EVALUATING THE SOCIAL ASPECT OF SUSTAINABLE CONSTRUCTION FOR PAKISTAN VIA ANALYTICAL HIERARCHY PROCESS

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ABSTRACT

Sustainable Development, sustainability and sustainable construction are not synonymous to each other. In the past decade researchers have presented models for sustainability and identified factors for different countries. Most of the definition related to sustainability, sustainable development, and sustainable construction relies on economy, environment and society. This makes social aspect (society) to be of prime importance. This paper focuses on the social aspects of the sustainable construction. Most of the sustainability studies are carried out through questionnaire or interviews. Similarly, this papers also uses the questionnaire for data collection. The collected data is analyzed with Analytical Hierarchy Process (AHP). The pair wise comparison (From-To) charts are generated for all central tendency measures. These measures are used as input for AHP independently. The factors are ranked on the basis of their Eigen values obtained from AHP analysis. The result shows that clean water is considered in almost all of the projects whereas the universities and other research institutes are hardly considered in any projects.

KEYWORDS: *Social Aspects, Sustainability, Sustainable Construction, AHP, Society*

INTRODUCTION

Investment in infrastructure development is on the rise in developing countries. Worldwide 10 percent to the world's GDP is associated with construction sector (Yun and Jung 2017). It is estimated that globally around 9.9 million people are involved with construction sector ((ECIF) 2010). However, in Pakistan the construction sector GDP contribution fell from 4.7 in 1960s to 2.4 % in the early 21st century (Rizwan U. Farooqui 2008). Pakistan construction sector had showed growth of around 9 percent for the year 2016-17 and is expected to maintain it in 2017-18 (Wasti 2016).

Construction industry have accepted technology but still it is very much labour intensive. Moreover, (Yun and Jung 2017) claimed that construction industry has ripple effect on the society. The improvements in construction sector has positive relationship with improvements in society (Yun and Jung 2017). This means the construction industry is well integrated in the social fabric of the society. This integration makes the social aspect of prime significance.

LITERATURE REVIEW

Just like sustainability which has so many complexities (Mebratu 1998), interpreting construction is also complex (Du Plessis 2007). These complexities are due to high fragmentation in construction environment (Myers 2005).Moreover, the limited structure methodology and the communication gap between different stake holder, complexes the problem more (Ugwu and Haupt 2007). Several attempts have been made to define the term construction. Some have ignored life cycle (Morton 2002), some defined it as site level activity (Irurah 2001, Du Plessis 2007) and many more.

Sustainability could be traced back to 1000s of years back. A book "Small and Beautiful: A Study of Economics as if People Mattered" by (Schumacher 1973) emphasized on the depleting resources and their effective utilization. (Pearce, Atkinson et al. 1994, Dresner 2008) defines sustainability as resource utilization keeping its effectiveness intact. In addition to this, (Silvius and Schipper 2015) considers sustainability to be an outcome of a process. The literature also suggests that sustainability is different from sustainable development (Daly 1990, Gunatilake 2013). Researchers such as (Parkin 2000) suggests that there are more than two hundred definitions for sustainable development and it has yet to get a universal definition. (Barbier 1987) implored that people, planet and profit defines sustainable development. In contemporary research, profit, people and planet are

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replaced by economy, society, and environment respectively (Gunatilake 2013).

A number of conferences, seminars and events on sustainability had been arranged. The Stockholm Conference in 1972 (Clarke and Timberlake 1982), World Commission on Environment and Development in 1987 (WCED 1987), and Earth Summit in 1992 (Summit 1992) paved ways to Kyoto Protocol in 1997 (Protocol 1997). The latest event is the announcement of Sustainable Development Goals (SDGs) by the United Nations (United Nations 2017). A total 17 goals have been defined and each goal has a number of indicators. Almost all of the goals are directly related to society. This makes the social aspect of sustainability much more important. (Lehtonen 2004) gave the social aspect much more importance then economy.

Social aspect is the welfare of humans especially local communities (Adetunji, Price et al. 2003). A construction project involves too many stakeholders (Meng 2012). These stakeholders could be clients, suppliers, employees, or communities (Pawłowski 2008) . The architects, government and other non-government agencies could also be stakeholders. Additionally, the construction industry is old fashion and can be disruptive, dangerous and dirty (Pawłowski 2008). Moreover, humans spends around 90 percent of their lives in buildings (BRE 2002). With economy on one side and humans needs on other, the social aspect within a construction environment takes pivot role in defining and determining the priorities of the construction sectors.

A number of studies related to identification and ranking of sustainable factors in construction industry have been reported. These studies are for both developing and developed countries. Such as for Thailand (Ogunlana 2008), for Singapore (Li, Chen et al. 2011), for India (Tabish and Jha 2011), for United States of America (Songer and Molenaar 1997) and many more. No comprehensive study related to sustainable construction exists for Pakistan. This paper full fills the gap.

Although the broader study considers all aspects of sustainable construction, the scope of this paper is narrowed down to social aspects only. This paper will first identify the social factors and then with the help of a decision-making tool (Analytical Hierarchy Process (AHP)) rank the different factors. The researchers typically use the mean values to analyze the data via AHP. This paper uses mode and median as an AHP input as well. The data is collected through a questionnaire.

METHODOLOGY

The Fig. 1 illustrates the methodology used in this paper. After a preliminary literature review a research questions "what are the significant factors for sustainable construction in Pakistan" was drafted. This was followed by a comprehensive literature review which helped in identifying the different social factors. The factors for which data will be collected was finalized. A questionnaire was developed having all the important factors highlighted in literature review. A pilot study was carried out by sharing the questionnaire with 3 academicians and 3 construction practioners. There suggestions and improvements were incorporated in the finalized questionnaire. The finalized questionnaire was then shared with potential respondents. A total of 165 questionnaire were shared out of which 120 were received. The benchmark for the number of received responses was 100. After receiving the required number of responses, the data was subjected to three reliability tests. This was followed by the data analysis via AHP method. The significant factors on the basis of Eigen values obtained from AHP are discussed and documented at the end.

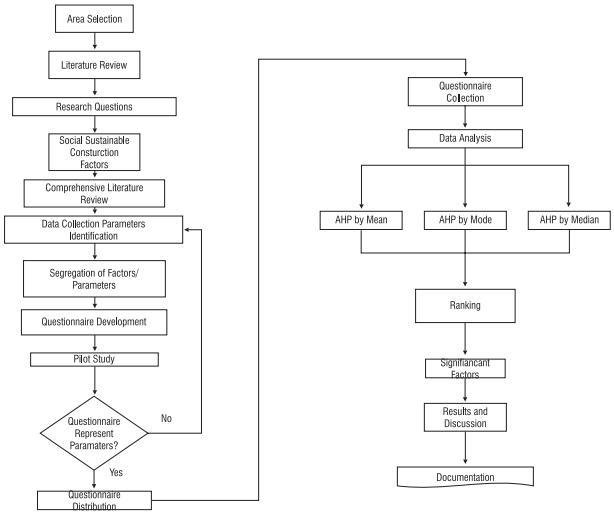

Fig. 1: Methodology Flow Chart

DATA COLLECTION

As discussed earlier, the data is collected via questionnaire. It is reported that in construction industry a sample of 16 could also be used for analysis (Banihashemi, Hosseini et al. 2017). Keeping the population size of the potential respondents at 0.1 million and error at 10 percent, the calculated sample size is 99. A total of 165 questionnaires were distributed. Hundred valid responses were received. The respondents were academicians, government current and ex-employees, architects, consultants, project managers. The respondents experience varied from 5 to 40 years. Their working experience incorporated different cities of Pakistan. The respondents were asked to rate the factors on a Likert Scale (1-5), 5 was Very high, 3 Moderate and 1 Very Low.

The questionnaire was distributed via google form, email, WhatsApp, and by hand. A large number of responses were received via google form.

Table 1: Reliability Tests

S. No	Test	Acceptable Value	Calculated Value
i	Cronbach Alpha	Greater than 0.7	0.917
ii	Kaiser Mayer Olkin	Greater than 0.5	0.889
iii	Bartlett's Test	Significance value Less than 0.05	0.000

DATA ANALYSIS

The first step for the data analysis is to check the reliability of the collected data. The collected data was subjected to three different reliability tests. Table 1 summarizes the different reliability tests carried out for this research. The most commonly use reliability tests is Cronbach alpha test. As shown in Table 1, the Cronbach alpha value is higher than its acceptance threshold value. Similarly, the Kaiser Mayer Olkin (KMO) tests and Bartlett's test also satisfies the reliabilities constraints.

It is concluded that the available data is reliable and can be subjected to further data analysis. There are two methods of AHP. One is the consistency ratio which is applicable to 15 X 15 Matrix, the second is the squaring method which could be applied on all matrices, irrespective of the size. This paper uses the second method as the number of social factors are 19 so the matrix generated will be 19 x 19. Although the research indicates that large matrices can also be solved via consistency ratio method but the squaring methods seems to be much simpler one.

The Following steps were carried out in analyzing the data via AHP through squaring method.

1. Generate From-To Matrix [A]
2. Multiply the From-To matrix with itself to get Matrix [B]
3. Calculate the row sum of all the rows for Matrix [B]
4. Calculate the total sum of Matrix [B]
5. Identify the Eigen values by dividing the Individual Row Sum by Total Sum
6. Multiply Matrix [B] with itself to get Matrix [C]
7. Repeat step 3 to 5 for Matrix [C]
8. Subtract Eigen Values of Matrix [B] from Eigen values of Matrix [C]
9. If the values at step-8 is zero then stop otherwise multiply Matrix [C] with itself and repeat step 3 to 5 unless the Eigen values of two adjacent matrix are identical.
10. Sort the Eigen value to identify the significant factors.

As discussed earlier, this paper uses measures of central tendency as an input. So, the steps mentioned above are done for mean, mode, and median individually. Table 2 shows the factors and their respective mean, mode and median.

Table 2: Factors and their respective Measures of Central Tendencies

S. No	Factors	Mean	Mode	Median
1.	Child Labour	2.85	3	3
2.	Community Support	3.36	3	3
3.	Competitor	3.39	4	4
4.	Customer Privacy	3.17	3	3
5.	Eight Hour Shift	3.7	4	4
6.	First Aid Box	2.64	1	3
7.	Innovation	2.99	3	3
8.	Latest Research	3.01	4	3
9.	Local Culture and Heritage	3.48	4	4
10.	Local Resources	3.65	4	4
11.	Local Sub Contractor and Workers	3.66	4	4
12.	Personnel Protective Equipment (PPE)	2.94	4	3
13.	Politics (Local, National and International)	3.59	4	4
14.	Safety Aspects	2.97	4	3
15.	Sharing Problems with Universities	2.38	1	2
16.	Social Welfare	2.95	3	3
17.	Special People (Handicapped)	2.69	1	3
18.	Stake Holders	3.52	3	4
19.	Team work	3.85	4	4

The data shown in Table 2, is used to generate the From-to charts for mean, mode and median. The data is analyzed by squaring method. Table 3 shows the calculated Eigen Values for all the central tendency measures.

Table 3: Factors and their respective Eigen Values

S. No	Factors	Eigen Values		
		Mean	Mode	Median
1.	Child Labour	0.04688271	0.04444444	0.06153846
2.	Community Support	0.05527225	0.04444444	0.06153846
3.	Competitor	0.05576575	0.03333333	0.04615385
4.	Customer Privacy	0.05214673	0.04444444	0.04615385
5.	Eight Hour Shift	0.06086527	0.03333333	0.04615385
6.	First Aid Box	0.0434282	0.13333333	0.04615385
7.	Innovation	0.04918572	0.04444444	0.04615385
8.	Latest Research	0.04951472	0.03333333	0.06153846
9.	Local Culture and Heritage	0.05724626	0.03333333	0.06153846
10.	Local Resources	0.06004277	0.03333333	0.06153846
11.	Local Sub Contractor and Workers	0.06020727	0.03333333	0.06153846
12.	Personnel Protective Equipment (PPE)	0.04836322	0.03333333	0.06153846
13.	Politics (Local, National and International)	0.05905577	0.03333333	0.04615385

14.	Safety Aspects	0.04885672	0.03333333	0.04615385
15.	Sharing Problems with Universities	0.03915118	0.13333333	0.03076923
16.	Social Welfare	0.04852772	0.04444444	0.04615385
17.	Special People (Handicapped)	0.0442507	0.13333333	0.04615385
18.	Stake Holders	0.05790426	0.04444444	0.06153846
19.	Team work	0.06333278	0.03333333	0.06153846

RESULTS AND DISCUSSION

The Eigen values calculated are shown in data analysis section. This section discusses the ranks of different factors. Table 4 summarizes the factors. First column represents the serial number whereas the second column represents the social factors. The third, fourth and fifth column represents the respective rank of the factor with respect to mean, mode and median respectively.

Table 4: Ranking of Factors

S. No	Factors	Rank (Mean)	Rank (Mode)	Rank (Median)
1.	Child Labour	16	4	1
2.	Community Support	9	4	1
3.	Competitor	8	10	10
4.	Customer Privacy	10	4	10
5.	Eight Hour Shift	2	10	10
6.	First Aid Box	18	1	10
7.	Innovation	12	4	10
8.	Latest Research	11	10	1
9.	Local Culture and Heritage	7	10	1
10.	Local Resources	4	10	1
11.	Local Sub Contractor and Workers	3	10	1
12.	Personnel Protective Equipment (PPE)	15	10	1
13.	Politics (Local, National and International)	5	10	10
14.	Safety Aspects	13	10	10
15.	Sharing Problems with Universities	19	1	19
16.	Social Welfare	14	4	10
17.	Special People (Handicapped)	17	1	10
18.	Stake Holders	6	4	1
19.	Team work	1	10	1

As picture speaks louder than words. The same information in Table 4 can be represented by a graph. However, as shown in Table 4, the rank order via mode and median shows duplication. The mode and median value of a Likert scale data could be same for some factors which results in similar eigen values. It can be concluded that for a Likert Scale data AHP via mean is preferred.

Fig. 2 plots the ranks of each of the social factors on a line diagram. The analysis implores that “Team Work” is the most significant social factors. Moreover, factors such as “Sharing Problem with Universities”, “Child Labour” and availability of “First Aid Box” are the least considered factors. Although the literature indicates that these factors will makes the construction practices much more sustainable and will socially integrate the construction, still the results shows that these factors are least significant for the construction practioners in Pakistan.

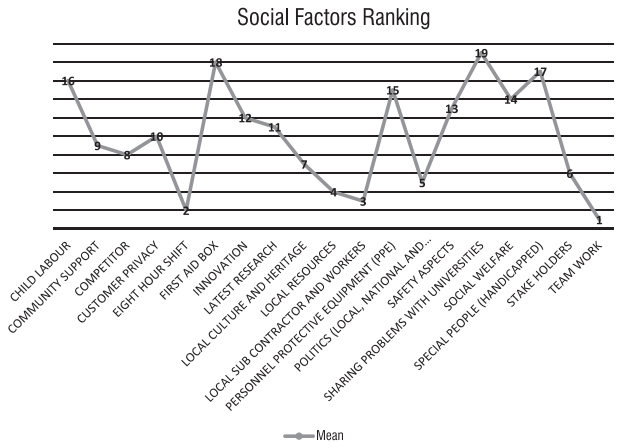

Fig. 2: Line Diagram for Factors Ranking

In addition to this, Factors such as "local community", "local resources", "Local Culture", "Politics" and "local sub-contractors" are consistent and are ranked in the top quarter. This concludes that most of the construction practioners consider local community, their culture, resources and politics to be of prime significance and is considered in all the projects they manage.

Although, the literature review indicates that all the considered factors are important for sustainability. The Table 3, Table 4, and Fig. 2 shows "Customer Privacy" and "Innovation" are moderately significant. Moreover, "Sharing Problem with the Universities", "Child Labour" and "First Aid Box" are given least considerations within construction practices. In other words, the practioners within the construction sector do consider the local resources but are least bothered about safety practices and rarely shares the problem with the universities.

Furthermore, most of the practioners do considers the "local culture and heritage" but does not consider "social welfare" within their practices and projects. Although most of the construction projects are for the welfare of public in general. However, "Social Welfare" is the factor which has a rank of fourteen. This implores that very little attention is being paid to the welfare of society and community especially during the project implementation phase.

Factors such as "Personal Protective Equipment" and "Safety Aspects" are also on the higher side. This indicates that personnel safety and user's safety is very much neglected in construction sector. The construction industry needs to address these issues for being sustainable.

Handicapped people does exist in society. They are called special people because they require special attention and care. The analysis shows that the needs of special people are very much ignored in buildings and other infrastructure projects. For being sustainable, the architects and designer should consider this aspect in every project.

In Synopsis, the results indicate that practioners are more concerned about the factors which can help their projects economically but have very little consideration for the society in general and workers in specific.

CONCLUSIONS

Society is an integral element of sustainable construction. The social aspects in sustainability is of prime importance. The analysis shows that factors such as team work and local resources, are more significant whereas the social welfare, special people, universities collaboration are the least considered factors. Factors such as local culture and heritage, politics and local resources are considered significant but the community support and social welfare is hardly integrated within the construction projects. Additionally, factors ranking by mode (AHP) and median (AHP) have similarity and duplication but has variation with respect to mean (AHP).

Although this paper discusses the most and least significant factors but for achieving sustainable construction, the practioners needs to give importance to all the factors. They have to consider all these factors within a complete life cycle of a project. Ignoring one of the factor will move the project away from being sustainable.

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