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Aims and Scope

Global Journal of Structural Design and Construction is a peer reviewed journal published by Original Papers. It is one of the pioneering starts up journal in Civil and Structural engineering which receives high quality research works from researchers across the globe. The journal publishes original research and review papers falling within the broad field of Civil Engineering.

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Contents

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Assessment of Policy Schemes to Foster Energy Refurbishment of Multi- Apartment Buildings

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A B S T R A C T

The article deals with barriers of large-scale refurbishment of residential multi-apartment buildings and provides comparative assessment of policy schemes to overcome these barriers in order to foster refurbishment of residential multi-flat apartments buildings. The main major policy schemes related to climate change mitigation in buildings sector were identified and assessed: fiscal and economic instruments such as tax incentives, subsidized loans or measures to increase energy prices and eliminate harmful energy subsidies; regulatory measures such as product and device standards, building codes, ESCO participation, regulatory-normative and information and voluntary actions such as voluntary agreements, training and awareness-raising programs and campaigns, etc. While most countries in the world have introduced policies to reduce greenhouse gas emissions from the buildings sector, these policies have not led to a significant reduction in GHG emissions. Many studies have been carried out to show why the energy saving potential of buildings is not fully realized. One of the major obstacles to energy efficiency and the reduction of greenhouse gas emissions in buildings is that policies of reducing greenhouse gas emissions in buildings is usually multi-faceted and involves more than one stakeholder. Many countries have implemented financial incentives such as capital subsidies, subsidies, subsidized loans and loan discounts to encourage building owners and residents to invest in energy efficiency measures and equipment, but these support measures are not sufficient for realization of full energy saving potential in residential buildings as the more complex measures are necessary to overcome barriers therefore financial and economic instruments need to be combined with information campaigns and training programs, ESCO involvement etc. in order to create effective policy schemes and achieve full realization of energy saving potential.

Keywords- Barriers Of Renovation Of Residential Buildings, Policy Schemes To Promote Refurbishment Of Residential Multi-Flat Buildings.

I. INTRODUCTION

Though, most of world countries have introduced policies to promote renovation of buildings, however, these polices have not resulted in an actual reduction in energy consumption and GHG emissions [1-3].

Most countries have implemented financial incentives such as capital subsidies, grants, subsidized loans and rebates to encourage building owners and occupants to invest in energy efficiency measures and equipment however, there may be large obstacles and barriers to large-scale energy renovation in apartment buildings [4-9].

Therefore, building owners or housing associations cannot benefit from state subsidies and loans and other financial measures measures due to lack of awareness or lack of adequate and reliable information [10-14]. In addition, potential implementers of large-scale energy renovation projects are hardly aware of the efficiency and benefits of energy efficiency measures. There are also financial difficulties, such as capital access difficulties, which also hinder investments in large-scale energy refurbishment [15-18]. Even if the apartment owners have access to capital, they cannot invest in energy refurbishment of residential buildings because of the high risk of such an investment. Risks are considered to be related to limited rationality and uncertainty about the benefits of large-scale energy refurbishment of residential buildings due to the uncertainty of future energy prices [19-21].

The paper aims to analyze the main barriers of refurbishment of multi-flat apartment's buildings and to assess policy schemes to foster large scale energy refurbishment of multi-apartment buildings in terms of their effectiveness in realization of energy saving potential in these buildings.

II. BARRIERS OF REFURBISHMENT OF MULTI-APARTMENT BUILDINGS

There are many discussions among scholars in defining and grouping barriers of large scale energy refurbishment [12; 14; 22]. The main barriers and measures to overcome these barriers are generalized in Table 1.

Main barriers	Origin of barrier	Examples of barriers
Economic/ financial barriers	High investment cost to the price of saved energy due to low internalization rate of external energy generation costs	High up-front costs for large scale energy refurbishment of multi-apartment buildings accompanied by low income of population and lack of access to capital
Hidden costs	Cost that are not captured directly in financial flows for energy refurbishment	Costs due to high performance risks, high transaction costs etc.
Market failures	Market constraints that prevent trade-off between energy saving costs and energy saving benefits	Fragmented market structure; landlord/tenant dilemma, split incentives; administrative and regulatory barriers;
Behavioral and organizational barriers	Behavioral patterns of individuals and companies that hinder implementation of energy efficiency technologies and practices	Tendency to ignore small energy saving opportunities; difficulties to make common decision by apartment owners for large scale refurbishment due to conflicting interests; Non-payment and electricity theft; traditions, behavioral patterns and lifestyles etc.

Information barriers	Lack of in formation provided on energy saving potentials of large scale energy refurbishment	Lacking awareness and knowledge of apartment owners, building managers, construction companies, politicians etc.
Political and structural barriers	Structural characteristics of political, economic, energy system making investment decisions in energy refurbishment difficult	Process of drafting local legislation is slow; huge gaps between regions at different economic level; Insufficient enforcement of standards; lack of detailed guidelines and experts; lack of incentives for investments; lack of policy interest; lack of equipment certification services; inadequate energy service levels etc.

Source: created by author

Table 1. Barriers of energy refurbishment of multi-apartment buildings

One can notice from Table 1 that there are 6 types of the main barriers of large scale energy refurbishment of multi-apartment buildings: economic/financial barriers, hidden costs, market failures, behavioral and organizational barriers, information barriers, political and structural barriers etc.

III. ASSESSMENT OF EFFECTIVENESS OF POLICY SCHEMES TO FOSTER ENERGY REFURBISHMENT OF MULTI-APARTMENT BUILDINGS

The literature provides [4-7] that already implemented policy schemes do not adequately address the barriers in homeowners' decision making. The traditional policies fostering energy refurbishment have focused on financial incentives such as soft loans and subsidies. Some scholars highlighted that in addition to financial incentives it is necessary to implement other policy schemes such as regulatory and informative measures and to ensure middle actors activities in the market by increasing involvement of energy efficiency and refurbishment experts [1-2].

There is huge difference between individuals' values, risk aversion and preferences which are revealed in their decisions on investments large scale energy refurbishment of multi-apartment buildings so these differences should be addressed by developing policy schemes targeting specific individuals and other players in this [21-24].

Apartment owners can't reach common decision on large scale refurbishment of multi-apartments buildings as they have different values and risk aversion and preferences due to the difference in age, education, awareness level, income etc. The perceived risk of apartment owners is also linked to time and environmental and social preferences of apartment owners.

Policy schemes should address the perceived risk of energy refurbishment and to provide apartment owners with guaranteed future earnings due to energy savings.

The Energy Service Company Obligation (ESCO) model can be applied for contracting on energy refurbishment of multi-apartment buildings in order to raise investments which are too risky for apartment owners to undertake. The UK government has implemented ESCO model more than 20 years ago [5]. The main measures to promote the renovation of multi-apartment buildings can be divided into the following five broad categories: regulatory and control measures, information and voluntary activities, energy and CO2 taxes, flexible market measures, financial incentives.

Table 2 provides policy schemes to foster large scale energy refurbishment of multi-apartment buildings applied in various countries. The policy schemes grouped into regulatory and informative measures, market based instruments, fiscal and financial measures.

Policy schemes and countries, which implemented them	Effectiveness to overcome barriers	Recommendations for effectiveness
Mandatory or voluntary regulatory or progressive regulatory and control measures; communicative and information instruments (Germany, UK, Denmark, Italy, France, Sweden, England and many new EU member states)	These instruments fail to address the barriers of apartment owners decision making in large-scale energy refurbishment of their apartments	Periodical updating and independent control is necessary. In addition, provision of information, communication, and education is necessary. Mandatory programs are more effective than voluntary ones. For increase of effectiveness combination with other policies are necessary
Market based instruments such as White Certificates or Energy Performance Certificates (Italy, France, Poland, England and Wales)	These measures do not address the organizational barriers of decision making on energy refurbishment of multi-apartment buildings. They have high monitoring and enforcement costs and need institutional support, the interaction with other measures is unclear	Provision of information, communication, and education is necessary. In order to increase effectiveness combination with labeling and standards are necessary.

Fiscal measures CO_2 and energy taxes (Germany, Sweden, Norway, Denmark etc.)	High energy taxes have impact on energy saving behavior of households however the external costs of energy production are not fully internalized and impact is insignificant	Effectiveness is linked to price elasticity. Most effective when are combined with other tools
Financial measures. Programs that provide subsidies and soft loans for energy refurbishment (Germany, UK, France, mots new EU member states)	They can provide access to capital of low-income population however the effectiveness of these programs is low due to free-riders, i.e. apartment owners receiving the subsidy which would also have renovated without the subsidy their apartments	The independent administration of funds and regular monitoring &feedback are necessary. The simple & clear design is necessary.
Policy packages which seek to address multiple financial and other barriers at the same time (EU, USA, Japan)	There are no results about effectiveness of these policy packages to overcome major barriers of large scale energy refurbishment programs	

Source: created by author

Table 2. Examples of policy schemes to foster large scale energy refurbishment of multi-apartment buildings in world countries

An overview of key homeowners' motivation measures for large-scale energy refurbishment (Table 2) has shown that in many countries (Germany, UK, Denmark, USA, and Japan); only a limited number of such instruments were introduced.

Regulatory or progressive regulatory and control measures; communicative and information instruments were introduced in many EU Members states. Some regulatory measures are voluntary and some are mandatory. However, these policy schemes were not able to deal with behavioural and organization barriers of large scale energy refurbishment of multi-apartment buildings preventing common decision making by apartment owners to renovate their houses. These policy schemes require periodical updating and independent control. In addition, provision of information, communication, and education is necessary. Mandatory programs are more effective than voluntary ones. For increase of effectiveness combination with other policies are necessary.

Market based instruments such as White Certificates or Energy Performance Certificates were implemented in several EU member states and also do not address organizational barriers of decision making on large scale refurbishment. These instruments need to be combined with information provision measures and communication campaigns. The combination with labelling and standards are also advisable to increase effectiveness of this policy scheme.

Fiscal measures such as CO2 and energy taxes were introduced in many EU member states however just in Sweden, Denmark , Norway the very high taxes have impact on behavioural changes of households. In other EU member states the taxes are too low to generate incentives for large scale energy refurbishment of residential buildings. They also do not address important organizational barriers and their effectiveness is entirely linked to price elasticity.

Usually they are more effective when combined with other tools.

Financial measures, such as pogrammes that provide subsidies and soft loans for energy refurbishment are the most popular policy schemes to support large scale refurbishment of multi-apartment buildings. They deal with some economic barriers of energy refurbishment however the effectiveness of these programs is low due to free-riders, i.e. apartment owners receiving the subsidy which would also have renovated without the subsidy their apartments. In addition these policy schemes are not able to deal with organizational and behavioural barriers of energy refurbishment.

As one can see from information presented in Table 2, for successful implementation of policy schemes to promote large scale refurbishment of multi-apartment buildings and achieve full energy saving potential, several important issues should be taken into account then implementing these policy schemes in order to ensure their effectiveness in dealing with the most important barriers energy refurbishment.

Policy packages which seek to address multiple financial and other barriers at the same time were implemented in several EU member states, USA and Japan.

Most of the instruments in order to be successful should be implemented in combination of other instruments. Especially it is important for support, information and voluntary actions. Regulatory and informative policies would also provide for more effective results if are well structured and enforced in combination with other measures. However, literature analysis showed that policy scheme packages linking several policy schemes to foster large scale energy refurbishment of multi-apartment buildings

being introduced together haven't yet provided for very good results in closing energy efficiency gap in multi apartment buildings. The schemes should be grouped by assessing their interlinkages in order to achieve synergy in overcoming specific energy refurbishment barriers in multi-apartment buildings.

IV. CONCLUSION

There are various barriers of large scale energy refurbishment of multi-apartment buildings: economic /financial barriers, hidden costs, market failures, behavioral and organizational barriers, and information barriers, political and structural barriers which do not allow to realize full energy saving potential of multi-apartment buildings and to fill in energy efficiency gap.

The policy schemes to overcome these barriers of large-scale energy refurbishment: regulatory and control measures, information and voluntary activities, energy and CO2 taxes, flexible market measures, financial incentives are not able to overcome the main barriers of energy renovation alone and need to be combined.

The existing policy schemes to foster large scale energy refurbishment are not adequately combined with each other and do not take into account the main organizational barriers of making common decision by apartment owners' on large scale energy refurbishment.

Policy schemes to foster energy refurbishment of multi-apartment buildings should be implemented through a combination with each other and conducted analysis showed that a number of important issues need to be taken into account for the successful implementation of policy schemes to overcome barriers of large scale energy refurbishment of multi-apartment buildings.

The policy packages combining informative, regulatory and economic policy schemes have become more popular in recent years, but they have not yet provided any evidence of their effectiveness in improving the energy efficiency of multi-apartment buildings through energy refurbishment.

The further research is necessary to develop packages of policy schemes to provided support of policy-making, in developing policy schemes packages to address various barriers of energy renovation of multi-apartment buildings especially those related to behavioral changes and organizational barriers that are not sufficiently addressed by current policies and measures.

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Relationship Between Demographics and Management Functions in Construction Projects Delays

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A B S T R A C T

This paper focus on the relationships between demographics of managers and the management of construction project delays. A sample of 150 large construction contractors were used to empirically test a proposed theoretical model. Partial correlations were calculated to establish whether demographics predicted the management functions in construction project delays. Results show that demographics only predicts two of the four functions of management namely organising and leading. Demographics influenced how contractors with different educational levels executed organising and leading in managing construction project delays. As this study only included large and experienced contractors, different results can be expected for smaller construction contractors.

Keywords - Construction Management, Construction Project Delays, Demographics.

I. INTRODUCTION

The construction industry is known as a very highly fragmented industry with activities involving different parties and professionals such as architects, engineers, quantity surveyors, contractor teams, suppliers, financiers and other role players. To gain a higher level of competitiveness, management efficiency and competency in the industry is needed. The major suggestions on how to reduce construction delays revolved around the four management functions namely: Planning (forecasting); Organising (staffing); Leading (commanding); Control (coordinating). The demand of construction clients for the timely delivery of construction projects and the susceptibility of projects to delays and cost overruns has attracted the attention of researchers all over the world, most of whom have tried to identify the immediate as well as the root causes of project delays. However, despite the various studies and investigations into the causes of delays, it is still a major problem in the construction industry. Although it is often clear what the causes and effects of construction project delays are, little attention has been given to the role of management in construction project delays. Further the relationship between the demographics and management functions were neglected in previous studies. This research thus aimed to fill this gap in literature. More specifically, the research focused on the relationships between demographics of managers and the management of construction project delays.

II. PREVIOUS RESEARCH ON DELAYS IN CONSTRUCTION PROJECTS AND DEMOGRAPHICS

Hashim and Chileshe explored the major challenges to managing multiple project environments in Australia [1]. The views from Australian project management practitioners indicated that "commitment and responsibility", "leading projects", "planning", and "conflict and communication" were perceived as the four challenges of most importance. Furthermore, the 22 challenges could b e classified into 11 sub-groupings, namely, project management processes, competencies of project managers, project assignments, human resource allocation, resource availability, organisational culture, problem-solving, competition among projects, information sharing, management of a single project and project location. Mahamid's research identified 14 factors that are reasons for project business failure, namely project management techniques; replacement of key personnel; labour productivity and improvement; documentation system use; fraud; incompetent consultation; procurement practices; lack of managerial development as the company grows; one-man rule; owner involvement in the construction phase; increasing size of projects; internal company problems; company organization and commitment [2].Research conducted among construction students to track the skills they acquired during a project exercise showed that student construction skills were enhanced through active learning.

Focus was on the construction planning and construction documents, tracking construction progress, finishing the project on time, using computerised tools, reducing construction waste and preparing final reports [3].

A framework for construction project success in the United Arab Emirates (UAE) identified 15 key success factors related to mitigation measures in construction projects where there had been some largedisagreements between construction project stakeholders and problems in achieving a fair resolution in respect of incomplete/on-hold projects/delayed projects persisted [4].

Many sources of risk in a construction project include client delays payment or does not pay for work done; tendered amount is insufficient to cover costs; community is opposed to the project; heavy rains delay the construction programme; inflation adjustments provided for in the contract are insufficient to cover the real cost of inflation; raw sewerage spills into the water course; bank will not provide sufficient bridging finance; labour strikes during the project; tender is awarded to another contractor owing to high levels of competition in the market; site is susceptible to flooding; worker is injured or killed during construction;- labour is insufficiently skilled to achieve required quality; criminal acts and acts of vandalism occur and vehicles cannot access the site in the raining season[5]:

Construction organisations can achieve excellence and enhance excellence through knowledge and workforce management where human resource development and training is the most important enabling factor that enhances organisational capabilities. Both workforce management and knowledge management are key components of people capability, and they play crucial roles in the performance of construction firms, and there is a high degree of dependence on these two components [6]. Construction businesses were rethinking their business and project processes under growing competitive pressure [7]. Many initiatives aimed at improving productivity, quality and client satisfaction require information on operational and industrial performance.

Construction projects should be considered as a process where all customers must be satisfied. These customers include internal customers (employees, units, departments within an organisation) and external customers (owner, designer and contractor). To achieve sustained success, an organisation needs to develop and improve their people, partnerships and processes to deliver value-adding products to their external customers.

III. THE FUNCTIONS OF MANAGERS IN CONSTRUCTION

Managers in construction plan, organise, direct, control and evaluate the activities of a construction business or a construction project within a business, under the direction of a project manager. They are employed by residential, commercial and industrial construction businesses and by construction departments of businesses outside the construction industry [8]. In comparison to managers of other disciplines, the work conditions leading to stress is significantly higher for construction project managers [9]. The demanding project-based environment consists of longer than average work hours compared to other industries [10]. Professionals and managers commonly work well above their contracted work hours and unpaid overtime is the norm [11]. There appear to be two beliefs in the project management community. The first is that the project manager's competence makes no contribution to project success. If he or she uses the right tools and techniques, the project will be successful. The second is that as long as a given project manager has learnt to apply those tools and techniques well, he or she can apply them to any type of project, regardless of technology, discipline or domain [12]. modern construction projects there are significant challenges for both clients and contractors to deliver the project successfully owing to increasing complexity in design and the involvement of a multitude of stakeholders [13]. In addition to this complexity of construction projects, defining project success itself is a complex issue [14]. There is considerable debate in project management research practice about what determines project success. While the topic has been discussed for a long period of time, an agreement has not been reached. In addition, when it comes to a definition of project success, there is no single list that is totally comprehensive. However, the concept

of critical success factors (CSFs) presents a smarter way to identify certain factors, which when present or absent in a project are likely to make the project successful. These critical success factors (CSFs) include [15]:

Financial attributes

- Turn over history
- Credit history
- Bonding capacity
- Cash flow forecast

Management attributes

- Staff qualification
- Management capability
- Site organisation
- Documentation

Technical attributes

- Contractor's IT knowledge
- Knowledge of particular construction method
- Work programming
- Experience of technical personnel

Past experience attribute

Type of past project completed

The key performance indicator which was observed to be the most significant individual variable contributing towards the success of any project included the staff variable [16].

Businesses must thus ensure that project-related training is imparted to staff. There were significant correlations between years of work experience in the construction industry and the conceptual skill components.

This signifies that the higher the years of work experience of project management personnel, the higher their conceptual skill, thus indicating that experience or learning by doing may be the most effective way to develop the conceptual skill of project managers [17].

A further study confirmed the importance of management skills for project success [18].

IV. PROPOSED THEORETICAL FRAMEWORK FOR THE RESEARCH

Considering the brief literature overview, the following can be concluded.

A. Factors causing construction project delays

For the purposes of this study, nine factors causing construction project delays are identified.

• Delays related to clients

Client related causes of delays involve, amongst others, an unrealistic time period to complete the construction project, design and scope changes by the client and inadequate decision-making.

• Delays related to contractors

Contractor related causes of delays often revolve around inadequate experience and poor coordination of activities.

• Delays related to labour and equipment Unskilled labour and labour disputes are one of the causes of construction project delays.

• Delays related to equipment

Faulty equipment and improper equipment selection also lead to delays.

• Delays related to materials

Poor quality material, material shortages, late ordering and late delivery of materials also cause construction project delays.

• Delays related to consultants

Delays related to consultants revolve around incorrect communication, lack of information and inappropriate coordination of information.

• Delays related to community

Lack of community buy-in to a construction project and community unrest cause construction project delays.

• Delays related to the contract

Communication between parties, disputes and negotiations can cause construction project delays. Contracts are also sometimes not properly understood.

•Delays related to external issues

External issues that can cause construction project delays relate to nature disasters as well as delays causes by humans such as political interference. So external issues can be either those related to natural causes and those related to human causes.

B. Management functions

Each of four management functions is briefly discussed in this section.

• Planning

Planning is also a management process, concerned with defining goals for a future direction and determining the missions and resources to achieve those targets. To meet objectives, managers may develop plans.

• Organising /staffing

Organising is the function of management that involves developing an organisational structure and allocating human resources to ensure the accomplishment of objectives. The structure of the organisation is the framework within which effort is coordinated. Contractors need to ensure that they appoint the correct people to carry out their projects.

• Leading / commanding

Leading is the third step in the management process and is accomplished by communicating, motivating, inspiring, and encouraging employees towards a higher level of productivity.

• Control / coordinating

Controlling is the final function of management in which the manager, once a plan has been carried out, evaluates the results against the goals.

C. Demographics impacting on the management functions

This section provides a brief description of the demographics that may impact on management functions.

• Education

It is expected that the more educated people are, the better they will be able to manage a construction project. However, this needed to be tested empirically.

• Years employed

A contractor that has been employed for a long period is considered to perform management functions better than one that has not been employed for long. This needed to be tested.

Research [17] – [18] indicated that demographics do influence management functions. Hypothesis one was thus formulated as:

H1: Demographics of contractors predict the management functions employed in construction project delays

Figure 1 shows the proposed theoretical framework that will be empirically tested in this study.

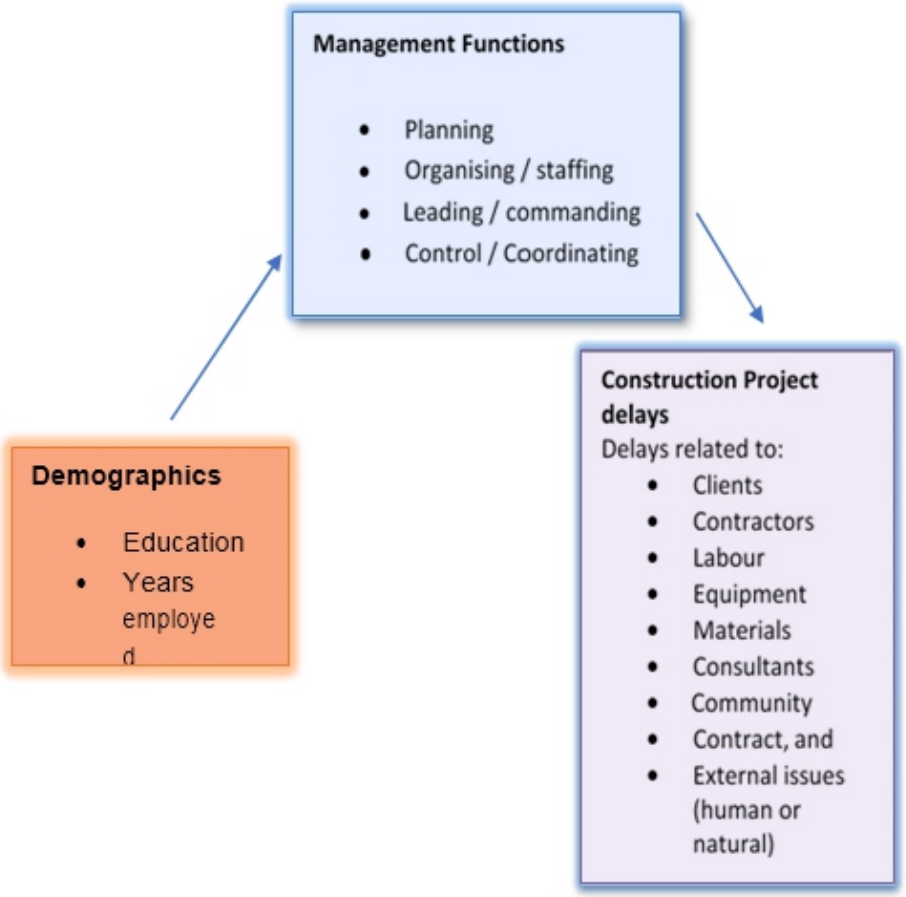

Figure 1: The relationship between demographics and the managing functions in construction project delays Source: Authors own compilation

V. RESEARCH DESIGN

In this study, the non-probability sampling technique known as criterion-related sampling was used to select respondents. To be included in the sample, the respondents had to meet specific criteria. In this study, the contractors needed to have a CIDB grade of at least 7. This meant that the contractor's tender range was above R13 000 000. A large-scale contractor would be exposed to construction delays and effects in a different manner than a contractor who is small-scale. In the study, the researcher made use of a measuring instrument to collect the primary data from the sample group.

A. Measuring instrument development

The proposed framework (see Figure 1) served as basis to develop the questionnaire. As relationships in this framework needed to be tested, the three constructs, namely, demographics, management factors and factors causing delays had to be included in the measuring instrument. The measuring instrument used in this study consisted of a covering letter and three sections each one dealing with a construct. In the cover letter, an explanation of the purpose of the study and the type of information requested was provided. The cover letter also included a promise of confidentiality and instructions on how to complete and return the questionnaire. The survey was conducted by a research solutions business.

Sections 1 of the questionnaire requested demographic information relating to both the respondents and the contactor businesses. Section 2 of the questionnaire consisted of five-point Likert-type questions investigating management in construction delays. Section 3 of the questionnaires also consisted of the five-point Likert-type questions focussing specifically on the causes of delays in construction.

B. Sample size

In quantitative studies, a representative or good sample is one in which the results obtained for the sample can be taken to be true for the whole population, in other words, the researcher will be able to generalise from the results. To ensure statistical analyses in this quantitative approach the sample size for this study was 150 units (construction contractors).

C. Pilot survey

To establish whether the measuring instrument would be usable, a pilot study was conducted. The researcher approached 20 contractors to complete the questionnaire. During the process of getting contractors to complete the questionnaires, the researcher recognised the time- consuming process of getting one questionnaire completed.

It was then decided to use a research business to assist in collecting the data. No major changes to the questionnaire was necessary after the pilot survey.

D. Administration of measuring instrument

Data was collected using an outside research business. During the pilot survey, it became clear that it would be very time-consuming to collect data from building contractors personally. Therefore, it was decided to use an outside research business to collect the data online. The researcher, however, closely-monitored the collection of data and had a couple of sessions with the research business to ensure the success of the data collection.

E. Method of analysis

Once the primary data was collected, it was analysed using appropriate statistical methods. A custom developed computer programme developed by a qualified statistician and performed in Excel was used to do the statistical analyses.

• Validity of the measuring instrument

The validity of a measuring instrument refers to whether it has measured what it intended to measure [19]. In other words, it is concerned with the effectiveness and soundness of the measuring device. The validity of this study's instruments was based on previous studies conducted (theory). Content validity was further done by asking experts to judge the guidelines included in the questionnaire.

• Reliability of the measuring instrument

Reliability differs from validity in that it measures the accuracy of results based on their consistency, as well as the probability that if the same research were conducted in the same setting, it would yield similar results [19]. This means that apart from delivering accurate results, the measuring instrument must deliver similar results. Cronbach's alpha coefficients are commonly used to assess the internal reliability of a measuring instrument. In this study, reliability was confirmed by calculating Cronbach's alpha coefficients, and coefficients of less than 0.7 were considered unacceptable. Statistica 10 was used to test for internal reliability of the questionnaire to determine the degree to which the test scores were accurate and consistent. The test scores were assessed for internal consistency by obtaining Cronbach's coefficient alpha. The results of the reliability tests showed a Cronbach alpha of 0.78 for delay causes and 0,92 for the management functions. These Cronbach alphas was acceptable and further analyses could be done.

VI. RESULTS

The results will include the demographic profile of the respondents and the results of the partial correlations to empirically test the proposed model.

A. Demographic profile of the respondents

The analysis of the demographic findings of the empirical survey showed that the majority of respondents were males (76%), were above 40 years old (52%), had a post-matric qualification (91%), where 30% had a bachelor's degree and 32 % had a post-graduate qualification and the median number of years that respondents had been in the business was 19 years and they had on average 20-29 employees.

It can thus be concluded that the majority respondents were well-educated and had been in business for a significant period of time. It should be kept in mind that the data would have been completely different if smaller businesses (CIDB grade lower) were included in the sample or if respondents were in possession of lower qualifications.

B. Relationships between demographics and management functions in construction project delays

To test hypothesis one partial correlations were employed.

Table 1 provides the partial correlations to investigate the relationship between the respondents' education and years employed (demographics) and management functions in construction projects.

Partial Correlations for H_1						
	Planning	Organising	Leadership	Control		
Educ.No Degree	.212	.234	.276	.195		
Educ.PostGrad	.096	.038	.124	-.001		
Employed	.068	.040	.080	.067		
Regression Summary Statistics for Planning						
n=127	R= .22950555 R^2= .05267280 Adjusted R^2= .02956726 F(3,123)=2.2797 p<.08274 Std.Error of estimate: .74433					
	b*	Std.Err.	b	Std.Err.	t(123)	p-value
Intercept			2.808824	0.156813	17.91192	0.000000
Educ.No Degree	0.251716	0.104724	0.390702	0.162548	2.40361	0.017727
Educ.PostGrad	0.112768	0.105312	0.181515	0.169514	1.07080	0.286358
Employed	0.066906	0.088799	0.004526	0.006006	0.75346	0.452614
Regression Summary Statistics for Organising						
n=127	R= .26175448 R^2= .06851541 Adjusted R^2= .04579627 F(3,123)=3.0158 p<.03258 Std.Error of estimate: .79457					
	b*	Std.Err.	b	Std.Err.	t(123)	p-value
Intercept			2.598748	0.167397	15.52447	0.000000
Educ.No Degree	0.277774	0.103845	0.464144	0.173519	2.67490	0.008492
Educ.PostGrad	0.044118	0.104428	0.076448	0.180955	0.42247	0.673419
Employed	0.039463	0.088053	0.002874	0.006412	0.44818	0.654814

Regression Summary Statistics for Leadership						
n=127	R= .29550458 R^2= .08732296 Adjusted R^2= .06506254 F(3,123)=3.9228 p<.01028 Std.Error of estimate: .80646					
	b*	Std.Err.	b	Std.Err.	t(123)	p-value
Intercept			2.488633	0.169902	14.64743	0.000000
Educ.No Degree	0.327669	0.102791	0.561409	0.176116	3.18773	0.001818
Educ.PostGrad	0.143808	0.103368	0.255517	0.183663	1.39123	0.166668
Employed	0.077551	0.087160	0.005790	0.006508	0.88976	0.375330
Regression Summary Statistics for Controlling						
n=128	R= .24094012 R^2= .05805214 Adjusted R^2= .03526308 F(3,124)=2.5474 p<.05897 Std.Error of estimate: .75683					
	b*	Std.Err.	B	Std.Err.	t(124)	p-value
Intercept			3.211549	0.157471	20.39457	0.000000
Educ.No Degree	0.228837	0.103582	0.362793	0.164216	2.20924	0.028994
Educ.PostGrad	-0.001442	0.104193	-0.002371	0.171389	-0.01384	0.988983
Employed	0.065594	0.088295	0.004531	0.006099	0.74290	0.458950

Source: Researcher's own compilation

Table 1: Partial correlations of education and years employed and management functions in construction projects

From Table 1, the following can be reported on whether demographics predicted the management functions in a construction project delays:

• Management function: Planning

The results of R2adj = 0.029 [(F(3,123) = 2.2797, p = 0.08274]. The p-value is greater than 0,05 which means that demographics did not significantly predict planning in construction projects. In other words, demographics did not influence how constructions managers of all ages and years of employment executed planning in construction projects.

• Management function: Organising

The results of R2adj = 0.045 [(F(3,123) = 3.0158, p = 0.03258]. This means that demographics significantly predicted organising in construction projects. In other words, demographics influenced how construction managers of all ages and years of employment executed organising in construction projects. In particular, those managers with no degree had a statistical significant relationship with how they executed leadership in construction projects.

• Management function: Leadership

The results of R2adj = 0.065 [(F(3,123) = 3.9228, p = 0.01028]. This means that demographics, significantly predicted leadership in construction projects. In other words, demographics influenced how contractors of different ages executed leadership in construction projects.

• Management function: Control

The results of R2adj = 0.035 [(F(3,124) = 2.5474, p = 0.05897]. This means that demographics did not significantly predict controlling in construction projects. In other words, demographics did not influence how construction managers of all ages and years of employment executed control in construction projects. To conclude demographics predicted only two of the four functions of management, namely, organising and leading. H1 could thus only partially be accepted.

VII. RECOMMENDATIONS AND PRACTICAL IMPLICATIONS OF THIS STUDY

Respondents in this study included only contractors at CIDB level above 7, thus the larger and more experienced contractors. For contractors dealing with large-scale projects, this study has indicated that education is important as it influences both leadership and organising functions of these contractors. It was determined that demographics significantly predicted organising and leading in construction project delays. More specifically, demographics influenced how contractors with different educational levels executed organising and leading in managing construction project delays. Important organising and leading tasks that contractors should attend to include the appointment of skilled contractors and other building employees to oversee the activities on site and also provide more practical onsite training; ensuring sufficient, adequate and good quality materials as well as suppliers of the materials and equipment are available to execute the project successfully; addressing contractor related causes of delays such as legal disputes by constant liaising with the role players; appointing an onsite health and safety officer; ensuring timeous planning of building activities and coordinate it to ensure a constant flow of activities; executing daily monitoring of activities executed on site; ensuring constant quality inspections by the relevant managers; having bi-weekly meetings with project managers to ensure that cost and quality are adhered to; keeping a daily site progress chart whereby time, quality and resources are managed; appointing a community liaison officer to improve or maintain good relationships with the community where necessary; and ensuring that planning at the design phase is executed properly to minimise changes to project at later stages in execution as changes will inevitably lead to project delays. The managers that contractors appointed should be onsite regularly as quality can be compromised. It should be noted that the correct distribution of labour force is very important; constant monthly evaluations of payments or evaluations of critical value will eliminate cash flow problems which can lead to disputes; Late change or additional work to the project should be minimised or completely eliminated to ensure timeous completion of the project and as quality is problematic owing to unskilled labour, this should be addressed by constant training, good incentives, better salary and paid training opportunities. For the respondent contractors who were included in the research, demographics influence two management functions namely organising and leadership and they should pay attention to these functions and more specifically to the tasks outlined.

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Modeling Problems in Building Materials Science

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ABSTRACT

The subject of this paper is properties modeling of building materials. The problem is a lack of reliable calculation models of designed predicted properties of materials. These models will ensure compliance with real material properties which will appear during the service life. These models should consider structural inhomogenuity and anisotropicity of building materials. It is shown that the strength is based on an ion-ion and ion-dipole interaction of the solid surfaces. The proposed formulas allow taking into consideration such objective material characteristic as chemical composition.

Keywords— Building Materials, Ion-Ion And Ion-Dipole Interaction, Structural Levels, Strength.

I. INTRODUCTION

Nowadays the contradiction between the theoretical and real strength of the building materials is increasing. The improvement of the modern research methods allows us to investigate different kinds of materials at their various levels – from macroscale to atomic and nanolevel. While the calculation formulas are based on the existing notions about materials as homogeneous whole substance which has identical properties throughout cross-section in all directions. However, taken with an electron microscope photos indicate a distictly defined discrete structure (Fig. 1).

As a result the data of calculated models for continuous medium differ from real materials behavior. To consider this nonhomogenity many calculation methods are proposed that use the random field theory for stresses [1]-[3] or deformations [4]. Moreover, the existing testing methods of material properties don't allow obtaining sufficiently accurate results. It isn't always possibly to extrapolate the results which were got on small samples to a big construction, for example soil massives, concrete structures. Is it possible to take into account the discrete structure during the strength calculation?

II. THEORETICAL BASES

According to our notions the material structure deter- mines its properties. The structure is a size, a shape, an interposition, and a quantity ratio of contained structural elements. Each of structural levels is determined by the size of structural elements (Fig. 2): more than 5 mm for macrostructure, 0.14-5 mm for mesostructure, 10-140 μm for microstructure, and 200-600 nm for submicrostructure.

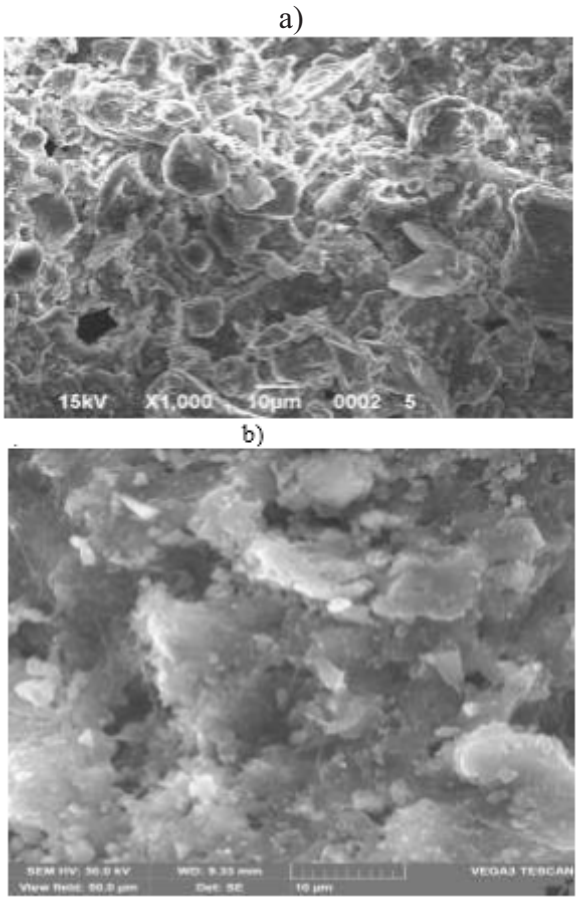
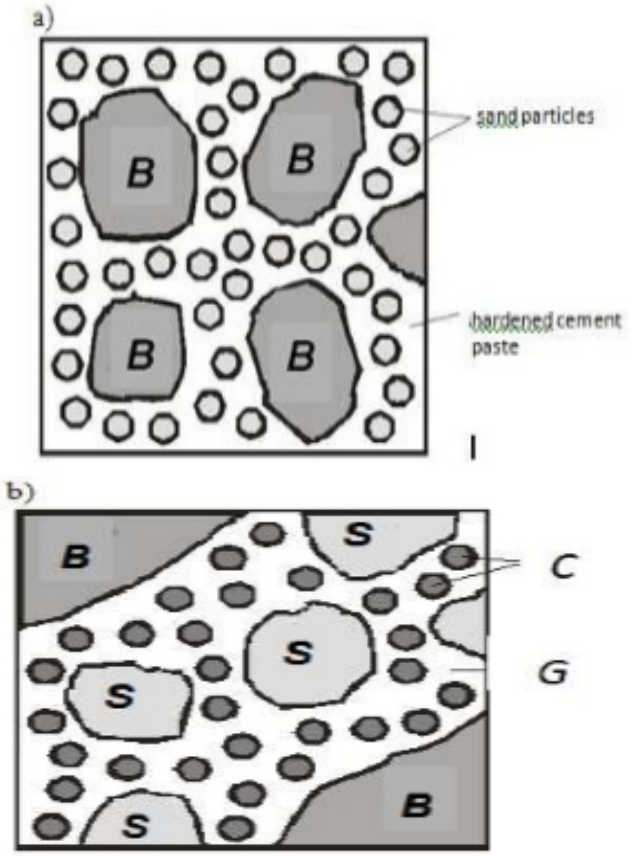


Fig. 1. The SEM photos of clay (a) and concrete (b)



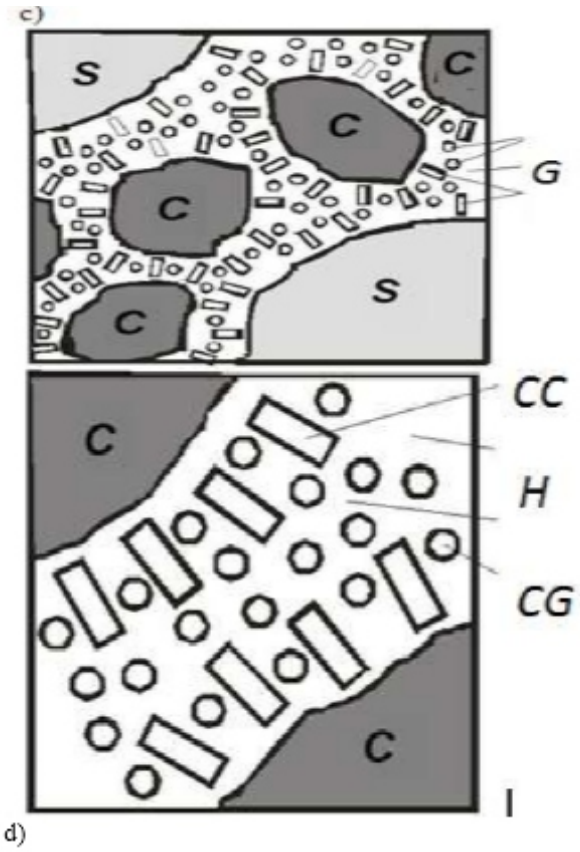


Fig. 2. The scheme of concrete structure at the macro- (a), meso- (b), micro- (c) and submicrolevel (d): B – broken stone; S – sand particles; CP – hardened cement paste; C – cement particles; G– cement gel and crystals; CC - cement crystals; CG – cement gel

As can be seen from Fig. 2 the concrete is not the homogeneous whole structure. The discrete model as the alternative to the whole substance model is at the initial stage of it development. It needs to study a behavior of a material which consists of particles in three aggregation states. These are solid particles and hollows filled both with water and air. The main problem is a stochastic pattern of the structural elements distribution and hollows between them. Every particle size is a random value. Particle sizes vary within certain limits from the minimum value dmin to the maximum value dmax. More often the distribution value law is considered to be normal. For example, a distribution of various particles size for a concrete is shown on the Fig. 3. Due to various particles sizes the final structure has a random pattern.

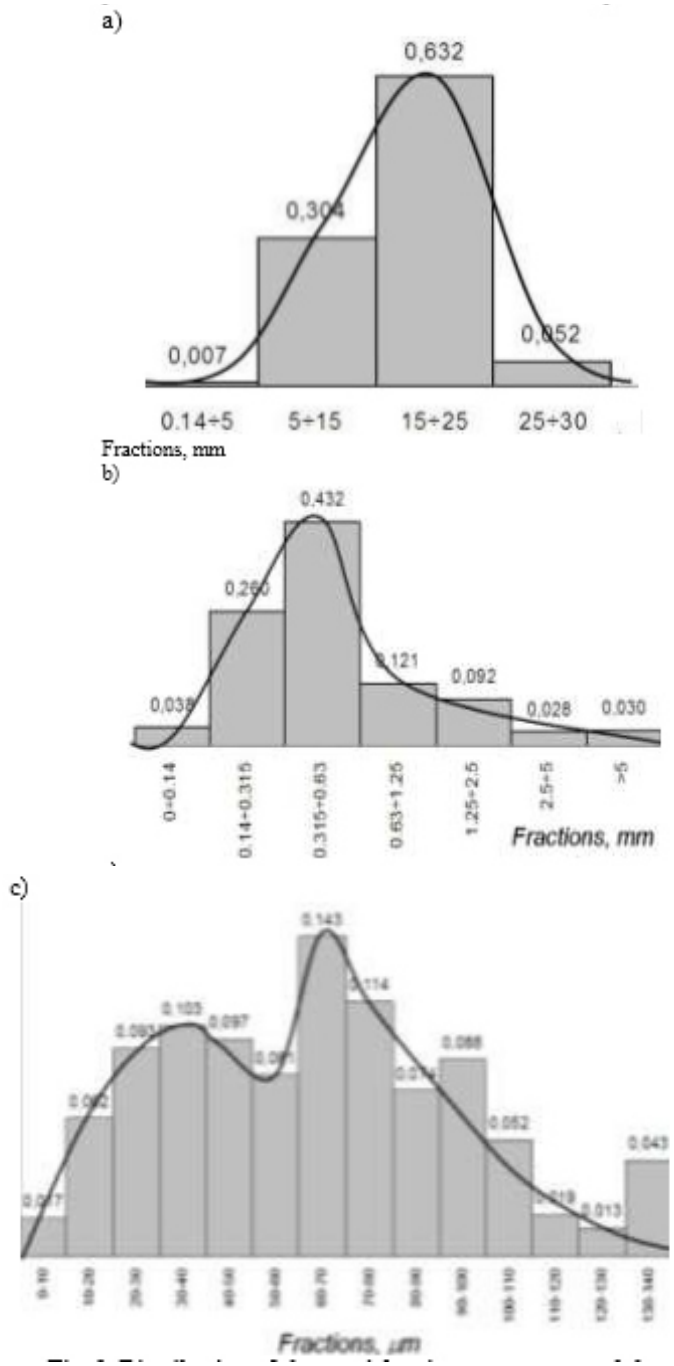


Fig. 3. Distribution of the particles sizes: a – monomodal distribution of broken stone; b – monomodal distribution of sand particles; c – bimodal distribution of cement particles

The particle sizes affect hollowness. The bigger a particle according to size the bigger porosity. Therefore, the distribution of particles size determines the distribution of hollows size. The hollowness determines two principal properties of materials – strength and density: the smaller hollowness the bigger strength and density. Besides, an extent of hollows filled with water depends on actual humidity (Fig.4). So, it is neseccary to create a math model that allows calculating the material strength based on random values distribution laws – the solid particle size and the extent of hollows filled with particles of smaller sizes, water, and air.

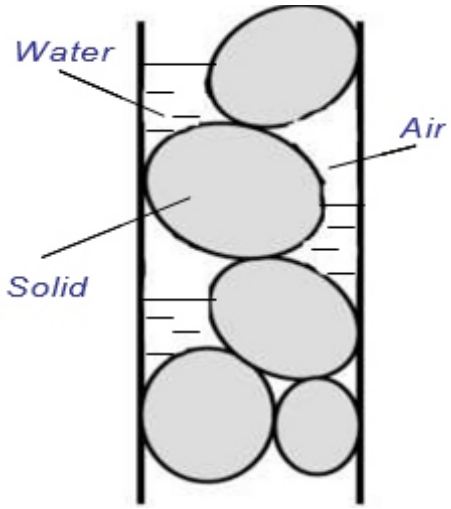


Fig. 4. The three-phase soil model

The material properties are influenced by a value of electric-surface interaction of the studied system components. The phase boundary presence and high degree of dispersion of the components require considering the sign of the charge of the particle surface and the particle size. The charge influences the nature of interaction between the surfaces and thus allows defining the possible methods of modifying the surface properties in order to obtain needed materials. The interaction force between two ions (for example, Ca^{2+} and OH^- in $Ca(OH)_2$ or SiO_2, Al_2O_3, $CaCO_3$) defines the ultimate materials strength (Fig. 5). This approach differs from expounded in [5] in which the particle connections are modelled using the springs.

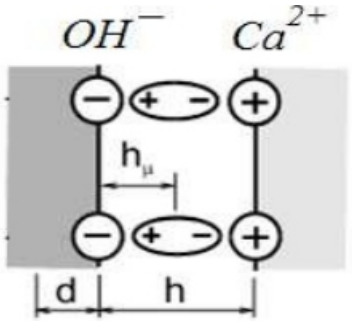


Fig. 5. The scheme of ion-ion interaction

The interaction force F is defined by ion-ion and ion-dipole interaction between ions and molecules by formula

$$F = \frac{z_1 z_2 e^2}{8\pi\varepsilon\varepsilon_o h^2} + \frac{z_{1(2)} e\mu_d}{2\pi\varepsilon\varepsilon_o h_\mu^3}, \qquad (1)$$

where ε, ε0 are the relative dielectric constant and electric constant; z is valence; e is the electron charge, C; h is the distance between the interacting ions, m; hμ is the distance between the ion and the water molecule, m; μd is the dipole moment of the water molecule, C·m.

The number of such contact can be determined by formula

$$n = \frac{\varepsilon\varepsilon_0\psi^0_{ES}}{4\pi d \cdot ze}, \qquad (2)$$

where ψ^0_{ES} is the solid phase electro-surface potential (cement, gypsum, lime, depending on experiment), V; d is the distance between potential-defining ion and anti-ion in dual electrical layer of dispersed phase particles, m; z is valence of the potential-defining ion; e is electron charge, C.

Thus, this calculation by formulas (1)-(2) provides an opportunity to predict the building materials properties based on a single objective parameter – chemical composition.

III. ANISOTROPY PROBLEM

The second result of structure heterogeneity is anisotropy of properties. The anisotropy leads to the various properties (for instance, strength, deformability, electrical resistance, thermal conductivity, permeability) in different directions. The heterogeneity can even appear on the manufacture stage. For example, the concrete mixture stratifies during its compaction. In this connection the construction properties throughout cross-section become absolutely different. It changes the calculation construction scheme in which the cross-section characteristics are accepted to be equal in all the points. Accordingly stresses and deformations of real systems do not correspond to the calculated ones what cause the decrease of durability.

While the construction is loaded a direct σ and tangential τ stresses appear. Due to the action of a load the real material structure changes, the redistribution of the particles interposition occurrs. The direct stresses compress the bulk, and the tangential stresses shear it. It can be imagined that the element consists of spherical particles connected in contact points then the direct stresses affect the particles compression and reinforce the ties between them. The tangential stresses lead to the relative shear of particles and destruction.

The equation is known which is called Coulomb's law.

This equation connects direct σ and tangentialτ stresses. But actually this function is not linear.

Moreover, the values of shearing strength parameters are determined only in a lab. But the obtained results are depended very much on the testing methods. For example, the three testing methods can give the results which are ten times different for the same soil. It should be mentioned these tests were made

for dry consolidated soils. Practically it needs to get the soil characteristics in their natural humid state. It is important for calculations of stability, for example foundation pit walls, embankment, and etc. In this case the tangential stresses τ are nonlinear function of the humidity W.

According to Cauchy the stresses in any points of the whole body are completely determined by nine components of stress tensors. Sometimes it is necessary to find the maximum direct stress and maximum tangential stress and the direction in which they act. To solve this problem it will be necessary to make stress tensor transformation that is known as Mohr's circles. However, due to a number of assumptions the calculated values are very far from real ones. For prediction of real stress values it will be necessary to take into account the impact of hollows and humidity upon the final stress values. For simplification of calculations the connection between deformations and stresses is accepted as linear. Coefficients are obtained by the experimental way during the strength testing of materials. However under these conditions the material behaves as a brittle elastic body. Objectively elastic deformations don't develop when construction and structures work under the load in real life. In this case the plastic deformations appear which the connection with stresses is nonlinear.

As a result these methods do not exactly reflect the behaviour of the material under a load during maintenance time. The known solutions do not consider an influence of outside conditions on the deformation value. For example, the humidity increase leads to the deformation rise under the same load. Therefore, coefficients in these equations are not constants but they are the functions of time, temperature, humidity and other factors. The deformation value can depend on the load direction or the location specimen angle relating to the vertical load. The example of such anisotropy is a piece of wood with various deformation properties along and across fibres. To design glued materials from wood waste it is necessary to predict in which direction the strength will be the biggest in order to place correctly a construction in relation to action loads.

IV. CONCLUSION

To sum, let us outline some problems for the search of the common solutions.

1. The first problem is at the material design stage. It needs a math model which allows determining the material strength as the function of the stochastic pattern of the structural elements distribution and hollows between them.
2. The second problem is at the construction design stage. It is necessary to develop a math model which allows determining stresses and deformations in any point of the heterogeneous material. It should be taken into account the stochastic distribution of the solid, liquid, and gaseous phases in the cross-section.

3. The third problem is at the construction service life stage. It is expected to have a math model which allows determining stresses and deformations in any point of the heterogeneous material. In this case it should be taken into account that the temperature and humidity change affects the stresses and deformation values. It is important for the prediction of construction durability.

In future to get the same models for a description of other properties would be preferable, for example, electrical resistance, thermal conductivity, and etc.

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A Theoretical Review of Construction Project & Precast as A Probable Solution for Delay in IT

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ABSTRACT

This paper represents a theoretical literature review on the current scenario in the construction industry, which is adopted in infrastructure project. It have been noticed that in the construction industry the completion time of a project is mostly delayed and wrongly estimated, which causes over budgeting. Not adopting the right approach while working on an infrastructure project which affects the growth of the company. In a developing industry, we need to provide the best quality, keeping the completion time to minimum. The Precast construction technique can be an alternative to overcome its need. Hence, it's necessary to know the fundamentals associated with it. Thus, by viewing the past research, we can recognize the cause of delay and problems connected with industry and providing a cost-effective, speedy construction at infrastructure project.

Keywords- Current Scenario, Precast, Cost-Effective, Speedy Construction, Technique

I. INTRODUCTION

BACKGROUND & PRESENT SCENARIO:

Since the existence of human they have created something or the other without the knowledge of what they have been doing, as they needed a place to stay, a place to work and a mode of transportation. Generation after generation humans have improved the way they think and the way they have been implementing the work in a systematic manner.

The present scenario of the construction industry is facing a serious issue towards completing the project on time. Thus, it increases the cost of projects affecting the industries which overall affect the growth of any nation.

India is the 2nd largest industry in construction field. It provides a large number of employments towards the growth of national economy. Primarily there are 3 segments in the construction industry the real estate construction, which comprises of commercials and residential, Building infrastructure comprises of roads, railways, ports, power, pipelines, textiles etc. that belongs to industrial construction.

In India people are using the conventional technique to construct any building across the county. Thereby the biggest infrastructure project is facing a hard time to complete the work on time due to which the cost of the project gets increased, that the overall burden of completing the project on time is on hands of any engineer of the company. To solve this issue we need to choose an alternative of cast-in-situ technique.

II. NEED OF STUDY

To study the current scenario in infrastructure project and cause related to delay in construction which lead to increase in overall projects cost, henceforth completing project on time is beneficial for all parties involved in the project. Thus, it is essential to identify an alternative to it.

III. REVIEW APPROACH

This study is concentrates on collecting data from the secondary data collection approach. A vast number of research literature related to infrastructure projects, problems affecting the industry and using precast as an alternative to counter down the delays have been studied.

IV. FINDING AND DISCUSSION

Various elements which have been found by different literature review are brought to the surface. Their summary is written down by going through the research paper, analysis of the reviewed articles has been formulated for the conclusion of the study.

A. Present scenario of construction industry.[1] Summary:

India needs to create more infrastructure to cope- up with the demand required for the growth of the county, thus making more efforts on government to raise funds to do so. Thereby, we shall be able to achieve constant development for Indian construction industry.

B. Construction sector: Current scenario and emerging trends.[2]

Summary:

Subsequently recording a huge progress over 12% than the country's GDP in the past decade, because of the global disorder of financial which affected the construction sector a loss in the last year. Not only to this extend in also affect the different sectors which include cement, steel, power, petroleum, IT and ports to add on a bad mark on Indian economy. Moreover compare to sectors such as telecom, urban infrastructure, railways, oil and gas, which are being produced in a large market in construction are not been affected that much, hence by increasing a noticeable rise in project orders from the center, states and local firms.

C. Major challenges facing the construction industry in India.[4]

Summary:

- **Lack of trained labor force :** Construction industry offers a lot of chances for service even though it is limited to manual job only. Thus affecting to the workers, which they have been provided with a low wage for their work, they come from rural area in search of work. Even when the modern technology is available to the contractors, still they trail the same old-fashioned work practices. Thus reducing the speed of work and makes, the work more risky for labor.

- Non-availability of land within the city limits: The demand for commercial project and housing in the city area has been increased, the supply is limited due to unavailability of the land and thus affecting the rise in costs. Price of materials has increased over the past years.

- Alleviated cost of materials: Materials cost of construction have gone through a major change after the implementation of GST (Goods and Service Tax). Most of them fall under high-end category in 28% GST slab. Thus big issues for the stakeholders.

- **Technology Adoption:** Modern technology has been a big differentiator in the industry today.as when international investors investing in India. Elements are BIM, VR and AL security are transforming trends for now in sector of industry.

Figure 1: Trained labor on site

D. Success and failure factors of Indian construction companies.[5]

Summary:

In this study,a survey is carried out in the Indian Construction Company. Critical factors leading to Construction Company have been investigated through interview with top managers and the CEO of the companies.

Results show that the cash flow management is one of the most important factors for a success of any large firm. Compare to medium size firm the insufficient capital was a factor considered to it. Compared to small size firm inadequate sales was a major factor.

In addition, it was found that manager/CEO did not consider project management technique an essential item for a success of the company.

E. Study of factors affecting performance of construction project.[6]

Summary:

From the questionnaire-based survey, the most important factors agreed by the owners, contractors, and engineers as the main cause affecting the performance of construction project were: improper planning, improper designing, site management, decision making, construction methods, shortage of labor and technical personnel, quality-shortage of materials, construction mistakes and defective work, productivity. The owners considered the client and technical factors to be more important than operational ones.

F. Precast building system.[7] Summary:

According to the writer -"Precast concrete is a construction product produced by casting in a reusable mold or "form" which is then cured in controlled environment, transported to the construction site and lifted and set into place." Elements of precast building and various systems:

Precast footing, Beams, Columns Slab, Shear wall, Partition walls, Connection between precast elements.

G. Comparative study on prefabrication construction with cast-in-situ construction of residential building.[8]

Summary:

Due to the quick growth rate development in the India construction, the adoption of precast construction is increased.

Total cost and duration time in double storied residential building have been resolute for both the prefab and conventional construction. The comparison showed from the company is enormous cost difference between the methods, which the prefab is much higher when compared to conventional on this type of individual houses.

H. Advantage and limitations of precast concrete construction in high-rise buildings: Hong Kong case studies.[9]

Summary:

The case studies revealed that the benefits of adopting the prefabrication/precast in building construction were considerable, when compared with cast-in-situ construction method. Improved quality can be achieved as the precast elements manufactured in a factory environment with stringent quality control. It's been seen that the construction cost in precast was slightly higher than cast-in-situ. However, this additional cost would offset by a reduction in construction time, improved quality and environmental benefits at the site.

The important issue when adopting the precast was the requirement of early decisions, the scheduling and logistics, at the site access to the storage of precast elements in dense urban areas.

I. Advantage and disadvantage of precast concrete construction.[10]

Summary:

Enlisted advantages where found for precast concrete-

- **Save construction time:** While adopting the precast concrete it saves the construction time. Risk of delay in project is less. In precast, Casting can be carried on simultaneously while working on the other work on site such as earthwork, survey etc.

- **Quality assurance:** In precast it regulates the quality of construction such as for curing, temperature, mix design, formwork etc. its monitored well. So improved quality construction can be performed.

- **Cost-effective:** Easier or simple construction process reduces the time, increases the productivity, quality and safety, thus the cost is reduced.

- **Durability:** On precast structure, it has longer service time period and minimum repairs required. High density is more durable in precast that affect an acid attack, corrosion, impact, reduces surface voids and accumulation of dust.

- **Safe construction platform:** Raw materials are not required to be stored on site for precast. Reduces the requirement of formwork and props likely a conventional method, wastage, workers etc. thus providing a safe working platform.

Some of the Disadvantage seen in precast.

- **High initial investment :** Installing a precast plant takeaway heavy machines which required high initial investment. A large scale of the precast construction project should be available to ensure sufficient profit.

- **Transportation:** The site of work can be at a distant location for the plant. In that case, the precast members must be carried to the site using trailers. In many cases, the reduced cost of precast is compensated by the transportation cost.

- **Handling difficulties:** Usually, precast members are heavy and large, which makes it difficult to handle, thus require proper care and precaution.

- **Modification:** It is difficult of modifying the structure created with precast. For example, if a structural wall needs to be dismantled for modification it will affect the overall stability of the structure member.

V. CONCLUSION

From the reviewed analysis, it's been seen in the development of any nation, its infrastructure place hasan important role. The contractor should emphasize more on skill development of labor, they should adopt an alternative technique for the big infrastructure project. Thus improving the quality of the work and saving the time required in construction project which overall be cost-effective.

Precast construction method can be a solution for delay in construction industry but to implement precast, it requires high initial funding and proper managing skills. Thereby, a person needs to study more about the precast and different technique while executing the project.

This research is limited to secondary data and the paper, article collected might differ from place to place. It is advised that one should go on the site and consider applying the approach needed for it.

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Quality Perception of Main Constructors and Sub-Contractors on the Internal Wall Inspection: Case of High-Rise Residential Buildings in Thailand

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ABSTRACT

Real estate investment, one of the key economic drivers in Thailand, is likely to increase continuously, especially concerning high-rise residential building projects in major cities. According to the literature review, problems on the quality inspection of architectural works cause reworking and cost overrun. Internal wall construction is selected for this study to investigate the possible conflicts and limitations arising during the quality inspection process of high-rise building construction projects. According to the regulations of construction-related organizations in Thailand, the specifications of internal wall quality inspection are subjective, and mostly involve the perception and judgment of inspectors. Main contractors and sub-contractors, who experience high-rise residential building constructions were selected for this qualitative research. Six purposive interviewees, with the collected data analyzed using content analysis. The findings indicate that main contractors and sub-contractors agree that the quality of internal walls in high-rise buildings are measured by the discretion, knowledge, ability, experience, expertise of each inspector. The quality of work assessment is not consistent between deliverers (Sub-contractors) and inspectors (Main contractors). Internal wall quality emphasizes flatness, alignment and evenness, angle, cracks, and range. However, there is a lack of clear prescription standards for work such as tolerance acceptance.

Keywords - Real Estate, Residential Project, High-Rise Building, Internal Wall, Quality Inspection Process.

I. INTRODUCTION

Quality of work is very important because it is an indicator of project success. Most clients are satisfied if they receive high-quality work, especially if it is higher than expected. Therefore, unclear quality specification and quality measurement in the construction project may easily lead to unexpected problems including in the quality inspection process because each client has their own perception of quality. Construction projects are consisted of a variety of specific tasks, which require a lot of expertise and experience of subcontractors. This allows the main contractor to properly control and evaluate the subcontractor's work quality to complete the designated task correctly, efficiently, and effectively. Thus, contractors and customers' equal perception and understanding about the work quality, along with proper communications regarding the appropriate quality standard, are crucial. Contractors should pay attention and understand both parties' situations in order to alleviate conflicts that may arise from misunderstandings, which include different views on the quality in different aspects.

Misunderstandings are especially prevalent on subjective, aesthetics matters in architecturural designs. Quality assurance in high rise buildings with housing purposes' interior walls is considered to be the greatest amount of work, in a buildings' entire constructing work, calling for craftmanship. When assessing work quality, many factors come in to consideration: each inspector's knowledge, experience, and discretion; physical senses, such as visual and tactile perceptions; and each party's subjective level of satisfaction. Therefore, Quality inspection on architectural works may use only subjective visual inspection, especially those aesthetic defects. Inspectors might be not able to quantify the value of defect and could not evaluate works correctly and impartially (Laofor and Peansupap, 2012)

II. PREVIOUS STUDIES

Building construction and contractors

The construction industry is one of the major industrial groups that contribute to Thailand's economy, by increasing construction wages, in order to statisfy the international market's immense, diverse demands. In the construction industry, maintaining a contract firm is highly costly, calling for high investment values. Projects require machines, human knowledge, specialized expertise, and labor workers, calling for highly organized construction management to accommodate each project's great complexity. Examples of high complexions include building villages, condominiums, and commercial buildings; these call for a minimum of 30 million Thai Baht. Work of construction firms are in the form of projects, which are comprised of fivestages: 1) Initiating 2) Planning 3) Controlling, 4) Implementing, and 5) Closing (ISO 21500:2012) (Zandhuis and Stellingwerf, 2013). A project follows a designated purpose, completed by a given time under cost and quality controls. There are many parties involved in aconstruction project: a main contractor and subcontractors. Main and sub contractors contribute greatly to the project's success in the form of the company and individuals, in which subcontractors contribute the most to. In general, 80 – 90% of the tasks are respond by subcontractors in the construction projects. Due to the specialized tasks such as M&E system, structural work, architecture, machine and equipment installation, cost control, customer services, and risk management. However, subcontracting in the project can show specific problems linked, which affects the work quality and construction management. Ahmed and Yusuff (2016) found that the factors influencing project quality in construction in the area of Quality System were lack quality control, assurance system, and feedback, poor checking and inspection, and implementation of time schedule. In addition, Enshassi, Arain and Tayeh (2012) also found that the lack of construction work quality was one of the important causes of interface problems.

Quality inspection process

Quality of work is very important because it is an indicator of project success. Most clients are satisfied if they receive high-quality work, especially if it is higher than expected. Therefore, unclear quality specification and quality measurement in the construction project may easily lead to unexpected problems during the quality inspection process because each client has their own perception of quality. Therefore, each responding party should understand the customer's requirements to achieve satisfaction. Previous research has made a considerable contribution toward quality and customer satisfaction in construction. For example, the findings show that public and private customers need contractors to improve their performance on quality assurance, handover procedures, and materials. Public customers were found to be less satisfied with the performance of contractors than private customers, whereas contractors mainly considered high customer satisfaction achievement in order to maintain their customer relationships (Kärnä, 2014). In addition, Sutheeraphat (2000) presents that problems among owners, construction management consultants, and contractors occur during the handover process of construction work in Thailand. Such issues include 1) document management, where the necessary data was not updated, and 2) inspection acceptance of criteria was unclear.

Related regulations

The Construction Quality Assessment System (CONQUAS)

The Constuction Quality Assessment Sytem (CONQUAS) was introduced in Singapore during 1989 has been under a process of continuous development. In 2014, the eighth edition of CONCUAS was adopted. The objective of this system is to serve as a standard for evaluating the quality of building construction. There are three components in the building: 1) structural works, 2) architectural works, and 3) mechanical and electrical works. CONQUAS is widely applied in many construction projects such as housing, commercial buildings, high-rise buildings, etc. Moreover, CONQUAS could also help the stakeholders involved in the construction project to standardize not only the specification and quality of human works but also customer expectations. Developers can use this guide to specify product and service quality, whereas the contractor can satisfy customer expectations regarding quality at a reasonable cost. Internal wall work in this system consists of five main criteria: 1) finishing of work; 2) alignment and evenness; 3) cracks and damage; 4) hollowness and delamination; and 5) jointing. (Building and Construction Authority, 2014)

Quality Assessment System in Construction (QLASSIC)

In 2006, the Construction Industry Development Board (CIDB) launched a quality evaluation system, namely Quality Assessment System in Construction (QLASSIC). QLASSIC has been adopted from

CONQUAS, and therefore, both quality assessment systems are similar, including their main elements. (Construction Industry Development Board Malaysia, 2006)

The aforementioned data presents that, in other countries, quality assessment systems are created for use in construction projects as a standard for the quality of works, including internal wall construction. Whereas, this is not the case in Thailand. Although each project might have its own quality standard or specification to control the quality of work, it has not been cleared for use and standardized.

III. RESEARCH METHODOLOGY

This study aims to perceive what constitutes quality of an internal wall and what standards is using in the quality inspection process. This study uses qualitative research methodology to gain insight into the perspective of internal wall quality by a target group during the inspection process for high-rise building projects in Thailand. The in-depth interview was used as a research instrument to collect data from six respondents.

The experts were divided into two groups: 1) main contractors and 2) sub-contractors. There were three persons of each group. Moreover, the sample respondents interviewed in this research should be suitably qualified in their respective roles.

1. The project management consultant or project manager should have a degree in civil engineering and architecture.
2. Respondents should have at least five years' experience of internal wall quality inspection on no less than 10 residential high-rise buildings.

Research instrument

Semi-structured questions were used to collect data based on the concept of the internal wall inspection process. The final semi-structured questions were prepared and proven to work well in gathering the required information.

Data collection

The interviews took place face-to-face using the prepared open-ended questions. The guideline questions were intended to elicit information in two areas: 1) quality of the internal wall and 2) standards or guidelines used in practice by Thai experts. All the interviews were tape-recorded, noted, and photographed. The interviews were conducted in the Thai language and transcribed word for word into English.

Data analysis

The qualitative approach was chosen for this study with content analysis deployed using coding and categorization to acquire insight into the quality of the internal wall and standards or guidelines used by main contractors for high-rise internal wall inspection in Thailand. Content analysis was carried out in two stages: the first of which involved single interview transcripts, and the second involved cross-interview transcripts. All content analysis was performed manually, with a combination of inductive and deductive approaches.

IV. RESULTS AND DISCUSSION

Table 1 quality perception of main constructors and sub-contractors on the internal wall inspection: case of high-rise residential buildings in Thailand

Respondent	Qualification	Quality of internal wall	Standards or guidelines used
Main Contractor A	Project Manager Experience: 10 years	- - Wall finishing must be smooth with no cracks or waves. The wall must be in alignment, flattened, leveled, and right -angled.	- - A mock up room is used to demonstrate the standard of work . –
		- - There is no set quality level for internal wall construction .	- - There is a conflict of quality acceptance between main contractors and sub -contractors, therefore, a mock up room is used to demonstrate the standard of work.
		- - The quality of work is dependent on the owner or the consultant .	
		- - Defects are wall jointing, crack and angle.	
Main Contractor B	Project Manager Experience: >10 years	- Wall finishing must be smooth with no waves . The wall must be in alignment, flattened, leveled, and right- angled.	- Each project has their own specification and work guideline . –
		- There is no set quality level for internal wall construction . It is difficult to assess quality level of the internal wall because it depends on the discretion of the inspectors .	- A mock up room is used to demonstrate the standard of work .-
		- The quality of work is dependent on the owner .	- Each project has their own specification and work guideline.
		- Most of defects are spotted color .	- Acceptance of work is dependent on the inspector 's experience.
Main Contractor C	Project engineer	- - Wall finishing must be smooth with no cracks or waves. The wall must be in alignment, flattened, leveled, right- angled, right width and height.	- A mock up room is used to demonstrate the standard of work .
	Experience: >10 years	- - There is no set quality level for internal wall construction .	- Each project has their own specification and work guideline.
		- - Defects are wall jointing, crack and angle. - The quality of work is dependent on the owners.	-There is a conflict of quality acceptance between main contractors and sub -contractors
Sub-Contractor E	Project Manager	- Wall finishing must be smooth with no cracks or waves. The wall must be in alignment, flattened, leveled, and right- angled.	- There is no standard or guideline from any regulators in Thailand for this type of work.
	Experience: >10 years	- There is no set quality level for internal wall construction .	It is dependent on the inspector 's experience.

		- Quality level or acceptance is dependent on the inspector by MainContractor	
Sub-Contractor F	Project Manager	- Wall finishing must be smooth with no cracks or waves. The wall must be in alignment, flattened, leveled, and right- angled.	- A mock up room is used to demonstrate the standard of work .
		- There is no set quality level for internal wall construction .	- Each project has their own specification and work guideline.
	Experience: >10 years	- Quality level or acceptance is dependent on the inspector by Main Contractor and the consultant .	- It is dependent on the experience and discretion of inspectors, which often differ.
Sub-Contractor G	Project Manager	- Wall finishing must be smooth with no cracks or waves. The wall must be in alignment, flattened, leveled, and right- angled.	- A mock up room is used to demonstrate the standard of work .
	Experience: >10 years	- There is no set quality level for internal wall construction .	- It is dependent on the inspector 's experience.
		- Quality level or acceptance is dependent on the inspector.	

V. CONCLUSION

This research found that both main and sub contractors generally share the same views on the high rise buildings' interior walls' work quality. However, main contractors believe that the quality level/acceptance depends on the customers' satisfaction, whereas subcontractors believe that the quality level depends on the maincontractor's work inspectors and advisors. Additionally, during the interior wall quality inspection process, there exists conflicts between parties involved quality inspection. Because the accepted quality level of each specialized task is different, construction consultants and contractors collaborate to make a sample room, which provides the same standard for quality inspection of high rise buildings' interior walls. However, in each inspection, the experience and discretion of the inspector are still involved, while the sample's room standard is sometimes maintained. This is due to a possible change in the people involved in the inspection process.

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