the case of facilities, monitoring programs such as post-occupancy evaluations should be carried out to provide feedback to the owner, users and the design team (Vanegas 2003), providing information that can solve issues not considered during the design and construction phases. This evaluation helps to confirm that the project outcomes or the satisfied needs of the users are met by monitoring such factors as indoor air quality, thermal comfort, light quality, energy and water conservation, and waste management. In addition, it is during this phase that monitoring plans based on SIA are conducted, evaluating such variables as population change, institutional structures stability, loss of privacy, and community infrastructure needs (Burdge, 2004).

Finally, when a construction project exhibits a deficit in performance with respect to its initial requirements, two possible choices are available: reconstruction/rehabilitation or ending the life cycle of the project (Pearce 1999). These options impose such social considerations as rework, lack of education, safety and health, challenge in coordination, procurement, and security, especially when information is not available about the project (Sanvido and Riggs 1991, and Gibson *et al*. 2007).

As Figure 2.2 indicates, this life cycle is not always linear as the one delivered by Design-Bid-Build (DBB) method. This traditional delivery method does not allow the construction phase to begin until the contract for the project is bid and awarded, a step required after the design is completed. However, Design-Build (DB) and Construction Management at Risk (CMAR) allow these phases to be performed concurrently. For instance, both DB and CMAR allow for construction to begin without having 100% of the design documentation completed, allowing for the early hiring of contractors. For sustainable project outcomes to be obtained, increased integration among the various parties delivering the project is required, a situation reported to be better achieved using DB than the other two methods (Gransberg *et al*. 2010).

2.2.2 Construction Project Stakeholders

In general, construction project stakeholders are those who will be affected, both positively and negatively, during the different phases of a construction project (Pearce 1999). The stakeholder theory as currently known was first introduced by Freeman (1984), evolving from identifying people who will experience potential benefits and harms as result of an organization's actions or inactions (Donaldson and Preston 1995) to considering people's opinions and concerns in the decision making process (Olander 2007). According to Olander, a construction project stakeholder is an individual or group of people who have such attributes as power, rights or urgency. Thus, they need to be included in each project to enhance sustainable outcomes.

This study recognizes two categories of stakeholder affected by the development of a project: internal and external. Internal stakeholders have a specific interest and involvement in the project and the functions it will serve. They may be affected by the project at any point in time. These stakeholders include owners, tenants, users, and clients. External stakeholders are those beyond the boundary of the project such as designers, contractors, communities groups and government agencies. Some of these like the designers have a direct relationship to the project, while others (e.g., community groups) are involved only indirectly, providing infrequent feedback about the design. However, their participation is highly encouraged to increase ownership and reduce the risk of project delays due to misconceptions or legal issues (Olander and Ladin 2005). Table 2.1 presents the typical stakeholders involved in each phase of a construction project life cycle.

Table 2.1 Stakeholders Based on the Construction Project Life Cycle (Pearce 1999)

External Stakeholders: Indirect	External Stakeholders: Direct	Construction Project Life Cycle	Internal Stakeholders: Direct	Internal Stakeholders: Indirect
Zoning agencies Regulatory agencies	Planners Developers	**Planning**	Owners Land developers	Investors
Financers Code enforcement agencies Manufacturers Professional institutions Surrounding communities	Design team: architects engineers project managers consultants	**Design**	Owners Land developers	Investors Users/Tenants Facility managers Operators Clients/Product consumers
Manufacturers Vendors/suppliers Shippers Code enforcement agencies Regulatory agencies	Construction team: contractors consultants Utilities Financiers Project managers Surrounding communities	**Construction**	Owners	Investors Users/Tenants Facility managers Operators Clients/Product consumers
Manufacturers Vendors/suppliers Shippers Regulatory agencies	Surrounding communities Utilities Financiers	**Operation/ Maintenance**	Owners Users/tenants Facility mangers Operators Clients	Investors Product consumers Users' dependents
Waste disposal companies Recycling companies Regulatory agencies	Surrounding communities Demolition contractor Disposal agent Developers	**Deconstruction/ Demolition/ Disposal**	Owners	Future users Investors

To achieve sustainable construction project outcomes, it is necessary that all the stakeholders are involved in a fully integrated approach and that the project is seen as an integrated product, requiring cross-disciplinary teamwork early in the delivery method for its successful completion (AIA 2007, Kormaz 2007, Yudelson 2008, WBDG 2009, Gransberg *et al*. 2010, Erickson 2010). According to Vanegas (2003), the implementation of strategies that apply such an integrated approach during the planning and design phases is the key for achieving these sustainable outcomes. Thus, these two phases provide multiple opportunities for influencing the social impact of a construction project. Because of their importance this study focuses on identifying the processes of social sustainability that should be considered during these two phases, supporting to achieve social sustainability outcomes in construction projects such as safety and health of the users and the surrounding community.

2.3 Social Sustainability in Construction Projects

This section introduces four conceptual areas frequently discussed in research papers related to social sustainability: Community Involvement, Corporate Social Responsibility, Safety through Design, and Social Design. These areas are part of the foundation for this study because they are based on various stakeholder perspectives and they are currently being applied through various processes and techniques in different phases of construction projects. The objective of presenting these broad conceptual areas is to help create awareness that the consideration and integration of the processes in each will better support the sustainability agenda, to the advantage of the stakeholders of construction projects. While there is a large body of research in each of these four areas and a complete review of that literature is outside the scope of this study, a synthesis of a selected sample of the literature is appropriate for achieving the purpose of this research. Each conceptual area is described briefly in Table 2.2, and the next subsections expand on these descriptions.

Table 2.2 Preliminary Conceptual Areas of Social Sustainability in Construction Projects

Conceptual Areas	**General Description**
Corporate Social Responsibility	Considers the accountability of an organization to care for all of the stakeholders affected by its operations.
Community Involvement	Emphasizes the influence of public constituencies on private and governmental proposed projects.
Safety through Design	Ensures worker safety by eliminating potential construction/operation safety hazards from the work site during the design phase.
Social Design	Focuses on enhancing the safety, health, productivity and inclusion of the end users and on improving the decision-making process of the design team.

2.3.1 Community Involvement

Community involvement, also known as public participation or stakeholder engagement, refers to the concerns of indirect external stakeholders (e.g. residents in the vicinity of the project) with respect to the decisions made by internal stakeholders (e.g. owners and developers) during the planning and design phases of any construction project (Sanoff 2000, Solitare 2005). This involvement, usually considered during the planning and design phases, is advocated by external groups. When external stakeholders are included in a transparent decision-making process, they are more likely to have their needs and preferences reflected in the overall solution.

This expanded ownership is even more important in the context of sustainable built environments, in which most of the benefits occur during the operating phase, requiring end-users and surrounding communities to have significant buy-in for the choices adopted during the design phase (Shepherd and Bowler 1997, Mathur *et al.* 2008). For instance, reaching final decisions about the expansion, repairs, and rates of sustainable water systems in rural communities is more than a technical process (Flora 2004). As Flora highlights, the inclusion of the community is important because they will be in charge with creating the system and its subsequent monitoring.

Normally, community involvement in the U.S. is achieved through public hearings, town hall meetings, or reviews and comment procedures that promote equity and fairness in government decision-making (Innes and Booher 2004). These processes also give decision makers the opportunity to explain the project to surrounding communities and answer questions, responding to resistance by allaying fears. Those excluded may disproportionately rate the negative impacts of projects or policies, ignoring the positive. Thus, one key challenge for planning sustainable projects is to facilitate a dialogue encouraging reflection of issues and concerns (Meppem and Bourke 1999, Thompson *et al.* 2003). In addition, the social choice of including end-users, the communities impacted by the project, and various public agencies has been argued as being crucial for implementing sustainable projects.

However, numerous obstacles can impede meaningful participation, one of the biggest being information, specifically who controls it and whether it is trustworthy (Hanna 2000). To encourage involvement, Solitare (2005) puts forth five criteria that are necessary for community involvement:

- There must be a commitment to their involvement from all stakeholders;
- They must be aware of the opportunities to participate;
- They must have time to commit to the process;
- They must trust that the other stakeholders are fair and honest;
- The issues under consideration must be ones which they perceive to be a problem.

Considering these characteristics will improve the flow of information about the project from the developers to the community and *vice versa*. While collaborative methods may seem costly because of the amount of time required to ensure community involvement, the impact of not using such methods may be even greater. The public can delay the plans and increase the budget beyond the control of the project management and design team if their concerns are not taken into consideration (Olander and Ladin 2005).

Currently, the practice of community involvement has evolved to a point where it is becoming a relevant part of the planning and design of construction projects. Over the last two decades, U. S. public agencies including the Environmental Protection Agency (EPA) and the Department of Transportation (DOT) have encouraged such deliberative processes, providing resources and structures to ensure inclusion of external stakeholders in the design of the project. Owners and developers are increasingly devoting more resources to these social initiatives, making them a key factor in establishing a comprehensive approach to the design of the project and its impact on the community. For example, Social Impact Assessment (SIA) is used to estimate in advance the major consequences of proposed projects such as alterations to where people live, work, play, and engage in cultural activities (Burdge 2004).

The communities in which the projects are completed are demanding a share of the benefits that owners and developers receive. Thus, establishing successful community involvement processes is becoming increasingly more relevant during the design of construction projects. To be effective, this collaborative participation must be related to how the companies participating in the project take care of other stakeholders as well (Olander and Ladin 2005, Herd-Smith and Fewings 2008).

2.3.2 Corporate Social Responsibility

In addition to being aware of the social sustainability from the perspective of the community, the construction industry can enhance the awareness of this concept by implementing Corporate Social Responsibility (CSR) strategies. While these are business strategies, they are translated into processes for improving relationships between companies and the marketplace, including employees and subcontractors and the communities in which the company operates. To do so, companies must analyze their core competencies and key resources to determine where their resources can provide the greatest benefit to the workforce and the community.

A CSR strategy can consist of such components as human resources, safety and health, and community service (Kolk 2003). The human resource component should be designed to attract, recruit, develop and retain a diverse workforce, particularly underrepresented groups. Safety and health programs, another fundamental component of CSR programs, reflect a commitment to the workforce through such managing systems as the Occupational Health & Safety Assessment Series (OHSAS) 18001 or through techniques such as Zero Accidents developed by task forces of the Construction Industry Institute (CII 1993, CII 2003). In addition, these programs help to enhance project performance measures because safety records impact morale, profitability, turnover, and productivity (Rechenthin 2004). The community service component commits the firm to act as a responsible member of the local community and the global society in which it operates. Specific examples of this component include charitable donations and sponsorships, volunteer work, and education initiatives. Finally, there is an ethical component stipulating that firms follow local regulations and do not engage in corruption.

Sustainability reporting initiatives indicate the various views of social sustainability among companies. For example, a study considering the trends in sustainability reported by the Fortune Global 250 (Kolk 2003) found this type of reporting to be already common in companies that have implemented such environmental management systems as ISO14001 and that regulatory requirements and/or government incentives for sustainability reporting have been applied in companies with multinational business units.

Furthermore, the Global Reporting Initiative (GRI) presented the first general overview of sustainability reporting based on a review of reports from 16 global construction and real estate sector companies in 2008. These primary findings indicate that these companies focus on such social aspects as creating a more flexible working environment, increasing the diversity mix of the workforce, providing equal employment opportunities, offering health and safety educational programs, and community involvement (Lamprinidi and Ringland 2008). Commonly reported indicators measuring company success consist of fatal incident rate, accident rate, and percentage comparison of male and female employees. Currently, efforts are underway to develop GRI guidelines specific to construction and real estate sectors, but these guidelines are still under discussion. Some of the key social aspects considered are women in management, displacement and compensation of communities, and corruption and lobbying (GRI 2010). Other design, construction and consulting firms such as CH2M-Hill, Lafarge, Skanska, Fluor, and Obayashi are investing in these practices as evidenced by their annual sustainability reports.

As this discussion suggests, CSR is a relevant component of social sustainability in construction projects, and such strategies are normally incorporated by the construction firms during the execution phase. The companies in these sectors have the opportunity to transfer their workplace knowledge to the community through their commitment to education and employee safety. In addition, they can assist the communities in a variety of other issues that may be identified from those community involvement processes presented early.

2.3.3 Safety Through Design

For the construction industry, another important consideration in social sustainability is protecting and promoting well-being through a healthy and safe working environment. Safety through Design aims to reduce construction worker injuries and fatalities as well as increasing construction worker health. This concept, also known as Prevention through Design (PtD) or Design for Construction Safety (Toole and Gambatese 2008), has been recognized by the National Institute for Occupational Safety and Health (NIOSH) as a key strategy for improving workplace safety (Schulte *et al.* 2008).

Designers (architects and engineers) can and should ensure worker safety by eliminating potential safety hazards from the worksite during the design phase (Gambatese and Hinze 1999). Normally in the U.S., health and safety of workers are frequently overlooked until the execution phase begins, meaning the contractor is the primarily responsible for it. However, early stages can eliminate hazards before they are present on the job site. Thus, Safety through Design helps to encourage more sustainable construction projects (Gambatese *et al.* 2008).

The link between a project's design and its construction site injury and fatality incidents has been reported by previous research (Haslam *et al*. 2003, Gibb *et al*. 2004, Behm 2005, and Gambatese *et al*. 2008). For example, the lack of implementation of design suggestions that facilitates permanent fall protection when erecting structural steel framing results in an increased number of such incidents. Thus, these professionals can directly impact safety outcomes because they are involved in the selection of a procurement system, the preparation of contract documentation, the sequencing of the construction process, and the decisions regarding contract duration (Trethewy and Atkinson 2003). In these roles, they can have a positive impact on improving worker safety by preventing potential safety hazards.

Practitioners in the U.S. face barriers for implementing the Safety through Design concept because of a lack of education among designers concerned with construction safety (Gambatese 2003). In addition, another important barrier involves the legal and liability issues, regulatory actions, and the nature of construction contracts (Behm 2005, Behm 2008). As these studies indicate, there are few regulatory actions that place the responsibility for safety upon the design professional. For example, construction contracts and regulatory requirements from the Occupational Safety and Health Administration (OSHA) place the responsibility for worker safety on the contractor.

The nature of the traditional construction design-bid-build process is another barrier for implementing the concept of Safety through Design. This separation of the design and construction phases creates the contract language between the designer and owner and the owner and contractor delineating that the contractor is responsible for job site safety, means, methods, techniques, sequences, and procedures (Hinze and Wilson 2000). In addition, project owners who consider a safe construction site to be a priority place the liability of construction site safety primarily upon the contractor. According to

Gambatese *et al*. (2008), these owners utilize pre-qualification practices to select only those contractors with proven safety performance records, lower insurance rates, and written safety programs. Toole and Gambatese (2008) introduce four strategies to consider among engineers and architects, including increased prefabrication, increased use of less hazardous materials and systems, increased application of construction engineering, and increased spatial investigation and communication of hazards.

In particular, the implementation of prefabrication methods will help increase safety performance because of their controlled construction environment (CII 2002, Na 2009). In addition, the design decision of open spaces for natural lighting, such as skylights, considered a sustainable feature, might generate hazards to the workforce during the construction and operating phases, so such prevention measures as guard cages to protect workers will be required as well. However, not all accidents can be prevented in the design phase. Therefore, a health and safety program is imperative once construction is underway (Levitt and Samelson 1987, Hinze 1997, CII 2003).

In summary, safe design in this context also means a design that allows for safe use across the entire life cycle of the project. The industry is dealing with these issues by using delivery method such as design-build, which is more conducive to implementing this concept (Gambatese *et al*. 2008). Designing for construction safety is one social component that supports a truly sustainable construction approach.

2.3.4 Social Design

Social design incorporates a variety of components related to various users (final and temporary) and design decisions. The first component of this conceptual area focuses on ensuring a design that is inclusive by considering underrepresented groups (e.g. accessibility for the elderly and the disabled). The disability concerns are normally addressed by following the regulations and standards from the American with Disabilities Act. Designers also face the need of providing a design that helps the increasing elderly population (Smith *et al*. 2008).

In addition, Evidence-Based design is currently being used to provide a better understanding of human behavior through scientific explanation (Brant *et al*. 2010). For instance, this approach uses evidence from research and practice to make decisions that will have a positive impact on the care and safety of patients and staff in healthcare facilities (Hamilton 2003). In particular, it investigates the desires, preferences, attitudes, perceptions, and motivations of the future users of a facility or product, providing results that shape the design. One of the benefits of this method is having a culture of peer review of the evidence, leading to meaningful collaboration with clients and users (Hamilton and Watkins 2009). The studies conducted during the design phase need to be monitored after the project is completed. Various examples of this method can be found in Brand *et al*. (2010), ranging from improving the treatment of patients in nursing homes and hospitals to enhancing the productivity of the workforce in office buildings and the productivity of students and faculty in educational buildings.

Other elements that should be considered in social design are the impact of temporary users such as the workforce and vendors. According to Benoit and Mazijn (2009), the social life cycle of products and materials should be determined by following a systematic process. This analysis will impact the performance of the project in terms of time, cost, and the perception of the community.

The second component of this the social design includes understanding the social interrelations embedded in the process of designing, constructing, and operating buildings (Rohracher 2001). In this context, design teams are challenged to create value during the entire delivery process, not just as an end product. However, this group of interdisciplinary professionals may bring individual interpretations of sustainability (McIsaac and Morey 1998). The decisions made by designers in these instances will influence social aspects as well. Again, since the greatest opportunities for influencing project performance occur during the early stages, the design decision-making process has a major social impact.

Thus, the social design of a sustainable construction projects involves more than the final users. This design concept encourages designers to rethink their responsibility and to increase their understanding and appreciation for goals, strategies, and values in field complementary to theirs. The same vision can be extended to other professionals such as contractors. As sustainable projects require the involvement of more stakeholders, it is important to remember that issues can arise resulting from incompatible or opposing needs among them.

Major sources of conflicts and disputes specific to design and construction projects have been identified related to organizational issues and construction projects characteristics (Ng *et al*. 2007). Researchers such as Fenn *et al*. (1997) have argued that since conflicts will always exist, they should be managed during a project, similar to other variables such as cost, schedule, safety, and quality. Specifically, the development of partnering strategies in the construction industry has been helpful in minimizing litigation and creating an effective collaboration among stakeholders (Liska 1993, Thompson and Sanders 1998, Anvuur *et al*. 2007). The underlying cautionary note is that to be successful partnering needs an equal level of commitment from all the partners and good lines of communication so that all parties are fully informed of the status of a project.

One of the most effective ways of ensuring social design is through integration, transparency, accessibility, and collaborative learning among these various stakeholders (Kaatz *et al.* 2005). In particular, according to Klotz *et al*. (2009), the implementation of process transparency can provide cost savings by providing visibility of the goals, rules and status of the project to all stakeholders. Hence, one of the challenges in sustainable projects is to maintain effective conflict management in construction projects by revolving around the participants' understanding of conflicts and their knowledge about the outcomes of project. Processes such as partnering and transparency offer such advantages as including the understanding of the stakeholders' motivations, trustworthiness, and means of communication.

2.4 Need for Future Research

The literature suggests that there are various categories of processes included during the delivery of construction projects aiming to obtain social sustainability outcomes. As this discussion implies, the conceptualization of social sustainability varies in the construction industry. All stakeholders may see it as having different levels of importance and value it accordingly. More importantly, previous research also has indicated the need to have processes in place for social sustainability by providing general principles and indicators related to equity, well-being, safety and health (Hill and Bowen 1997, Trinius 2005, Gilchrist and Allouche 2005, Surahyo and El-Diraby 2009).

Since the concept of social sustainability is still evolving, this is an important time to begin defining the social sustainability processes that should be integrated during the planning and design phases of construction projects. However, attempting to create a model based solely on the previous literature will be limited by individual bias. The understanding of social sustainability processes could be enhanced by engaging experts in developing a general framework, critical first step in creating more awareness about this topic in construction projects.

2.5 Chapter Summary

This chapter has outlined social sustainability in the construction industry by synthesizing some of the concepts associated with the project life cycle and based on various perspectives. Figure 2.3 indicates the course followed in this study, which started by organizing the previous knowledge discussed in this chapter. The next chapter introduces the concept mapping method used in the selection and categorization of social sustainability processes in the context of construction projects.

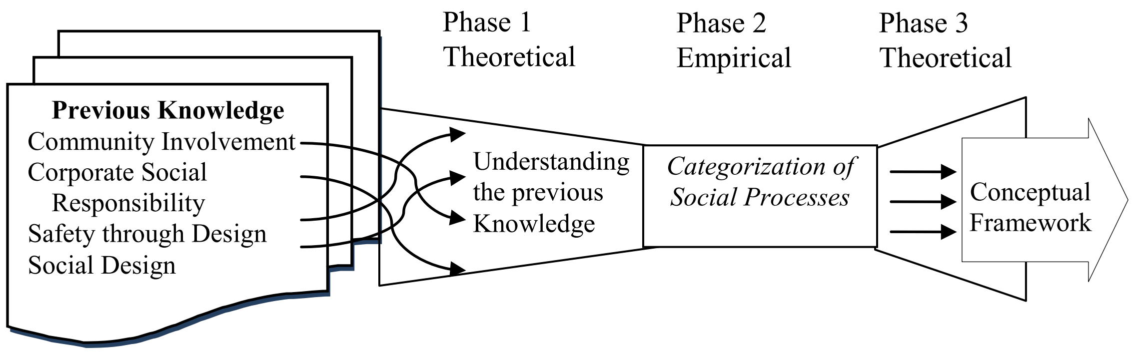


Figure 2.3 General Course of this Research

CHAPTER 3

CONCEPT MAPPING BASED ON EXPERT KNOWLEDGE AS A RESEARCH METHOD

The purpose of this chapter is to describe the research method that was used to gather data for the categorization of social sustainability processes in construction projects. This categorization was determined using a concept mapping research method based on the knowledge obtained from a group of experts with professional experience in academia, industry and government projects. This group of experts helped to ensure a more comprehensive view of the social sustainability concept than would be possible using experts from only one field or practice, especially since their expertise represents different backgrounds such as safety and health, sustainability design, sustainability construction management, and community development.

3.1 Expert Knowledge

Expert sources of information are valuable because they might provide current information that journal articles and book sources cannot because their publishing timeframes (Björk and Bröchner 2007). In particular, the majority of the knowledge in the Architecture, Engineering and Construction (AEC) industry is experience-based because the nature of unique projects (Woo *et al*. 2004). Perhaps the most important benefit of expert-based information for this research is that these experiences can be used as tangible evidence to gain first-hand insight about the processes of social sustainability.

According to Bosch (2003), expert-based methods are grounded in techniques that gather information from several independent experts to obtain results that eliminate the individual bias of the researcher. Since the time commitment expected from the participants is controlled by the researcher, these methods encourage participation ensuring an appropriate response rate. In addition, these methods can be conducted with participants geographically dispersed, meaning group members can generate many ideas in relatively short time. These methods also allow for the examining of topics that are complex or not well defined as social sustainability in construction projects. Finally, having a well-established group of participants in this research established a commitment from the participants, encouraging future implementation of the framework in construction projects because their judgment helped to develop it. Expert-based research provides explicit benefits; however, care must be taken to address several concerns with this type of research approach, including experts can be costly, the data may not be able to be disclosed due to liability concerns/organizational policies, and the knowledge may be based on highly individualized/specialized projects, meaning it may not be applicable to other projects or locations.

While there are several types of expert-based methods, the Delphi method and concept mapping were considered for this study. Both are useful research methods for soliciting individual judgments, combining them, and making decisions. The Delphi method was originally used in forecasting as it provides the benefits of aggregating the knowledge of anonymous experts through a repeated series of questionnaires (Moore 1987). It does not require meetings with the experts, important when anonymity among participants is required because of the subject investigated. Most importantly, the goal of this method is to have small variance among the responses from the series of questionnaires (Hallowel and Gambatese 2010). According to Hallowel and Gambatese's review of past studies in construction research, when applying the Delphi method the selection experts needs to consider such factors as scholarship, professional registration, and leadership.

For this study, concept mapping was chosen for several reasons; among those mentioned in Trochim (1989) and Kane and Trochim (2007), the following apply to this particular research:

- A framework can emerge from the collective judgment of experts.
- A range of professional areas is allowed without having a dominant judgment influence the results.
- While a meeting of the participants is suggested to interpret the results, the researcher can provide this interpretation if it is based on previous knowledge from the literature when such meetings are not feasible due to time and cost constraints.
- There is enough flexibility to have various participants at different steps of the research.
- Face-to-face interaction among participants is not required, eliminating the need to invite only those within the physical proximity of a region.
- This method requires the least time for the participants to complete idea generation, sorting and rating as a web-based software can be used.

3.2 Concept Mapping Research Method

While several methods share the name concept mapping, they differ in their approaches. One of the best known is the one developed by Novak, which is used as an educational technique to assess individual understanding related to a general question or topic (Novak 1990, Novak and Cañas 2008). In Novak's approach, the individual writes ideas in separate boxes using lines to connect related concepts, often including labels showing the type of connection to build meaning among a given set of concepts. This technique is suitable when an individual wants to represent a mental model. However, this technique is limited in being able to identify an aggregate representation of processes across experts in the form of categories or clusters, which is the purpose of this research.

To meet the goal of this study, the expert knowledge was categorized subsequently using a more structured concept mapping method, which combined quantitative and qualitative analysis (Trochim 1989). This method has been used by diverse groups to guide planning and evaluation studies as well as the development of conceptual frameworks (Kane and Trochim 2007). Thus, this structured concept mapping method can help in understanding the social sustainability concept in construction projects.

In particular, the concept mapping method allows experts to cluster their own knowledge as a group without losing the uniqueness of their individual expertise. Thus, concept mapping is useful method for helping experts generate a clear understanding of how they characterize processes of social sustainability. The concept mapping method proposed here is particularly appropriate because it (Kane and Trochim 2007):

- Integrates input from multiple sources with differing content expertise or interest
- Generates group aggregate maps (graphical conceptualizations) based on the thinking of the experts without losing the uniqueness of their individual expertise
- Utilizes Multidimensional Scaling (MDS) and Cluster Analysis to construct the maps representing the knowledge of experts
- Allows pattern matching comparisons across variables such as rating criteria based on subgroups of experts and different points in time

This concept mapping method involves the six general steps shown in Figure 3.1: preparing the project, generating ideas, structuring statements, developing maps, interpreting maps, and utilizing maps. The method adapted for this study, developed from the general one, is described in the reminder of this chapter.

1. Preparing the Project

a. Focus: The desired outcome of a study
b. Sampling Participants: Identifying relevant stakeholders and how they will be engaged
c. Scheduling and Logistics: Organizing stakeholder participation

2. Generating Ideas or Concepts (Brainstorming)

a. Brainstorming: Gathering knowledge and opinions from experts and/or literature review
b. Ideas Analysis: Creating a rationalized set of ideas

3. Structuring the Statements

a. Demographics: Identifying stakeholder groups for comparative analysis
b. Unstructured pile sorting: Organizing ideas into groups or clusters
c. Rating(s): Assigning values to concepts or ideas (statements)

4. Developing the Maps

a. Point Map
b. Cluster Maps
c. Point and Cluster Rating Maps
d. Pattern Matching Displays/ Go-zone Plots

5. Interpreting the Maps

a. Structured, stakeholder-based interpretation: Developing joint stakeholders authorship

6. Utilizing the Maps

a. Action: Items for future work
b. Measurement: Comparison of results against initial desired outcomes

Figure 3.1 Steps in the Concept Mapping Method (Kane and Trochim 2007)

3.3 Adapted Method for this Research

The concept mapping method helps to identify key processes of social sustainability (i.e., Health Impact Assessment) that experts from different backgrounds identify as important to incorporate during the design phase of construction projects. These processes are meant to be at a level that can be applied across the entire range of the construction industry. For instance, hiring and training local labor is common to building and highway projects. However, they may be applied slightly differently depending on the industry sector. Keeping the processes at this level provides the opportunity to develop categorizations applicable to specific types of projects as needed. The components of the concept mapping method adapted for this research are shown in Figure 3.2:

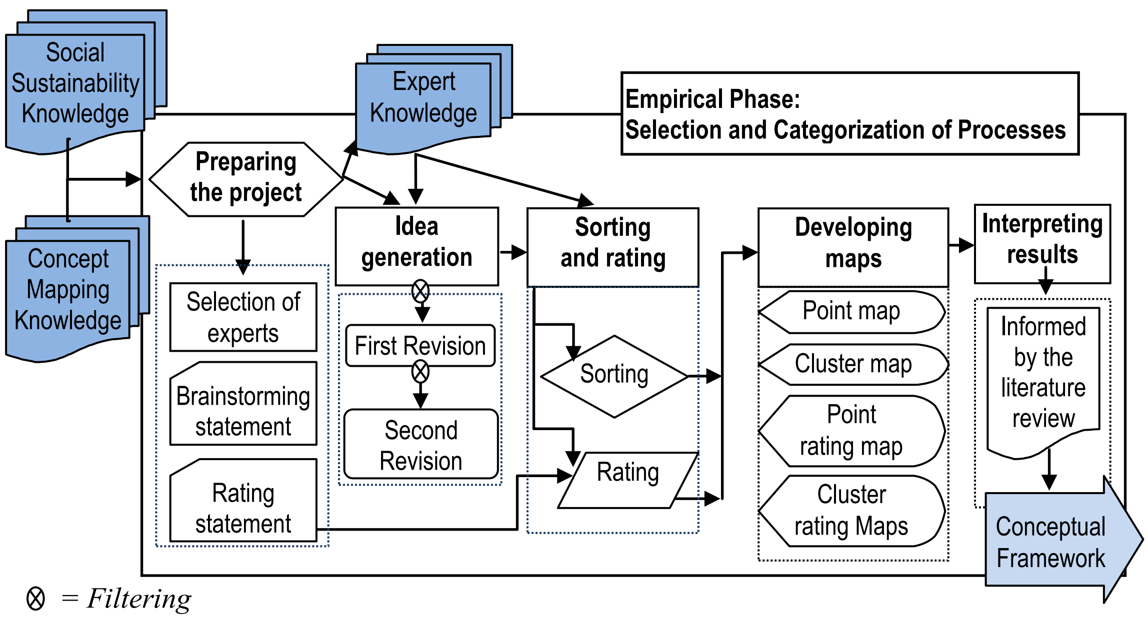


Figure 3.2 Components of the Concept Mapping Method Adapted for this Study

The general outcomes from the concept mapping in this study include:

- A list of 50 social processes generated by experts representing a variety of stakeholders in the construction industry
- Concept maps grouping these processes

- Average ratings for each social process and for each cluster based on expert input on its importance in the planning and design phases
- Graphical representations of the experts' judgment by including pattern matching analysis of subgroups
- The interpretation of the results based on the literature review
- A synthesized framework of social sustainability in construction projects

Four general steps implemented for this study were accomplished between May 2010 and June 2011. These steps included preparing the project, idea generation, sorting and rating, analysis of the results, and interpretation of the results. The following sections describe them.

3.3.1 Preparing the Project

The first step helped to prepare the project. In particular, a first group of participants was identified, the focus and rating statements finalized, and concept mapping training completed.

One of the critical elements in the preparation of this research project was the selection of participants[3]. This step ensured that the participants will represent various perspectives of social sustainability. The recruiting of the experts was based on two strategies. First, experts from relevant organizations and institutions currently working towards incorporating social sustainability considerations into their industry and research

[3] For the purpose of this study, the term *participant* is considered synonymous with the term *expert*.

projects were contacted, e.g., the Construction Industry Institute (CII), the United States Green Building Council (USGBC), the American Society of Civil Engineering (ASCE), Government Agencies such as the Center for Disease Control and Prevention (CDC), the National Institute of Occupational Safety and Health (NIOSH) and the General Services Administration (GSA), and other research groups in Engineering Sustainability. Second, experts were identified from such lists as the Top 100 Design Firms and the Top 100 Contracting Firms published by the *Engineering News-Record Magazine*, in particular invitations were sent to those firms that have sustainability directors or managers.

Initially, several phone conversations were held with the leaders of some of these groups to confirm their interest and participation. This approach allowed identifying other experts based on the references provided during these conversations. This initial communication introduced the motivation for this study and provided an overview of the concept mapping method. From July to August 2010, at least six experts committed to contributing to this research, ranging from academics from first tier academic institutions to sustainability directors in the Top 100 Design firms. In addition, an expert from a government agency committed to this study. Having the commitment from this group of experts at the beginning of the study ensured that a qualified group of participants continued until the end.

The aim of this step was to compile a heterogeneous group that represented a range of perspectives from construction project stakeholders in various positions and from various backgrounds in the U.S. This heterogeneity was one reason why the concept mapping research method was more suitable for this study than the Delphi method, which traditionally have been used in construction engineering research to achieve agreement on a value through multiple rounds of questionnaires (Hallowell and Gambatese 2010).

To further guarantee a variety of perspectives, experts were invited based on their practice in the industry and/or academia on sustainability, and to a certain extent, by their implementation of at least one of the social conceptual areas identified in Chapter 2 (Corporate Social Responsibility, Community Involvement, Social Design, and Safety through Design). From 10 to more than 75 participants have been included during previous studies using this method. Groups of 10 to 20 help ensure that the group is not too large for meaningful participation yet large enough so that a variety of opinions are captured (Trochim 1993). The same participants are also not required to be included in every step of the process, allowing for flexibility (Kane and Trochim 2007). Thus, this study involved two cohorts of experts, which were not mutually exclusive, meaning, participants in the first cohort who provided their judgment about social processes could also participate in the second cohort during the sorting and rating steps.

Another aspect of preparing this study was the idea generation and rating(s) focus statements, which guided the responses of the experts, were also generated in this step. These prompts guided the experts as they identified various social sustainability processes that should be incorporated during the planning and design phases of construction projects. Based on this objective, the following prompt was used as an idea generation statement:

"Generate short statements or ideas that describe specific processes of social sustainability that should be included during the planning and design phases of construction projects."

A final list of processes[4] was created after the idea generation step for experts to rate. A five-point Likert-scale was used to help the experts rank this list. The following rating prompt served this purpose:

How important do you consider the process for inclusion during the planning and design phases of construction projects, with 1 indicating little importance and 5 high importance.

1 2 3 4 5

Little Importance High Importance

Finally, anticipating the challenges faced by gathering experts from academia and industry from a variety of institutions and organizations across the U.S. in one place, this study used the Concept System software with a global license to facilitate reaching participants nationwide. In addition, this Core Concept Systems software was used to calculate the multidimensional scaling and the cluster analyses. A pilot-study was conducted to verify that instructions would be clear to participants. The idea generation step began on January 2011.

[4] For the rest of this document, the term *statement* is considered synonymous with the term process.

3.3.2 Idea Generation

The second step of the concept mapping used here involved the idea generation of 50 social sustainability processes to be included during the planning and design phases of construction projects. Invitations were sent via e-mail to various experts identified during the preparation phase following approval of the study by the Institutional Review Board (IRB) at Clemson University (see Appendix A). This method of contact was selected to minimize the in-person time required by participants.

These participants were invited to generate processes based on the idea generation prompt previously introduced. There was not a limit to the number of such ideas each participant could generate. Experts were encouraged to generate as many as possible. The participants were asked to either express themselves in a concise list format or to explain themselves more fully in a short narrative. They were not required to provide rationales for their suggestions. The time commitment from the experts for this first generation of ideas was expected to be approximately 30 to 60 minutes. The idea generation was open for eight weeks, allowing enough time for participants to return again to the web-site and generate new processes, inspired by the suggestions of others.

Experts taking part in this step included 12 sustainability directors from Top 100 Design and Contracting Firms, 6 researchers and academics focusing on topics such as sustainable construction, safety, community development and design, and 1 expert who oversees a national safety prevention initiative sponsored by a government agency. They have experience in one or more of the following area: construction safety and health, sustainability, community development, construction management, and research and teaching at the college level, as evidenced by a review of their curriculum vitae accessible on the internet.

This phase produced more than 50 ideas related to social processes. This exercise posed challenges; most importantly, several brief responses were not completely clear. In addition, since they were posted on an open web-base forum, there was no opportunity for immediate inquiry to enhance understanding and determine who specifically posted the process. Considering these challenges, during this time the researcher monitored the website, randomizing the ideas several times to eliminate anchoring processes based solely in the last responses posted.

In addition, the research evaluated those preliminary processes generated by experts, eliminating as many redundancies as possible, creating a draft list of processes for final selection. The researcher selected the final list of processes by having two focus groups review the initial ideas posted by the experts. The first group, which met on February 25, 2011, included six scholars in community development, sustainable construction, sustainable transportation, construction management practices, and English. This focus group helped narrow the list of processes by editing and revising for repetition of the ideas, unclear identification of social sustainability processes, conceptual miss understanding, spelling and grammar, and providing operational definitions when required. On March 1, 2011, the second focus group, consisting of six expert-novices on sustainability, met to test the clarity of language for each process to minimize misunderstanding for the sorting and rating in the next step.

Both of these focus groups helped eliminate the individual bias of the researcher in the selection of the processes, enhancing the validity of the results. This revision step was important so that the experts could focus their full attention on the sorting and rating steps (Kane and Trochim 2007). To ensure that each social sustainability process was considered independently of the others, each process was given a random number from 1 to 50 as shown in the final list of processes in Table 3.1. Appendix B also includes the operational definitions provided to the experts.

Table 3.1 List of Social Sustainability Processes Selected in this Study

ID	Process
1.	Determine the expectations of the owner, designer and public early in the project
2.	Conduct a social impact assessment of the project
3.	Respond quickly to community concerns and perceptions
4.	Conduct a social life cycle analysis of construction products and materials that considers workforce safety and health
5.	Use an Evidence-Based Design process, basing decisions about the built environment on valid and reliable research
6.	Engage local governments in design so that decision makers can understand and anticipate their needs
7.	Conduct a Health Impact Assessment (definition provided in the attachment to the e-mail)
8.	Select a diverse design team including participants from various professions, genders, races, and firm sizes
9.	Design to enable the use of local construction labor
10.	Analyze the effect of the project on cultural, historical, and archeological resources
11.	Generate a stakeholder management plan that encourages interaction, integration, and collaboration among stakeholders
12.	Include health professionals in the design team to help analyze health impacts on the final users and the community
13.	Train designers to help them address future hazards during the construction and maintenance phases of the project
14.	Incorporate social considerations (e.g. health, productivity, quality of life) into a return on investment analysis (ROI)
15.	Include privacy considerations for the final users
16.	Select design and construction firms with a sustainability focus
17.	Use local designers and professionals
18.	Assess the impact of introducing new social classes into the surrounding community (e.g. a community where low-income housing is proposed might perceive the new social class as a threat based on stereotypes and misconceptions)
19.	Establish Zero Harm or Zero Accident targets for the project (definition provided in the attachment to the e-mail)
20.	Adopt designs that increase the wellness and productivity of the final users
21.	Create design features that instill pride in ownership of the users and the surrounding community

Table 3.1 List of Social Sustainability Processes Selected in this Study (continued)

ID	Process
22.	Analyze new/additional community infrastructure needs resulting from the project (e.g. water, power, emergency responders)
23.	Incorporate safety prevention techniques that prevent or minimize occupational hazards and risks during construction (e.g. the analysis of the sequence of construction activities, the use of prefabrication techniques)
24.	Include human interaction (connectivity) considerations for the final users in the project design
25.	Inform stakeholders of the project constraints (e.g. budget, schedule, location, size, design and construction standards)
26.	Require a management plan for improving construction worker productivity
27.	Ensure participation of final users in design so that decision makers can understand and anticipate their needs
28.	Establish a plan to evaluate progress on Zero Harm or Zero Accident targets for the project (definition provided in the attachment to the e-mail)
29.	Assess the results from Post-Occupancy Evaluation (POE) of similar projects
30.	Perform an asset-based design analysis of the surrounding community so that design solutions can convert social liabilities into assets
31.	Establish partnering strategies for resolving interpersonal conflicts among project stakeholders
32.	Use an integrated design-construction process
33.	Require education, training, counseling, prevention, and risk-control programs to assist workforce members, their families, or community members regarding serious diseases
34.	Analyze the impact of the project on the cultural and ethnic identity of the surrounding community
35.	Educate the public about the planning/design progress
36.	Include security considerations for the final users in the project design
37.	Assess the planning and zoning decisions of organizations/institutions with jurisdiction over the proposed project area
38.	Encourage neighborhood engagement in the design
39.	Develop a plan for ongoing evaluation of the impact of the project on surrounding communities once it is in operation
40.	Establish requirements to assess the impact of the project on the health and safety of the final users

Table 3.1 List of Social Sustainability Processes Selected in this Study (continued)

ID	Process
41.	Document and share the lessons learned during the planning and design phases with all stakeholders
42.	Provide a plan to minimize disruption caused by the construction process (e.g. traffic congestion, dust and noise)
43.	Use local material/product suppliers for the project
44.	Communicate the deliverables and intended project outcomes with each stakeholder group
45.	Assess seasonal population changes in the surrounding community and their effect on employment patterns, business practices, and community infrastructure
46.	Maintain and/or restore natural habitat important to the final users and the surrounding community
47.	Communicate the rationale for the commissioning process to the stakeholders
48.	Design to consider the job skills of the women, young people, unemployed, disadvantaged, racial and ethnic minority groups in the area
49.	Monitor and respond to incidents of corruption
50.	Analyze the impact of the project location on access to public transit, biking opportunities, safe walking routes, and green spaces

3.3.3 Sorting and Rating of Processes

Once the final list of processes was selected, experts were invited to sort and rate them. Using experts to code their own knowledge ensured that the categories of social sustainability emerging from the analysis were not influenced by the researcher's bias. During this time other academics identified during conferences and by references from various experts were also invited to participate in this sorting and rating. Again, Appendix A includes a copy of the general instructions. In this step, each expert was asked to commit from 40 to 60 minutes between the middle of March to the middle of May 2011.

The participants were provided with a handout of the final list of social sustainability processes and the operational definitions generated during the previous step as well as instructions for sorting and rating them. The first step was to read all the processes to obtain a general overview of all of them. Then, the experts sorted and grouped these statements into logical categories based on their own judgment. The rules used for sorting statements can be seen in Table 3.2:

Table 3.2 Rules Provided for the Sorting Step

In this activity, you will categorize the processes based on your understanding of their meaning or theme. To do this, you will sort the processes into groups that make sense to you. First, read through the processes in the Unsorted Statements column. Next, sort each process into the groups you create. Group the processes based on how similar in meaning or theme they are to others in the list provided. Give each group a name describing its theme or contents. Do NOT create groups according to priority or value such as Important or Hard To Do. Do NOT create groups such as Miscellaneous or Other to group together dissimilar processes. Put a process alone in its own group if it is unrelated to other processes. Make sure every statement is put somewhere. Do not leave any statements in the Unsorted Statements column. People will vary in how many groups they will create. Usually 5 to 20 groups work well for organizing this number of processes.

Next, they rated each social sustainability process on its importance, using a five-point Likert scale. The responses to this question were dependent upon the judgment of the participants. Again, to minimize confusion about sorting the processes, a pilot study was conducted to verify that the instructions were clear. In addition, the randomization of the processes prevented those with similar meanings from being listed together, to minimize influencing the results. The participants' input during the sorting and rating was obtained using a web-based approach; as with any similar approach, it is difficult to confirm who completed these tasks. However, the experts had to use their company or personal e-mail accounts as a user name to log into the software.

During these steps, the researcher was available to follow up with the experts through phone conversations or e-mails if they needed more information. For instance, if experts had technical difficulties with the instructions or the link, clarification was then e-mailed to them. Only three experts requested help because of sign-in and web-browser issues.

For the sorting and rating steps, a total of 18 experts participated with 16 of them completing both steps. Thus, the input data for generating the concept maps (point map, cluster maps, and rating maps) included only the responses from these 16. Ten of these participants had also provided their judgment in the idea generation step. As a result, having 10 of 19 the participants involved in both idea generation and then sorting and rating enhanced the representativeness of the categorization of the processes and their relevance as recommended by Trochim (1989). While a better representation could have been obtained if the same experts participated in all the steps, the results indicate that it was not feasible because of schedules and priorities, especially when coordinating such a high profile group of experts. In addition, while more experts would have strengthened the results, the size of the sample group matched the recommendations of previous studies (Trochim 1993) as will be detailed in the next chapter.

As in any expert-based approach, the quality of the results is based on the expertise of the participants. For the study reported here, the experts met at least three of the following criteria: a) two or more publications related to sustainability, b) member or chair of a sustainability committee, c) sustainability director or sustainability manager in a Top 100 Design or Contracting Firm, d) five or more years employed in an industry related to sustainable projects, e) author or editor of a book focusing on sustainability, f) employed as a professor or researcher at an institute of higher education or government agency with a focus on any of the previous social sustainability categories identified in the literature review, and g) bachelor's degree or higher in a related field. These criteria were based on the recommendations suggested by Hallowell and Gambatese (2010) for selecting experts. While the names of participants are excluded from this report for IRB reasons, the qualifications of the 16 experts who completed both sorting and rating steps are presented in Table 3.3:

Table 3.3 Experts Qualifications

Criteria	Expert															
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Bachelor's degree or higher	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
At least five years of professional experience in the construction industry	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓		✓	✓
Professor or researcher at an accredited higher education institution or government agency						✓	✓		✓			✓	✓	✓	✓	✓
Sustainability director or manager in a Top 100 Design or Contracting Firm	✓	✓	✓	✓				✓		✓						
Member or chair of a sustainability related committee	✓	✓	✓		✓		✓				✓					
Primary or secondary author of at least two peer-reviewed journal articles on any of the topics covered in the literature review						✓			✓			✓		✓	✓	
Author or editor of a book or book chapter related to sustainability topics	✓				✓				✓						✓	

For the purpose of examining subgroups during the analysis of the maps and to establish the heterogeneity, or representation, of various perspectives, information about the participants was collected indirectly by reviewing their qualifications online, typically a posted resume or curriculum vitae. Table 3.4 provides a description of the experts who provided input for this research, and their demographic information is listed in Table 3.5:

Table 3.4 Experts General Profile

Expert	Experience
1	• Sustainability director of a Top 100 Contracting Firm, representing both owner and construction managers for more than 20 years • Previous chair of a sustainability task force • Publishes on execution plans for projects required to be certified under a sustainability rating system
2	• Sustainability director of a Top 100 Contracting Firm • Past chair of sustainability task force for industrial projects • More than 20 years of experience in the application of health, safety and environmental procedures and policies, both nationally and internationally • Experience with projects in the energy sector, and major engineering and construction facilities
3	• Sustainability director of a Top 100 Design Firm • Chairperson of a task force for sustainability design groups • Educates owners on the integration of sustainability design • Trains sustainability leaders about design strategies that aim to reduce energy consumption in new and existing buildings
4	• Sustainability director of a the Top 100 Contracting Firm • Supervises the development and operations of such integrated project delivery methods as DB, CMAR, and PPP • Experience in renewable energy projects, preparation of estimates, scheduling and virtual designs • More than 20 years experience in the construction industry
5	• Works with organizations in both private and public sectors applying sustainability procedures • Publishes on sustainability infrastructure projects • More than 20 years of experience in sustainability and management • Co-chair of a task force for the development of a sustainability rating system
6	• Academic focusing on land use policy and planning • More than 10 years of experience researching sustainability topics for local governments in the U.S. • Chair of a professional association • Member of an editorial board for a professional journal

Table 3.4 Experts General Profile (continued)

Expert	Experience
7	• Leader in the government sector overseeing facilities policies and programs • Focuses on the integration of processes across phases of construction projects, in particular developing budgets over their life cycles • More than 20 years of practice in both health and engineering • Member of a task force for sustainability capital projects
8	• Sustainability director of a Top 100 Design Firm • More than 20 years of experience related to quality management and sustainability solutions for clients in the private and public sectors • Develops and implements environmental management systems and standards addressing the three dimensions of sustainability
9	• Academic with more than 15 years of experience focusing on design for safety of construction workers • Develops and implements research projects on integrated contracting methods, constructability and sustainability of materials • Has published more than 25 peer-reviewed journal papers and books
10	• Sustainability director of a Top 100 Design Firm • Responsible for developing and reviewing architectural design and project contract documentation with more than 10 years of experience • Projects overseen include design and construction of both commercial and residential buildings, distribution and manufacturing facilities, and medical and educational buildings.
11	• Manager of a design firm that focuses on working with both public and private organizations that implement sustainable procedures • With more than 15 years of design experience has served as a member of sustainability task forces • Lectures on design topics at a first-tier research institution

Table 3.4 Experts General Profile (continued)

Expert	Experience
12	• Researcher and academic at a first-tier research institution • Has published more than 30 studies focusing on sustainability development • Investigates various phases of the life cycle of construction projects • Implements an integrated approach for community service, education, and research, which interacts with various stakeholders in the construction sector at both the organizational and project levels • Served as a member of various sustainability task forces in academia and industry
13	• Academic focusing on the design of sustainability projects at a first-tier research institution • Director for a community program finding solutions by involving architects, engineers, contractors, and researchers • More than 10 years of experience in the design and build method • Teaches about the challenges of collaboration and design among stakeholders
14	• Researcher focusing on the incorporation of sustainability in infrastructure projects at a first-tier research institution • Investigates the interface of transportation systems with public health and its management • Interacts with various stakeholders focusing on the planning and management of processes for the inclusion of social sustainability considerations
15	• Academic working towards the implementation of the safety design practices in construction projects • More than 15 years of experience in industry and academia focusing on project management simulation and construction innovation topics • Served as co-director of a management institute • Has published more than 20 peer-review journal papers and chapter books
16	• Coordinator for government programs in safety prevention • More than 20 years of experience in partnerships among industry and government agencies • Experience includes the assessment of jobs integrating healthy, safety and environmental sustainability concerns

Table 3.5 Expert's Demographic Information Gathered

Participant Demographic Information Obtained	Summary Data
Current job position	Faculty/Research = 7 Industry = 7 Government = 2
Years of professional experience	Fewer than 20 years = 7 Twenty or more years = 9
Professional background	Engineering = 7 Architecture = 4 Other = 5
Geographical location in the U.S. based on the U.S. Census Bureau designated regions[5]	Northeast =3 Midwest = 4 South = 7 West = 2
Expert focusing on project phase	Planning and Design = 9 Construction =2 Other = 5
Gender	Female = 8 Male = 8

In particular, more than 300 years of experience are combined among this group of experts. To further demonstrate their expertise, each of the 16 are mapped in Figure 3.3 to the four conceptual areas of Community Involvement, Corporate Social Sustainability, Safety through Design, and Social Design as determined from the literature review. In addition, as Figure 3.4 shows, these experts have experience in various phases of the project life cycle.

[5] Information about these regions and divisions can be found at www.census.gov/geo/www/us_regdiv.pdf

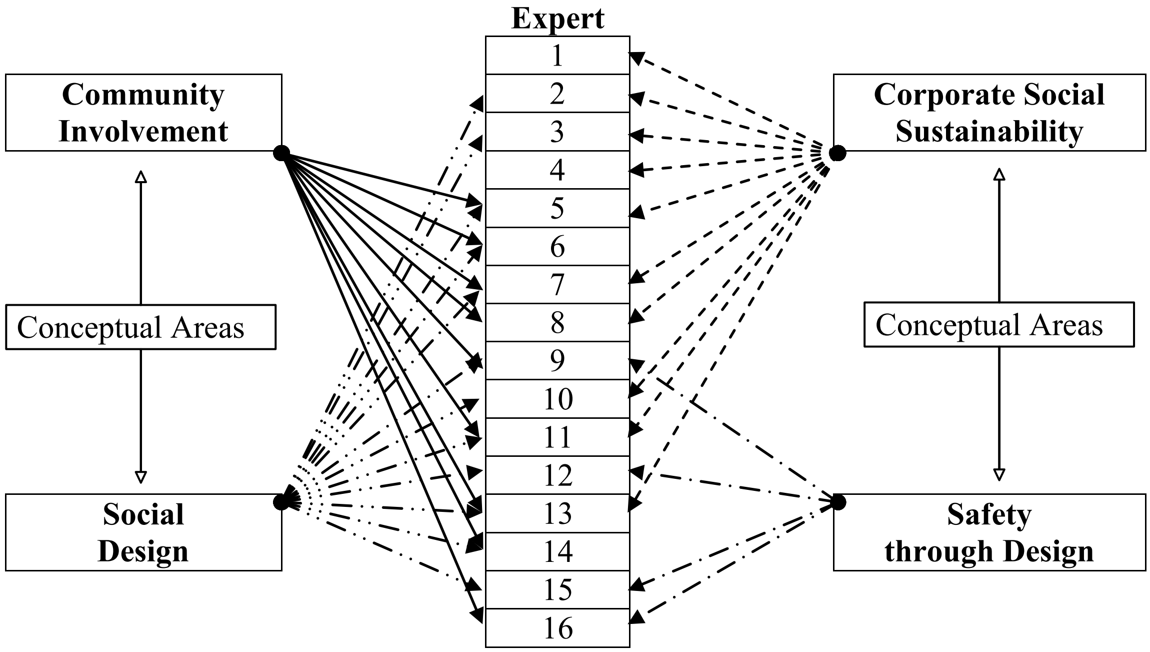


Figure 3.3 Experts Related to the Conceptual Areas

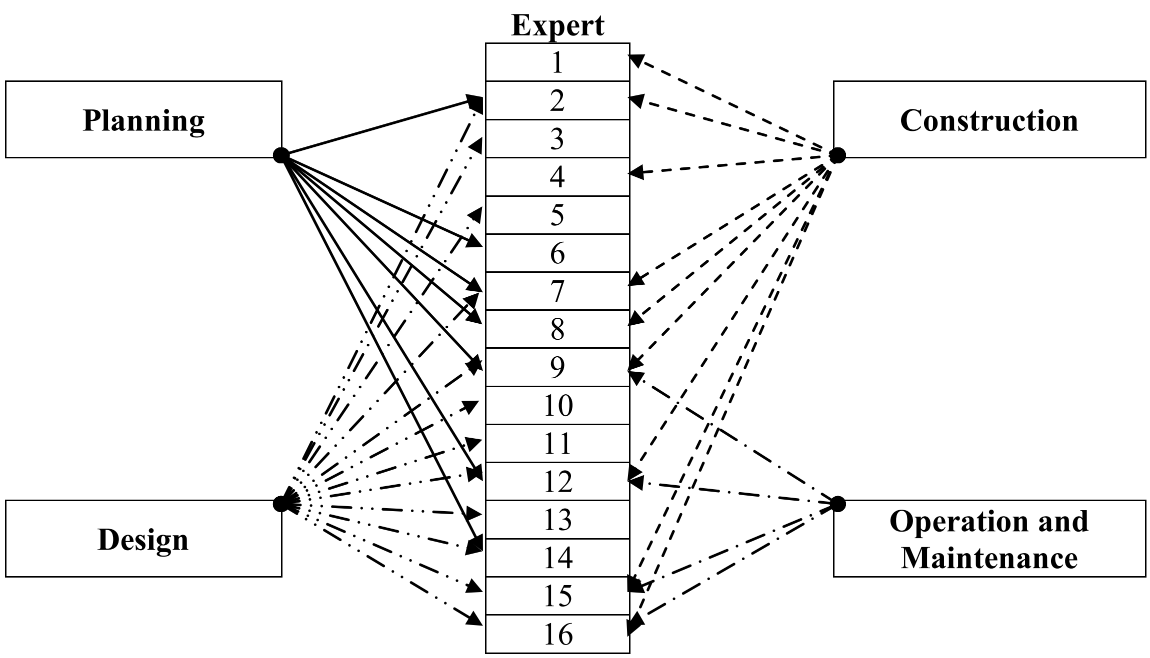
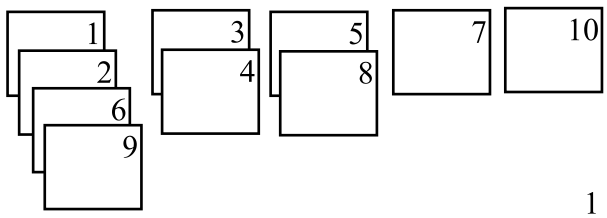


Figure 3.4 Experts Related to the Project Life Cycle Phase

Both of these figures represent these relationships by the straight arrows connecting the 16 experts to either conceptual areas or project phases. These graphical representations show that the majority of the experts focus on several, not just one, conceptual areas of social sustainability and phases of construction projects, no matter if the participant is from academia, industry or the government.

3.3.4 Generating the Maps

The last step before the interpretation of the results was creating conceptual maps based on the knowledge gathered from the 16 experts. To do so, a binary symmetric similarity matrix for each participant was created, identifying how the processes were grouped. This individual matrix had as many rows and columns as processes. As shown in Figure 3.5, if 10 processes were included, a 10 x 10 binary square matrix was created to represent them. This individual binary matrix had only 0s or 1s in each cell: 0 where the two processes were not grouped and 1 where they were.



← **Sort for one participant**

Binary Similarity Matrix →

	1	2	3	4	5	6	7	8	9	10
1	1									
2	1	1								
3	0	0	1							
4	0	0	1	1						
5	0	0	0	0	1					
6	1	1	0	0	0	1				
7	0	0	0	0	0	0	1			
8	0	0	0	0	1	0	0	1		
9	1	1	0	0	0	1	0	0	1	
10	0	0	0	0	0	0	0	0	0	1

Figure 3.5 Symmetric Similarity Matrix for One Participant from his/her Card Sort adapted from Kane and Trochim (2007).

The outcome formed an aggregated similarity matrix, determined by summing across the individual matrices generated by all the participants. This aggregated matrix had as many rows and columns as processes, meaning that for this study a 50 x 50 matrix was created. The value in each cell represented how many participants placed that pair of processes in a group. Values along the diagonal were equal to the total number of people who did the sorting task; for this research this value was 16. According to Kane and Trochim (2007), this aggregated matrix indicates how all the participants grouped the concepts; for this study, the higher the value the more participants put that pair of processes together, implying that they are conceptually similar based on participant expertise. Based on this aggregated matrix, a Multidimensional scaling analysis (MDS) that calculates coordinates (x, y), generating a two-dimensional map of distances between the processes called a point map[6], was determined. The detailed analysis of this map generation is presented in the next chapter.

3.3.4.1 Point Map

The point map is a relational map indicating how the processes are related to one another. Each point represents a process, its nearness to other points representing how often these processes are placed into the same groups by the participants (Trochim 1989). The position of the points on the map (e.g., right, left, top, bottom) is not important, only the distance or spatial relationship between them (Kane and Trochim, 2007). The software used here was designed to construct and plot a map representing a process with its corresponding number assigned during the sorting and rating steps. An example of a point map is shown in Figure 3.6:

[6] The concept mapping method was developed to generate a two-dimensional solution because that was more desirable for interpretation than others, in particular when the results needed to be displayed in groups of concepts (Kane and Trochim 2007). The developer of the method based this decision by citing the work of Kruskal and Wish (1978).

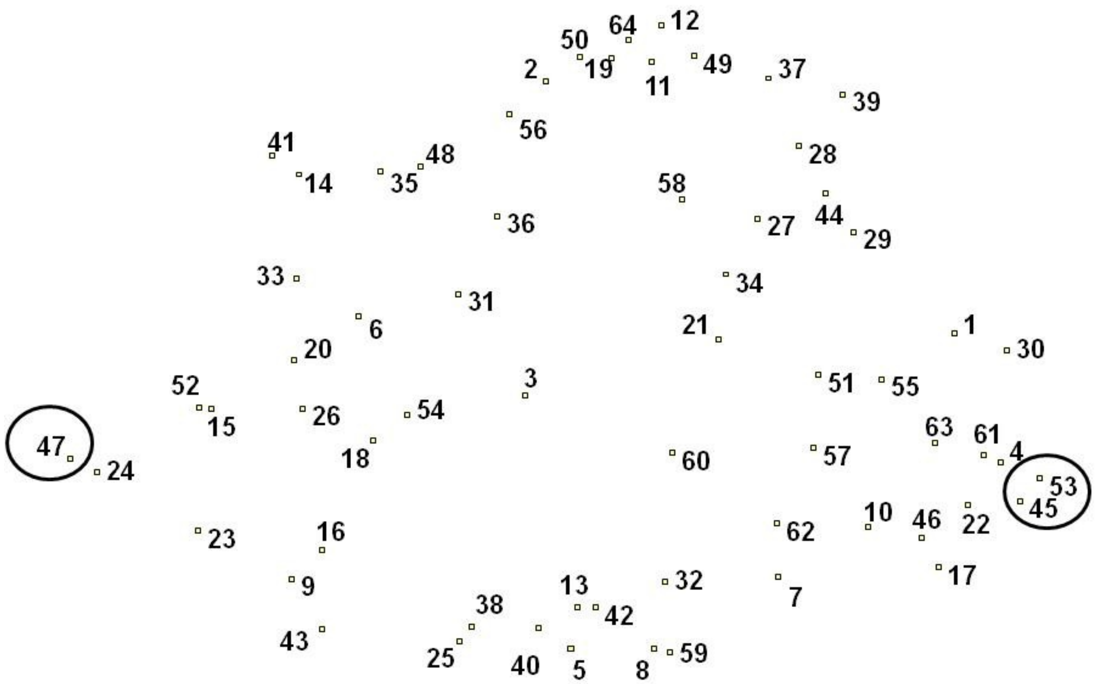


Figure 3.6 Example of a Point Map

In this map, points 45 and 53 are closely related to each other (i.e., they were more often grouped by the participants) compared with point 47 since it is farther away, meaning they were not often grouped. The benefit of such a visual representation for this research is the ability to represent the collective knowledge of the experts. The coordinates (x, y) from this map subsequently served as an input to generate the cluster maps.

3.3.4.2 Cluster Map

In general, a cluster map is a series of polygons formed by various clusters. For this study, this representation allowed for the determination of how social sustainability processes can be categorized based on the experts' judgment. Although this map uses the same data as the point map, it focuses on boundary lines around those points that cluster. The concept mapping method uses a cluster analysis based on Ward's algorithm to determine how individual data points (i.e. processes) cluster based on the distances calculated from the point map[7]. According to Trochim (1989), the analysis of the various cluster maps should begin with a higher number of clusters and work to a smaller number until an appropriate representation is achieved. Typically, for 80 ideas, 5 to 20 clusters are ideal (Trochim 1989). This type of cluster analysis is appropriate for this research because it allows for the categorization of the social sustainability processes previously identified in this study. In addition, this categorization has the potential corroborate the preliminary categories previously presented in Chapter 2.

Similar to the points on a point map, clusters farther away on the map contain processes that were sorted together less often than those closer together. The position of clusters (e.g., right, left) on the map is not meaningful, only the spatial relationships between them. In addition, the shape and size of a cluster indicate whether it is a broad or narrow conceptual area. For this study, the clusters presented in the next chapter represent the categories of social sustainability, providing a conceptualization of them in the planning and design phases of construction projects. Figure 3.7 below shows an example of a cluster map:

[7] Trochim has argued that using this algorithm was the best option for developing the concept mapping method because it generates clusters that do not overlap, allowing for adequate interpretation of the results by researchers and participants (Kane and Trochim 2007). This argument was supported by citing the work of Anderberg (1973) and Hair *et al*. (1998).

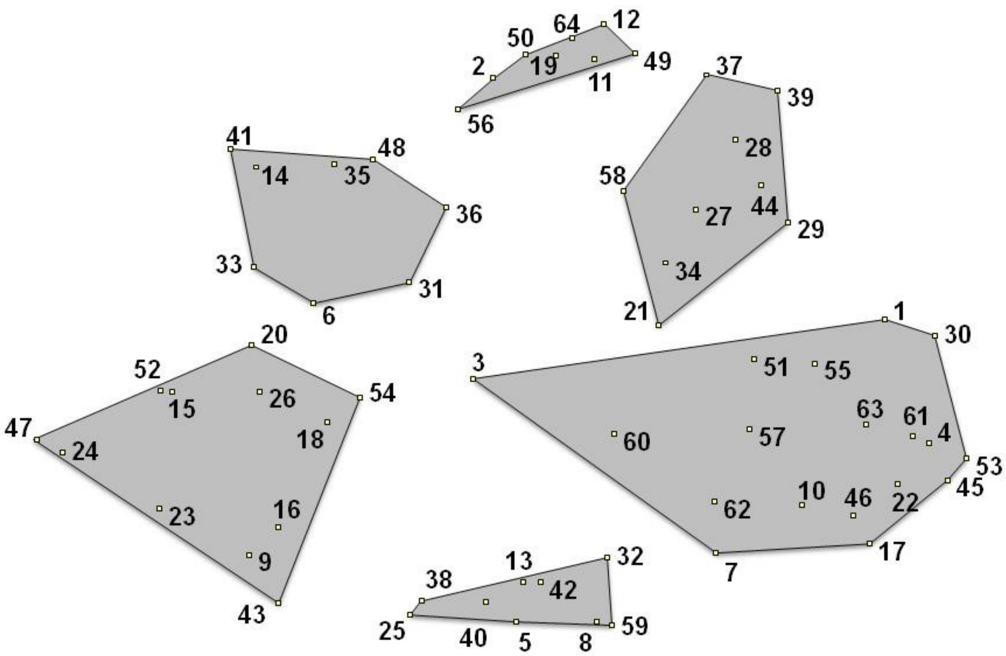


Figure 3.7 Example of a Cluster Map

3.3.4.3 Point Rating Map

The point rating map combines data based on how the participants grouped the processes with their average rating values being based on their Likert-scale responses to generate this three-dimensional map. A point rating map looks similar to a point map, except the height of the points represents the average group rating for each item (see Figure 3.8). Thus, this map identifies those processes considered relevant from the experts' points of view. In addition, the identification of lower ranked processes can suggest where further research is needed.

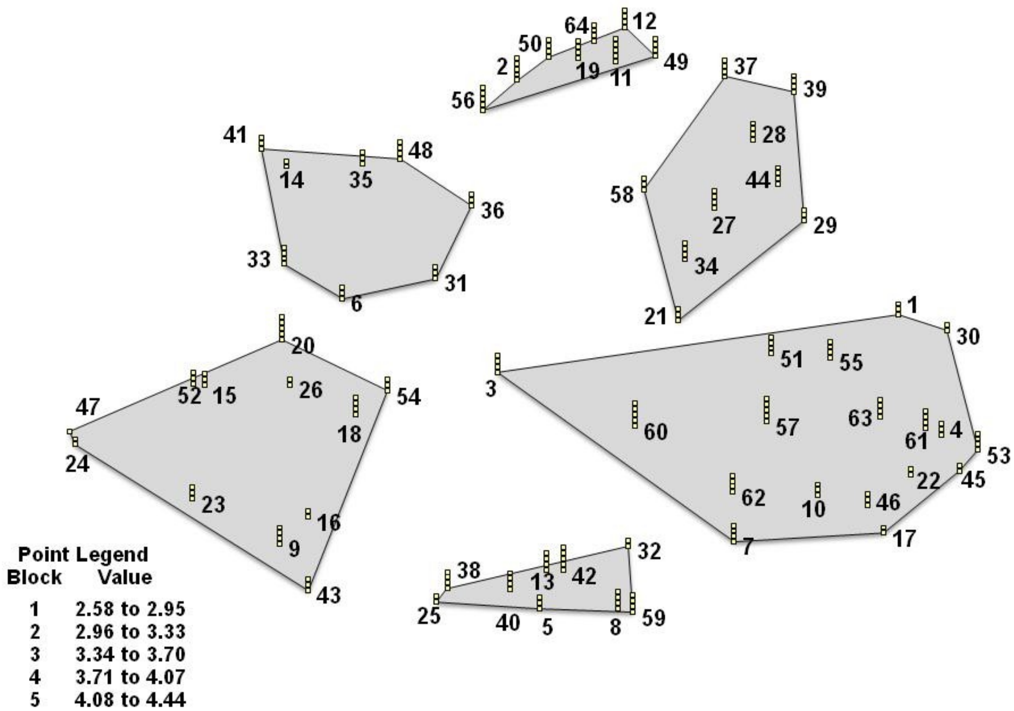


Figure 3.8 Example of a Point Rating Map

3.2.4.4 Cluster Rating Map

In a cluster rating map, the three-dimensional layers of the polygons represent the average cluster rating, calculated by averaging the rating of all ideas in each cluster (Kane and Trochim 2007). For this study, the clusters with higher values contain the processes to which the participants assigned higher values. This overall visual representation provides an idea of the level of importance of each cluster (i.e., category) of social sustainability. Figure 3.9 shows an example of this type of map:

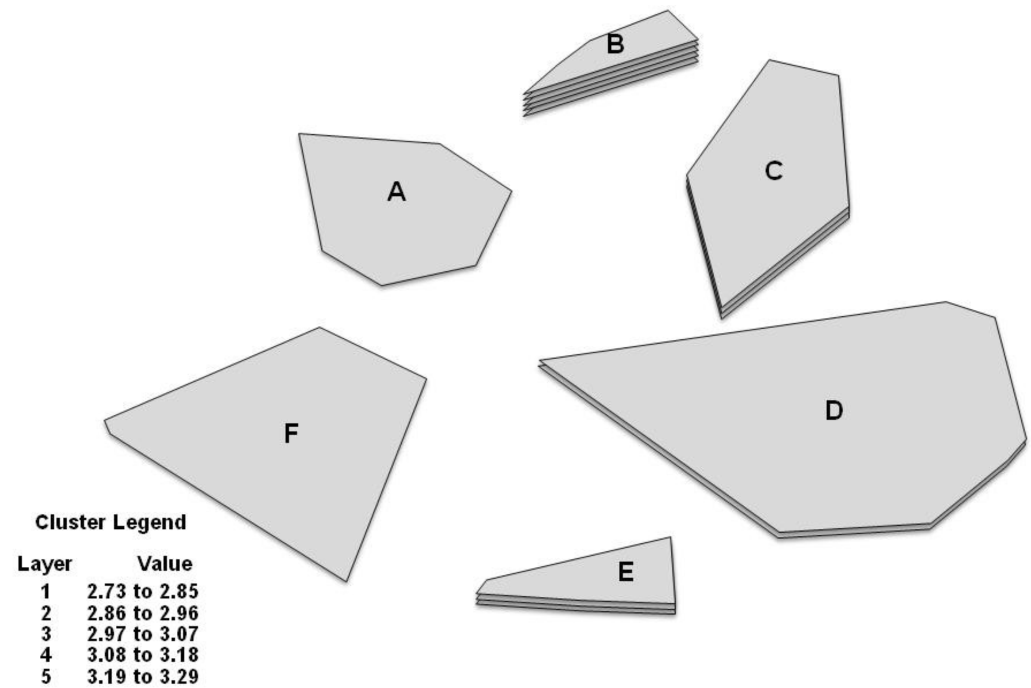


Figure 3.9 Example of a Cluster Rating Map

It is important to remember that the main outcome of these steps is a list of processes of social sustainability grouped into categories and rated according to their relative importance based on group averages. Specifically, the software facilitates the collection of data and the calculation of the MDS and the cluster analysis, allowing the researcher to focus on the interpretation of the categories (clusters) and the processes included in each. This interpretation is based on the literature review. These four types of concept maps help to focus the development of a framework for social sustainability processes in construction projects.

3.3.5 Interpreting Results

The central decision in interpreting the results is determining the number of clusters to select and which processes should be included. To select the final cluster solution, the researcher examined the clusters solutions ranging from 4 to 10, beginning with the highest number continuing downwards. The labeling and the subsequent interpretation are based on the insight of the researcher, the analysis of the information collected from the respondents, and from the literature review. These findings are presented in the next chapter.

In addition, once the final cluster solution is determined, pattern matches can be used to compare the results across subgroups, with the goal of formulating new research questions. Pattern matches compare and contrast the average cluster ratings between two variables, for example the difference in responses between men and women. In general, pattern matching displays a graphic representation of these two response subgroups on each side, with the clusters being listed in the order that they are rated by each subgroup. The data can be represented by color-coded, dashed, or grayscale straight lines that link the cluster name on the left to the same cluster name on the right for ease of viewing.

A perfect correlation or agreement between the two subgroups is displayed as straight lines between the variables being considered. Figure 3.10 illustrates a pattern match created by computing averages across subgroups of participants to arrive at an idea average and then computing averages across all ideas within a cluster to arrive at a cluster average for the variable being considered, in this case two stakeholder groups. A correlation value known as the Pearson Product-Moment Correlation is displayed at the bottom of the graph. This correlation estimates the linear association based on the data for each variable.

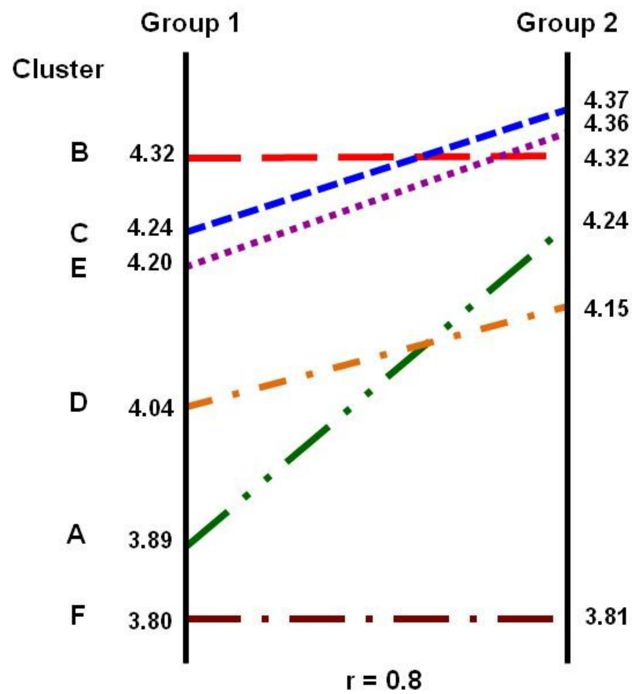


Figure 3.10 Example of a Pattern Matching Between Two Variables

As Figure 3.8 shows, each line in this pattern match indicates a group of ideas that are now represented as a cluster. For example, Clusters B compares very closely across both variables, being given a high average by both groups, whereas Cluster A has very divergent average ratings and other clusters have moderately different ratings. This type of display allows for identifying divergence of opinion between participant subgroups (Marquart 1988, Kane and Trochim 2007), which helps to identify future research questions related to various subgroups of experts as presented in the next chapter. In addition, comparing different subgroups guided the researcher in identifying the limitations and implications of this new knowledge.

3.4 Chapter Summary

This chapter has provided an overview of the concept mapping method used throughout this study. This method was appropriate for accomplishing the goals of this research project because it provides a flexible means of asking experts to identify, cluster, and rate processes of social sustainability in a timely manner. In addition, the analysis of the findings helps to identify conceptual categories based on expert knowledge without the use of forced classifications that may introduce individual bias.

In particular, the final cluster selection of the categories and their processes of social sustainability indicate those that should be integrated during the planning and design phases of construction projects. The data from the cluster analysis were subsequently used to develop a conceptual framework outlining the categories of social sustainability that should be considered during the planning and design phases of construction projects. By involving various experts from various professional backgrounds, this framework can be more representative and generalizable for construction projects. The specific results and analysis are further explained in Chapter 4.

CHAPTER 4

RESULTS AND ANALYSIS OF THE CONCEPT MAPPING

The purpose of this chapter is to present and analyze the research findings from employing the concept mapping method. In particular, the following steps are discussed: the Multidimensional scaling (MDS) analysis of the sorted data, the Cluster Analysis of the MDS coordinates to determine a final cluster solution, and the selection of the cluster names. The intent of these analyses is to determine how the 50 processes selected during the idea generation phase were categorized and rated by the 16 experts. The data used here were the result of the experts' responses to the sorting and rating steps of the concept mapping method. As a result, this categorization furthers the understanding of social sustainability for construction projects.

In addition, this chapter includes the pattern matching analysis that informed the formulation of future research questions and a proposed practical guide. This guide could explain more effectively to practitioners and academics as well as lay audiences the social sustainability concept in construction projects. Finally, the validity of the results at each stage of the analysis is discussed.

4.1 Multidimensional Scaling Analysis

Two techniques are used in concept mapping to help understand the relationships among concepts. The first is MDS, which helps evaluate such constructs as social sustainability that are difficult to measure and that may be evaluated in various ways by experts (Kane and Trochim 2007). Using MDS, concepts judged to be similar in meaning will fall close together in multidimensional space while those considered unrelated will be farther apart. Thus, MDS is used to assess perceived similarities and differences among concepts, helping the researcher to understand the group knowledge obtained from the experts.

The 50 processes originating from the literature review and the experts' knowledge were clustered by 16 experts from industry, academia, and government organizations/institutions. Appendix C presents the clusters generated by each expert and his/her rating of each process. Based on this individual clustering, a software was used to generate individual binary matrixes for each participant; then, all of these matrixes were combined to create an aggregated matrix serving as the input into MDS (see Appendix D).

A two-dimensional map of distances among the processes was then determined by MDS, resulting in the best representation of the aggregated matrix. For instance, the most similar pair (processes 8, 17) must be located closer together than any other pair in this two-dimensional space and the least similar pair (processes 17, 30) must be farther apart. According to Trochim (1989), in the concept mapping method, this two-dimensional solution is a useful representation for further interpretations by participants as well as when this solution is joined with the cluster analysis proposed by Kruskal and Wish (1978). Concept mapping software was subsequently used to analyze this data matrix to create the point map shown in Figure 4.1.

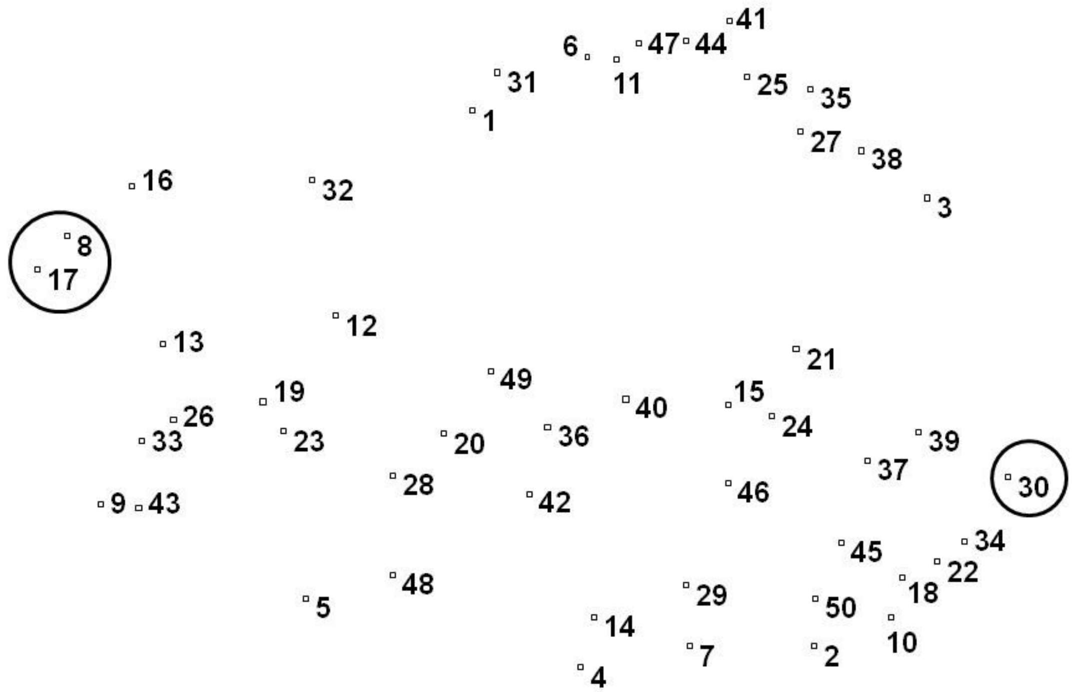


Figure 4.1 MSD Point Map Showing the 50 Social Sustainability Processes

As seen in this figure, the point map presents these relationships as geometric configurations closely corresponding to the original matrix. The important aspect of this figure is the spatial relationship among points, i.e. positioning similar processes close together. In other words, processes that are closer together on this point map were sorted together more often than those farther apart. For example, in the research reported here, pair processes 8 and 17 were matched 10 times more than pair 17 and 30, which were never combined by the experts.

In MDS, the important diagnostic statistic is the stress index, which ranges from 0 to 1, where the former represents the perfect fit and the latter the worst fit by considering the sum square discrepancies divided by a scale factor (Krustal and Wish 1978). In other words, a higher stress value implies that there is a greater discrepancy in the distances on the map compared with the input data in the aggregated matrix. Likewise, when creating a geographical map, the physical representations should correspond to the data obtained from surveying measurements, which represent the input to generate the map. However, the map might not accurately represent the physical locations producing discrepancies between the measurements and the map, influencing the accuracy of the results. When referring to the representation of concepts, this accuracy is measured in terms of stress, in particular, in the concept mapping method (Trochim 1989).

This study had a stress value of 0.257 based on 24 interactions, which is a value similar to those found in other concept mapping studies using the same number of participants. Specifically, Trochim (1993) identifies a range of stress values in concept mapping from 0.155 to 0.352, with an average of 0.285. Consequently, there is confidence in the geometric configuration of the point map presented here based on the stress value.

4.2 Choosing a Final Cluster Solution

The second technique used in concept mapping is Cluster Analysis, which helps to group similar concepts. To initiate its application, the coordinates obtained from the MDS are used to group concepts based on their proximity by computing their Euclidean distance, which is the shortest distance between two points. Then, Ward's algorithm developed by Ward (1963) was applied to the point map coordinates to cluster the processes based on similarity. According to Kane and Trochim (2007), this type of cluster analysis, which combines MDS coordinates and the Ward's algorithm, was selected for the concept mapping method because it yields non-overlapping cluster solutions, providing interpretable maps. As a result, the clusters are developed sequentially as seen in Figure 4.2.

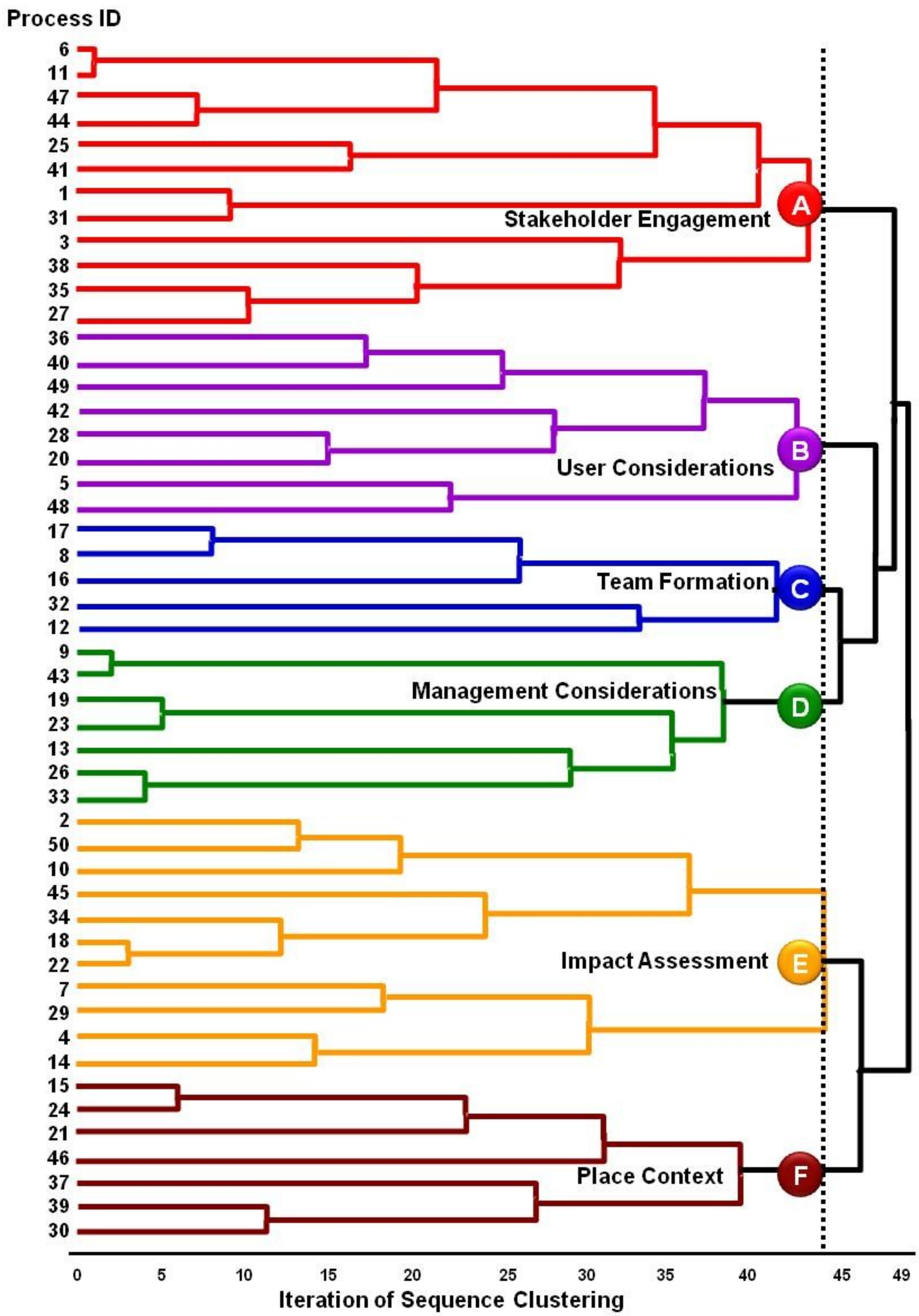


Figure 4.2. Dendogram of the 50 Social Sustainability Processes Using Cluster Analysis

As the dendogram, or tree diagram, in this figure illustrates, the iteration of sequence clustering began with each of the 50 processes individually and continued until all of them were integrated into just one cluster. The benefit of this diagram is that one can follow when each of the 50 processes clustered. For instance, processes 6 and 11 were the first two to be grouped in Cluster A, while processes 12 and 32 were the last ones to become part of Cluster C.

The segmented vertical line in the figure indicates the point at which the clustering solution best represents the data based on the analysis of the researcher. Using the review processes described by Trochim (1989), from 8 to 4 clusters were analyzed to determine an appropriate cluster solution for categorizing the 50 processes of social sustainability. This determination was based on three general guidelines, the first being the evaluation of how many clusters the experts used individually, resulting in a range from 4 to 10 representations in this study. This first guideline was also confirmed by the typical range of clusters recommended in previous research for similar size data sets; for instance, a range of 8 to 20 is good for 100 ideas (Jackson and Trochim 2002). By assuming a linear relationship, if there are 50 processes in this study, the required range should have 4 to 10 clusters. Figure 4.3 shows the frequency graph of the number of clusters created by the experts. The total number of clusters created by the experts was 109 with an average of 7.3 processes in each.

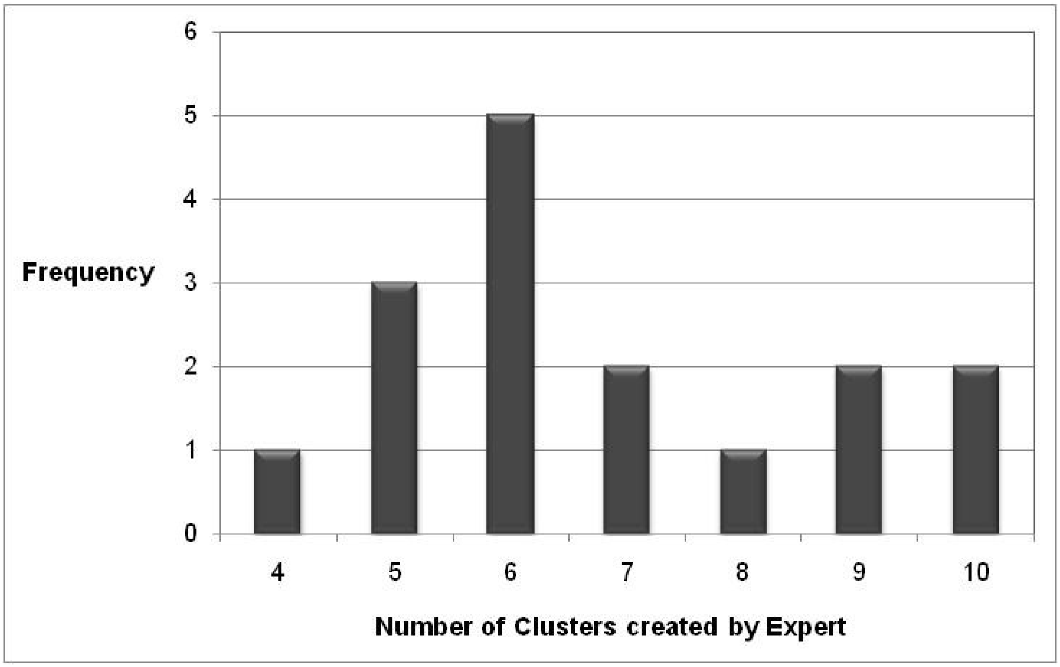


Figure 4.3 Frequency of Number of Clusters Created by the Experts

The second guideline used was that each solution had to include at least three processes in each of the cluster representations. These two first guidelines were met after iteration 42, which formed a group of 8 clusters as show in Figure 4.4. The representation of the solution with 4 clusters is illustrated in Figure 4.5. Then each of these 8 to 4 clusters solutions was analyzed to determine the appropriate solution. To select the number of clusters that "best" fit the data the researcher's judgment was informed by the literature review because there is no mathematical criterion that can be applied (Trochim 1989). This decision was also based on keeping a logical conceptual representation. For the research presented here, the selected number of clusters was six, labeled A-F in Figure 4.2 and Figure 4.6.

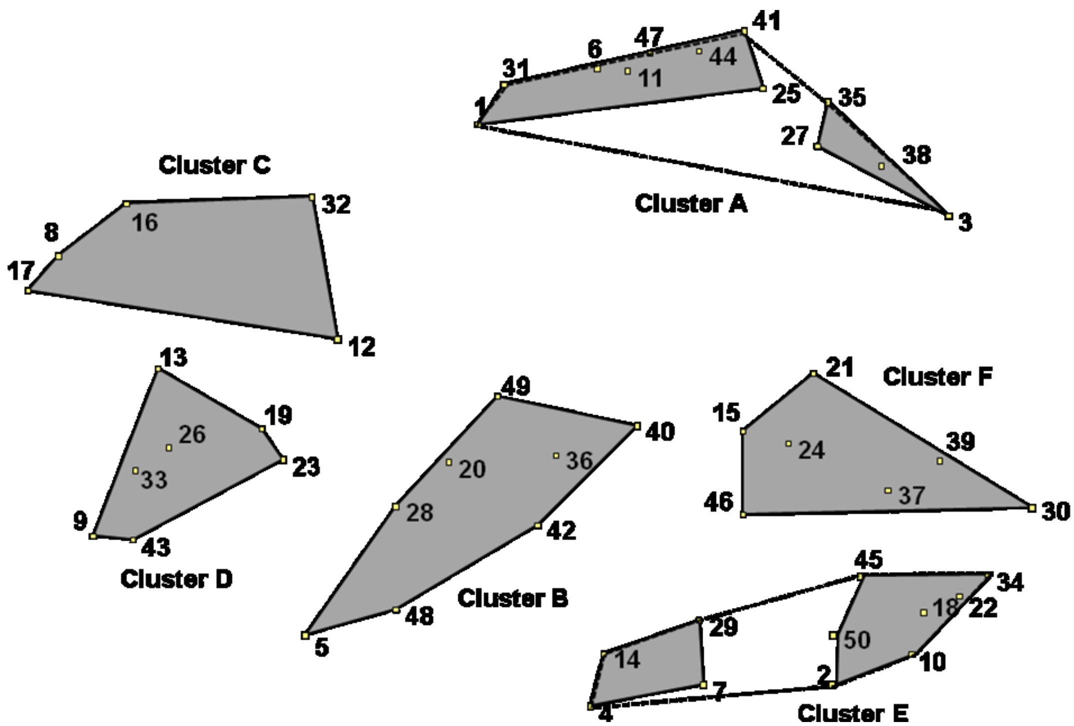


Figure 4.4 Cluster Map Representing a Solution of 8 Clusters

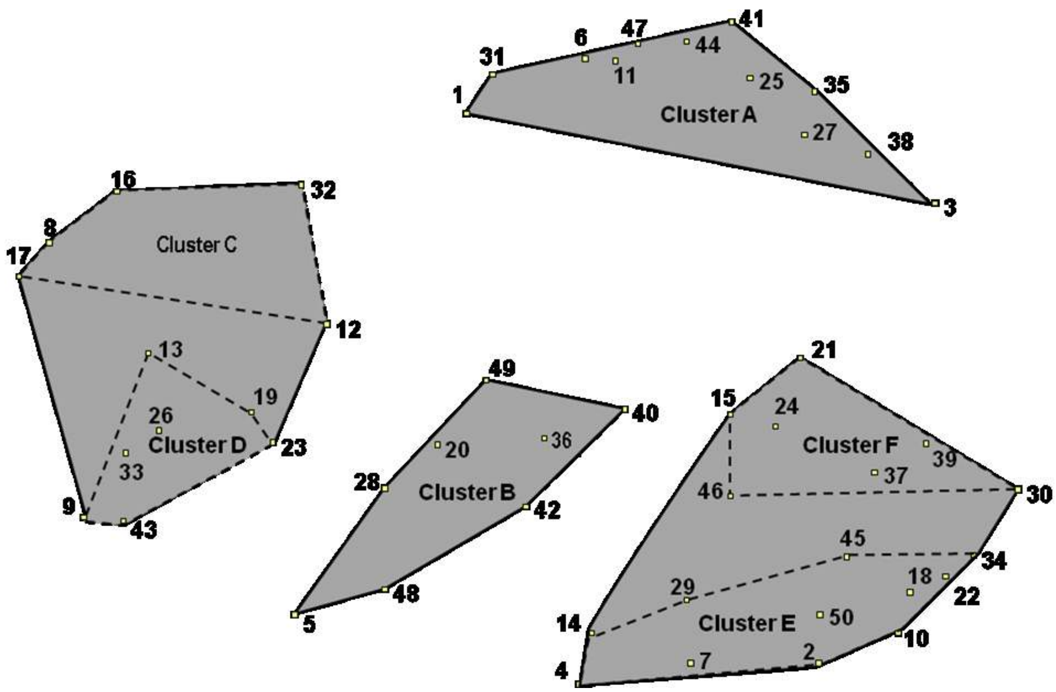


Figure 4.5 Cluster Map Representing a Solution of 4 Clusters

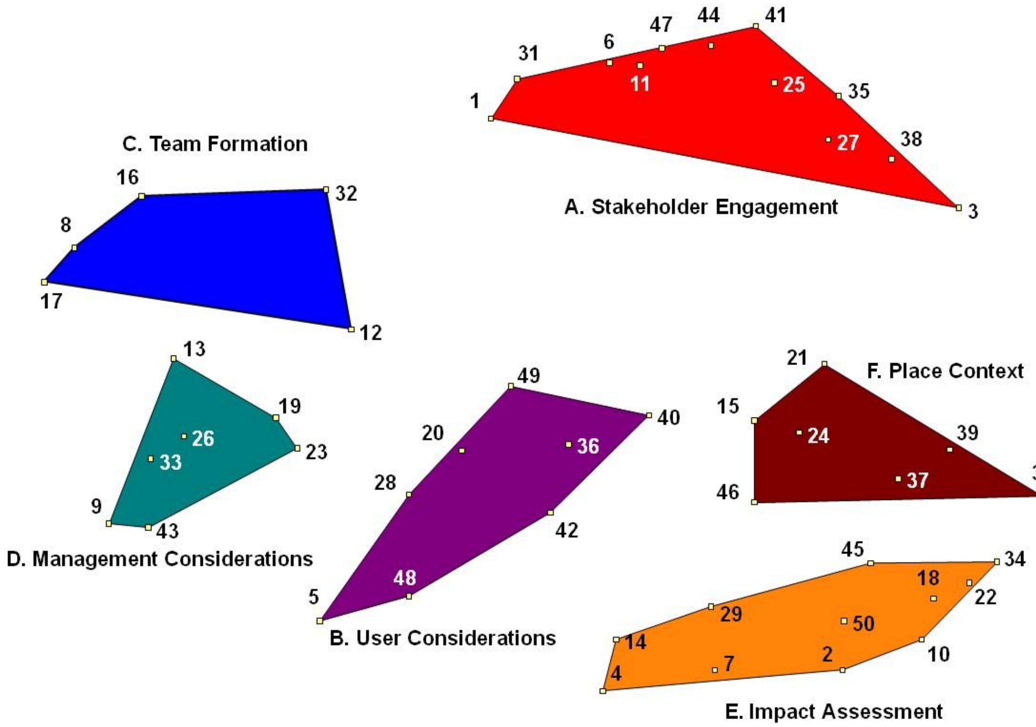


Figure 4.6. Cluster Map Representing the Six Cluster Solution

In interpreting these clusters maps, it is important to remember that these figures also indicate the processes in each cluster, each represented by a point accompanied by their ID. For example, Cluster C (Team Formation) contains the processes 8, 12, 16, 17, and 32. Details about the description of each of the clusters are in section 4.3. The proximity of these clusters indicates how similar these processes were considered to be by the experts, meaning they were sorted together more often than those that are farther apart. In addition, the distance between the clusters is the meaningful indication of their relationship, not the locations of each cluster on the map, for example, at the top left or bottom right.

In this study, the shape and size of a cluster are influenced by the number of processes in each of them and if their meaning is closed or wide-ranging. The more compact the cluster area, the more processes it contains that the experts judged to be closely related. For example, Cluster E contains 11 processes with a higher relationship among them, indicating that most of experts considered them to be closely related. In contrast, the processes in Cluster C indicate that they have the lowest relationship compared with the previous cluster based on its size and the fact it includes only five clusters.

To assist in the interpretations of the clusters, the bridging values, which range from 0 to 1, were determined to indicate how often a process was sorted with others on the map. Lower bridging values suggest a cohesive relationship with other concepts in the vicinity (Jackson and Trochim 2002). For this study, processes with higher bridging values indicate that the meaning is related across other parts of the map more often than those that have lower values. This information is helpful in understanding if a process represents its surrounding location or if it bridges relations with processes across the map. The bridging values are calculated by combining the proportion of experts who group any of two processes (*i*,*j*) and the distances between them determined by the MDS (Trochim 1989).

Appendix E shows the steps for calculating these values, and Appendix F contains the specific bridging values of the processes divided by each of the six cluster solution. Specifically, Table 4.1 shows the bridging values for the six cluster solution, which were obtained after adding the bridging values of each process within a cluster and dividing by the number of processes in that specific cluster. Clusters with higher bridging values are more likely to "bridge" between other clusters on the map than those that have low bridging values, which are usually more cohesive, representing better the content in that specific part of the map.

Table 4.1 Final Cluster Solution Bridging Values

Cluster	Bridging Value
A- Stakeholder Engagement	0.37
B- User Considerations	0.47
C- Team Formation	0.83
D- Management Considerations	0.69
E- Impact Assessment	0.28
F- Place Context	0.45

The results show that there is more cohesiveness in Cluster E (Impact Assessment) than in Cluster C (Team Formation). In other words, those processes in Cluster E are more related to their own area. However, the processes in Cluster C have more connectivity with some of the processes nearby such as those in Clusters A, B and D. This type of information helps in the interpretation of previous results when deciding if a cluster should remain separated or combined with others.

4.3 Selection of Cluster Names

The next step in the analysis was to identify the names that best identify each cluster. The final selection was determined based on the researcher's judgment because not all the results based on the centroid analysis[8] used by the Core Concept System software captured the theme of the clusters. This selection of names began by reviewing the cluster names created by the experts; see Appendix G for the complete list. Then to ensure an inclusive name representing all the processes in each, a series of discussions with two people with expertise in social sustainability were held to eliminate personal bias.

The resulting names for each of the six clusters originating from this analysis are below as well as the content of each of them:

- Cluster A: **Stakeholder Engagement** consists of the 12 processes that address collaboration among the various stakeholders, fundamental for obtaining a sustainable project. Determining the expectations and perceptions of the owner, designers and public is critical early in the project. This allows for the generation of a stakeholder management plan, which includes provisions for communicating the outcomes, constraints, and deliverables of the project. This plan helps to respond to stakeholder concerns in a timely manner. In addition, the requirements for encouraging local government and neighborhood engagement allow decision makers to understand and anticipate their needs. This cluster also involves educating the public about the planning and design phases as well as future processes such as the commissioning one. Another important aspect is to document and share the lessons learned during the planning and design phases with all stakeholders. Finally, the importance of

[8] For those who would like to know more about the centroid analysis refer to the discussion presented by Jackson and Trochim (2002).

having such strategies as partnering in place for resolving conflicts among stakeholders is emphasized in this cluster.

- Cluster B: **User Considerations** involves eight processes focusing on productivity, safety, health, and security of the final users, key components of the social sustainability concept. These components can be determined by using a Evidence-Based Design method. This cluster includes minimization of the disruption caused in the construction phase, e.g., traffic congestion, dust and noise. Furthermore, the construction project should be designed to consider the job skills of the women, young people, unemployed and other minority groups in the surrounding community. Finally, the planning and design phases should include provisions for monitoring incidents of corruption ranging from stealing and misuse of information to requesting special treatment in a contract, which is related to the sustainability principle of transparency.

- Cluster C: **Team Formation** is composed of five processes concerning the selection of design and construction firms which have a sustainability focus. This design team should be composed of various professions, genders, races and firm sizes. In addition, this cluster emphasizes forming a team with knowledge about health topics who can analyze the health impact on the final users and the community. Using an integrated design-construction process is also included to improve project performance.

- Cluster D: **Management Considerations** involves seven processes influencing the health, safety and productivity of the temporary and final users by including prevention techniques to minimize occupational hazards and risks during the construction and operation phases. To do so, this cluster considers training designers on future hazards and prevention techniques during the construction and maintenance phases of the project. In addition to training designers, this cluster considers future education, training, counseling, prevention and risk-control programs to assist workforce members, their families, or community members affected by serious diseases resulting from the execution of the project, e.g. the removal of asbestos. Another component of this cluster considers the use of local construction labor and local materials/product suppliers to invest in the surrounding community. Because it focuses on considerations required to administrate the processes included in the User Considerations and the Team Formation clusters, it seen as the bridge between these two.

- Cluster E: **Impact Assessment** involves 11 processes, which are divided into two subgroups, one considering the social impact assessment on the surrounding community and the second on the health impact assessment of the users. These assessments allow for understanding the needs of the various stakeholders such as the future community infrastructures resulting from the construction project. These assessments range from physical considerations (the access to public transit and green spaces) to resources (cultural, historical, and archeological) as well as changes in populations based on introducing new social classes, ethnic groups, and seasonal population, all of which affect socio-economic patterns. In addition, this cluster includes a health assessment of materials and products that can impact workforce safety and health based on the life cycle approach. A Post-Occupancy Evaluation of similar projects supports this health assessment. More importantly, the results of these various assessments should be incorporated into a return on investment analysis, translating these impacts into costs and schedules in the documentation of the project.

- Cluster F: **Place Context** encompasses seven processes related to analyzing the location of the project in terms of the user needs. This cluster includes the need for creating a design that instills pride in ownership for the users and the surrounding community such as maintaining and restoring natural habitat. It includes privacy considerations and human interaction for the final users as well as assessing the planning and zoning decisions of organizations and institutions with jurisdiction over the proposed project area. In addition, the Asset-Based Design analysis of the surrounding community helps to convert social liabilities into assets. Finally, it includes a plan for the ongoing evaluation of the impact of the project on the surrounding communities during its execution and operation. For instance, monitoring the integration of the use of space will help to improve future designs and to incorporate measures to reduce social inequalities. This cluster relates to the Stakeholder Engagement, User Considerations and Impact Assessment clusters as it emphasizes the impact of the project on the users and the community.

The various clusters and their names, the primary results of this research, guide the development of an empirical framework. This framework defines social sustainability processes in construction projects, which was not clearly delineated in the literature. While the selection of the final number of clusters is based on human judgment, this selection is informed by the MDS and cluster tree analysis (Trochim 1989). For this study, the researcher is providing his interpretations based on the literature review. However, future research, which includes the input from the experts, could be conducted to enhance these interpretations.

4.4 Cluster Rating Analysis

Experts also ranked the importance of the 50 social sustainability processes during the planning and design phases of construction projects by using a Likert-type scale. The following question formed the basis for this evaluation:

How important do you consider each process for inclusion during the planning and design phases of a construction project, with 1 indicating little importance and 5 high importance?

The experts were asked to rate these processes considering what is best for society as a whole rather than what is best for a single group, company, institution or industry. Table 4.2 shows the average rating of each process and the descriptive statistics by cluster. To obtain these values, first the ratings of each process by the 16 experts were averaged, and then to obtain the cluster rating, the average rating of each process within a cluster was added and divided by the number of processes in that particular cluster. For instance, Cluster A includes 12 processes with an average rating of 4.32.

Table 4.2 Summary Rating Results of the Six Cluster Solution

ID	Social Sustainability Process	Importance
Cluster A: Stakeholder Engagement		
1	Determine the expectations of the owner, designer and public early in the project	4.94
27	Ensure participation of final users in design so that decision makers can understand and anticipate their needs	4.63
11	Generate a stakeholder management plan that encourages interaction, integration, and collaboration among stakeholders	4.63
44	Communicate the deliverables and intended project outcomes with each stakeholder group	4.56
25	Inform stakeholders of the project constraints (e.g. budget, schedule, location, size, design and construction standards)	4.50
6	Engage local governments in design so that decision makers can understand and anticipate their needs	4.44
3	Respond quickly to community concerns and perceptions	4.25
41	Document and share the lessons learned during the planning and design phases with all stakeholders	4.13
38	Encourage neighborhood engagement in the design	4.13
35	Educate the public about the planning/design progress	4.00
31	Establish partnering strategies for resolving interpersonal conflicts among project stakeholders	3.88
47	Communicate the rationale for the commissioning process to the stakeholders	3.81
	No. Processes: **12** Std. Dev.: **0.33** Average:	**4.32**
	Variance: **0.11** Median:	**4.34**
Cluster B: User Considerations		
42	Provide a plan to minimize disruption caused by the construction process (e.g. traffic congestion, dust and noise)	4.50
36	Include security considerations for the final users in the project design	4.38
40	Establish requirements to assess the impact of the project on the health and safety of the final users	4.38
20	Adopt designs that increase the wellness and productivity of the final users	4.31
49	Monitor and respond to incidents of corruption	4.31
28	Establish a plan to evaluate progress on Zero Harm or Zero Accident targets for the project	4.25
5	Use an Evidence-Based Design process, basing decisions about the built environment on valid and reliable research	4.06
48	Design to consider the job skills of the women, young people, unemployed, disadvantaged, racial and ethnic minority groups in the area	3.56
	No. Processes: **8** Std. Dev.: **0.27** Average:	**4.22**
	Variance: **0.08** Median:	**4.31**

Table 4.2 Summary Rating Results of the Six Cluster Solution (Continued)

ID	Social Sustainability Process				Importance
Cluster C: Team Formation					
32	Use an integrated design-construction process				4.38
16	Select design and construction firms with a sustainability focus				4.25
12	Include health professionals in the design team to help analyze health impacts on the final users and the community				3.69
8	Select a diverse design team including participants from various professions, genders, races, and firm sizes				3.69
17	Use local designers and professionals				3.31
	No. Processes: **5**	Std. Dev.:	**0.39**	Average:	**3.86**
		Variance:	**0.16**	Median:	**3.69**
Cluster D: Management Considerations					
19	Establish Zero Harm or Zero Accident targets for the project				4.50
23	Incorporate safety prevention techniques that prevent or minimize occupational hazards and risks during construction (e.g. the analysis of the sequence of construction activities, the use of prefabrication techniques)				4.44
13	Train designers to help them address future hazards during the construction and maintenance phases of the project				4.06
43	Use local material/product suppliers for the project				3.88
9	Design to enable the use of local construction labor				3.75
26	Require a management plan for improving construction worker productivity				3.38
33	Require education, training, counseling, prevention, and risk-control programs to assist workforce members, their families, or community members regarding serious diseases				2.81
	No. Processes: **7**	Std. Dev.:	**0.55**	Average:	**3.83**
		Variance:	**0.30**	Median:	**3.88**

Table 4.2 Summary Rating Results of the Six Cluster Solution (Continued)

ID	Social Sustainability Process	Importance
Cluster E: Impact Assessment		
22	Analyze new/additional community infrastructure needs resulting from the project (e.g. water, power, emergency responders)	4.63
50	Analyze the impact of the project location on access to public transit, biking opportunities, safe walking routes, and green spaces	4.63
2	Conduct a social impact assessment of the project	4.25
10	Analyze the effect of the project on cultural, historical, and archeological resources	4.25
7	Conduct a Health Impact Assessment	4.13
14	Incorporate social considerations (e.g. health, productivity, quality of life) into a return on investment analysis (ROI)	4.06
29	Assess the results from Post-Occupancy Evaluation of similar projects	3.88
18	Assess the impact of introducing new social classes into the surrounding community (e.g. a community where low-income housing is proposed might perceive the new social class as a threat based on stereotypes and misconceptions)	3.88
4	Conduct a social life cycle analysis of construction products and materials that considers workforce safety and health	3.75
34	Analyze the impact of the project on the cultural and ethnic identity of the surrounding community	3.75
45	Assess seasonal population changes in the surrounding community and their effect on employment patterns, business practices, and community infrastructure	3.50
	No. Processes: **11** Std. Dev.: **0.34** Average:	**4.06**
	Variance: **0.12** Median:	**4.06**
Cluster F: Place Context		
21	Create design features that instill pride in ownership of the users and the surrounding community	4.38
24	Include human interaction (connectivity) considerations for the final users in the project design	4.38
37	Assess the planning and zoning decisions of organizations/institutions with jurisdiction over the proposed project area	4.38
46	Maintain and/or restore natural habitat important to the final users and the surrounding community	4.38
30	Perform an asset-based design analysis of the surrounding community so that design solutions can convert social liabilities into assets	3.88
39	Develop a plan for ongoing evaluation of the impact of the project on surrounding communities once it is in operation	3.81
15	Include privacy considerations for the final users	3.31
	No. Processes: **7** Std. Dev.: **0.39** Average:	**4.07**
	Variance: **0.15** Median:	**4.38**

This information can be also graphically displayed in point rating and cluster rating maps. Figure 4.7 shows the point rating map of the six social sustainability clusters proposed by this research.

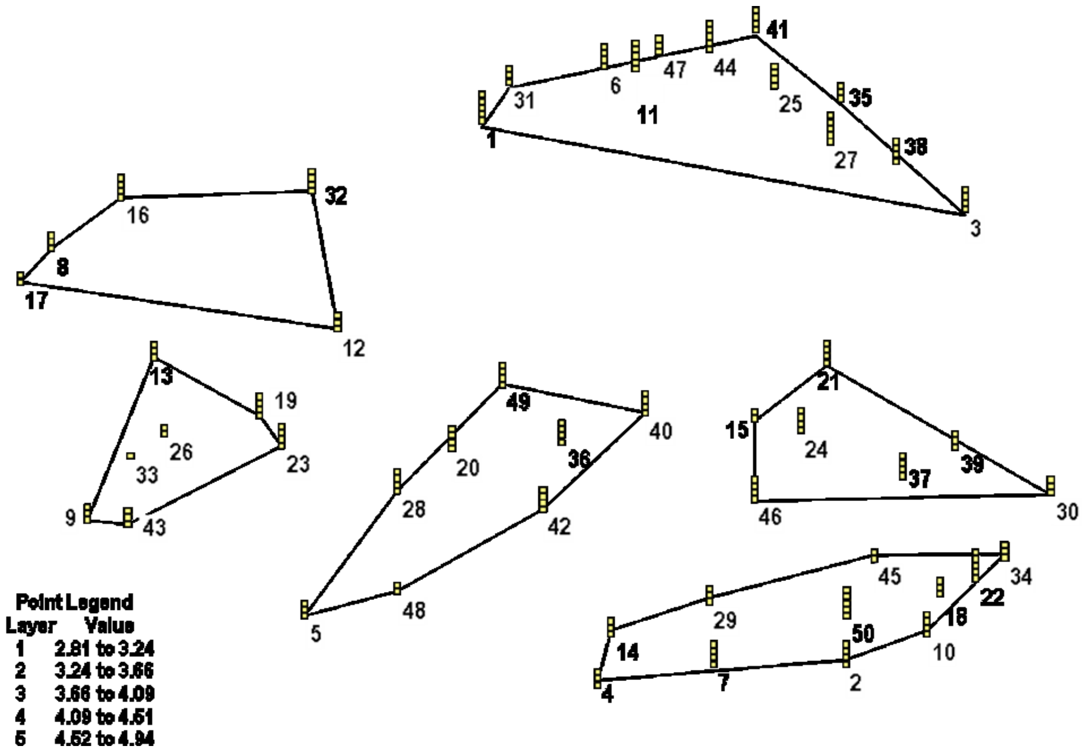


Figure 4.7 Point Rating Map Along with the Six Cluster Solution

The level of importance of these processes is indicated by the number of blocks shown for each one. These blocks range from one to five. The more blocks for a process, the more important it is according to the experts' judgments. In this figure the legend in the lower left corner indicates the importance of these processes. For instance, if a point is represented by 5 blocks, then its average rating is between 4.51 and 4.94. Based on these results, the top-rated and bottom-rated processes are shown in Table 4.3 and 4.4, respectively.

Appendix H shows a complete list of how each expert rated each process and Appendix I shows the frequency rating distributions for each process. This list was reviewed to verify that experts did not answer all one rating for every process (for example, rating everything a 5 just to finish quickly). The frequency distributions were reviewed to ensure that low overall ratings, for example, were not the result of a small number of individuals who gave very low ratings.

Table 4.3 Top-Rated Processes

ID	Process	Rating
1	Determine the expectations of the owner, designer and public early in the project	4.94
50	Analyze the impact of the project location on access to public transit, biking opportunities, safe walking routes, and green spaces	4.63
27	Ensure participation of final users in design so that decision makers can understand and anticipate their needs	4.63
22	Analyze new/additional community infrastructure needs resulting from the project (e.g. water, power, emergency responders)	4.63
11	Generate a stakeholder management plan that encourages interaction, integration, and collaboration among stakeholders	4.63
44	Communicate the deliverables and intended project outcomes with each stakeholder group	4.56
19	Establish Zero Harm or Zero Accident targets for the project	4.50
25	Inform stakeholders of the project constraints (e.g. budget, schedule, location, size, design and construction standards)	4.50
42	Provide a plan to minimize disruption caused by the construction process (e.g. traffic congestion, dust and noise)	4.50

Table 4.4 Lowest-Rated Processes

ID	Process	Rating
33	Require education, training, counseling, prevention, and risk-control programs to assist workforce members, their families, or community members regarding serious diseases	2.81
15	Include privacy considerations for the final users	3.31
17	Use local designers and professionals	3.31
26	Require a management plan for improving construction worker productivity	3.38
45	Assess seasonal population changes in the surrounding community and their effect on employment patterns, business practices, and community infrastructure	3.50
48	Design to consider the job skills of the women, young people, unemployed, disadvantaged, racial and ethnic minority groups in the area	3.56
8	Select a diverse design team including participants from various professions, genders, races, and firm sizes	3.69
12	Include health professionals in the design team to help analyze health impacts on the final users and the community	3.69

Notably, all the processes were rated by the experts as being at least moderately important as shown in Figure 4.8.

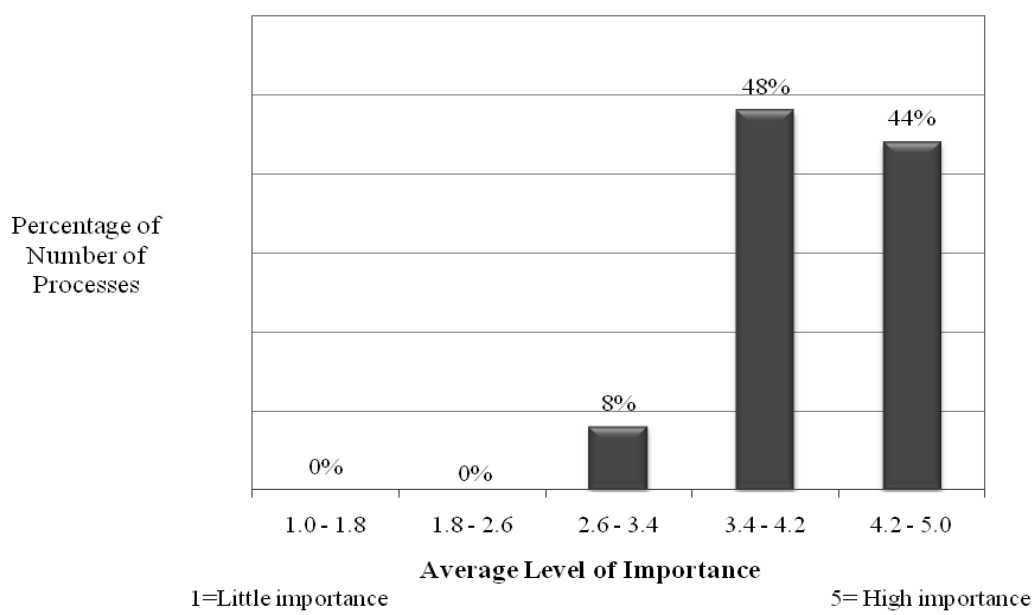


Figure 4.8 Percentage of the Number Processes by Level of Importance

This graph shows that 92% of the processes have an average rating above 3.4, meaning that most of the expert ratings were above 3 on a Likert-scale of 1 to 5. These results reinforce the need to have all these processes integrated during the planning and design phases of construction projects. In the event that prioritization of these processes is needed, a selection of the most important ones can play an important role. Future research could investigate the impact of focusing on those processes receiving the highest ratings to accomplish social sustainability goals in a construction project.

In addition, the rating data was averaged for each cluster and graphically displayed as a third dimension in a cluster rating map as seen in Figure 4.9.

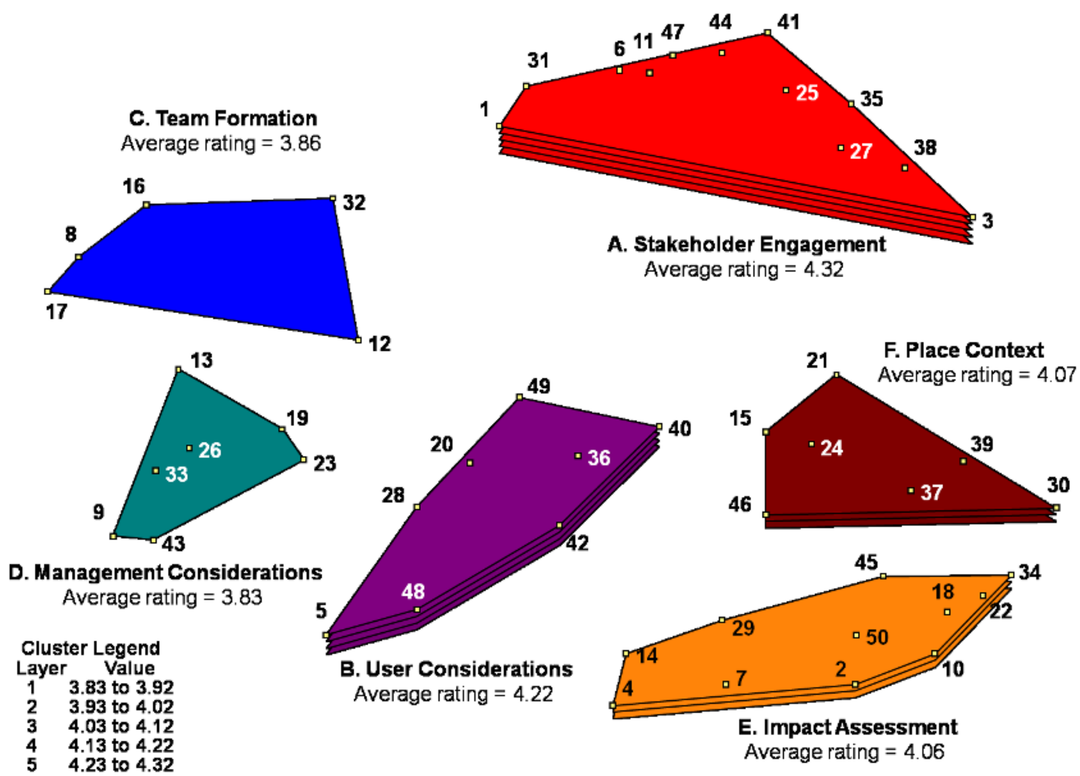


Figure 4.9 Cluster Rating Map Representing the Six Cluster Solution

In this figure the importance of the cluster is shown by the number of layers it has. These layers range from one to five, with the more layers in a cluster, the more important it is based on the experts' ratings. The legend in the lower left corner of this figure indicates the importance of these layers. For example, a cluster with 3 layers, such as Clusters E and F, exhibits an average rating between 4.03 and 4.13 on the importance scale. It is important to remember that the average represented by the layers is the result of averaging across all of the experts and all of the processes in each cluster. The rating cluster map shows that the two highest clusters are Cluster A (Stakeholder Involvement) and Cluster B (User Considerations) with an average of 4.32 and 4.22, respectively.

While these results show the specific processes and clusters that one should focus on to obtain the outcomes of social sustainability, the feasibility of selecting the most relevant processes could involve considering other factors such as selecting those processes relevant for accomplishing social sustainability outcomes and appropriateness for the type of construction project. Thus, future research could be conducted to select these factors and others considering an expert-based approach.

4.5 Pattern Matching Results

Pattern matching is a technique for more fully comparing the responses of experts across the clusters. This section presents the results three of such analyses used in this research: current job position, years of experience, and gender. These factors were selected because they potentially influence the perspectives of social sustainability. In addition, they were appropriate for forming representative subgroups based on the demographics of the experts sampled, ones that could yield meaningful questions for future research. However, these results are not statistically significant because of the size of the expert sample.

The first pattern matching analysis compares experts currently holding an academic position or members of a research institution with the experts from industry (design and construction firms) and government institutions. Figure 4.10 shows the average rating of each cluster for these subgroups.

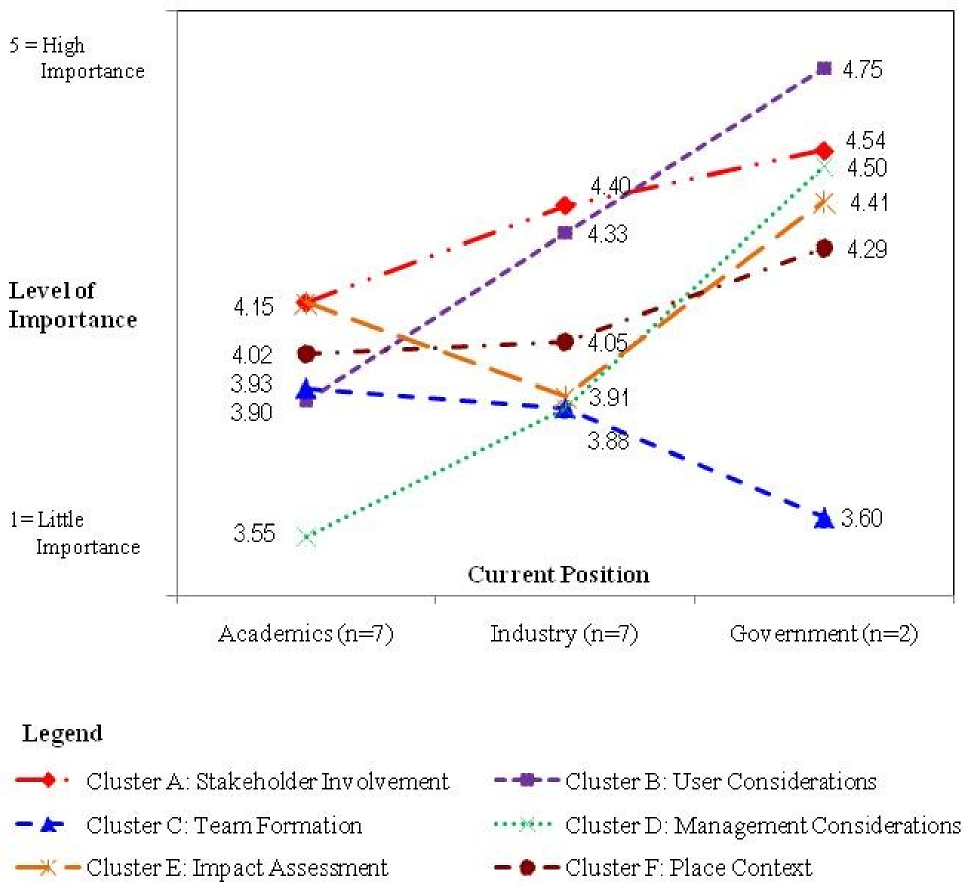


Figure 4.10 Pattern Matching of Cluster Importance Comparing Current Professional Position

These results indicate that academics judged Cluster D (Management Considerations) relatively lower than the other two cohorts, findings which could lead to future research on the reasons for this ranking. The same is true for Cluster C (Team Formation), which was ranked particularly low by the two government participants. These results also indicate that Cluster E (Impact Assessment) was rated lower by experts from the industry group. This result suggests the need to investigate the types of experiences that influenced these ratings, meaning what type of projects these experts have the most experience with, e.g. vertical or horizontal projects. Since these experts may have more experience with buildings in private projects, it may influence the lower rating of Cluster E. Infrastructure projects, such as highways and utilities, may involve a larger number of impacts than buildings. In addition, these infrastructure projects impact a range of communities, crossing multiple jurisdictions and funding opportunities. Such is the case for the current improvement of the Old Greenville Highway Corridor (SC-93) in Clemson, which has federal, state and university funding sources and affects the activities of the university, the city and the surrounding areas.

The same type analysis was conducted based on the years of professional experience. The experts were divided in two subgroups, the first with up to 20 years of experience and the second with more than 20 years, to see if social sustainability has some correlation to generational perspective. Figure 4.11 compares these generational differences. Future research could explore why some of the clusters such as Management

Considerations were rated lower by participants with less experience as well why as User Considerations is not among their top priorities.

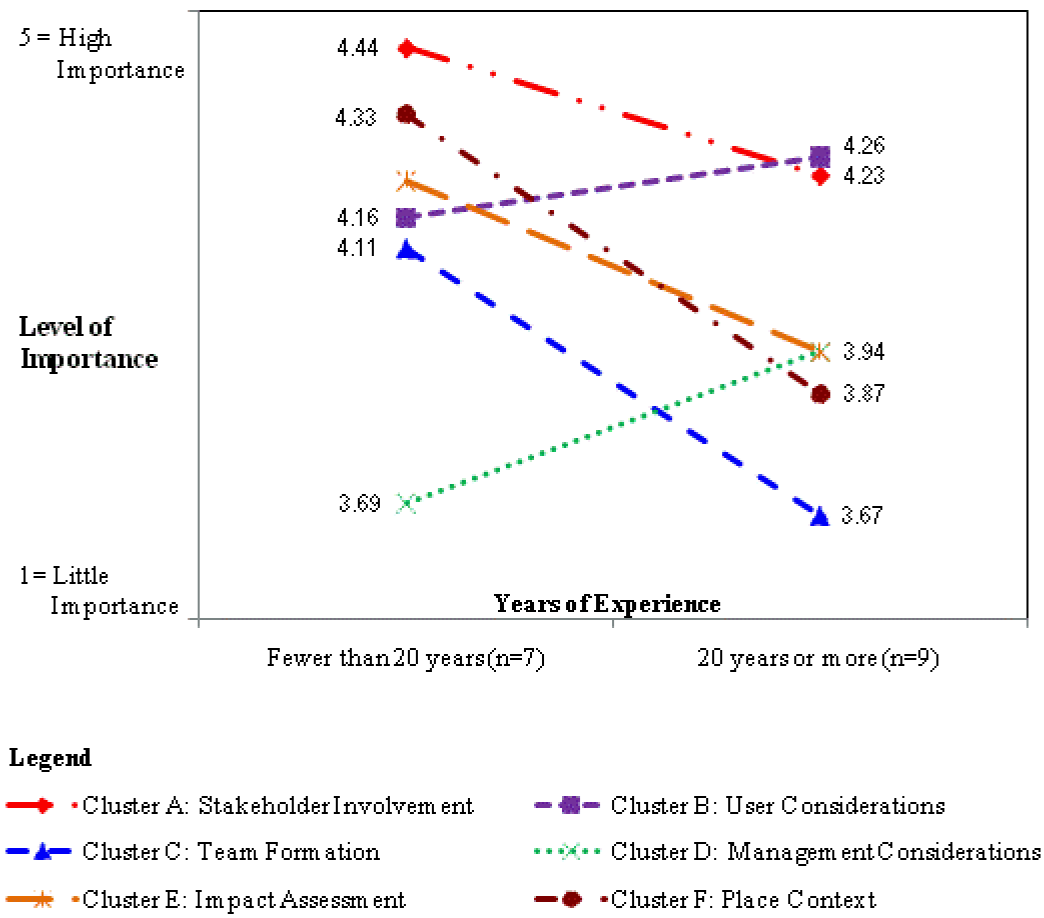


Figure 4.11 Pattern Matching of Cluster Importance Comparing Years of Experience

Finally, previous research has shown that sustainability is a relevant concept for women in leadership positions (Harrison and Klotz 2010). The relationship between the average importance across female and males experts for the six clusters is shown in Figure 4.12:

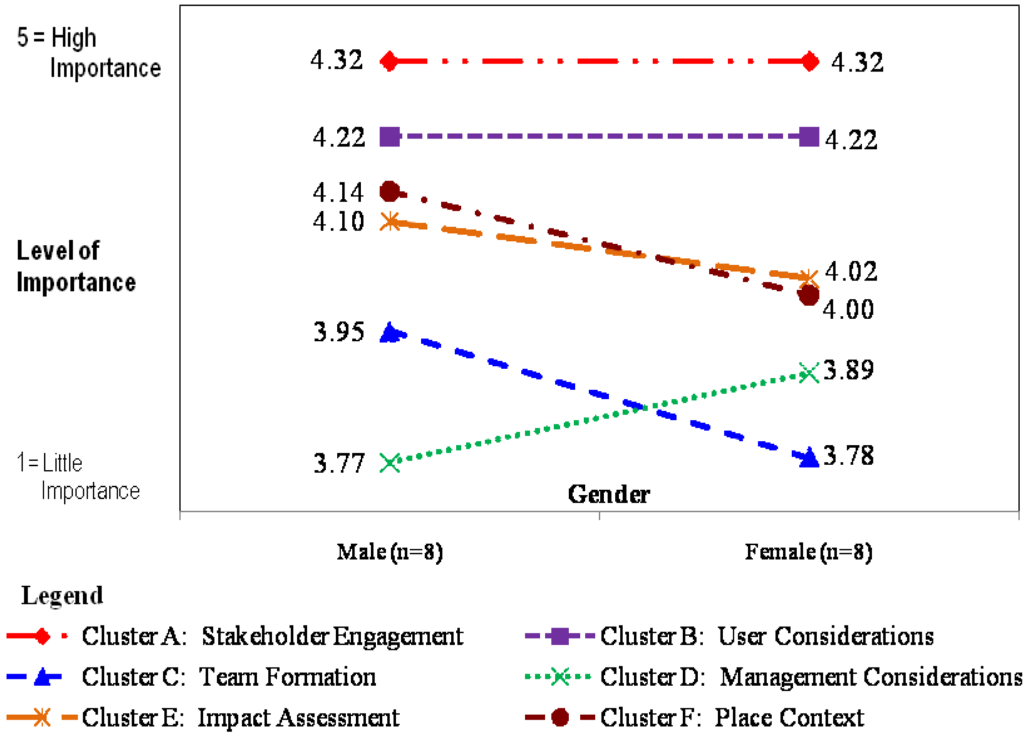


Figure 4.12 Pattern Matching of Cluster Importance Comparing Gender

In general, both groups consider that the processes important to pursue are those in Cluster A (Stakeholder Involvement) and Cluster B (User Considerations). Appendix J includes other pattern matching figures that were generated to inform new research questions. In the future, the experiences that influenced the experts to cluster and rate the 50 processes as they did could be investigated. Table 4.5 summarizes of the future research questions suggested by these pattern matching configurations:

Table 4.5 Future Research Questions Based on Pattern Matching Results

Pattern-Matching Comparisons	Future Research Questions
Current professional position	How are Management Considerations, Team Formation and Impact Assessment processes ranked by experts from different areas?
Years of professional experience	How are Management Considerations and User Considerations processes rated by those participants with different years of experience?
Geographical location	How does the experts' geographical region, for instance East Coast vs. West Coast, influence the level of awareness of social sustainability?
Engineering background	How does teaching and training professionals in AEC industry about social impact assessment techniques influence their awareness of social sustainability?
Currently working for Top 100 Design and Construction firms or not	How are Impact Assessment processes rated by experts from Top 100 Design and Construction firms Is there a difference in the social sustainability awareness based on experience in vertical (buildings) or horizontal projects (highways)?
Background in Planning and Design with those who have another focus such as construction and research	What is the difference of awareness between these subgroups?
Gender	What are the consensus priority processes of these two subgroups?

While these are interesting questions to research, for this study the fundamental goal was to determine an emerging framework of social sustainability processes that should be considered during the planning and design phases of construction projects using an expert-based approach. In the future, research using a wider range of professionals could be conducted to examine the applicability of social sustainability processes in the planning and design phases in more depth.

4.6 Proposed Practical Guide of Social Sustainability for Planning and Design Phases

In particular, the categorization of the social processes into six clusters can be taken one step further by examining the regional positioning of the data (i.e. maps) based on the conceptual interrelationship among them. In other words, a region on the cluster map illustrates those processes that can be meaningfully grouped more strongly than they can be with others (Jackson and Trochim 2002). Since this new categorization relies on the research knowledge of the topic, this grouping becomes a practical guide that can be investigated in the future, aiming to better communicate social sustainability to practitioners and academics as well as lay audience.

To do so, the content and the relationship among the six cluster solution was again analyzed to form these new regions. The key guideline for creating these regions was maintaining the geometric configurations obtained from the multidimensional scaling analysis. Another important factor considered was that this new representation must keep the relationship among the clusters without any overlapping of the processes. In addition, this analysis considers the bridging values as well as the planning and design phases, from understanding the needs of the owner to providing a final set of documents (drawings, models, and specifications) that will allow for the completion and operation of the project (Pearce 1999). As a result, three regions were formed, Approach, Assessment and Desired Results, as seen in Figure 4.13.

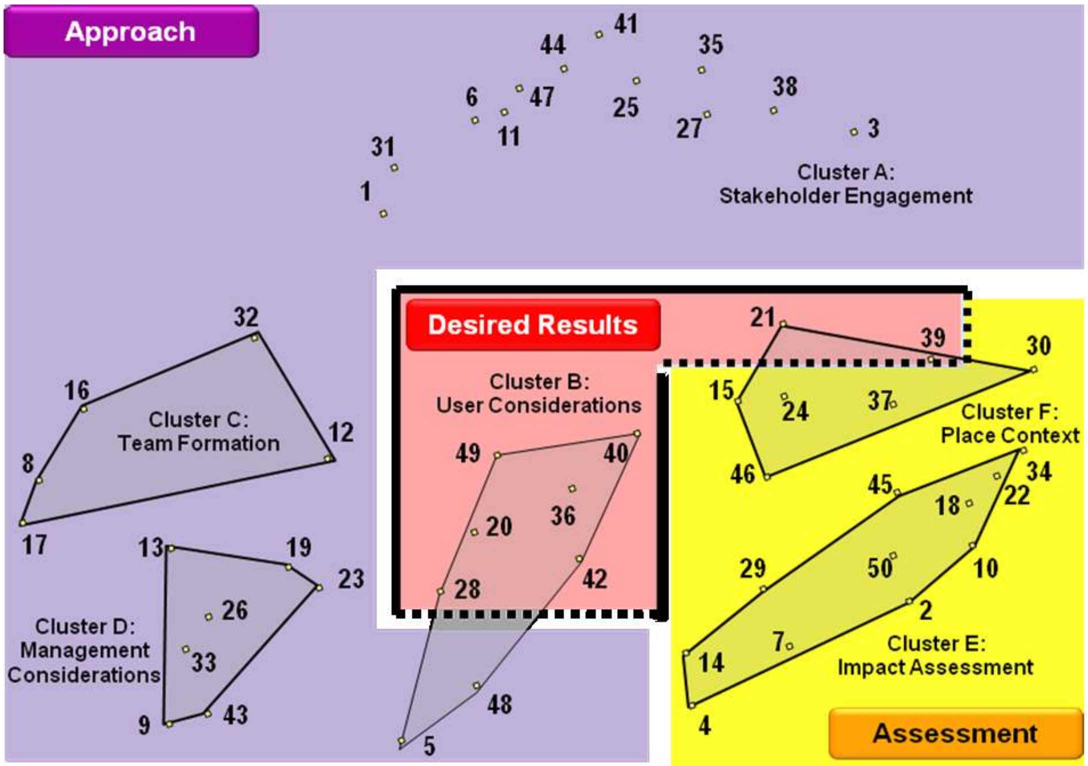


Figure 4.13 Grouping Social Sustainability Processes by Regions

The first integrated region, **Approach**, includes Clusters A, C, and D as well as Processes 5 and 48 from Cluster B. These processes are grouped because all of them help to establish the preliminary project scope before any type of assessment is conducted and subsequent revisions are determined. Specifically, Cluster A (Stakeholder Engagement) was included in this region because the processes within it were rated the highest by the various experts. Owners and designers need to identify the key stakeholders in the early phases and establish a Stakeholder Management Plan that will allow for collaboration among them throughout the project. This collaboration approach should allow for reflection by explaining the project goals to those constituencies who may enhance the design on one hand or have reservations about the proposed project.

The high average bridging values of Clusters C (Team Formation) and D (Management Considerations) implies that they were judged to be fundamental connections across clusters. In particular, a diverse design team knowledgeable about sustainability and local requirements is considered to be key for enhancing the planning and design phases. In addition, the results indicate the need to communicate with stakeholders regarding serious diseases by analyzing risk-control programs.

The use of an integrated-design construction method that allows having cross-disciplinary teamwork is fundamental. Proposed methods for integrative design include Design-Build (Kormaz 2007, Gransberg *et al.* 2010), Integrated Project Delivery (AIA 2007, Erickson 2010) and Whole Building Design Guide (WBDG 2009), providing stakeholders with more opportunities to increase productivity and to protect a consistent design from costly disputes (Yudelson 2008). But perhaps they also can help in the development of social sustainable outcomes such as the successful recruitment of local individuals or firms, resulting in community satisfaction by enhancing the human and economic capital.

Finally, Processes 5 and 48 relate to early decisions made during the planning and design phases as they focus on approaches such as Evidence-Based design (Hamilton and Watkins 2009) and the consideration of assessing various job skills. This region integrates processes that allow developing a comprehensive scope of the project.

The second region, **Assessment**, combines Clusters E and F except for Processes 21 and 39, the two which have the highest bridging vales in these two clusters. This region focuses on the various processes available for assessing the impact of the project at the user and community levels. When focusing on the users, it is important to consider their safety, health, security, and productivity. For instance, one variable to consider is avoiding death and injury during the execution or operation of a project, or as a result of design failure, i.e., the inadequate selection of materials/equipment or failure in structural calculations (Martland, 2011). In addition, on the community level, impact assessment includes such variables as the formation of attitudes toward the project, population change, institutional structures stability, and community infrastructure needs. Some specific variables to consider are the disruption of the community caused by the project such as traffic, air pollution, loss of privacy, and relocation of people (Burdge, 2004).

The identification and mitigation of these impacts require an understanding of both the users and the surrounding community affected by the proposed project. In other words, owners and designers need to identify the stakeholders who will be affected and collect information about their current conditions to establish a baseline for evaluating those changes in the future. These assessments can be identified through appropriate methods, techniques and input from the stakeholders, generating comprehensive for information addressing issues and allocating resources to the project as well as further supporting the need to have a Stakeholder Management Plan emphasized in the previous region.

The final region, **Desired Results**, includes Processes 21 and 39 from Cluster F (Place Context) as well as the 6 remaining processes in Cluster B (User Considerations). This region is seen as the core of social sustainability in construction projects as it is aligned with sustainability outcomes such as health, safety, and transparency. Particularly, Processes 21 and 39 are included here because they are more aligned with sustainability outcomes such as pride in ownership and monitoring. Furthermore, these two processes have the highest bridging values within their cluster, supporting their high connections with the processes in Clusters A and B. For instance, Process 21 is aligned with the social overarching goal of having a design which instills pride in ownership among the users and the surrounding community. Process 39 is also considered a link to the execution and operation phases by as it calls for an ongoing evaluation plan of the impact of the project. In other words, this process supports the need for the social impacts to be monitored, ensuring that mitigation plans are created to identify further potential impacts (Burdge, 2004).

The remaining 6 processes in Cluster B are also aligned with the overarching goal of sustainable construction projects, which is to improve the health, safety, productivity, and security of current and future users and the surrounding community by monitoring its desired results and maintaining transparent communication among stakeholders. For example, Process 49 assists in this transparency by monitoring and reporting incidents of corruption, which have been determined as a key social performance indicator in the Global Reporting Initiative™.

The proposed model of these three regions shown in Figure 4.14 can serve as a practical guideline for the implementation of social sustainability in construction projects during the planning and design phases:

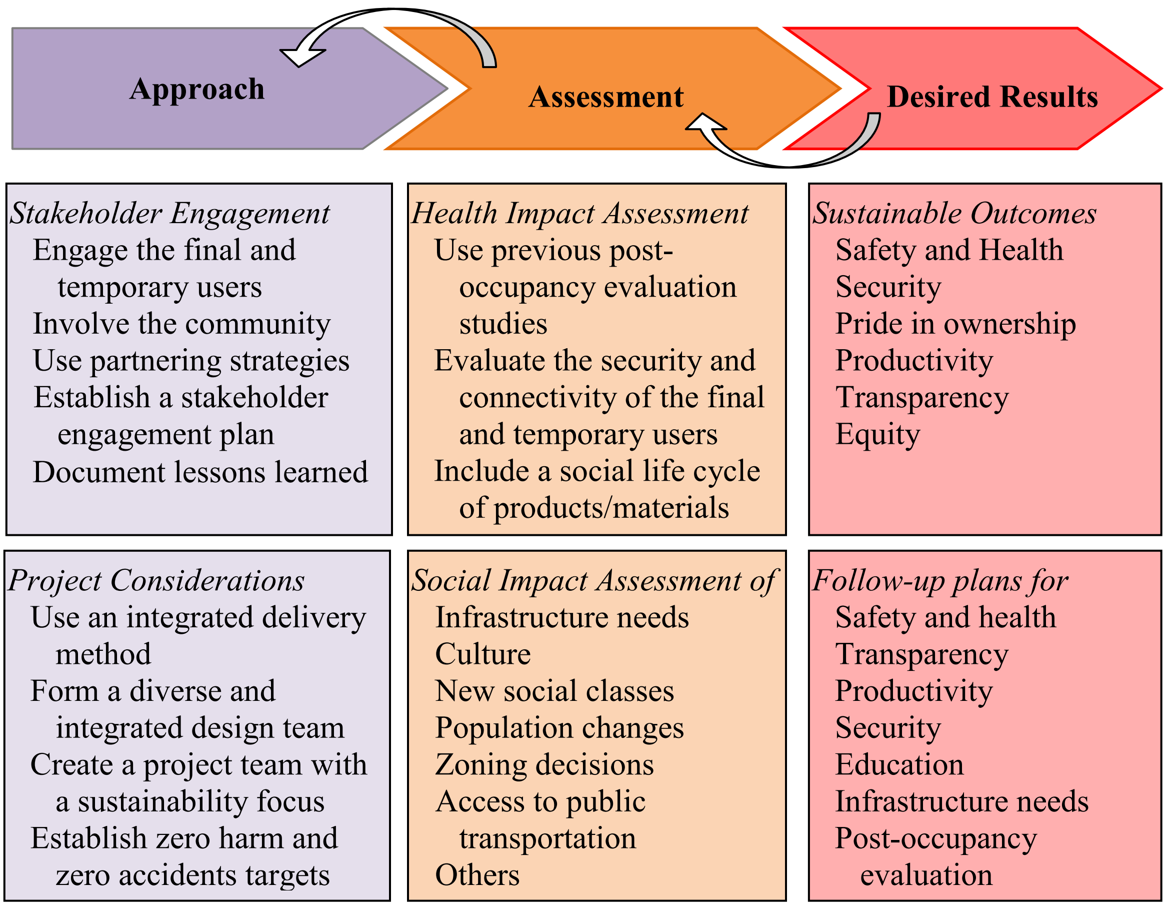


Figure 4.14 Proposed Model of Social Sustainability in Construction Projects

The representation of the life cycle of a construction project as a linear approach has been widely used in the construction industry; thus, the same linearity is used here for this new representation of the regions. However, although it focuses on individual regions, the reality is this application operates as an integrated combination, representing a system perspective. For this reason feedback loops have been included in the diagram to represent the influence of one region on the others, allowing for adjustment in implementation and self-monitoring.

In addition, according to the type of project, some processes may or may not be relevant. For instance, when considering infrastructure projects, such as highways or bridges, the range of stakeholders affected may be more extensive than for a commercial building; thus, community participation will be more significant in the former than in the latter. Even when considering the same type of projects and locations, different stakeholders will have various levels of understanding of the concept of sustainability and their needs, affecting the dynamics of the processes that should be applied at any given phase.

4.7 Validity of the Results

While numerous researchers discuss validity, there are slight differences in their definitions depending on the method (e.g., Robson 2002, Cooper and Schindler 2003). In general, the purpose of validation is to ensure that each step of the method adheres to the highest possible levels of quality (Lucko and Rojas 2010). The primary purpose of the validation of this study is to ensure that the findings accurately capture the selection of the 50 social sustainability processes and their categorization by the experts.

The literature review of social sustainability in the planning and design of construction projects informed the selection of an expert-based approach. This review was conducted by sampling important peer-review journals articles as presented in Chapter 2. This careful selection minimized individual bias by providing comprehensive points of view concerning social sustainability. In addition, during this processes it was concluded that while previous work made contributions to environmental sustainability, the social component still was not fully integrated into the body of knowledge. Given the current definition of social sustainability in the construction industry as a series of processes for improving health, safety and well-being throughout the life cycle of projects, the need for identifying and categorizing social processes during the planning and design phases was established. Then, the expert-based approach was selected to identify and categorize these processes because social sustainability was found to be an evolving concept with various perspectives. Concept mapping was considered to be an appropriate research method for conduct this study because its integrated approach effectively organizes and represents ideas (Trochim 1989, Kane and Trochim 2007).

Specifically, concept mapping addresses validity by using multidimensional scaling and cluster analyses, grouping the judgments of various participants to minimize individual bias (Jackson and Trochim 2002). In other words, the findings are determined by the subjects and the context of the inquiry rather than the individual judgment of the researcher and participants. As a result, the researcher could not force a meaning into a categorization that may not accurately represent the combined experts' judgment.

Specifically, the validity of this study was addressed in the following ways:

- The selection of experts was based on representing various perspectives, not one particular industry sector. This selection provided multiple sources of data collection, and their participation makes the results of this study more compelling to a general audience.

- Nineteen experts were involved during the idea generation phase, ensuring that units of analysis (social sustainability processes) were generated without individual bias. An additional value of concept mapping is that because of the diverse background of the participants, a comprehensive and varied list of processes was produced during this step.
- The selection of the final list of processes was conducted by eliminating repetition and using two focus groups to revise for vagueness in the wording.
- The units of analysis (social sustainability processes) were randomized before the experts conducted their individual sorting and rating, so that the proximity of the processes on the list did not influence this step. While placing similar processes close to one another may have help experts to finish the sorting more quickly, this placement may also introduce bias.
- The experts did not have preconceived categorical coding schemes, meaning that they could not fit their judgment into a prefabricated framework. With this technique the tendency of mentioning a sporadic and wide variety of concepts was minimized by focusing the analysis on each of the clusters.
- The processes were coded into categories which represent similar relationships based on multidimensional scaling and cluster analysis. Thus, this coding was not driven by the researcher as 16 coders from various backgrounds were used. In addition, 10 of these coders participated in the idea generation phase, enhancing the codification of the processes.

- The stress value calculated for MDS (0.257) also provides confidence in the geometric configuration of the point map by comparing it with an average stress value of 0.285 with a standard deviation of 0.04 that was determined by a previous study conducted by Trochim (1993).

Table 4.6 summarizes the research techniques and their contribution to the quality of this research:

Table 4.6 Research Technique Summary

Major Research Phase	Research Techniques	Validity
Literature Review	Revision of different journals	+
	Preliminary conceptual areas of social sustainability	±
Data Collection	Selection of experts	±
	One idea generation round	±
	Filtering repetitive process	+
	Individually sorting by the experts	+
	Individually rating by the experts	+
	Receiving feedback from focus groups	±
Data Analysis	Multidimensional scaling	+
	Cluster analysis informed by the literature review	+
	Pattern Matching	+

+ Enhance the validity of the results
± May affect the validity of the results

As this table shows, those research techniques with a positive symbol improve the validity of the results; while those with a plus-minus enhanced validity on one hand, but they also may have introduced issues that need to be explored in future research. In general, the techniques used here for data collection (one round of idea generation, elimination of repetitive processes, randomization of the units of analysis, individual sorting and rating by experts) and the analysis phase (multidimensional scaling, cluster analysis, and pattern matching) help to support the validity of this study.

Furthermore, the development of the empirical framework helps to align the divergent knowledge discussed in the literature review in Chapter 2. The findings based on expert knowledge obtained by using the concept mapping method can be compared to the literature review. This conceptual verification helps us see whether the framework represents social sustainability as defined based on the previous body of knowledge. Thus, each of the six clusters forming the empirical framework is conceptually verify in Figures 4.15 to 4.20 by connecting their processes with the four conceptual areas of Community Involvement, Corporate Social Sustainability, Safety through Design, and Social Design determined from the literature review.

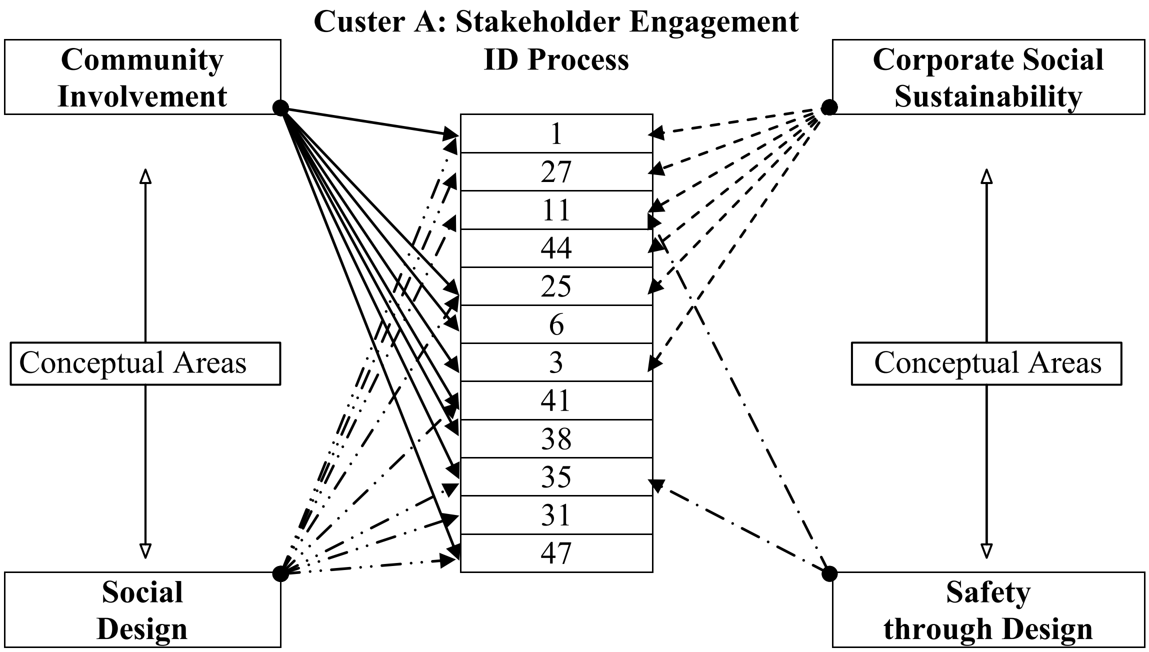


Figure 4.15 Stakeholder Engagement Processes Related to the Conceptual Areas

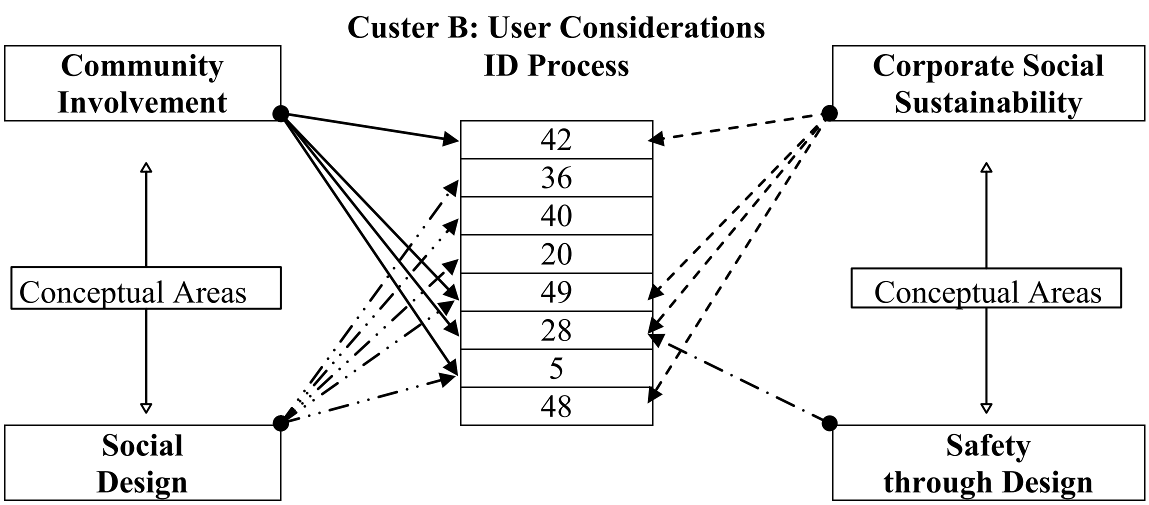


Figure 4.16 User Considerations Processes Related to the Conceptual Areas

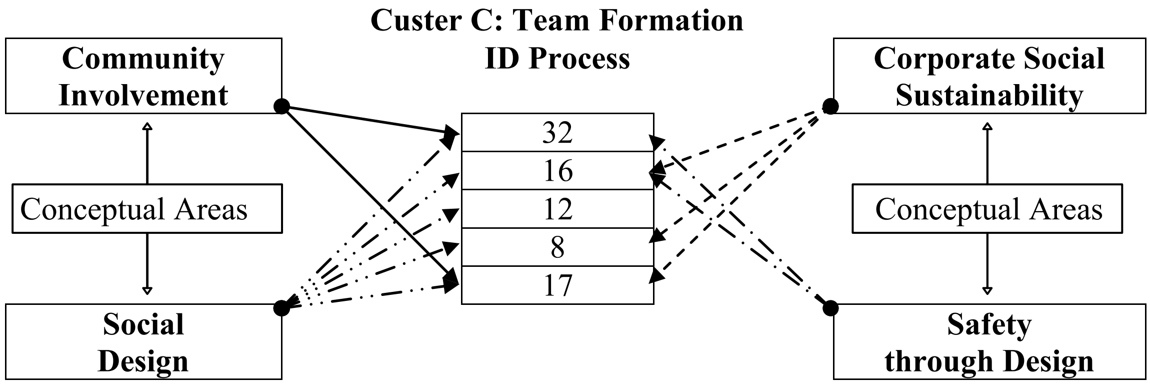


Figure 4.17 Team Formation Processes Related to the Conceptual Areas

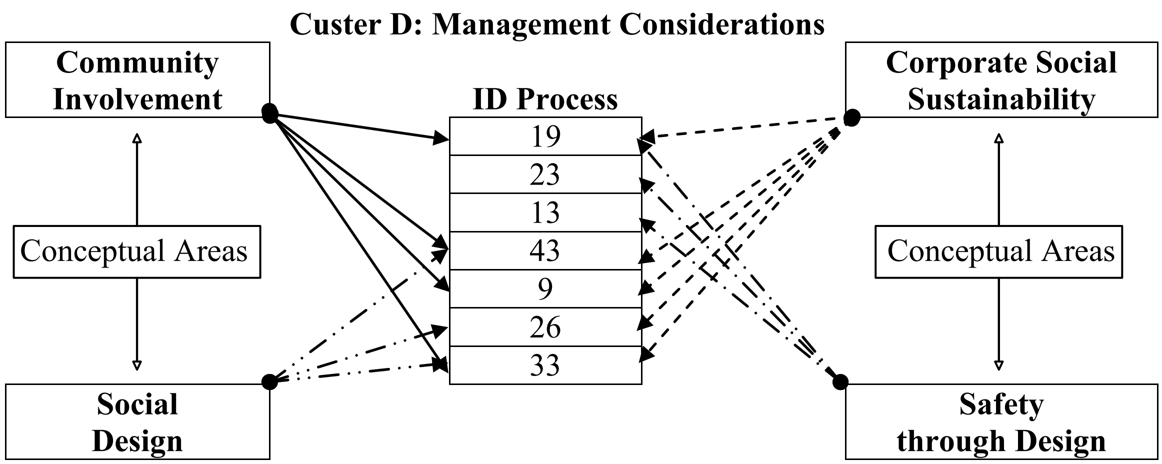


Figure 4.18 Management Considerations Processes Related to the Conceptual Areas

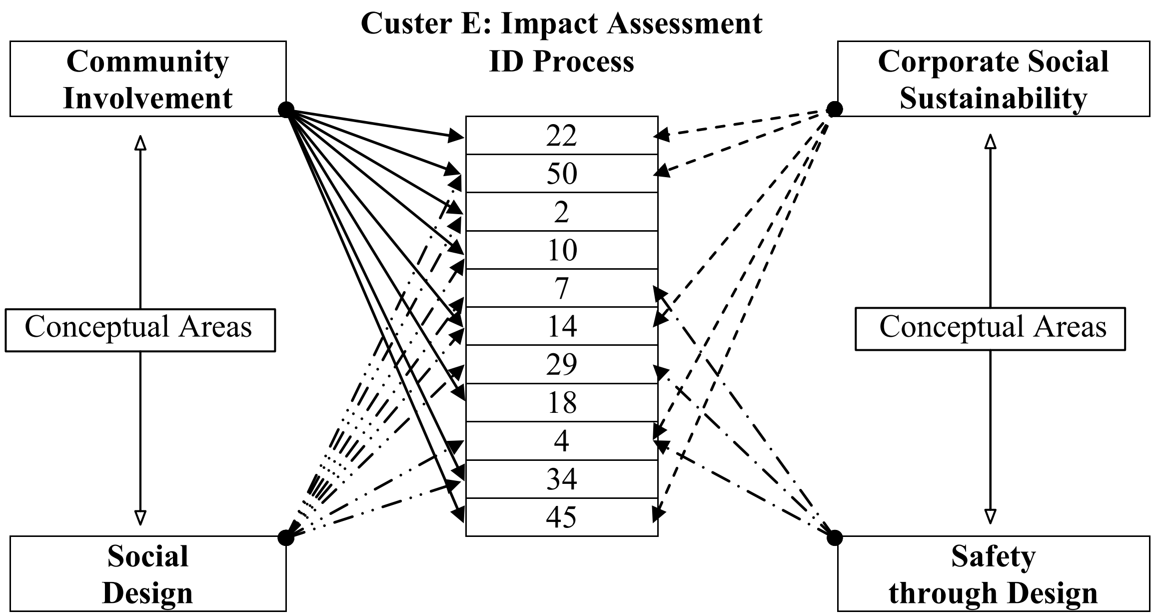


Figure 4.19 Impact Assessment Processes Related to the Conceptual Areas

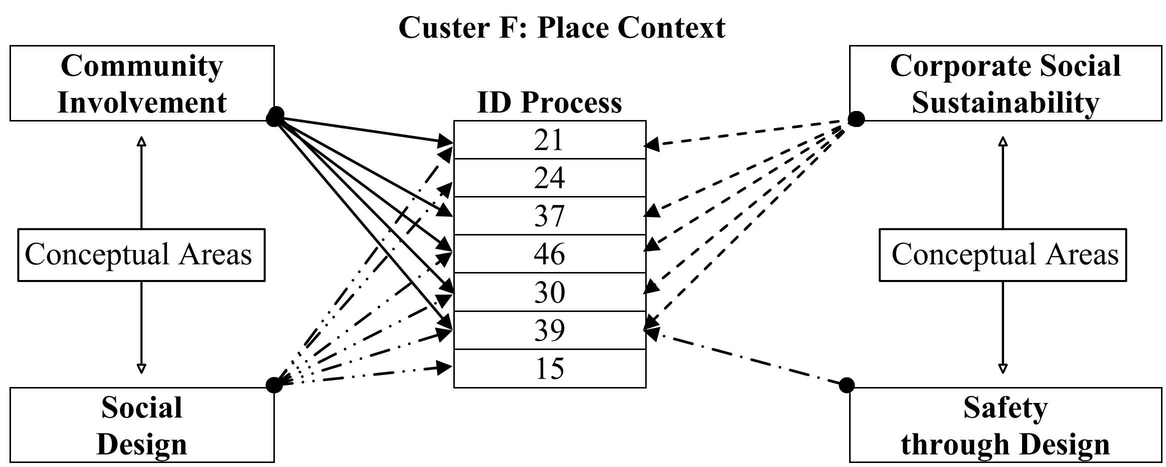


Figure 4.20 Place Context Processes Related to the Conceptual Areas

As these figures show, the processes found here connect to the conceptual areas suggested by previous research. In particular, the majority of the processes are part of at least two conceptual areas. These relationships ensure that the categorization of these 50 processes can be applied during the planning and design phases of construction projects.

4.8 Chapter Summary

This study offers several findings supporting the application of the social sustainability concept in construction projects. The 50 processes identified here based on a variety of perspectives from industry, academia and government served as units of analysis that were sorted and rated by 16 experts, resulting in a framework of six categories: Stakeholder Involvement, User Considerations, Team Formation, Management Considerations, Impact Assessment, and Place Context. In general, this categorization of social sustainability processes reveals that this concept focuses on the users, appealing to the needs of those who will utilize the project during its life cycle. Social sustainability requires the assessment of the impact of the project both at the user (final and temporary) and community levels, emphasizing its broader obligation to others.

Lastly, the results presented in this chapter, in particular the six cluster solution, guided the development of the proposed practical guide for integrating social sustainability during the planning and design phases of construction projects. The next chapter includes the limitations, significance and future research based on the findings of this study.

CHAPTER 5

LIMITATIONS, IMPLICATIONS AND FUTURE RESEARCH

The framework and practical guide presented in Chapter 4 can provide a platform for further discussion since it could be appropriate to integrate it with the other two spheres of sustainability in construction projects. The actions of the various stakeholders motivate such aspects of construction projects as investing in local communities and reducing the depletion of natural habits; therefore social sustainability, which is about people, should be intrinsically at the front-end for achieving the environmental and economic goals. This chapter addresses these implications more fully as well as the limitations of this study and future research areas.

5.1 Limitations

The primary limitation is that the empirical framework is based on the sorting and rating of 16 experts. Further external validation involving a larger number and broader range of experts needs to be conducted. Thus, future studies could test this framework empirically by including experts representing the various perspectives of social sustainability including owners, contractors, community leaders, construction workforce, and operation managers. This external validation will strengthen the results of this study and provide an opportunity for applying this framework to a variety of projects, making a stronger case for the inclusion of these processes in other sustainability frameworks.

This research is only the first step in clarifying these social sustainability processes and their categories. There may be other processes related to the four conceptual areas discussed in the literature review and/or applied by the industry not covered in this study. However, these 50 processes determined by the concept mapping approach here can be applied across the entire range of the construction industry. For instance, having a stakeholder management plan should be common to both horizontal and vertical projects. These plans may be applied slightly differently depending on the industry sector but keeping the processes at this level provides the opportunity to apply this framework to specific projects as needed. In addition, focusing on these 50 processes based on expert knowledge and literature provides the most prominent social sustainability concepts to date for construction projects, a valuable contribution to the knowledge in the field.

5.2 Implications

The implications of this study move forward the concept of social sustainability in construction projects by providing guidance to address such social sustainability principles as health, safety, and well-being. The findings of this study help to organize, prioritize and translate these principles into an empirical categorization of 50 processes that need to be applied in construction projects. Thus, the social sustainability concept can be implemented to improve safety, health, and well-being as well as productivity and transparency during the life cycle of projects, considering both current and future needs.

It is important to recognize that the results presented here can be generalized since the respondent experts who provided various perspectives are from different institutions and organizations in the U.S. This is relevant because this research was not conducted as a single study within a single organization, group, profession, or region in the U.S. In addition, this study includes different levels of information for various stakeholders, enabling participatory interpretations in the future. Thus, these findings should appeal to practitioner audiences and academic communities.

For the practitioner audiences, this social sustainability framework serves as important scaffolding for future discussion among those organizations and institutions that aim to assess a comprehensive sustainable construction project. The importance of sustainable projects that focus beyond environmental and economic considerations is gaining increased attention. For instance, organizations that have developed or are developing sustainability rating systems such as LEED, Greenroads, and envision^{TM}, could incorporate the findings of this study into their current deliberations and future revisions of their rating systems. In addition, these findings can shape sustainability reporting frameworks such as the Global Reporting Initiative for the Construction and Real Estate sector. These results can also be used to shape related frameworks developed in other cultures and contexts such as consulting, standards, and front-end planning.

In addition, this research provides project decision makers valuable information about these 50 processes and their interrelationships, which will help address social considerations that are often overlooked. By considering these social sustainability processes during the planning and design phases, construction project performance can be enhanced, helping stakeholders address the challenge of developing more truly sustainable construction projects. Interested and affected parties (owner, designers, ONGs) can use these 50 processes and their categorization as a reference, applying them as needed depending of the type of project, i.e. horizontal (highways and bridges) or vertical ones (buildings). The findings of this study may also help decision makers to achieve organizational core values such as caring for employees and improving community relations.

For the academic community, this research provides educators with a framework to introduce the next generation of designers to these social processes and their categories. By increasing the awareness of social considerations during the planning and design phases, the social pillar of sustainability will be better integrated with the environmental and economic ones. If these future professionals are not aware or do not value the social impact of construction projects at the user and community levels, then they will tend to ignore these issues. For instance, social sustainability can be incorporated in various civil engineering courses such as project evaluation, sustainable construction, and capstone. Concept and topics such as Prevention through Design, Social Impact Assessment, and Corporate Social Responsibility should be incorporated into the curriculum. As a result, students will begin thinking about their roles in improving user/worker health, safety and well-being during the life cycle of projects.

The current study also increases awareness of the concept mapping method in civil engineering research and related fields. Although this approach has been used successfully in such fields as program planning and evaluation, medicine, and psychology (Kane and Trochim 2007), published empirical studies remain limited in civil engineering. Employing such a structured research method provides a further benefit for those researchers working with human subjects, especially when triangulating results. Finally, the results obtained in this study using concept mapping serve as another valuable reference to compare changes in interpretations by practitioners and academics over time and across a range of institutions and organizations.

5.3 Future Research

In general, adapting the concept mapping has been a useful method in deducing how the concept of social sustainability is understood by the construction industry. However, the selection of other processes and the interpretation of the concept map results require further research to enhance the understanding of social sustainability in construction projects. Some of the most promising opportunities for future research include:

a) Refining the framework by including concept mapping interpretations from the experts who participated in this study and others who represent various perspectives including owners, contractors, operation managers and community leaders.

b) Refining the list of processes presented in this study by engaging experts from various backgrounds to verify the applicability and reliability of these processes. Social sustainability processes can be advanced by partnering with institutions and organizations that have developed or are developing comprehensive assessment frameworks for construction projects.

c) Redefining the questions related to subgroups of experts and asking additional ones, such as how the integration of these processes influences the success of a construction project.

d) Expanding the list of processes presented in this study since the concept of social sustainability is still evolving in the context of construction projects by engaging experts from various backgrounds to verify the applicability and reliability of these processes. In addition, this future research could focus on determining the critical processes for enhancing environmental and economical sustainability of construction projects. The expectation that social sustainability processes will be evaluated and incorporated as extensively as economic and environmental ones when planning and designing construction projects can be established by partnering with those leading institutions and organizations that have developed or are developing comprehensive assessment frameworks for construction projects.

e) Focusing on the effects of sustainability project outcomes and user performance by establishing measures that consider types of owners (public, private, and PPP), infrastructure projects (highways, bridges, and utilities), and project delivery methods (DB and CMAR). In addition, these studies can compare the implications of applying these processes on sustainability outcomes between new projects and renovations. For instance, case studies could document the details that determine the inputs, cost, and time required in the integration of these processes for both situations.

f) Establishing effective teaching approaches and training efforts for sustainable leaders by increasing their awareness about social sustainability. This research could lead to a broad implementation of these processes in their organizations/institutions. The pilot studies conducted at Clemson University show encouraging results for implementing a Social Sustainability teaching module (Valdes-Vasquez and Klotz 2010b, Valdes-Vasquez 2011). These efforts helped the students conceptualize their ideas and the implications about social sustainability during the planning and design of construction projects. Future research can investigate the different ways in which students experience or think about this concept. In addition, a parallel implementation of courses for continuing education of AEC professionals could support to the development of truly sustainable construction projects.

APPENDICES

Appendix A

Institutional Review Board (IRB) Documentation[9]

Consent Form for Participation in a Research Study
(Categorizing Social Processes of Sustainability)

Description of the research and your participation
You are invited to participate in a research study, which has the purpose of gathering information about how to integrate the social processes of sustainability during the planning and design of construction projects. This study was developed by Mr. Rodolfo Valdes under the guidance of Dr. Leidy Klotz.

Your participation will involve giving us permission to use data to be collected for dissertation purposes through a series of steps: idea generation, sorting, rating, analyzing concept maps, and personal interviews. If you are selected only for idea generation, it will take approximately 1 hour over one month-period. Otherwise, your participation will take approximately 2-3 hours over 2 month-period.

Risks and discomforts
There are no known risks associated with this research.

Potential benefits
Those who participate in this study will provide information to help develop a conceptual framework, which integrates social processes of sustainability during the planning and design phase of construction projects.

Protection of confidentiality
Records and data from this study will remain confidential. The research group will do everything we can do to protect your privacy. In addition, your identity will not be revealed in any publication that might result from this study.

Voluntary participation
Your participation in this research study is voluntary. You may choose not to participate, and you may withdraw your consent to participate at any time. You will not be penalized in any way if you decide not to participate or if you withdraw from this study. Your decision not to participate or to withdraw from this study will not affect your reputation in any way.

[9] The chair of the Clemson University Institutional Review Board (IRB) validated the protocol identified as #2010-224 using exempt review procedures and it was approved on September 24, 2010.

Contact information
If you have any questions or concerns about this study or if any problems arise, please contact Dr. Leidy Klotz at Clemson University at 864.656.3326. Finally, if you have any questions or concerns about your rights as a research participant, please contact the Clemson University Institutional Review Board at 864.656.6460.

Consent

I have read this consent form and have been given the opportunity to ask questions. I give my consent to participate in this study.

Participant's signature: _________________________________ Date: ______________

A copy of this consent form will be provide to you.

Appendix A (continued)

Cover Letter to Recruit Participants in a Research Study
Clemson University
(Categorizing Social Processes of Sustainability)

Dear __________:

I hope you will be willing to offer your expertise to help with my Ph.D. research in the area of sustainable construction. Dr. _________ recommended you as an expert in this area.

Specifically, my research focuses on the social dimensions of sustainable construction. My goal is to develop a conceptual framework of the key social processes of sustainability that should be considered during the design phase of construction projects. As a first step in developing this framework, I require to communicate with experts like you who will provide short statements or ideas that describe specific social sustainability processes. You can find more information about this project on the attached abstract. In addition, you may suggest other appropriate people in your organization to communicate with.

If you are willing to participate in this study or would like to hear more, I will be happy to provide more details. I estimate to begin this project during the next couple of weeks. I would appreciate your input in the development of this conceptual framework. Your participation will make a valuable contribution to this research project and to the construction industry as a whole. I look forward to hearing from you.

Best regards,

Rodolfo Valdes, M.S.
Department of Civil Engineering
Clemson University

131 Lowry Hall, Box 340911,
Clemson, SC 29634-0911

Appendix A (continued)

Attachment -- Research abstract:
Sustainable construction requires improvement not only in its environmental and economic pillars but also in its social one. Social sustainability is fundamentally about people. For the construction sector, this concept considers processes for improving social safety, health and well-being during the life cycle of projects, including both the current and future needs of populations. While social sustainability requires action during construction and operation, improved benefits are possible if it is also addressed during the planning and design phases where there are the greatest opportunities for influencing project performance. To help address this issue, this research will develop a preliminary conceptual model based on literature and professional expertise, identifying and creating awareness about social dimensions that should be considered during planning and design phases of construction projects.

Currently, this model focuses on four primary categories of social sustainability: (a) community involvement refers to the influence of public constituencies on governmental and private decisions; (b) corporate social responsibility considers the accountability of an organization to care for all of the stakeholders affected by its operations; (c) Safety through Design ensures worker safety by eliminating potential safety hazards from the work site during the design phase; and (d) social design focuses on aspects related to the final users and considers the improvement of decisions-making during the design process. This model is meant as a starting point that can be refined by incorporating academic and industry input to generate a conceptual model representing social sustainability process for the construction industry. To do so, a concept mapping technique* is proposed to conceptualize the knowledge obtained from multiple participants with differing expertise.

* Concept Systems Incorporated, co-founded by Dr. Trochim, has used this methodology for defining constructs and products. For more details visit http://www.conceptsystems.com/content/category/concept-mapping.html

Appendix A (continued)

Instructions to Participants in a Research Study
Clemson University
(Categorizing Social Processes of Sustainability)

Phase 1: Idea Generation

The objective of this phase is to generate short statements or ideas that describe specific processes of social sustainability that should be included during the planning and design phases of construction projects. These statements will be used later to develop a general conceptualization of social sustainability based on your expertise. Please follow the steps listed below to share your ideas.

Step 1: Click on the link provided. You will be directed to the Sign Up web page (A link will be provided here).

Step 2: Fill out the form to create your account. You will need to create a user name and password. Please use your e-mail address as the user name. This will become your sign in name. Click on the Sign Up link at the bottom of the form. Then, you will be directed to a project page.

Step 3: On the project page, click on the Brainstorming link and follow the instructions provided (Below is the instructions box that appears).

> Brainstorming Statements -- In the text box below, type a statement that completes or answers the focus prompt. You may add as many statements as you wish. Please keep each statement brief, just one thought. Select "add this statement" after each statement or idea. Your statement will then be saved and added to the list of collected statements at the bottom of the page. Please review the other statements to see if your idea is already there. You may search this list of collected statements using the search function below.
>
> **FOCUS PROMPT: Generate short statements or ideas that describe specific social processes that should be included during the planning and design phases of a construction project. Be sure to phrase your statement as a Process!**

Step 4: Be sure to click on "Done Brainstorming", so that your statement is saved. You may return to this web page at anytime by using the link provided in Step 1.

Step 5: Sign out.

We would appreciate completing this activity by ________. If you have any questions, please contact Rodolfo at vvaldes@clemson.edu.

Thanks for your participation in the Idea Generation Phase.

Phase 2: Sorting
In this phase, you will categorize the social processes based on your understanding of their meaning or theme. Please follow the steps listed below to begin this phase.

Step 1: Click on the link provided. You will be directed to Sign Up web page (Link will be provided here).

Step 2: Fill out the form to create your account. You will need to create a user name and password. Please use your e-mail address as the user name. This will become your sign-in name. Click on the Sign Up link at the bottom of the form. Then, you will be directed to a project page.

Step 3: On the project page, click on the Sorting link and follow the instructions provided (Below is the instructions box that appears).

> Sorting Statements -- In this activity, you will categorize the processes based on your understanding of their meaning or theme. To do this, you will sort the processes into groups that make sense to you. First, read through the processes in the Unsorted Statements column.
>
> Next, sort each process into group you create. Group the processes based on how similar in meaning or theme they are to others in the list provided. Give each group a name describing its theme or contents.
>
> Do NOT create groups according to priority or value such as 'Important' or 'Hard To Do.'
>
> Do NOT create groups such as 'Miscellaneous' or "Other" to group together dissimilar processes. Put a process alone in its own group if it is unrelated to other processes. Make sure every process is put somewhere. Do not leave any process in the Unsorted Statements column.
>
> People will vary in how many groups they will create. Usually 5 to 20 groups works well to organize this number of processes.

Step 4: Be sure to click on "Save Sorting" link so that your group will be saved. You may return to this web page at anytime by using the link provided in Step 1.

Step 5: Sign out.

We would appreciate completing this activity by ________. If you have any questions, please contact Rodolfo at vvaldes@clemson.edu.

Thanks for your participation in the Sorting Phase.

Phase 3: Rating

In this phase, you will rate the social processes of sustainability based on your opinion of the level of its importance in the planning and design phases of construction projects. Please follow the steps listed below.

Step 1: Click on the link provided. You will be directed to the Sign Up web page (Link will be provided here).

Step 2: Sign In by using the user name and password you created during the previous phases of this project. Then, you will be directed to a project page.

Step 3: On the project page, click on the Rating link and follow the instructions provided (Below is the instructions box that appears).

Rating Statements -- Please rate the following statements using the range indicated below.

How important do you consider the statement or process for inclusion during the DESIGN phase of construction project, with 1 indicating little importance and 4 high importance.

Note: Design is the second phase of the construction project life-cycle, where the project is transformed from concept to construction documents by creating a description of the project, usually represented by detailed drawings, specifications and models (Pearce 1999).

1 Little Importance	2	3	4	5 High Importance	Statement
☐	☐	☐	☐	☐	Process 1
☐	☐	☐	☐	☐	Process 2
					. . .
☐	☐	☐	☐	☐	Process 50

Step 4: Be sure to click on "Save Rating" so that your information will be saved. You may return to this web page at anytime by using the link provided in Step 1.

Step 5: Sign out.

We would appreciate your completing this activity by ________. If you have any questions, please contact Rodolfo at vvaldes@clemson.edu.

Thanks for your participation in the Rating Phase.

Appendix B

Operational Definitions/Explanation

Commissioning: It is a systematic quality-oriented process of ensuring that engineering systems are designed, installed, functionally tested, and capable of being operated and maintained to perform in conformity with the design intent. Commissioning verifies that the design meets the needs and functions of the facility, verifies that the project performs as designed and intended, and prepares the customer to effectively and efficiently maintain the facility for its service life. (Building Commissioning Association).

Diversity: Specifically, when applied to a human context, diversity refers to a wide variety of cultures, ethnic groups and race, socio-economic backgrounds, opinions, religious beliefs, sexuality, and gender identity (Sustainability Dictionary, http://www.sustainabilitydictionary.com/s/diversity.php)

Evidence-based design (EBD): The process of basing decisions about the built environment on credible research to achieve the best possible outcomes (Design Accreditation and Certification website)

Life Cycle Analyses: An examination, like an audit, of the total impact of a product's or service's manufacturing, use, and disposal in terms of material and energy. This includes an analysis and inventory of all parts, materials, and energy, and their impacts in the manufacturing of a product but usually doesn't include social impacts (United Nations Environment Programme, 2009).

Health Impact Assessment (HIA): "a multidisciplinary process within which a range of evidence about the health effects of a [proposed project] is considered in a structured framework, …based on a broad model of health which proposes that economic, political, social, psychological, and environmental factors determine population health." (Northern and York Public Health Observatory, 2001). This HIA framework is used to bring potential public health impacts and considerations to the decision-making process for plans, projects, and policies in such areas as transportation and land use.

Social Impact Assessment (SIA): Social Impact Assessment (SIA) is the process of identifying the social consequences or impacts that are likely to follow specific policy actions or project development, assessing the significance of these impacts and formulating measures that may help to avoid or minimize adverse effects (Burdge, 2004).

Social – LCA: A technique within which methods are developed for associating company level information with processes in a life cycle system and for reporting and possibly summarizing this information across product life cycles (United Nations Environment Programme, 2009).

Appendix B (continued)

Partnering: The process of creating a cooperative and mutually beneficial team from potential adversaries on a construction project. In 1987, Construction Industry Institute (CII) formed a task force that defined partnering as "a long-term commitment between two or more organizations for the purpose of achieving specific business objectives by maximizing the effectiveness of each participant's resources. The relationship is based upon trust, dedication to common goals, and an understanding of each other's individual expectations and values. Expected benefits include improved efficiency and cost effectiveness, increased opportunity for innovation, and the continuous improvement of quality products and services."

Post Occupancy Evaluation (POE): The process of systematic evaluation of buildings one occupied, so that lessons may be learned about how well buildings match user needs and identifies ways to improve building design, performance and fitness. In the U.S., POEs started in the 1960s and 1970s involved collecting information about occupants and buildings such as student housing. Currently, this process is applied to other facilities such as office buildings and other commercial real estate. Building users include staff, managers, customers or clients, visitors, owners, design and maintenance teams, and particular interest groups such as the disabled (National Institute of Building Sciences, http://www.wbdg.org/about.php).

Stakeholders: Individuals or organizations with an interest in the success or failure of a project or entity. Potential stakeholders in a company may include customers, clients, employees, distributors, wholesalers, retailers, suppliers, partners, creditors, stockholders (shareholders), communities, government courts and departments (city, state, federal, and international), banks, media, institutional investors and fund managers, labor unions, insurers, NGOs, media, business groups, trade associations, competitors, and the general public. (Sustainability Dictionary, http://www.sustainabilitydictionary.com/s/stakeholders.php)

Zero Harm: The main goal is to eliminate deaths and injuries to the public and construction workforce. In addition, this initiative considers developing products and services, managing their use and deployment, and creating training techniques to eliminate the amount and toxicity of waste and materials and conserve and recover all resources. (Balfour Beatty, 2009)

Zero Accidents: In 1995, the Construction Industry Institute (CII) completed its initial research into how some owners and contractors could work millions of hours with Zero Lost Time Injuries. In general, Zero Accidents techniques include site-specific safety programs and implementation, evaluation, and incentives to create a project environment and a level of training that embraces the mindset that all accidents are preventable and that Zero Accidents is an obtainable goal.

Appendix C

Clusters of Social Processes Generated by the Experts

Cluster	Processes included in each cluster by					
	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6
1	27, 1, 15, 24, 11, 36, 41, 44, 29, 20, 21	11, 16, 19, 23, 25, 31, 35, 41, 44, 47, 1	25, 1, 11, 6, 32, 35, 39, 40, 44, 47, 19	42, 28, 4, 36, 20, 12, 40, 26, 23, 19, 7, 13, 33	3, 6, 1, 11, 38, 27, 31, 44, 41, 35, 25, 47	6, 27, 35, 41, 11, 38, 1
2	3, 34, 18, 22, 6, 30, 37, 45, 49, 35, 42, 10, 38	4, 14, 30	2, 45, 7, 18, 22, 27, 50, 33, 30, 36, 4, 10, 34	18, 8, 48, 10, 9	32, 16, 17, 8	31, 3, 44, 25, 47
3	4, 5, 43, 12, 14, 17, 19, 31, 2, 48, 7, 9	2, 7, 10, 12, 28, 29, 34, 39, 40, 42	49, 24, 14, 20, 15, 3, 23, 28, 26, 46, 21, 48, 13, 43, 42, 5, 37, 9	27, 49, 2, 21, 22, 24, 30, 34, 3, 38, 45, 35, 39, 15, 25	19, 23, 13, 12, 33, 43, 9, 26	2
4	47, 33, 16, 25, 28, 26, 32, 23, 39, 40, 8, 46, 13, 50	6, 27, 5, 32, 22, 21, 20, 17, 13, 8, 37	12, 16, 38, 17, 31, 8	5, 43, 50, 46	22, 50, 18, 10, 30, 39, 45, 37, 34, 2, 29	39, 7, 10, 12, 18, 5, 36, 45, 46, 48, 42, 4, 22, 20, 50, 19, 24, 23, 29, 14, 28, 34, 30, 40, 37, 21, 15
5	-----	9, 38, 49, 48, 46, 45, 43, 36, 33, 26, 24, 15, 50, 3, 18	41, 29	29, 44, 41, 37, 32, 31, 17, 16, 14, 11, 1, 47, 6	4, 42, 28, 49, 20, 48, 7, 5, 14	8, 43, 49, 32, 26, 16, 13, 17, 9
6	-----	-----	-----	-----	46, 24, 40, 36, 21, 15	33

Appendix C (continued)

Cluster	Processes included in each cluster by					
	Expert 7	Expert 8	Expert 9	Expert 10	Expert 11	Expert 12
1	6, 47, 11, 25, 31, 41, 35, 27, 44, 32, 1	48, 1, 23, 49, 32, 36, 20, 17, 16, 8, 42	28, 1, 26, 11, 32, 39, 40, 42, 31, 19	34, 45, 22, 14, 30, 18, 2, 10, 4, 7, 50, 37	5, 32, 25, 1	1, 47, 44, 41, 38, 35, 27, 25, 11, 6, 3
2	50, 37, 45, 22, 46, 10	2, 46, 34, 30, 24, 29, 50, 45, 39, 40, 10, 4, 18, 28, 22, 7	2, 22, 10, 4, 14, 15, 18, 29, 30 34, 45, 7, 50, 37	20, 24, 1, 5, 9, 43, 48, 15, 21	11, 6, 3, 35, 41, 44, 38, 47, 27	4, 12, 7, 19, 23, 33, 28
3	21, 34, 18, 38, 24, 30, 3, 39	37, 15, 31, 11, 3, 41, 47, 25, 35, 27, 38, 44, 12	38, 43, 17, 27, 16, 12, 6, 8	26, 19, 42, 23	16, 8, 9, 17, 12	8, 48
4	12, 36, 33, 20, 14, 40, 15, 49, 2, 7	5, 21, 14, 9, 6, 43,	23, 20, 5, 36, 24, 48, 9, 21	32, 13, 47, 46, 44, 40, 38, 31, 36, 25, 35, 28	45, 10, 29, 30, 22, 50, 37, 7, 18, 2, 4, 14, 34	9, 43, 17, 16
5	13, 48, 42, 28, 26, 19, 8, 23	13, 33, 26	13, 41, 35, 33	33, 39, 3, 49	31, 13	24, 40, 36, 21, 20, 5, 15, 14, 2
6	29, 43, 16, 4, 9, 17, 5	19	3, 25, 49, 47, 46, 44	29, 41	40, 28, 23, 20, 36, 49, 26, 21, 42, 46, 48, 39, 19, 24, 15, 43	42, 18, 10, 37, 39, 45, 50, 34, 22, 30, 46
7	-----	-----	-----	8, 11, 27, 16, 17, 6, 12	33	49
8	-----	-----	-----	-----	-----	29, 32, 31, 26, 13

Appendix C (continued)

Cluster	Processes included in each cluster by Expert 13	Expert 14	Expert 15	Expert 16
1	20, 30, 1	6, 11, 25, 31, 35, 38, 41, 44, 47, 3	27, 37, 1	36, 16, 40, 13, 45, 50, 29, 11, 26, 28, 1
2	2, 48, 18, 4, 14	12, 17, 16, 13, 8, 43	4, 19, 28, 23, 13	3, 33, 38, 6, 35
3	11, 16, 44, 47, 8	14, 32	40, 12, 20	4, 10
4	5, 39, 37, 50, 22, 46	22, 34, 40, 39, 2, 7, 10, 50, 18	24, 3, 18, 30, 21, 34, 39, 42, 49	5, 15, 19, 7
5	23, 26, 28, 45, 33, 32, 17, 19, 9, 43, 42, 13	5, 29	35, 32, 45, 33, 31, 5, 38	21, 8, 23, 32, 37, 20, 9, 12, 24
6	10, 34	1, 27	22, 50	39, 2, 30, 42, 34, 48, 46, 14, 18
7	27, 40, 12, 24, 36, 29, 15, 7	45, 37, 30	2, 29, 7, 14	43, 17, 22
8	6,49	19, 49, 33, 4, 28, 23, 26	41, 25, 44, 6, 47, 11	25, 47, 44, 31, 27
9	21, 3, 31, 25, 38, 35, 41	24, 36, 48, 42, 9, 15, 20, 21, 46	10, 48, 46, 15, 43, 36, 26	41
10	-----	-----	8, 17, 8, 16	49

Appendix D

Aggregated Matrix

P	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1	16																								
2	0	16																							
3	2	1	16																						
4	0	7	0	16																					
5	2	2	1	4	16																				
6	6	0	6	0	2	16																			
7	0	10	0	10	4	0	16																		
8	1	0	0	0	1	3	0	16																	
9	1	1	2	2	6	1	1	5	16																
10	0	8	1	7	1	1	8	1	1	16															
11	10	0	5	0	0	10	0	2	0	0	16														
12	0	3	1	4	2	2	7	6	4	2	2	16													
13	1	0	1	2	2	1	1	5	4	0	1	3	16												
14	1	9	1	8	6	2	8	0	3	4	1	3	1	16											
15	2	4	4	2	5	0	5	0	4	3	2	4	1	5	16										
16	4	0	0	1	1	3	0	11	5	0	5	5	4	1	0	16									
17	2	1	0	2	3	4	1	10	7	0	2	6	4	2	0	12	16								
18	0	9	4	7	1	1	7	1	2	11	0	1	0	6	3	0	0	16							
19	3	1	0	6	3	1	5	1	3	1	3	5	5	2	3	1	2	1	16						
20	4	2	1	3	7	1	4	3	5	1	1	5	3	5	8	1	2	1	3	16					
21	2	2	5	1	7	2	1	2	6	1	1	2	2	4	9	0	1	3	2	10	16				
22	0	8	2	6	3	2	7	1	0	11	0	1	1	4	3	0	2	10	1	2	3	16			
23	2	0	1	5	3	0	3	4	5	1	1	5	7	2	3	3	2	1	11	7	5	1	16		
24	2	3	5	2	5	0	3	1	6	2	1	3	1	3	11	0	0	5	2	9	13	3	5	16	
25	6	1	8	0	1	6	0	1	0	0	8	1	2	0	2	2	0	0	2	0	2	1	2	1	16
26	2	0	2	2	1	0	1	3	5	1	2	2	10	1	4	3	2	1	8	3	2	0	9	3	1
27	7	2	5	1	1	8	2	3	0	1	8	4	1	0	4	2	3	1	0	2	3	3	0	3	6
28	2	2	1	7	3	0	6	2	2	3	2	4	8	3	3	2	1	2	9	5	3	2	10	4	2
29	3	6	0	5	3	1	7	0	1	6	3	3	2	5	4	3	2	5	1	2	2	5	1	4	0
30	1	8	4	7	1	1	6	0	0	9	0	1	0	6	3	0	0	12	1	2	4	10	1	5	1
31	5	1	5	1	2	4	1	1	1	0	7	3	3	2	1	3	3	0	3	0	1	0	1	0	9
32	6	0	0	0	3	4	0	6	3	0	4	1	6	2	0	5	6	0	3	3	2	1	4	1	5
33	0	2	3	4	1	1	4	1	3	1	0	4	6	1	2	1	1	2	5	2	0	1	6	1	1
34	0	10	4	6	1	1	8	0	0	12	0	2	0	5	3	0	0	13	1	1	4	11	1	5	1
35	6	1	9	0	1	9	0	0	0	1	9	1	2	0	2	1	0	1	2	0	2	2	1	1	10
36	3	3	1	3	3	0	5	1	3	3	2	4	3	3	10	2	1	3	3	9	7	2	5	9	1
37	2	4	3	4	4	3	4	2	2	8	2	3	2	6	4	1	2	7	1	4	4	10	3	3	1
38	3	1	11	0	1	8	0	2	1	1	6	3	1	0	3	2	2	3	0	0	3	2	0	3	7
39	2	6	4	2	2	1	4	1	0	6	2	2	1	2	3	1	0	8	4	2	5	7	3	6	3
40	3	5	0	3	2	1	7	1	0	4	3	6	4	3	6	2	0	3	5	6	4	3	4	6	3
41	7	0	6	0	0	8	0	0	0	0	11	1	1	1	2	2	1	0	1	1	2	0	1	1	8
42	2	2	3	3	3	1	4	2	3	4	1	3	4	4	4	1	2	5	7	7	5	3	8	5	0
43	1	1	2	2	6	2	1	3	10	1	0	4	5	3	5	5	8	1	4	3	4	1	4	4	0
44	7	0	7	0	0	8	0	1	0	0	12	1	1	1	2	3	1	0	2	1	1	0	1	1	12
45	1	7	3	6	2	1	6	0	2	10	1	1	2	4	4	1	1	10	2	1	2	11	2	4	1
46	0	2	3	2	4	0	2	1	3	5	0	1	3	3	7	1	0	5	2	4	5	5	4	7	3
47	6	0	7	0	0	8	0	2	0	0	11	1	2	1	1	4	1	0	2	0	0	0	2	0	13
48	2	3	2	4	6	0	3	4	7	3	0	2	2	6	7	1	2	5	4	8	6	1	6	7	0
49	1	2	7	2	2	2	2	2	3	1	0	1	2	3	5	2	2	3	2	5	4	2	4	5	2
50	1	7	1	6	3	0	7	1	1	10	1	1	2	4	3	2	0	10	1	1	1	12	2	3	1

Appendix D (continued)

P	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
1																									
2																									
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25																									
26	16																								
27	0	16																							
28	9	0	16																						
29	2	2	4	16																					
30	0	2	2	5	16																				
31	2	4	2	2	0	16																			
32	5	2	4	2	0	6	16																		
33	7	1	5	0	1	1	3	16																	
34	0	2	3	6	13	0	0	1	16																
35	0	7	1	0	2	8	4	3	2	16															
36	5	3	5	4	2	1	2	4	2	1	16														
37	1	3	2	5	8	2	3	0	7	2	1	16													
38	1	7	1	0	3	7	2	3	3	12	2	2	16												
39	3	1	6	4	8	1	3	2	10	2	2	4	2	16											
40	5	1	9	5	2	2	4	3	4	2	9	1	1	8	16										
41	0	7	0	4	0	7	2	1	0	10	1	2	7	0	0	16									
42	7	0	9	2	5	1	3	2	6	1	5	4	1	7	5	0	16								
43	7	1	3	1	0	1	2	3	0	0	3	1	2	1	1	0	3	16							
44	0	7	1	2	0	9	4	0	0	9	2	2	6	1	2	10	0	0	16						
45	3	2	4	6	11	1	2	4	10	3	4	9	4	5	3	0	4	2	0	16					
46	5	0	6	2	4	1	2	2	4	1	7	5	2	7	6	0	6	5	2	5	16				
47	1	6	2	1	0	9	5	1	0	9	1	2	6	2	3	9	0	0	15	0	3	16			
48	5	0	5	1	2	1	1	1	2	0	7	2	1	3	2	0	8	6	0	2	7	0	16		
49	5	1	4	0	3	0	2	4	3	2	4	2	3	4	2	0	6	4	1	3	4	1	5	16	
50	3	1	4	6	8	0	1	3	9	0	4	8	1	7	5	0	2	2	0	11	8	1	2	1	16

Appendix E

Steps for Calculating Bridging Values[10]

A bridging value is computed for each statement and cluster as part of the concept mapping analysis. These values, which range from 0 to 1, are calculated after the point map is determined. To calculate the bridging value for a statement *i*, the following steps are used:

Step 1: For all pairs of statements *i* and *j*, compute the proportion of sorters who put statements *i* and *j* together:

$$\text{prop}(i,j) = \frac{\text{number of people who sorted } i,j \text{ together}}{\text{number of people who sorted}}$$

Step 2: Compute the raw bridging value for statement *i* by,

$$\text{raw bridging}(i) = \frac{\text{prop}(\text{value}(i,j) * \text{distance}(i,j))}{\text{SUM}(\text{value}(i,j))}$$

The top half of the formula multiplies the proportion of people who placed statements *i* and *j* together by the distance between them on the map. The distance is simply the standardized straight-line Euclidean distance computed from the x, y map coordinates determined after the multidimensional scaling analysis (MDS). This is divided by the proportion of sorters who placed the statements together. The result gives us the average distance between point *i* and all other points that *i* was categoried with:

Step 3: The raw bridging value is then standardized to a 0-1 scale by:

$$\text{bridging value}(i) = \frac{\text{raw bridging}(i) - \text{minimum}(\text{raw bridging}(\ ))}{\text{maximum}(\text{raw bridging}(\ )) - \text{minimum}(\text{raw bridging}(\ ))}$$

Note: The cluster bridging value is simply the average bridging value across all statements in a cluster.

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[10] Information provided from Concept Systems, Inc. via e-mail October 21st, 2010.

Appendix F

Six Cluster Solution with Bridging Values

ID	Social Sustainability Process	Bridging Value
Cluster A: Stakeholder Engagement		
44	Communicate the deliverables and intended project outcomes with each stakeholder group	0.00
41	Document and share the lessons learned during the planning and design phases with all stakeholders	0.09
47	Communicate the rationale for the commissioning process to the stakeholders	0.10
11	Generate a stakeholder management plan that encourages interaction, integration, and collaboration among stakeholders	0.15
25	Inform stakeholders of the project constraints (e.g. budget, schedule, location, size, design and construction standards)	0.20
35	Educate the public about the planning/design progress	0.29
6	Engage local governments in design so that decision makers can understand and anticipate their needs	0.41
27	Ensure participation of final users in design so that decision makers can understand and anticipate their needs	0.55
31	Establish partnering strategies for resolving interpersonal conflicts among project stakeholders	0.60
38	Encourage neighborhood engagement in the design	0.60
1	Determine the expectations of the owner, designer and public early in the project	0.66
3	Respond quickly to community concerns and perceptions	0.75
	Average:	**0.37**
Cluster B: User Considerations		
36	Include security considerations for the final users in the project design	0.26
20	Adopt designs that increase the wellness and productivity of the final users	0.27
42	Provide a plan to minimize disruption caused by the construction process (e.g. traffic congestion, dust and noise)	0.35
40	Establish requirements to assess the impact of the project on the health and safety of the final users	0.36
28	Establish a plan to evaluate progress on Zero Harm or Zero Accident targets for the project	0.41
49	Monitor and respond to incidents of corruption	0.53
48	Design to consider the job skills of the women, young people, unemployed, disadvantaged, racial and ethnic minority groups in the area	0.59
5	Use an Evidence-Based Design process, basing decisions about the built environment on valid and reliable research	0.97
	Average:	**0.47**

Appendix F (continued)

ID	Social Sustainability Process	Bridging Value
Cluster C: Team Formation		
12	Include health professionals in the design team to help analyze health impacts on the final users and the community	0.76
8	Select a diverse design team including participants from various professions, genders, races, and firm sizes	0.82
32	Use an integrated design-construction process	0.84
16	Select design and construction firms with a sustainability focus	0.86
17	Use local designers and professionals	0.89
	Average:	**0.83**
Cluster D: Management Considerations		
23	Incorporate safety prevention techniques that prevent or minimize occupational hazards and risks during construction (e.g. the analysis of the sequence of construction activities, the use of prefabrication techniques)	0.36
19	Establish Zero Harm or Zero Accident targets for the project	0.50
26	Require a management plan for improving construction worker productivity	0.52
13	Train designers to help them address future hazards during the construction and maintenance phases of the project	0.77
43	Use local material/product suppliers for the project	0.80
9	Design to enable the use of local construction labor	0.88
33	Require education, training, counseling, prevention, and risk-control programs to assist workforce members, their families, or community members regarding serious diseases	1.00
	Average:	**0.69**

Appendix F (continued)

ID	Social Sustainability Process	Bridging Value
Cluster E: Impact Assessment		
18	Assess the impact of introducing new social classes into the surrounding community (e.g. a community where low-income housing is proposed might perceive the new social class as a threat based on stereotypes and misconceptions)	0.10
10	Analyze the effect of the project on cultural, historical, and archeological resources	0.10
34	Analyze the impact of the project on the cultural and ethnic identity of the surrounding community	0.14
22	Analyze new/additional community infrastructure needs resulting from the project (e.g. water, power, emergency responders)	0.18
50	Analyze the impact of the project location on access to public transit, biking opportunities, safe walking routes, and green spaces	0.20
45	Assess seasonal population changes in the surrounding community and their effect on employment patterns, business practices, and community infrastructure	0.24
2	Conduct a social impact assessment of the project	0.25
7	Conduct a Health Impact Assessment	0.34
14	Incorporate social considerations (e.g. health, productivity, quality of life) into a return on investment analysis (ROI)	0.51
29	Assess the results from Post-Occupancy Evaluation of similar projects	0.52
4	Conduct a social life cycle analysis of construction products and materials that considers workforce safety and health	0.55
	Average:	**0.28**
Cluster F: Place Context		
24	Include human interaction (connectivity) considerations for the final users in the project design	0.33
46	Maintain and/or restore natural habitat important to the final users and the surrounding community	0.34
15	Include privacy considerations for the final users	0.35
30	Perform an asset-based design analysis of the surrounding community so that design solutions can convert social liabilities into assets	0.44
37	Assess the planning and zoning decisions of organizations/institutions with jurisdiction over the proposed project area	0.53
39	Develop a plan for ongoing evaluation of the impact of the project on surrounding communities once it is in operation	0.57
21	Create design features that instill pride in ownership of the users and the surrounding community	0.59
	Average:	**0.45**

Appendix G

Cluster Names Created by the Experts

Expert 1

Pile 1:	**Owner Project Requirements and Deliverables**
Pile 2:	**Community Outreach**
Pile 3:	**Design Considerations**
Pile 4:	**Delivery Team Requirements/Considerations**

Expert 2

Pile 1:	**Alignment**
Pile 2:	**Life Cycle Analyses**
Pile 3:	**Impact Assessment**
Pile 4:	**Design**
Pile 5:	**Community Interaction**

Expert 3

Pile 1:	**Goals and Expectations**
Pile 2:	**Data Collection and Analysis**
Pile 3:	**Design and Construction Performance Criteria**
Pile 4:	**Assemble the Team**
Pile 5:	**Post-Occupancy Performance Criteria**

Expert 4

Pile 1:	**Health, Safety and Wellness**
Pile 2:	**Valuing Diversity**
Pile 3:	**Healthy Communities**
Pile 4:	**Environmental/Ecological Design**
Pile 5:	**Integration/Collaboration**

Expert 5

Pile 1:	**Input/Participation**
Pile 2:	**Team building and selection**
Pile 3:	**Project Team Training**
Pile 4:	**Community Infrastructure**
Pile 5:	**Environmental/Ecological Design**
Pile 6:	**Human condition**

Expert 6

Pile 1:	**Input/Participation**
Pile 2:	**Communication with stakeholders**
Pile 3:	**Impact Assessment**
Pile 4:	**Impact analysis/assessment**
Pile 5:	**Design team and design process**
Pile 6:	**Health education?**

Expert 7

Pile 1:	**Stakeholder Participation**
Pile 2:	**Sitting Considerations**
Pile 3:	**Strengthen Local Community**
Pile 4:	**Quality of Life**
Pile 5:	**Workforce Considerations**
Pile 6:	**Maximize Sustainable Products/Processes**

Expert 8

Pile 1:	**Scoping**
Pile 2:	**Project Impact Assessments**
Pile 3:	**Community/Stakeholder Engagement**
Pile 4:	**Design Phase**
Pile 5:	**Project Team Training**
Pile 6:	**Establish Project Performance Indicators**

Expert 9

Pile 1:	**Planning**
Pile 2:	**Analysis**
Pile 3:	**Resources**
Pile 4:	**Design**
Pile 5:	**Education and training**
Pile 6:	**Implementation**

Expert 10

Pile 1:	**Impact Statements**
Pile 2:	**Design**
Pile 3:	**Construction**
Pile 4:	**Pre Design**
Pile 5:	**Community Involvement**
Pile 6:	**Seven?**
Pile 7:	**Project Team Development**

Appendix G (continued)

Expert 11

Pile 1:	**Internal collaboration**
Pile 2:	**External engagement**
Pile 3:	**Team building and selection**
Pile 4:	**Analyses**
Pile 5:	**Team capacity building**
Pile 6:	**Best practices**
Pile 7:	**External to project?**

Expert 12

Pile 1:	**Participative project delivery**
Pile 2:	**Safety and Health**
Pile 3:	**Diversity**
Pile 4:	**Capacity building**
Pile 5:	**Socially sensitive outcomes**
Pile 6:	**Project impacts on context**
Pile 7:	**Integrity**
Pile 8:	**Process optimization**

Expert 13

Pile 1:	**Pre-design**
Pile 2:	**Social context**
Pile 3:	**Strategic collaboration**
Pile 4:	**Built context**
Pile 5:	**Building culture**
Pile 6:	**Cultural context**
Pile 7:	**Human condition**
Pile 8:	**Municipalities**
Pile 9:	**Community context**

Expert 14

Pile 1:	**Community Inclusion/Stakeholder Engagement**
Pile 2:	**Project Team Development**
Pile 3:	**Business Model**
Pile 4:	**Community Impact Assessment (Before & after implementation)**
Pile 5:	**Peer Learning**
Pile 6:	**Visioning/ Defining Design Parameters**
Pile 7:	**Defining Context**
Pile 8:	**Workforce Protection**
Pile 9:	**Community-Oriented Design**

Expert 15

Pile 1:	**Planning**
Pile 2:	**Construction Safety**
Pile 3:	**User Safety**
Pile 4:	**Community Equity**
Pile 5:	**Misc Process**
Pile 6:	**Community Infrastructure**
Pile 7:	**Misc Metrics**
Pile 8:	**Stakeholders**
Pile 9:	**Misc Criteria**
Pile 10:	**Entity Selection**

Expert 16

Pile 1:	**Planning**
Pile 2:	**Community outreach**
Pile 3:	**Life cycle analysis**
Pile 4:	**Establishing design goals**
Pile 5:	**Design**
Pile 6:	**Social impact**
Pile 7:	**Community resources**
Pile 8:	**Stakeholder involvement and communication**
Pile 9:	**Start-up and occupancy**
Pile 10:	**Auditing**

Appendix H

Experts Rating

Process	Expert															
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
1	5	5	5	4	5	5	5	5	5	5	5	5	5	5	5	5
2	4	5	4	3	3	3	4	5	5	5	4	5	4	5	5	4
3	5	4	3	4	5	3	5	5	4	4	5	4	5	4	3	5
4	3	4	3	3	5	2	4	4	5	4	4	3	4	4	3	5
5	4	4	4	4	3	3	5	4	4	5	3	5	5	4	3	5
6	5	4	5	4	5	4	5	5	4	5	5	5	5	5	2	3
7	3	4	5	3	3	3	5	4	5	5	4	5	3	5	4	5
8	3	2	5	3	2	3	3	5	4	4	5	5	4	4	4	3
9	4	3	3	4	3	3	5	4	3	5	4	4	4	4	3	4
10	4	4	5	2	4	3	5	5	5	4	4	5	5	5	4	4
11	5	4	5	5	5	3	5	4	4	5	5	4	5	5	5	5
12	3	3	4	2	3	3	3	4	4	3	4	5	5	4	5	4
13	4	4	4	4	4	3	4	4	4	3	4	4	5	4	5	5
14	3	4	5	3	2	3	5	4	4	5	4	5	5	4	4	5
15	5	3	3	2	2	3	5	3	3	4	4	4	4	3	2	3
16	4	5	5	5	5	4	4	3	2	5	5	4	5	4	5	3
17	3	4	2	4	3	3	2	3	2	4	4	5	4	3	3	4
18	3	4	4	3	4	3	4	4	4	5	4	5	5	4	3	3
19	5	5	4	5	5	3	5	5	4	5	4	3	5	5	4	5
20	5	4	4	4	4	3	5	4	4	5	4	5	5	5	4	4
21	5	3	4	5	3	4	5	5	5	5	4	5	5	5	3	4
22	4	5	4	4	5	4	5	5	3	5	5	5	5	5	5	5
23	4	5	3	4	5	4	5	5	4	5	5	3	5	5	4	5
24	5	3	5	4	5	4	5	4	4	5	4	5	5	5	3	4
25	5	5	5	4	3	4	5	5	3	5	5	4	4	5	5	5
26	4	5	3	3	2	3	5	4	2	4	4	3	3	3	1	5
27	5	3	5	3	4	5	5	5	5	5	5	5	4	5	5	5
28	5	4	4	5	5	3	5	5	3	5	4	3	4	5	3	5
29	5	3	5	3	3	3	4	4	3	3	4	4	4	5	4	5
30	4	3	4	3	4	3	4	4	5	4	4	5	5	5	2	3
31	4	4	4	4	3	2	5	5	3	4	5	4	4	5	2	4
32	5	4	5	4	5	3	5	4	4	5	4	4	5	3	5	5
33	3	2	4	3	3	2	3	4	3	1	1	3	4	4	2	3
34	3	3	5	3	3	2	5	4	5	2	4	5	5	5	3	3
35	5	3	5	4	3	3	4	5	3	3	4	4	5	5	5	3
36	5	3	5	4	4	3	5	5	2	5	4	5	5	5	5	5
37	5	5	5	4	3	3	5	5	3	5	4	5	5	5	3	5
38	3	3	5	3	4	4	4	5	4	5	4	5	5	5	4	3
39	4	3	4	3	4	2	4	4	3	5	4	4	5	5	3	4
40	5	4	4	4	5	2	5	4	4	5	4	4	5	5	5	5
41	5	4	4	4	3	2	4	5	4	5	5	4	4	5	3	5
42	5	5	4	5	5	5	5	5	2	4	5	3	5	5	4	5
43	4	5	3	4	3	3	5	4	3	5	4	3	4	4	4	4
44	5	5	3	4	3	4	5	5	4	5	5	5	5	5	5	5
45	4	4	3	2	3	2	4	4	5	3	4	4	5	4	2	3
46	4	3	4	4	5	4	5	5	5	5	5	3	5	5	4	4
47	5	4	4	4	2	3	4	5	3	4	5	3	3	5	2	5
48	4	3	4	3	4	3	4	4	4	2	4	4	3	5	2	4
49	5	5	5	5	5	2	4	5	3	5	4	4	3	5	4	5
50	4	3	5	4	5	5	5	5	4	5	5	5	5	5	4	5

Appendix I

Frequency Distribution of Processes Rating

Process	Rating 1 Little Importance	 2	 3	 4	 5 High Importance
1	0	0	0	1	15
2	0	0	3	6	7
3	0	0	3	6	7
4	0	1	5	7	3
5	0	0	4	7	5
6	0	1	1	4	10
7	0	0	5	4	7
8	0	2	5	5	4
9	0	0	6	8	2
10	0	1	1	7	7
11	0	0	1	4	11
12	0	1	6	6	3
13	0	0	2	11	3
14	0	1	3	6	6
15	0	3	7	4	2
16	0	1	2	5	8
17	0	3	6	6	1
18	0	0	5	8	3
19	0	0	2	4	10
20	0	0	1	9	6
21	0	0	3	4	9
22	0	0	1	4	11
23	0	0	2	5	9
24	0	0	2	6	8
25	0	0	2	4	10
26	1	2	6	4	3
27	0	0	2	2	12
28	0	0	4	4	8
29	0	0	6	6	4
30	0	1	4	7	4
31	0	2	2	8	4
32	0	0	2	6	8
33	2	3	7	4	0
34	0	2	6	2	6
35	0	0	6	4	6
36	0	1	2	3	10
37	0	0	4	2	10
38	0	0	4	6	6
39	0	1	4	8	3
40	0	1	0	7	8
41	0	1	2	7	6
42	0	1	1	3	11
43	0	0	5	8	3
44	0	0	2	3	11
45	0	3	4	7	2
46	0	0	2	6	8
47	0	2	4	5	5
48	0	2	4	9	1
49	0	1	2	4	9
50	0	0	1	4	11

Appendix J

Pattern Matching Analysis

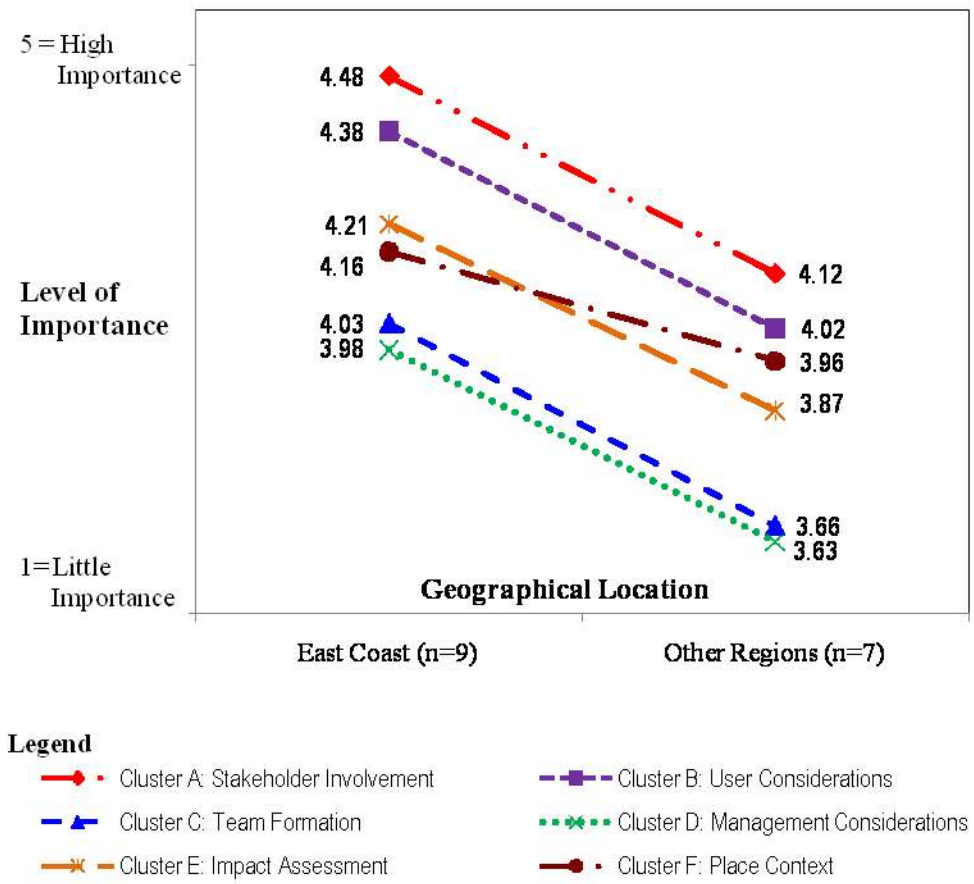

Figure H.1 Pattern Matching of Cluster Importance Comparing Geographical Location

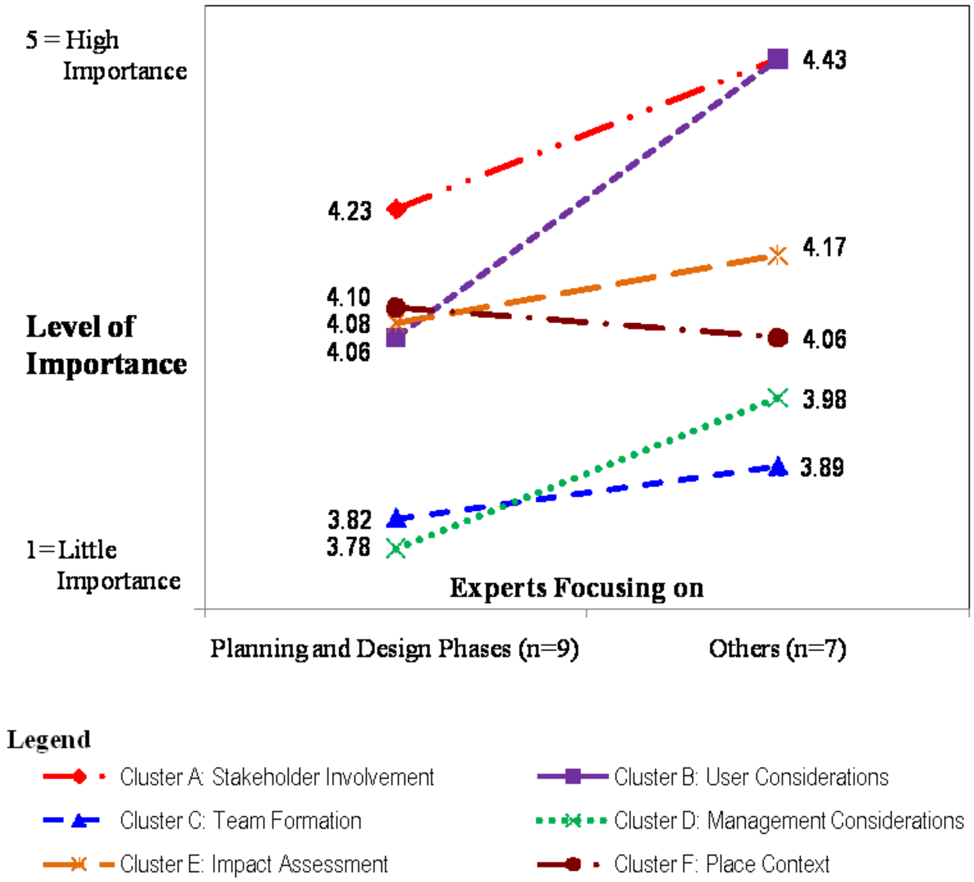

Figure H.2 Pattern Matching of Cluster Importance Comparing Experts Focuses

Appendix H (continued)

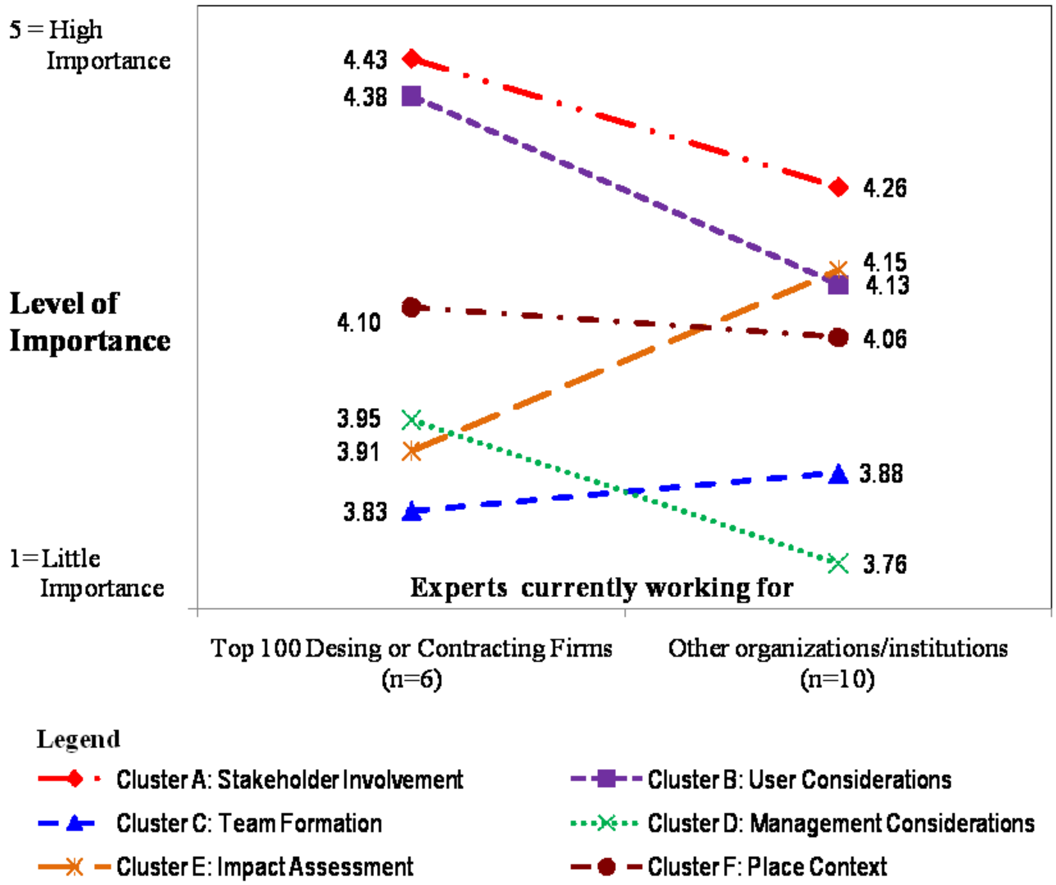

Figure H.3 Pattern Matching of Cluster Importance Comparing Experts Working for or not Working for Top 100 Design and Contracting Firms

Appendix H (continued)

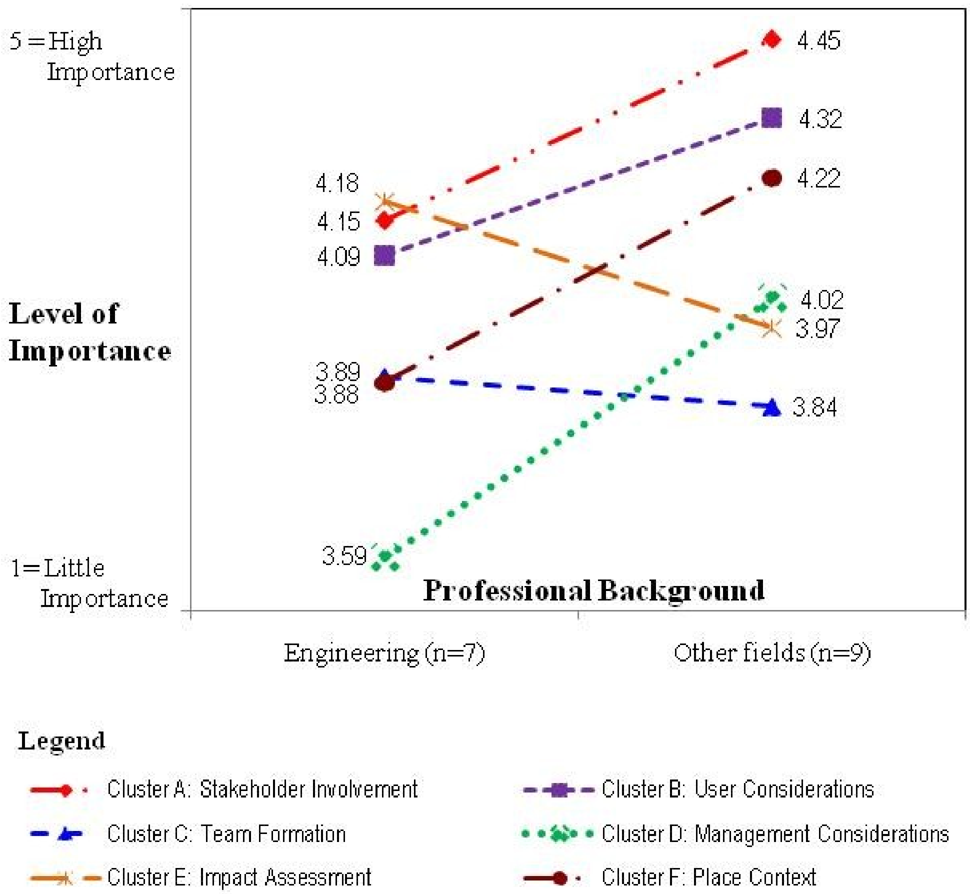

Figure H.4 Pattern Matching of Cluster Importance Comparing Professional Background

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