Civil and Environmental Research
ISSN 2224-5790 (Paper) ISSN 2225-0514 (Online)
Vol.8, No.9, 2016

Incompatibility between Design and Construction in Building Construction

Engr. Muhammad Yousaf* Dr. Ahmad Bilal khattak
School of Management, Riphah International University, Islamabad campus, Pakistan

1. ABSTRACT

Building construction projects are started with the ambition to transform the customer requirements into best serving products requiring minimum alterations or additions during the course of construction. However, requirements defined during the design phase change during construction phase (Alarcon et at. 1998). These changes cause incompatibilities between the design and construction phases. The most common changes or incompatibilities are made in the architectural details, structural details, materials and quality. The result of these changes is rework (Undurrage 1996), change orders, construction delays, cost over-runs, etc. Situations like these cause reduction in investment and potential growth of the building construction. Keeping in view the importance of the building construction and consequences of incompatibilities as explained above, it was decided to carry out a research in this field to study the causes of incompatibilities and their ranking in the building construction industry of Pakistan. This study included feedback in the form of questionnaire survey from two hundred and eighty one (281) respondents including clients, consultants and contractors connected with building construction constructed using the traditional procurement method, In addition, many of them have past experience of working in other parts of the country. From a detailed study of past literature review of international studies, a list of sixty five (65) causes of incompatibilities were outlined which were further grouped in four (04) categories. After obtaining data from the field survey, reliability test of data was conducted in order to confirm the authenticity of the field data. Next the individual ranking of each cause was ascertained using Relative Importance Index for clients, consultants and contractors. Overall ranking for each category was also calculated. Percentage mutual agreement between the three stake holders was also established in order to know the degree of agreement in their views about the causes of incompatibilities.

2. INTRODUCTION

Building construction consumes 40% of global energy, generates 5-15% of GDP, and provides 5-10% of employment (EFEI 2011). At the same time, it consumes 40% of the world's raw materials (NIBS 2007). In a developing country like Pakistan, building construction plays a key role in the overall development of the country. It provides employment to a huge bulk of population (Haseeb et al. 2011), brings foreign investment and creates economic activities, provides housing to the nation, contributes in the growth of other industries by using raw materials from them and helps in the circulation of money within the country. In the recent past, this industry brought a lot of foreign investment into the country and it has the potential to bring further investment. It is evident that building industry has an important role in the life of the entire nation. It is also worth mentioning here that the shortage of housing units has increased from 4.3 million in 1998 to an estimated 7.6 million in 2009, with simultaneous increase in the annual depletion of housing stock from 0.3 million in 1998 to 1.28 million in 2009 in Pakistan (World Bank 2010). With the increase in population, the demand for more housing units, educational and health facilities, offices, entertainment centers, etc. is increasing year by year. The cost of construction has also increased many folds during the recent years especially due to inflation. It is therefore imperative that the parties involved in the building construction industry make every possible effort to complete building projects within the planned budget, schedule, cost and quality. Otherwise, the consequences will be rework, cost overrun, schedule overrun, defects, etc.

3. OBJECTIVES

The main objectives of the research are:

- To list down major causes of incompatibilities between design and construction in building construction through review of international and national level literature and then updating the list of those causes with respect to building construction industry of Pakistan.
- To ascertain ranking of those causes from the perspective of three major stake holders i.e. client, consultant & contractor as well as over-all ranking.
- Address important causes of incompatibilities for improving efficiency of building construction industry.

4. LITERATURE REVIEW

The construction of a new project normally starts with the preliminary studies about the possibility and practicality of the proposed project in order to assess the benefits and risks associated with it. All possible options are considered and evaluated in search of the best possible option. The client/owner/principal may be a

public sector organization, an autonomous body or any private owner that funds the construction project and will own the completed facility (Eldosouky 2001). After completing the feasibility studies, the next step is to define an organization structure for the construction project. Organization structures for construction projects are a framework of contractual and communication relationships between project players. The organization structures are defined using project procurement systems.

The client, consultant and contractor are the three main parties that form the structure of the traditional delivery method as shown in the figure 2.1 (reproduced from Bennett 2003.A construction organization is selected, based upon the owner's criteria, and the owner enters into a contract with the successful contractor for the assembly of the project elements in the field. In this method, the contract for the design work is separate from that for the construction work (Bennett 2003). The contract price paid to the contractor may be in the form of a lump sum, a schedule of prices, or a mixture of both. It may even be, wholly or in part, cost-plus.

There are three main sequential phases to the traditional procurement method, 1) Design phase, 2) Bidding (or tender) phase and 3) Construction phase.

5. METHODOLOGY

The methodology used for this study in order to achieve research aim and objectives that were introduce Based on research questions, survey method is chosen as a research strategy. The whole survey design process is extensively elaborated. The construction of a questionnaire, collection of data through field survey and data analysis strategy is also presented.

5.1 RESEARCH DESIGN

In this research, survey was conducted from clients, consultants and contractors. Based on valid individual and company registrations maintained by Pakistan Engineering Council (PEC) up to 2016, there are 485 consultants and around 30500 contractors registered with Pakistan Engineering Council. The number of architects registered with Pakistan Council of Architects and Town Planners (PCATP) is 3100. As for the clients, 540 public organizations are listed with Public Procurement Regulatory Authority (PPRA). The sample size for each of these target populations was calculated using the following equation (Arain & Pheng 2005; Kish 1995):

$n = n' / (1 + n' / N)$

Where:

n' = Sample size from infinite population = S^2 / V^2 n = Sample size from finite population

N = Total population

V = Standard error of sample population equal to 0.05 for the confidence interval 95%

S^2 = Standard error variance of population elements, $S^2 = P (1 – P)$; maximum at $P = 0.5$

$n' = S^2 / V^2 = (0.5)^2 / (0.05)^2 = 100$

1) For clients: $N = 540$
   $n = 100 / (1 + 100 / 540) = 84$
2) For consultants:
   $N = 485 + 3100 = 3585$
   $n = 100 / (1 + 100 / 3585) = 97$
3) For contractors: $N = 30500$
   $n = 100 / (1 + 100 / 30500) = 100$

Sample sizes calculated for the target populations were 84 clients, 97 consultants and 100 contractors.

6. DATA ANALYSIS AND RESULTS

Analysis of the collected data is presented. In this connection, the most comprehensible and popular software for practical statistical analysis SPSS Ver.17.0 (Statistical Package for the Social Sciences) was used. In this research, the client, consultant and contractor gave their perceptions about causes of incompatibility in building construction. Different statistical tests such as Reliability, calculation of Relative Importance Index (RII) for ranking of factors and Percentage Agreement between the three parties was done in order to drive the overall ranking of causes. Six most important causes based on overall ranking are also listed.

In SPSS, widely used methods for assessing reliability include Cohen's Kappa Coefficient for categorical data and Cronbach's Alpha for continuous data (Likert-scale type items). Among them, Cronbach's Alpha is most popular method (Hinton et al. 2004 and Leech et al. 2005). Hinton et al. (2004) explained that Cronbach's Alpha value range from 0 (un-reliable) to 1 (reliable) with 0.75 being considered the most sensible value. They have also provided a guide line to assess the reliability of any data as shown in the Table

Table : Guideline for Assessing Reliability Results

a.	0.9 & above	Excellent reliability	**b.**	0.7 to 0.9	High reliability
c.	0.5 to 0.7	Moderate reliability	**d.**	0.5 and below	Low reliability

In reliability analysis, un-dimensionality i.e. correlation of each item with the total scale can be checked as well. De Vaus (2002) and Hinton et al. (2004) argued that if the item-to scale coefficient is below 0.3, the item should be removed. Since the data gathered was based on Likert-scale; therefore Cronbach's Alpha method was used to check the reliability in this research. The summary of the reliability analysis conducted on SPSS is presented here and full results can be seen in the appendices.

6.1 Data Reliability of Causes and Categories of Incompatibility

Cronbach's Alpha values for both causes and categories of incompatibilities were found through SPSS. It is observed that all the values were above 0.3, thus all the causes in each category were retained. Cronbach's Alpha values for each cause are given in appendices for client, contractor and consultant. Cronbach's Alpha values for the four categories are given in Table

Table : Cronbach's Alpha Values for Categories of Incompatibility

Sr. No.	Causes of Incompatibility	Client	Consultant	Contractor
1	Design Phase	0.922	0.903	0.933
2	Tendering Phase	0.862	0.756	0.870
3	Construction Phase	0.938	0.929	0.970
4	Overall Project Phase	0.941	0.904	0.957

6.2 DESCRIPTIVE ANALYSIS

Questionnaires were delivered to three hundred (300) professionals, out of which two hundred and eighty one (281) valid responses were collected.

6.3 Type of the Projects

Professionals who have worked in the building construction industry were included in the questionnaire survey.

6.4 Type of the Respondents

All the three key stake holders i.e. client, consultant and contractors were consulted as part of field survey. This helped to ascertain the perspective of each stake holder regarding causes of incompatibility in Building Construction in Pakistan. The number and percentage of respondents is given in Table

Table : Number and Percentage of Respondents

Respondent Type	Client	Consultant	Contractor
Number of Respondents	84	97	100
Percentage of Total Respondents	29.9%	34.5%	35.6%
Total Respondents	281		

A graphical representation of the number and percentage of respondents is shown in the figure :

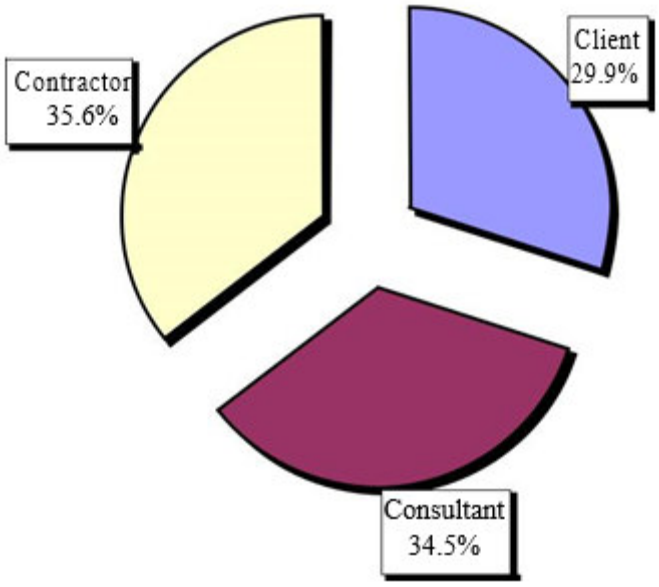

Figure : Percentage of Respondents

Majority of the respondents had experience in the range 0 - 20 years with about 58% respondents having experience more than 10 years.

Table shows the number of respondents and their percentages in different categories of experience:

Table : Number and Percentage of Respondents in Different Experience Categories

		Client	Consultant	Contractor	Total Number	Percentage
Experience	0 – 10	35	43	39	117	42%
	11 – 20	35	30	30	95	34%
	21 – 30	9	13	20	42	15%
	More than 30	5	11	11	27	10%

A graphical representation of the relationship between respondents and their experience in the building construction industry is shown in figure :

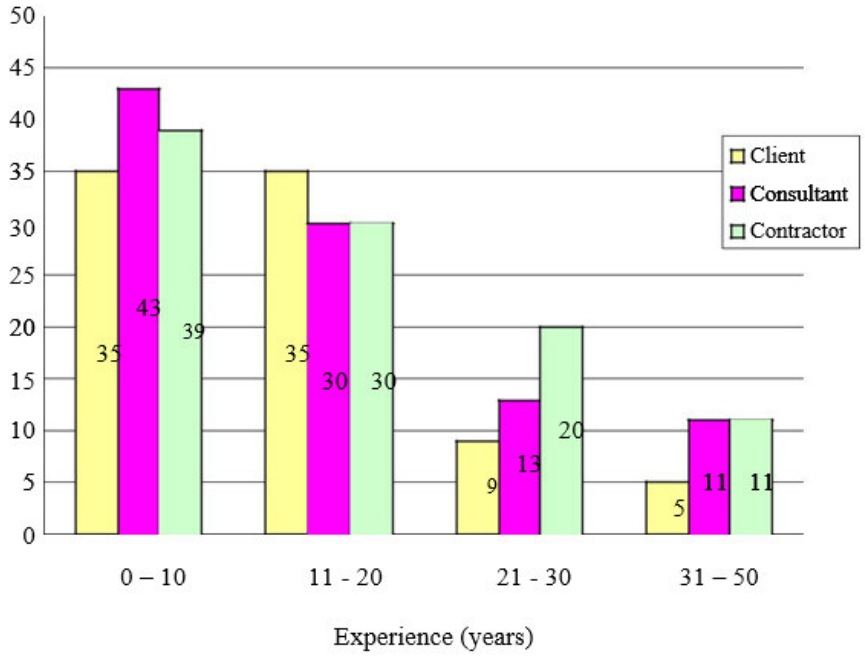

Figure : Number of Respondents in Different Experience Categories

6.5 Ranking of Causes of Incompatibilities

One of the objectives of this study was to rank the causes of incompatibilities. A number of researchers (Chan and Kumaraswamy 1997) have used the Relative Importance Index (RII) method to determine the relative importance of attributes. The formula for Relative Importance Index (RII) is:

$$RII = \frac{\sum w}{A \times N}$$

Where w = weighting as assigned by the each respondent in a range from 1 to 5, where 1 implies Not Important and 5 implies Extremely Important; A = the highest weight (5); N = the total number in the sample.

The RII and respective ranking corresponding to client, consultant and contractor for (i) each cause of incompatibility and (ii) each category of causes computed as per the field survey of 84 clients, 97 consultants and 100 contractors are given in the tables in the succeeding sections. The values of overall RII and the respective ranking were also calculated by taking the weighted average of the values of RII for the three stakeholders.

Table shows the RII and ranking of causes for the design phase for the three stakeholders along with the overall RII and ranking as given below:

Table : RII and Ranking of Causes for Design Phase

Cause	Client		Consultant		Contractor		Overall	
Design Phase	RII	Rank	RII	Rank	RII	Rank	RII	Rank
Contractor is not involved in the design conceptual phase	0.46	56	0.43	61	0.52	30	0.46	56
Contractor is not involved in the design development phase	0.52	47	0.45	58	0.50	36	0.48	51
Data provided to the designer is incomplete	0.75	**1**	0.74	**1**	0.66	**3**	0.72	**1**
Data provided to the designer is incorrect	0.66	16	0.62	22	0.45	49	0.58	26
Data provided to the designer is late	0.64	25	0.64	17	0.57	17	0.62	17
Lack of human resources with the designer	0.69	10	0.65	14	0.60	6	0.64	12
Designer busy in too many assignments	0.62	29	0.59	28	0.49	43	0.56	29
Lack of designer's knowledge of building bye-laws, codes & govt. rules	0.56	41	0.58	30	0.40	62	0.52	43
Lack of designer's knowledge of constructability of proposed design	0.43	61	0.54	43	0.52	28	0.52	44
Lack of designer's knowledge of availability of materials for construction	0.60	34	0.57	34	0.52	30	0.56	32
Lack of designer's knowledge of engineering design techniques & softwares	0.54	44	0.51	45	0.43	55	0.49	48
Lack of designer's knowledge of engineering drafting	0.49	51	0.51	47	0.47	46	0.49	46
Lack of designer's knowledge of suitability of materials for construction	0.60	34	0.55	41	0.51	34	0.54	39
Frequent replacement of designer by the owner	0.56	41	0.58	30	0.51	34	0.55	34
Personal and social problems of the designer	0.47	55	0.48	51	0.47	46	0.48	51
Lack of reward, delayed payment or low payment to the designer by the owner	0.72	**3**	0.67	13	0.58	14	0.65	10
Too little time given to the designer for completion of design documents	0.71	7	0.73	**2**	0.58	14	0.68	**5**
Lack of project planning & rigorous analysis of requirements of owner at the project start	0.73	**2**	0.67	10	0.60	6	0.66	8
Frequent changes in the proposed design due to owner dissatisfaction	0.72	**3**	0.65	14	0.50	38	0.62	18
Approving authorities do not check that structure is designed according to building bye-laws, codes & govt rules	0.69	10	0.72	**3**	0.69	**1**	0.71	**2**

Table shows the Relative Importance Index and ranking of causes for the Tendering phase for the three stakeholders along with the overall RII and ranking as given below:

Table: RII and Ranking of Causes for Tendering Phase

Cause	Client		Consultant		Contractor		Overall	
Tendering Phase	RII	Rank	RII	Rank	RII	Rank	RII	Rank
Incomplete or inaccurate design documents un-intentionally provided with bidding documents	0.59	38	0.46	55	0.45	49	0.47	53
Incomplete or inaccurate design documents intentionally provided with bidding documents	0.61	32	0.56	37	0.50	38	0.55	36
Contract type	0.59	38	0.50	49	0.39	63	0.48	50
Contractor did not consider that the design is exotic, complex or difficult to build, and he does not have the required expertise	0.60	34	0.60	27	0.52	30	0.57	27
Selection of contractor on the basis of lowest Bid	0.51	48	0.62	24	0.61	**5**	0.60	23
Amount of Performance security / retention Money	0.62	29	0.58	29	0.51	33	0.57	28
Absence of third party validation during defect liability period	0.56	41	0.58	32	0.53	26	0.56	31

Table shows the RII and ranking of causes for the Construction phase for the three stakeholders along with the overall RII and ranking as given below:

Table : RII and Ranking of Causes for Construction Phase

Cause	Client		Consultant		Contractor		Overall	
Construction Phase	RII	Rank	RII	Rank	RII	Rank	RII	Rank
Owner proposes changes because he had planned to make changes from the beginning	0.44	59	0.57	33	0.60	6	0.56	29
Owner proposes changes during construction due to sudden changes in his req. / expec.	0.45	57	0.56	37	0.48	45	0.52	42
Owner proposes changes during construction due to change in ownership	0.40	62	0.44	60	0.56	20	0.47	54
Owner proposes changes to assert his authority and make undue interference	0.26	65	0.38	64	0.50	36	0.40	64
Owner proposes changes due to financial Problems	0.69	10	0.68	9	0.69	**2**	0.69	**3**
Slowness in decision making by owner	0.64	25	0.69	7	0.53	26	0.63	13
Changes in codes, bye-laws & govt. rules	0.48	53	0.47	54	0.41	59	0.45	59
Delayed revision of drawings by designer	0.69	10	0.62	23	0.56	19	0.61	20
Drawings not properly stamped or certified by designer	0.51	48	0.45	56	0.45	49	0.46	56
Custody and supply of drawings at site	0.45	57	0.48	52	0.45	52	0.46	55
Delayed approval of drawings by owner or Consultant	0.67	15	0.55	42	0.49	40	0.55	38
Material changes due to shortage of particular material in the market	0.66	16	0.63	21	0.59	12	0.62	16
Material changes due to procurement delays by contractor	0.66	16	0.63	20	0.56	20	0.61	21
Contractor does not follow recommended construction methods	0.65	21	0.69	8	0.49	40	0.62	15
Contractor's lack of skilled manpower	0.68	14	0.72	**4**	0.59	12	0.67	6
Contractor's lack of comprehension of drawing details	0.71	7	0.70	**5**	0.60	10	0.67	7
Contractor's lack of coordination and management during construction	0.66	16	0.56	40	0.40	61	0.53	41
Contractor's-staff facing lack of tools etc.	0.65	21	0.65	16	0.58	14	0.63	14
Contractor & his staff focusing on other projs	0.64	25	0.57	34	0.47	46	0.55	36
Designer's lack of awareness / interest about ongoing construction process	0.61	32	0.64	18	0.55	22	0.61	22
Unanticipated weather conditions	0.51	48	0.51	45	0.44	54	0.49	49
Unforeseen problems / diff. site conditions	0.63	28	0.61	26	0.54	23	0.59	24
Timing of the proposed changes	0.62	29	0.52	44	0.54	24	0.54	40
Approving authorities do not check that the structure is constructed according to the approved building plans	0.72	**3**	0.69	6	0.65	**4**	0.68	**4**

Table shows the RII and ranking of causes for the Overall Project phase for the three stakeholders along with the overall RII and ranking as given below:

Table : RII and Ranking of Causes for Overall Project Phase

Cause	Client		Consultant		Contractor		Overall	
Overall Project Phase	RII	Rank	RII	Rank	RII	Rank	RII	Rank
Economic situation of the country	0.72	**3**	0.67	11	0.60	6	0.66	9
Nationality of participants	0.37	64	0.38	65	0.38	65	0.37	65
Organizational structure of owner, consultant and contractor	0.53	46	0.47	53	0.41	59	0.46	56
Lack of communication and coordination between parties	0.65	21	0.57	34	0.49	40	0.56	32
Lack of mutual respect between parties	0.57	40	0.50	48	0.52	28	0.52	45
Conflicts and legal disputes b/w various Parties	0.60	34	0.49	50	0.44	53	0.49	47
Participant's honest wrong belief	0.54	44	0.56	37	0.54	24	0.55	35
Corruption / Fraudulent practices	0.71	7	0.62	24	0.57	18	0.62	18
Lack of an experienced consultant or his lack of interest in work	0.66	16	0.67	11	0.59	11	0.65	11
Frequent replacement of consultant during Construction	0.65	21	0.64	18	0.49	43	0.59	24
Appointment of contractor as consultant	0.40	62	0.45	58	0.39	63	0.43	63
Appointment of designer as consultant	0.49	51	0.45	56	0.42	58	0.45	60
Design firm or contractor firm goes bankrupt or is black-listed	0.44	59	0.42	63	0.43	55	0.43	62
Withdrawal of licenses and permits	0.48	53	0.43	62	0.42	57	0.43	61

Relative Importance Index and ranking were also calculated for each category by taking the sum of RII of causes and diving by the number of causes in that category. Table shows the Relative Importance Index and ranking of each category of incompatibilities as given below:

Table : RII and Ranking for each Category

CATEGORY	**CLIENT**		**CONSULTANT**		**CONRACTOR**	
	RII	RANK	RII	RANK	RII	RANK
Design Phase	0.608	1	0.595	1	0.526	2
Tendering Phase	0.582	3	0.556	3	0.499	3
Construction Phase	0.588	2	0.584	2	0.528	1
Overall Project Phase	0.558	4	0.523	4	0.476	4

The values of overall RII and the respective ranking for each category were also calculated by taking the weighted average of RII for the three stakeholders for that category. Table shows the overall ranking (weighted) of categories of incompatibilities:

Table : Overall Ranking of Categories of Incompatibilities

CATEGORY	OVER ALL RII	OVER ALL RANKING
Design Phase	0.576	1
Tendering Phase	0.543	3
Construction Phase	0.567	2
Overall Project Phase	0.514	4

6.6 Rank Agreement Factors (RAF) & Percentage Agreement (PA)

Rank Agreement Factors were next computed using formula and methodology described by Okpala and Aniekwu (1988). This shows the average absolute difference in the rank of factors. The RAF can range from 0, indicating perfect agreement, to a higher value indicating increasing disagreement. The percentage disagreement and Percentage Agreement are also calculated through formulae. Formulae related to these calculations are as under:

Absolute Difference (Di) = | Ri1 - Ri2 |
Where Ri1 = Ranking of First Group; Ri2 = Ranking of Second Group
Maximum Absolute Difference (Dmax) = | Ri1-Rj2|
Where Ri1 = Ranking ; Rj2 = Ranking with absolute maximum difference
j = N – i + 1
Rank Agreement Factor (RAF) = ∑D/N
Where D = Absolute difference; N = Number of Categories
Percentage Disagreement (PD) = RAF / RAFmax or (Di/N) / Dmax/N
Percentage Agreement (PA) = 100% - PD

The above formulae were used to establish the percentage agreement between the three key stake holders i.e. client, consultant and contractor regarding ranking of categories of incompatibility.
shows the calculations and the results for Percentage Agreement between Client and Consultant:

Table : Percentage Agreement (PA) between Client and Consultant

FACTOR NO	FACTOR	RII		ABS	FOR MAX ABS DIFF		ABS
		CLIENT (Ri1)	CONSULTANT (Ri2)		Ri1	Rj2	
1	DS	1	1	0	1	4	**3**
2	TSC	3	3	0	3	2	**1**
3	CN	2	2	0	2	3	**1**
4	PR	4	4	0	4	1	**3**
			Di=	**0**	**Dmax=**		**8**

Using equation, the RAF and RAFmax are calculated as follows:
Rank Agreement Factor (RAF) = 0 / 4 = 0.0
Rank Agreement Factor Maximum (RAFmax) = 8 / 4 = 2.0
Percentage Disagreement = 0.0 / 2.0 = 0.0 %
Percentage Agreement = 100.0 – 0.0 = 100.0 %

Using the above mentioned procedure, the Percentage Disagreement (PD) and Percentage Agreement (PA) between other stakeholders were also calculated.

The Percentage Agreement (PA) and Percentage Disagreement (PD) for the three stakeholders are shown in Table 4.16 given below:

Table : Percentage Agreement (PA) and Percentage Disagreement (PD) between all Stakeholders

STAKEHOLDER	DISAGREEMENT	AGREEMENT
CLIENT AND CONSULTANT	0.00	100.00
CONSULTANT AND CONTRACTOR	25.00	75.00
CLIENT AND CONTRACTOR	25.00	75.00

The overall results of Percentage Agreement (PA) between the three key stake holders, client, consultant and contractor are plotted in figure :

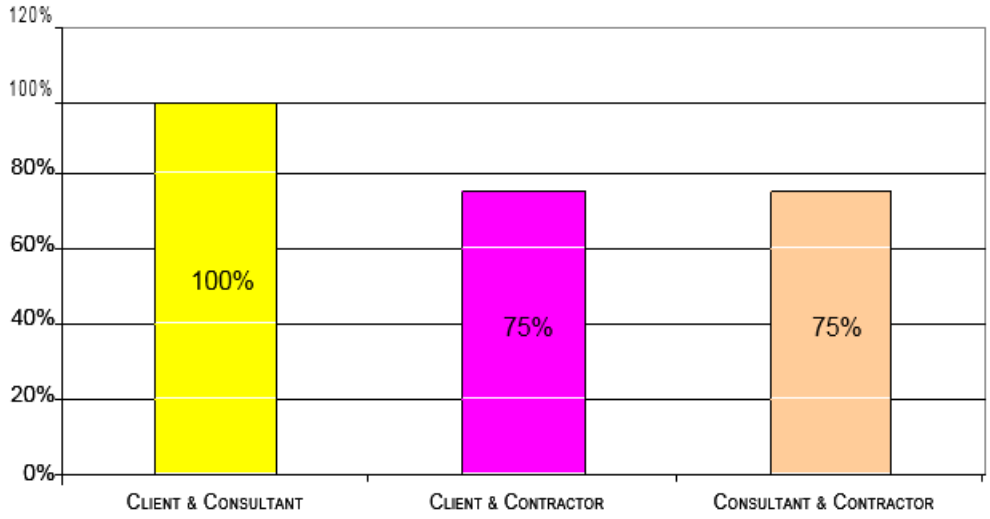

Figure : Percentage Agreement (PA) between Key Stakeholders

After obtaining the Percentage Agreement (PA) between the three stake holders about the causes of incompatibilities, it was observed that there was maximum (100%) agreement between consultant & contractor.

7. CONCLUSIONS

The results obtained from the analysis of data in chapter four indicate that, on the basis of overall ranking, the categories of incompatibilities were ranked as follows:

1. Design Phase ranked no. 1
2. Construction Phase ranked no. 2
3. Project related ranked no. 3
4. Tendering Phase ranked no. 4

Further, study of top two ranking categories was conducted in order to assess the most important causes in these categories. It was observed that six most important causes, on the basis of overall ranking, belong to the Design and Construction Phases as given in Table :

Table: Six Most Important Causes Based on Overall Ranking

CATEGORY	CAUSE	OVERALL RANK
DESIGN PHASE	Data provided to the designer is incomplete	1
	Too little time given to the designer for completion of design documents	5
	Approving authorities do not check that the structure is designed according to building bye-laws, codes & govt. rules	2
CONSTRUCTION PHASE	Owner proposes changes due to financial problems	3
	Contractor's lack of skilled manpower	6
	Approving authorities do not check that the structure is constructed according to the approved building Plans	4

8. REFERENCES

Al-Hammad, A.M. (2000). "Common Interface Problems Among Various Construction Parties." *J. Perform Const. Facil.*, 14(2).

Alarcon, L.F. and Mardones, D.A. (1998). "Improving The Design-Construction Interface." *Proceedings IGLC*, Guaruja, Brazil.

Ali, M. M., and Goraya, R. A. (1998). "Causes of delay in the construction industry of Pakistan." *Pakistan Engineering Congress,* Lahore, Pakistan, (558), 309-315.

Alwin, D. F. (1997). "Feeling Thermometers versus 7-Point scales, which are better?" *Sociological Methods and Research,* 25(3), 318-340.

Amjad, A. A. (2004-2005). "Cost Benefit Analysis for construction projects." *IEP-SAC Journal*, 85-90.

Ankrah, N. A., and Proverbs, D. "A framework for measuring construction project Performance overcoming key challenges of performance measurement." *21st Annual ARCOM Conference*, SOAS, University of London, 959-969.

Arain, F. M., Pheng, L. S., and Assaf, S. A., (2006), "Contractors' Views of the Potential Causes of Inconsistencies between Design and Construction in

Saudi Arabia" *J. Perform. Const. Facil*. 1(74)

Arain, F.M. and Pheng, L.S. (2005). "How design consultants perceive potential causes of variation orders for institutional buildings in Singapore", *J. Arch.Eng. Design Manage.*, 1(3), 163-178.

Arain, F.M. and Assaf, S.A. (2007). "Consultant's Prospects of the Sources of Design and Construction Interface problems in Large Building Projects in Saudi Arabia." *JKAU: Envi. Design Sci*., 5(2), 15-37.

Assaf, S.A., and Al-Hammad, A.M. (1988). "The effect of economic changes on construction cost." *American Association of Cost Engineers Transactions*, Morgantown West Virginia, 63-67.

Bell, J. (2005). *"Doing your research project: a guide for first time researchers in education, health and social science."* Maidenhead Open University Press.

Bennett, F. L. (2003). *"The Management of Construction: A Project Life Cycle*

Bryman, A. (2004). "*Social research methods."* Oxford, Oxford University Press, London, UK.

Clough, R.H. and Sears G.A. (1994). *"Construction Contracting."* (6th edition), John Wiley & Sons Inc, New York.

Chan, D.W.M. and Kumaraswamy, M.M (1997). "A comparative study of causes of time overruns in Hong Kong construction projects." *Int. J. Proj. Manage.,* 15(1), 55-63.

Che, A.A.I., Rakmat, R.A.O.K. and Yusof, M.A., Mohammad, N., (2010). "Investigation on the causes of variation orders in the Construction of building project – a study in the state of Selangor, Malaysia." *J. Build. Perfor.,* 1(1).

De Vaus, D. (2002). "*Surveys in Social Research."* Routledge, London, UK.

European Forum on Eco-Innovation (EFEI). (2011). "Achieving Green Growth: Role of Building & Construction Sector." *11th European Forum on Eco-Innovation*, Working with Emerging Economies for Green Growth, Inhee Chung, ERM Korea.

Eldosouky, A.I. (2001). *"Principles of Construction Project Management."* Tanta University Press, Egypt.

Federal Bureau of Statistics (FBS). (2010). "*Pakistan Statistical Year Book-2010."* Statistics Division, FBS, Government of Pakistan.

Fisk, E. R. (1997). "*Construction Project Administration."* (5th edition), Prentice Hall, New Jersey.

Fredrickson, K. (1998). "Design guidelines for design-build projects." *J. Manage. Eng.*, 14(1), 77-80.

Gaur, A. S., and Gaur, S. S. (2009). "*Statistical methods for practice research: A guide to data analysis using SPSS*." Sage Publications, New Delhi, India.

Harbans, S.K.S. (2003). "Valuation of Varied Work: A Commentary." *In: Bulletin Ingénieur,* The Board of Engineers Malaysia, 20(3), 32-42