
Correlation of Safety Culture Attributes in Construction Industry

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ABSTRACT

The importance of construction industry can not be overemphasized because it is one of the biggest contributors toward economic activities of a country. It employs a countable number of workforce and it is prone to accidents, incidents, hazards and disasters, therefore, the safety factor is equally important. The current research explores safety culture in the perspective of its important attributes. The EFQM (European Foundation for Quality Management) is taken as the bases for finding the ways and means of safety culture improvement of the construction industry. The correlation of pattern of responses is found for every attribute of the safety culture and the interrelationships and strengths are worked out to detect the involvement of the attribute.

Key Words: Safety Culture, Construction Industry, Correlation, EFQM.

1. INTRODUCTION

The activities of accountants, lawyers, contractors, subcontractors, property developers, architects and other engineering related professionals including workforce responsible for construction and repairs of structures in general and buildings in particular are termed as construction industry as a whole (Chinda, [1]). The jurisdiction of a consortium of large multinational organizations involved in construction industry may span to various countries, on the other hand, an individual persons an individual person involved in construction industry would also be considered as a tiny part of construction industry.

Jaafari [2] claims the construction industry as potential hazardous and differentiates the construction industry from manufacturing industry due to its (1) Fragmented structure, (2) Diffused responsibility, (3) Varying nature, (4) Influenced by public, various social groups, and regulatory bodies interest (5) Transient and itinerant workforce nature and (6) Virtual lack of development and research.

Generally the targeted date of a construction project is predetermined, hence resource demand along with its quality management demands an extensive skills of

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scheduling; while the construction activities, due to their interdependent nature, make the construction a complex project, hence Packendorff [3] identifies every construction project as a unique task. According to Resenfeld, et. al. [4] a construction project may be a simple hut to complex buildings and it has to face weathering conditions, unskilled workers and frequent teamwork rotations. Maloney [5] points out the characteristics of a construction organization as follows:

1. The construction project team undergoes stress to accomplish the project due to its relatively short and finite duration.
2. As management decision and project payments face time pressures, hence delays are inevitable.
3. Cost and work schedules and productivity determine project profit, which indirectly creates a stress.
4. The focus of an organizer and individual worker on accomplishment of project and procedure of work respectively generates a conflict between the two.
5. Planning and scheduling demand a clear goal.
6. Sometimes various contractors, may be as many as two dozens, work on a single project site at one time and this creates considerable complexity, diversity, and problems in the construction project.
7. It is estimated that the expert professional in their fields get approximately 80% of the work subleased to them as a subcontractor.

8. An individual subcontractor has lesser control in a collective working environment.
9. The quantum of work varies according to schedule, therefore workers are hired and fired as per need of the site. As a result, the operative employment of contractor may be short and transient.

In United Kingdom 33% of all occupational fatalities occur in construction industry and that makes ten construction workers to kill in month. Anyhow, the US public mortality rate is one person in a month due to construction activities (Goetsch [6]). Though 5% of the total workforce is involved in where construction industry but 17% occupational deaths are observed in US (Maloney [5]).

The fatality rate in Australia during 2001-2002 in construction industry was twice with respect to remaining industries with one mortality in 20,000 employees (NOSHC [7]).

In the light of above discussion, therefore, minimum same fatality rate can be assumed in developing countries also. Pakistan, being developing country and in the absence of authentic data, could be assumed to have same scenario. The Thailand and India, one of the world's fast growing economy, exhibit same kind of behavior in the construction industry having considerable number of occupational accidents in the construction (ILO [8]). Damodaran [9] claims "When one compares the sufferings of permanent disability case of construction workers with all other industries, will find five times more probability." A hotspot of international construction hub, the United Arab Emirates, is no exception, one will find the dominancy of construction accidents as compared to other occupational accidents records (The UAE Ministry of Labor and Social Affairs [10]).

By and large the construction accidents adversely affect the productivity, cost and reputation of the construction industry, cause human tragedies, de-motivate workers, delay project progress and disrupt site activities (Mohamed [11]). Kartam [12] classifies the general construction accidents' as: (a) unsafe acts caused by behavioral incidents; and (b) hazardous situations caused by physical incidents. Sawacha, et. al. [13] find behavioral incidents as major cause of construction accidents, which were already detected as reason for poor safety culture (Smith and Roth [14]).

The definitions, dimensions, development of tools and enablers of organizational safety culture is going on during past few decades in general, and the researcher are assessing and monitoring its 'health' in particular; in order to improve the safety performance (Anna and Luigi [15], Faridah, et. al. [16], Mendel [17]). Fung, et. al. [18] visualize that good safety culture would help in establishing the control the project cost and reduce hazards during construction significantly, and enhance the construction operations' efficiency ultimately.

2. SAFETY CULTURE

The term safety culture was coined by IAEA (International Atomic Agency) after nuclear disaster of Chernobyl, Ukraine during 1986 (Gadd and Collins [19]). The safety culture was found in a poor state at the disastrous site and a race of research start to measure safety culture at hazardous industries (Little [20]).

There is no consensus for the definition of safety culture yet, however, a number of studies define that it is combination of norms, rules, behaviors, beliefs, characteristics and values, which belong to safety (Potter [21]). One of the most prominent definition of safety culture is developed by the ACSNI (Advisory Committee on the Safety of Nuclear Installation) [22]. This definition was put forward by a broad-based study group and had been adopted for use in this study. Other safety culture definitions are listed in Table 1.

"Safety culture is the product of individual and group values, attitudes, perceptions, competencies, and patterns

TABLE.1 DEFINITIONS OF SAFETY CULTURE (POTTER, 2003) [21]

Definition	Source
"That observable degree of effort by which all organizational members direct their attentions/actions towards improving safety on a daily basis."	Cooper, 2000 [23]
"Those aspects of the organizational culture which will impact on attitudes and behaviors related to increasing or decreasing risk."	Guldenmund, 2000 [24]
"The attitudes, beliefs, and perceptions shared by natural groups as defining norms and values, which determine how they act and react in relation to risks and risk control systems."	Hale, 2000 [25]
"The involving perceptions and attitudes, as well as the behavior of individuals within an organization."	Harvey et al.,2002 [26]
"The ideas and beliefs that all members of the organization share about risk, accidents, and ill health."	Cooper, 2002 [27]
"An environmental setting where everyone feels responsible for safety, and pursues it on a daily basis, going beyond 'the call of duty' to identify unsafe conditions and behaviors, and intervene to correct them... people 'actively care' on a continuous basis for safety... (which) is not a priority that can be shifted depending on situational demands, rather safety is a value linked with all other situational priorities."	Geller, 2001 [28]

of behavior that determine the commitment to, and the style and proficiency of, an organization's health and safety management. Organizations with a positive safety culture are characterized by communications found on mutual trust, shared perceptions of the importance of safety, and confidences in the efficacy of preventive measures (ACSNI [22])."

The factors of safety culture in an organization, as depicted by Little [20], are shown in Fig. 1. An organization has its own environmental constraints and promotions, when they are combined with individual cultures and subcultures of the organization, would create safety culture (Fig. 2). Development of a safety culture is an integral part of an organizational culture and it must not be viewed as an individual isolated entity of the organization (Clarke, [29]). The interested researchers may find the studies of Choudhry[30] and Ali [31] for safety culture and safety climate of Pakistan.

3. PROCEDURE

The authors were interested to explore the safety culture of construction industry in their country, i.e. Pakistan.

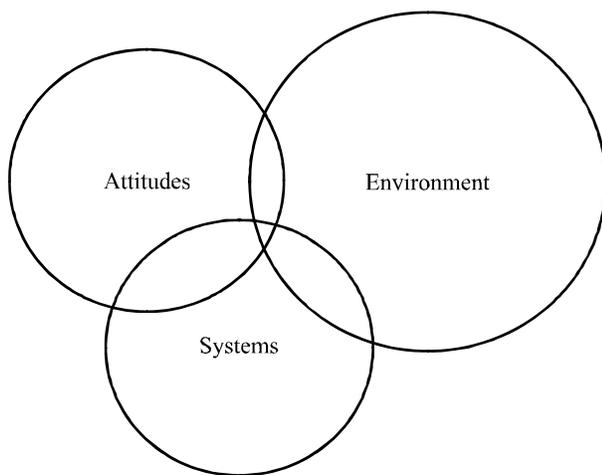


FIG. 1. FACTORS OF SAFETY CULTURE [20]

They decided to follow EFQM as a self assessment tool. The EFQM proposes to improve organizations' performance by keeping in view the following six factors: (a) Leadership, (b) Policies & Strategies, (c) People, (d) Partnerships & Resources, (e) Processes and (f) Goals. Afterwards, various attributes of the fix factors were searched in the literature (Chinda [1]) and they are enumerated in Table-2.

A questionnaire on five point Likert scale ranging from Agree Strongly to Disagree Strongly was circulated to construction managers comprising of site managers project directors, executive engineers, assistant engineers, resident engineers, contractors and supervisors.

After collection of 54 questionnaire during pilot study, the data was passed through various tests, like Visual inspection, Outlier test, Normalcy test of Kolmogrove-Smirnov with Lilliefors Significance Correction, Scale Reliability test of Cronbach's Alpha. The visual inspection rejected one respondent being working outside the geographical area under consideration and one respondent was rejected due to less experience than the standardized experience of one year, set by the authors. The z-score test rejecting one outlier leaving 51 respondents for further analysis. The significance level of Kolmogrove-Smirnov was $p=0.000$ at 95% level of confidence. The value 0.964, of Cronbach's alpha was quite satisfactory.

The data was crunched in SPSS for inter-correlations of 34 attributes and the results are reproduced in Appendix-A.

TABLE-2 SIX FACTORS OF EFQM AND THEIR SELECTED ATTRIBUTES

Factor	Attribute
Leadership	Commitment
	Communication
	Accountability
	Prompt decision
Policies & Strategies	Safety awareness
	Safety and Productivity Alignment
	Safety Standards
	Safety Initiatives
	Safety Integration in Business Goals
People	Shared Perceptions
	Safety Responsibilities
	Supportive Environment
	Workers' Involvement
	Workers' Relationships
	Workload
	Work Pressure
Partnerships & Resources	Stakeholders' Cooperation
	Financial Resources
	Safety Resources
	Human Resources
Processes	Training
	Risk Assessment
	Feedback
	No-blame Approach
	Housekeeping
	Safety Documentation
	Benchmarking System
Goals	Job Satisfaction
	Safe Work Behavior
	Reduction in Accidents
	Customers' Expectations
	Industrial Image
	Workforce Morale
	Cost of Accidents

Furthermore, Safety integration in business goals and Housekeeping occur in one cycle each, keeping themselves as weak attributes.

4.2 Cyclic Strong Correlation

There are a number of attributes contributing in a cyclic manner, e.g. Safety awareness, Safety and productivity alignment and Safety documentations show a strong correlation among themselves in Fig. 4. The figure reveals that more Safety documentations would result increase in Safety awareness and the two are ultimately going to result increase in Safety and productivity alignment.

One can find a lot of such cycles in the Appendix A. Few cyclic nature attributes are presented from Figs. 5-8. It is worth to note down that the cycles contain three, as well as four attributes.

Here is an example of seven-attribute cycle presented in Fig. 9. The Feedback improves Risk assessment. The Risk assessment improves Shared perceptions. The Shared perceptions improve Communication. The Communication improves Safety initiatives. The Safety initiatives improve Training. The Training improves Benchmarking system. And Benchmarking system supports Feedback ultimately.

Hundreds of such cycles could be traced out and, of course, it is beyond the working capacity of a human being to work manually on such cycles, hence, computer aided softwares may be employed to trace the interaction of the attributes for improving the state of safety in construction industry. However, a dozen of such cycles were explored by the authors and Safety resources was found as the most important attribute having strong correlation with 22 out of 34 attributes. The second important attribute was Safe work behavior having strong correlation with 21 out of 34 attributes. The attributes are ranked in Table 3.

APPENDIX-A INTER-CORRELATIONS OF 34 ATTRIBUTES

Cost of Acc.	.470	.327	.093	.346	.463	.304	.370	.305	.151	.384	.231	.360	.382	.152	.391	.581	.336	.477	.477	.551	.493	.466	.432	.438	.531	.407	.54	.490	.512	.415	.492	.418	.527	.620	1.00
Workforce Moral.	.532	.380	.225	.386	.444	.353	.377	.440	.237	.407	.256	.561	.371	.268	.276	.601	.515	.490	.537	.545	.463	.417	.377	.601	.533	.541	.459	.599	.525	.606	.494	.602	1.00	.620	
Indust. Image	.500	.553	.264	.421	.553	.422	.378	.411	.366	.653	.363	.346	.311	.369	.287	.513	.448	.573	.593	.345	.441	.660	.467	.461	.439	.530	.399	.608	.597	.514	.637	1.00	.602	.527	
Custom. Exp.	.406	.483	.299	.468	.456	.398	.476	.613	.358	.493	.416	.491	.482	.436	.272	.408	.453	.673	.536	.479	.551	.674	.710	.497	.223	.289	.480	.593	.611	.576	1.00	.637	.494	.418	
Reduc. in Acci.	.540	.540	.482	.504	.508	.357	.388	.467	.203	.509	.353	.538	.410	.311	.373	.514	.487	.539	.517	.548	.610	.326	.382	.485	.411	.394	.570	.509	.662	1.00	.576	.514	.606	.49	
Sale W. Behave.	.600	.634	.433	.589	.490	.489	.584	.622	.285	.592	.540	.490	.509	.433	.474	.453	.492	.606	.520	.505	.559	.571	.527	.555	.216	.465	.570	.681	1.00	.662	.611	.597	.525	.415	
Job Satisfaction	.586	.547	.346	.436	.519	.294	.295	.407	.252	.467	.439	.369	.467	.343	.271	.442	.508	.584	.560	.462	.317	.614	.417	.421	.208	.433	.385	1.00	.681	.509	.593	.698	.599	.512	
Benchmark Sys.	.385	.475	.309	.387	.554	.429	.486	.608	.039	.344	.354	.430	.495	.360	.562	.613	.276	.451	.574	.536	.705	.494	.607	.643	.329	.585	1.00	.385	.570	.480	.399	.459	.490		
Safety Docum.	.587	.481	.284	.430	.678	.633	.438	.352	.325	.574	.435	.430	.434	.468	.441	.657	.514	.470	.539	.433	.464	.544	.480	.622	.520	1.00	.585	.433	.465	.394	.289	.530	.541	.548	
Housekeeping	.369	.231	.234	.400	.356	.438	.195	.102	.191	.343	.410	.253	.323	.125	.408	.549	.373	.254	.483	.265	.176	.160	.149	.458	1.00	.520	.329	.208	.216	.411	.223	.439	.533	.407	
No-Blame App.	.524	.416	.297	.540	.449	.487	.429	.415	.202	.530	.476	.477	.432	.269	.584	.706	.520	.522	.594	.537	.580	.648	.558	1.00	.458	.622	.643	.421	.555	.485	.497	.461	.601	.531	
Feedback	.208	.307	.151	.363	.492	.392	.454	.569	.257	.346	.331	.426	.517	.281	.334	.405	.306	.514	.505	.436	.566	.696	1.00	.558	.149	.480	.607	.417	.527	.382	.710	.467	.377	.438	
Risk Assessment	.448	.478	.189	.395	.550	.461	.360	.445	.406	.628	.402	.355	.422	.409	.333	.529	.413	.578	.604	.471	.464	1.00	.696	.648	1.00	.544	.494	.614	.571	.326	.674	.660	.417	.432	
Training	.483	.502	.193	.323	.523	.428	.533	.667	.156	.356	.325	.497	.277	.372	.368	.443	.295	.520	.450	.560	1.00	.464	.566	.580	.176	.464	.705	.317	.559	.610	.551	.441	.463	.466	
Human Res.	.454	.418	.250	.539	.383	.283	.356	.345	.175	.454	.292	.529	.479	.364	.433	.497	.448	.397	.606	1.00	.560	.471	.436	.537	.265	.433	.536	.462	.505	.548	.479	.345	.545	.493	
Safety Res.	.533	.566	.298	.484	.563	.472	.324	.403	.248	.324	.248	.427	.394	.365	.603	.665	.552	.711	1.00	.606	.450	.604	.505	.594	.483	.539	.574	.560	.520	.517	.526	.593	.537	.551	
Financial Res.	.615	.625	.465	.498	.640	.569	.459	.597	.444	.653	.492	.534	.318	.478	.349	.485	.622	1.00	.711	.397	.520	.578	.514	.522	.254	.470	.451	.584	.606	.539	.673	.573	.490	.477	
Site. Cooperation	.689	.439	.558	.578	.428	.451	.271	.289	.358	.598	.493	.492	.441	.453	.270	.544	1.00	.622	.552	.448	.295	.413	.306	.520	.373	.514	.276	.508	.492	.487	.453	.448	.515	.336	
Work Pressure	.521	.419	.310	.403	.478	.621	.449	.333	.303	.535	.405	.462	.395	.260	.604	1.00	.544	.485	.665	.497	.443	.529	.405	.706	.549	.657	.613	.442	.453	.514	.408	.513	.601	.581	
Workload	.238	.382	.154	.425	.320	.477	.374	.230	.064	.371	.548	.259	.384	.135	1.00	.604	.270	.349	.603	.433	.368	.333	.334	.584	.408	.441	.562	.271	.474	.373	.272	.287	.276	.391	
Workers' Rel.	.554	.549	.428	.307	.603	.322	.260	.396	.184	.533	.382	.610	.475	1.00	.135	.260	.453	.478	.365	.364	.372	.409	.281	.269	.125	.468	.360	.343	.433	.311	.436	.369	.268	.152	
Workers' Inv.	.428	.324	.314	.496	.475	.328	.395	.443	.165	.373	.452	.489	1.00	.475	.384	.395	.441	.318	.394	.479	.277	.422	.517	.432	.323	.434	.495	.467	.509	.410	.482	.311	.371	.382	
Sup. environment	.527	.512	.481	.441	.612	.409	.427	.557	.207	.442	.343	1.00	.489	.610	.259	.462	.492	.534	.427	.529	.497	.355	.426	.477	.253	.430	.430	.369	.490	.538	.491	.346	.561	.360	
Safety Resp.	.549	.611	.428	.556	.476	.566	.338	.422	.170	.561	1.00	.343	.452	.382	.548	.405	.493	.492	.525	.292	.325	.402	.331	.476	.410	.435	.354	.439	.540	.353	.416	.363	.256	.231	
Shared percep.	.693	.692	.562	.665	.582	.574	.410	.417	.519	1.00	.561	.442	.373	.533	.371	.535	.598	.653	.597	.454	.356	.628	.346	.530	.343	.574	.344	.467	.592	.509	.493	.653	.407	.384	
Saf. Int. in B. Co.	.456	.303	.281	.428	.394	.592	.587	.442	1.00	.519	.170	.207	.165	.184	.064	.303	.358	.444	.248	.175	.156	.406	.257	.202	.191	.325	.039	.252	.285	.203	.358	.386	.237	.151	
Safety Initiatives	.540	.602	.384	.508	.556	.536	.743	1.00	.442	.417	.422	.557	.443	.396	.230	.333	.289	.597	.403	.345	.667	.445	.569	.415	.102	.352	.608	.407	.622	.467	.613	.411	.440	.305	
Safety Standards	.460	.477	.294	.527	.354	.672	1.00	.743	.587	.410	.338	.427	.395	.260	.374	.449	.271	.459	.324	.356	.533	.360	.454	.429	.195	.438	.486	.295	.584	.388	.476	.378	.377	.370	
Saf./Pro. Align.	.569	.574	.288	.436	.602	1.00	.672	.536	.592	.574	.566	.409	.328	.322	.477	.621	.451	.569	.472	.283	.428	.461	.392	.487	.438	.633	.429	.294	.489	.357	.398	.422	.353	.304	
Safety Awareness	.675	.628	.442	.353	1.00	.602	.354	.556	.394	.582	.476	.612	.475	.603	.320	.478	.428	.640	.563	.383	.523	.520	.492	.449	.356	.678	.554	.519	.490	.508	.456	.553	.444	.463	
Prompt Decision	.562	.544	.552	1.00	.353	.436	.527	.503	.428	.665	.556	.441	.496	.307	.425	.403	.578	.498	.484	.539	.323	.395	.563	.540	.400	.430	.387	.436	.589	.504	.468	.421	.386	.346	
Accountability	.495	.536	1.00	.552	.442	.288	.294	.384	.281	.562	.428	.481	.314	.428	.154	.310	.558	.465	.298	.250	.193	.189	.151	.297	.234	.284	.309	.346	.433	.482	.299	.264	.225	.093	
Communication	.659	1.00	.536	.544	.628	.574	.477	.602	.303	.692	.611	.512	.324	.549	.382	.419	.439	.625	.566	.418	.502	.478	.307	.416	.231	.481	.475	.547	.634	.540	.483	.553	.380	.327	
Commitment	1.00	.659	.495	.562	.675	.569	.460	.540	.456	.693	.549	.527	.428	.554	.288	.521	.689	.615	.533	.454	.483	.448	.208	.524	.369	.587	.385	.586	.600	.540	.406	.500	.552	.470	

4. RESULTS

The inter-correlations presented interesting results. All correlations were positive indicating that the attributes in the questionnaire were presented carefully. This research paper probes in the strong correlations only, i.e. having values of 0.5 or more (Pallant [32]).

4.1 Individual Strong Correlation

Referring Appendix A, one can find that Workers' involvement is found strongly correlated to only one of the attributes (Feedback) as shown in the following Fig. 3. Hence, the indicated attribute, i.e. Workers' involvement, would be not contributing to improve safety significantly.

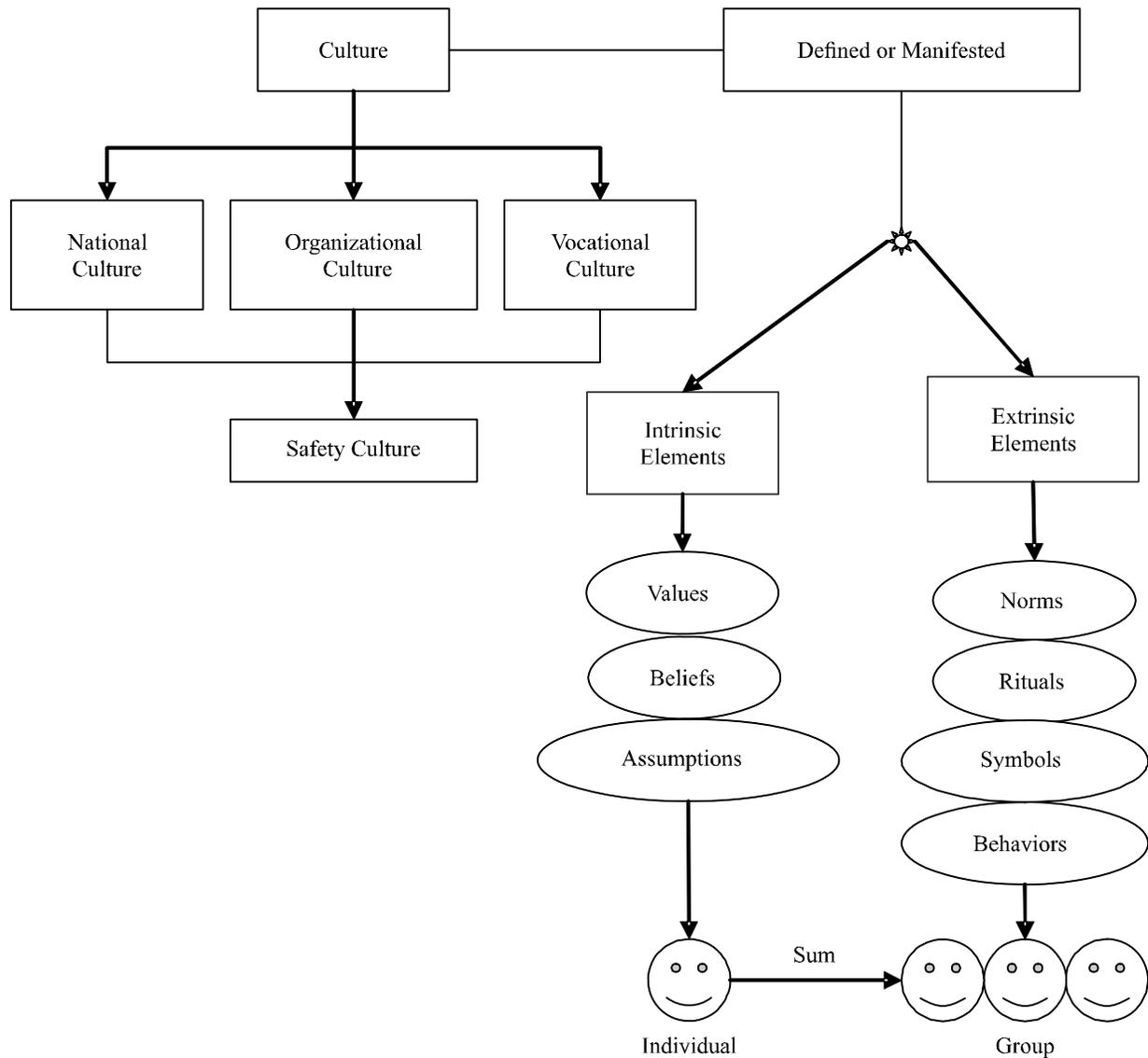


FIG. 2. TRADITIONAL CONCEPT OF CULTURE [29]

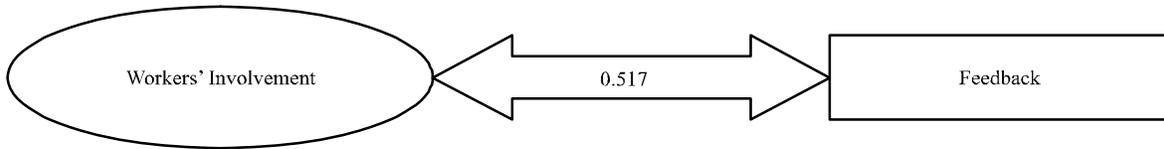


FIG. 3. INDIVIDUAL STRONG CORRELATION ATTRIBUTES

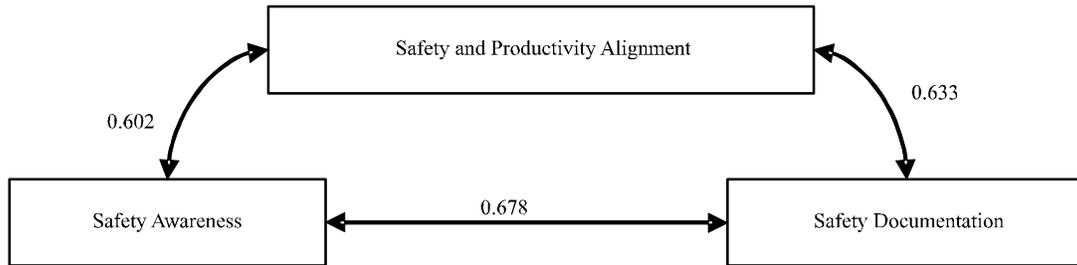


FIG. 4. THREE-ATTRIBUTE CYCLE

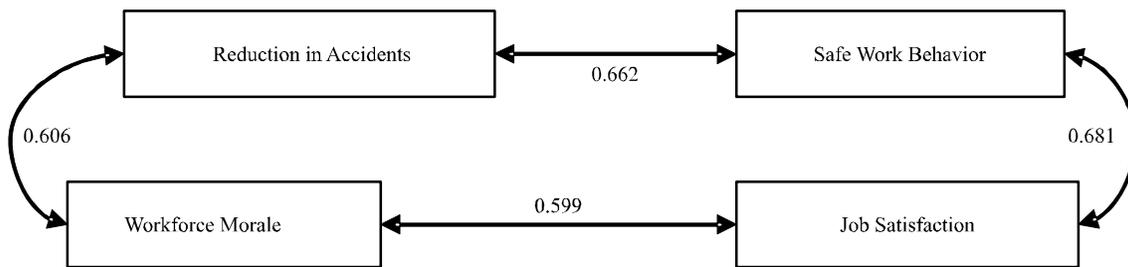


FIG. 5. FOUR-ATTRIBUTE CYCLE

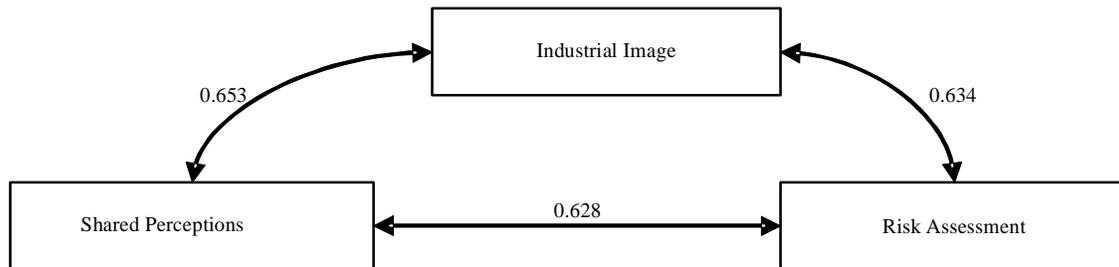


FIG. 6. THREE-ATTRIBUTE CYCLE

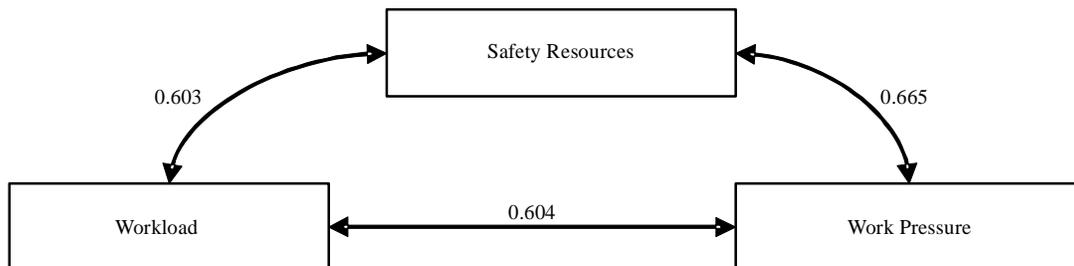


FIG. 7. THREE-ATTRIBUTE CYCLE

It will be worthwhile to carry out subsequent analysis by a well-known statistical technique, namely the Structural Equation Modeling analysis. As there would be lot of attributes coming into more than one cycle, therefore dynamical effects of the system under consideration shall be fruitful to be explored.

6. CONCLUSIONS

The cyclic concept of correlation is the bases for on coming research regarding the topic. The rank of attributes is a contribution towards safety culture of construction industry of Pakistan and help the researchers for their further studies. This study indicates that the

bottom three attributes, i.e. Workers' involvement, Houskeeping and Safety integration in business goals, be ignored in the improvement process of the safety culture in construction industry. A lot of information can be extracted from the inter-correlations of attributes presented in Appendix A. All the attributes are valuable for the research under given topic and their validity of significance has been shown in this research paper.

The governments may take the task of safety culture enhancement by educating people, especially children. The children should have lessons of safety culture in their primary education for its awareness. Moreover, media may be used as a tool for such education.

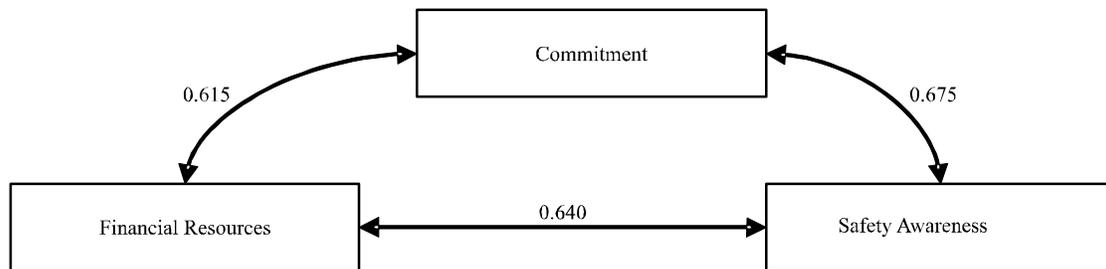


FIG. 8. THREE-ATTRIBUTE CYCLE

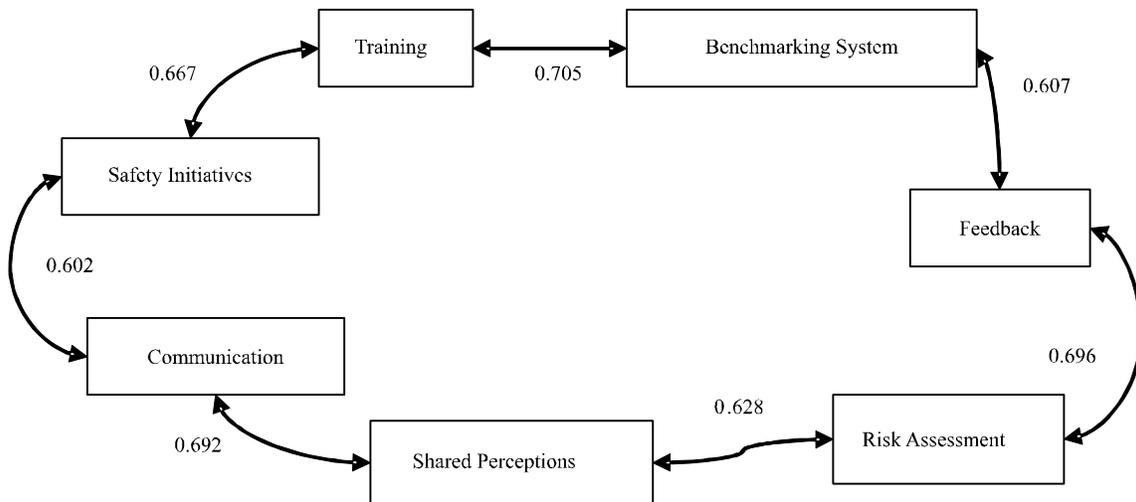


FIG. 9. SEVEN-ATTRIBUTE CYCLE

This study was to find out the direction and significance the safety. The results were positive and clearly showed that the set questionnaire, structure of questions, the bases of EFQM, and the data reliability were satisfactory and the out come of the end result could be relied on.

TABLE 3 RANKING OF ATTRIBUTES HAVING STRONG CORRELATION TO OTHER ATTRIBUTES

Rank	Attribute	Strong Correlation Connections
1	Safety resources	22
2	Safe work behavior	21
3	Commitment	20
4	Shared perceptions	19
5	Financial resources	18
6	Communication	17
6	No-blame approach	17
6	Reduction in accidents	17
7	Safety awareness	16
8	Work pressure	15
8	Industrial image	15
9	Safety documentation	14
9	Workforce morale	14
10	Safety initiatives	13
10	Job satisfaction	13
11	Prompt decision	12
11	Training	12
11	Risk assessment	12
11	Benchmarking system	12
12	Safety and productivity alignment	11
12	Stakeholders' cooperation	11
13	Feedback	10
13	Customers' expectations	10
14	Supportive environment	9
14	Human resources	9
15	Safety responsibilities	8
16	Cost of accidents	7
17	Safety standards	6
18	Workers' relationships	5
18	Workload	5
19	Accountability	4
20	Safety integration in business goals	3
20	Housekeeping	3
21	Workers' involvement	2

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