

# Real-time Supervision through ICT in Construction Quality Management and Monitoring System in Bangladesh

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**Abstract-** Although an innovative approach Construction Quality Management and Monitoring Systems / frameworks (CQMMS) in the development industry are regularly actualized to guarantee that adequate exertion is made by organizations to accomplish the required levels of value for customers. Achievement of these quality levels can bring about more prominent consumer loyalty, which is principal to guarantee long haul intensity for development organizations. In any case, the development division is as yet lingering behind different businesses as far as its effective reception of ICT based CQMMS, because of the relative absence of acknowledgment of the advantages of these frameworks among industry partners. Therefore there is a basic need for thorough investigation of selection of CQMMS in the development part. This paper thoroughly examines in the development part setting, the effects of all the notable variables encompassing effective usage of CQMMS in building associations, particularly those of outer elements.

This investigation is a piece of a progressing PhD venture, which intends to build up another structure that incorporates both inner and outside variables influencing CQMMS execution. To accomplish the paper point and goals, meetings will be led to characterize the outer variables impacting the selection of CQMMS, and to acquire all encompassing basic achievement factors or key success factors (KSFs) for executing these frameworks. In the following phase of information accumulation, a poll study will be produced to explore the prime boundaries confronting the reception of CQMMS, the KSFs for their execution, and the outer components influencing the reception of these frameworks. Following the overview, contextual investigations will be attempted to approve and clarify in more prominent detail the genuine impacts of these components on CQMMS selection.

In particular, this paper assesses the impacts of the outside variables in terms of their effect on execution accomplishment inside the chosen contextual investigations. Utilizing discoveries drawn from breaking down the information acquired from these different methodologies, particular suggestions for the fruitful execution of CQMMS will be exhibited, and an operational structure will be created. At long last, through a core interest gathering, the discoveries of the examination and the new created system will be approved. At last, this structure will be made accessible to the development business to encourage the more noteworthy selection and usage of CQMMS. What's more, organization of the material proposals recommended by the examination will be imparted to the development industry to all

the more adequately help development organizations to execute CQMMS, and conquer the obstructions experienced by organizations, in this manner advancing the accomplishment of higher levels of value and consumer loyalty.

**Index Terms-** Real-time, Monitoring, ICT, Construction, Supervision, Quality.

## I. INTRODUCTION

The introduction of an Information and Communication Technology (ICT) based Construction Quality Management and Monitoring System (CQMMS) in the development business will ensure the nature of the development work, give opportune supervision and evaluate the advance of the venture work with straightforwardness, effectiveness and responsibility. This activity of ICT base CQMMS is considered as advancement in Bangladesh. Bangladesh is a little nation in the south-east Asia, as far as land estimate it is 98th nation however regarding populace it is 8 biggest nations on the planet. Likewise positions among the best few as far as running number of benefactor subsidized foundation ventures. Over 3.5 million workers make this industry as the 3<sup>rd</sup> largest in Bangladesh.

## II. METHODOLOGY

The general examination will utilize a blended strategies approach, (both quantitative and subjective information gathering and investigation), to encourage the achievement of the expressed paper targets. This approach incorporates the utilization of a quantitative overview, subjective top to bottom meetings and contextual analyses to gather the required information. At long last, a concentration gathering will be used to guarantee the legitimacy of the system that is at last created from this paper. These different information accumulation stages and approaches are portrayed underneath.

### A. In-Depth Interview

Meetings will at first be utilized to gather the required information identified with outer components and KSFs for CQMMS selection in the development business. The choice of the meeting philosophy is influenced by the idea of the destinations and the examination questions. Along these lines, this examination will utilize semi-organized, up close and personal, top to bottom meetings to acquire particular and

centered information of the exploration marvels. The meeting calendar will incorporate open-finished inquiries to furnish respondents with the flexibility to talk about and express their points of view and empower the scientist to acquire criticism from interviewees. The inquiries will be planned to characterize the outside elements influencing effective appropriation of CQMMS in the development division. Next, inquiries will be developed to recognize extensive rundown of KSFs for CQMMS execution, since KSFs distinguished from the writing audit won't not be sufficiently comprehensive to be explored later, utilizing the poll study.

The assessed time of each meeting is around 60 minutes, which ought to give people satisfactory time to express their conclusions about particular issues. All respondents will be made a request to give their consent to record the meetings, with the scientist at the same time recording their answers by note-taking, which may be utilized later if any issues happen in recorded meetings. The meetings will be attempted with a similar populace which will be later utilized as the objective pilot test for the poll overview. Besides, the outcomes got from breaking down the information of meetings will be utilized to plan a poll overview.

#### **B. Poll Survey**

An overview will be utilized to evaluate the elements influencing the successful usage of CQMMS in the development business. Utilizing this strategy will encourage noting the initial three inquiries of the paper; RQ1, RQ2, RQ3. The essential explanation behind using this philosophy is to help the analyst to research hindrances to the powerful usage of CQMMS in the development section by achieving an extensive variety of members inside Bangladesh development organizations.

The overview philosophy will likewise be utilized to investigate the KSFs for actualizing CQMMS adequately in the development business. At long last, the survey will likewise help to explore the outer components affecting the reception of CQMMS inside the section. The survey will be developed to gather information development organizations; the poll populace will include all levels to accumulate a more all-encompassing learning with respect to CQMMS execution in various sizes and levels of multifaceted nature of associations.

The determination of organizations to take an interest in the fundamental poll will be embraced on the premise of their official number of workers. The foreseen test focused to take part in this examination contains roughly 250 Bangladesh development contractual workers, with a few members inside each organization being relied upon to take part in the poll review. These members will be illustrative of various administrative levels, for example, venture chief, development director, quality supervisor and site administrator, to acquire an exhaustive outline of variables influencing CQMMS execution.

#### **C. Personal and friends Demographics**

This section is created to gather individual and foundation data about members, for example, age, level of capabilities, years of experience, position inside their organization, and part inside their organization. This section will likewise include a few inquiries with respect to the principle elements of the partaking

organization, including the measure of the firm, organization income, organization section, and kind of works led.

#### **D. Barrier to CQMMS Implementation**

This section comprises of things investigating the real obstructions blocking effective usage of CQMMS in the development business. The things in this section will be founded on the hindrances already distinguished in the writing survey. The reactions to questions are chosen from a five-point Likert scale. As indicated by this is the most well-known scale for getting sentiments from respondents by deciding their assertion or conflict with an announcement. The respondents will be solicited to show their levels from understanding or difference in regards to the deterrents to fruitful execution of CQMMS by choosing one of five articulations, running from unequivocally consents to emphatically oppose this idea.

#### **E. KSFs for CQMMS Implementation**

This section incorporates the overview questions identified with exploring the KSFs for the effective reception of CQMMS. The things will be founded on the KSFs recognized from the writing audit, and the KSFs coming about because of breaking down the information from interviews led preceding the poll review. A five-point Likert scale will likewise be utilized to build the inquiries in this section.

#### **F. External Factors Affecting CQMMS Implementation**

The last section of the poll overview is intended to investigate the outside elements influencing effective selection of CQMMS in the development business. The motivation behind this section is to stress the effect of ecological elements characterized already amid the meetings. In the wake of posting and gathering outer components distinguished by the meetings, the inquiries of this section will likewise be built utilizing a five-point Likert scale. The normal results of the review will distinguish, the deterrents hindering the powerful execution of CQMMS in the development business, the KSFs for fruitful usage of CQMMS and, at long last, the ecological elements impacting compelling work of CQMMS in the development division.

### **III. ARGUMENTS**

ICT and its auspicious, successful and proficient Communication organizing do offer the best of the two worlds in terms of powerful and opportune correspondence network among significant partners and utilization of Hi Tech in ICT, and besides, features of bury correspondence systems and intra firm interchanges are upgraded to best, ideal degree. Notwithstanding, in the Bangladeshi Construction Business, CQMMS is surely testing and hazard loaded since , on a very basic level, there is absence of strong innovation requirement, howdy tech preparing and organization of best in class is reliant on outer experts, and restrictive expenses of ICT do go about as significant snag in minimal effort Bangladeshi Construction business [2].

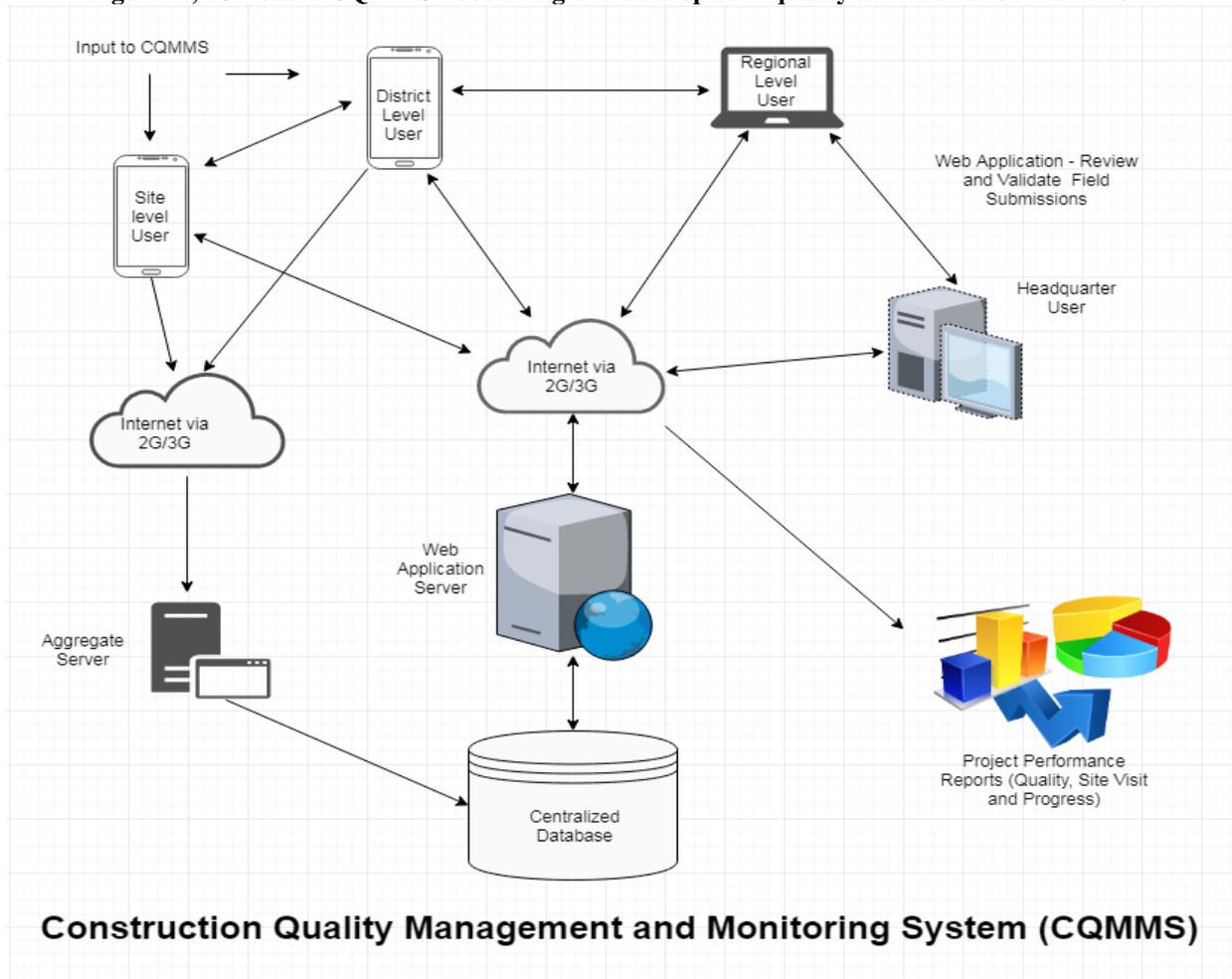
This paper needs to offer fitting Case Study investigation of some of real Bangladeshi Construction organizations which have accomplished outcomes because of ICT innovation authorization

and furthermore dive into fizzled ventures which needed required ICT bolster and due ingenuity [3]. Despite the fact that administration is altogether endeavoring to limit bungle and set up straightforwardness.

It is basic for a Mega Construction Projects spanning over different scattered geographic areas to be furnished with advanced observing and supervision framework for development quality administration framework (CQMMS) that use present day

ICT. The coveted ICT based CQMMS devices will be comprises of an android based versatile application, concentrated database server, web application and a revealing stage that helps to screen and administer development works guaranteeing most elevated quality (development) is achieved in the remote, topographically scattered areas of Bangladesh where assets are rare and physical access is trying because of poor street availability.

**Figure: 1, ICT based CQMMS - observing and development quality administration framework**



**Construction Quality Management and Monitoring System (CQMMS)**

To encourage the coveted quality and venture objectives, site or field level data is gathered through an android portable application called ICT Monitoring Tool. The base components of the apparatus have been gotten from redoing an open source arrangement, Open Data Kit. This portable application fills in as contribution to the ICT Monitoring frameworks were confirmation and information legitimacy are guaranteed through login and secret key. Likewise information submitted through the versatile application gives client data, telephone number, International Mobile Equipment Identification (IMEI) number [], date - time and GPS codes. The following figure portrays the framework engineering of the ICT Monitoring for Construction Quality Management and Monitoring System.

This portable application enables confirmed clients to submit review structures to report the advance of the development works [4]. These structures are created particularly

for huge scale development venture with frequent discussion with the undertaking partner/engineers from financing organization, execution office, counseling, checking/assessment and contracting organizations. Here is a rundown factor that altogether impacted the plan of the Survey/Supervision frames.

**A. Development Specifications and the offering reports**

Field understanding of the designers from different controls of the framework – (Owner, Consultants and Contractors)

- Knowledge of the cell phone innovation – (wifi, gps, 2/3/4 G systems, touch screens)
- Experience of the PDA use among the clients
- Network scope and web association speed in the remote undertaking destinations;
- Feedback of the pilot clients;
- English perusing and composing abilities of the clients;

• Limit elucidating writing inputs  
 The client of the frameworks can be any individual who is included and affected by the development beginning from the proprietor/benefactor, usage organizations, specialists, contractual workers and affected group. However essential supporters of the framework are proprietor, advisor, and contractual workers [5]. With a specific end goal to encourage

the smooth operation of the framework the clients are separated in the accompanying classifications as site level clients, area/local level clients, and headquarter level clients. The accompanying table separates the clients with parts for the ICT Monitoring and Construction Management System.

**Figure: 2, Roles of the team members in the ICT based CQMMS**

ID	User Designations	Roles	Submission Frequency	Role Description
1	Site Supervisor / Field Supervisor	FLU	Daily/Weekly	Responsible for close supervision, checking and revealing information from destinations on the day by day exercises. Directions exercises for Lab Technician cum estimator and Field Resident Engineers. Assesses and reports quality confirmation works - Lab Test exercises, test comes about, guarantee quality and amount of the development materials.
3	Field Resident Engineer	DLU	Fortnightly	Provided direction, supervision and preparing for the field level staffs. Directions exercises with contractual workers and execution organizations. Gives joint estimations temporary worker and usage offices.
4	Regional Resident Engineer	RLU	Monthly	Performs authoritative exercises for the district, helps field inhabitant engineers. Guarantee quality developments by giving preparing and incessant site visits.
5	Headquarter Engineer	HLU	Quarterly	Provides shop illustrations joining configuration changes, conducts preparing for the field level staffs and field inhabitant engineers. Audits the work presented by the site manager, lab specialists and estimators and field engineers.
6	Social/Environmental Assessment	HLU	Quarterly	Provides preparing and supervision for the field level staffs. Guarantees the social and ecological issues are tended to and alleviated by the characterized structure and moderation design, change the arrangement - look for endorsement if necessary.
7	Deputy Team Lead - Headquarter	HLU	Quarterly	Assists Team Leader with his everyday exercises, issues directions to the locales. Directions meeting with the temporary workers merchants. Approves and support the bills put together by the contractual workers. Behaviors starting execution survey for the staffs of the headquarter and district. Behaviors occasional site visits.
8	Team Lead - Headquarter	HLU	Quarterly	Provides administration as the Engineer for the task, rent with outer elements (contributors, temporary workers, sellers and other outsiders), sets up best practice, and rouses colleagues. Behaviors site visits to guarantee most elevated nature of development accomplished

**B. Accompanying practical Classification**

To outline the parts of the clients, these structures are separated into the accompanying practical classifications, for example,

1. Budgetary/Physical Progress;
2. Operational;
3. Quality Assurance/Quality Control;
4. Social and Environmental Assessment

**C. Accompanying consecutive work stages**

Further to the previously mentioned useful classes these review frames are separated into the accompanying consecutive work stages to precisely mirror the work quality and advance, following figure demonstrates the previously mentioned shapes – functionalities, frequencies and the reason for the structures created for the Large Scale Construction Project.

**Figure: 3, Checklists embedded in the CQMMS to facilitate superior quality construction**

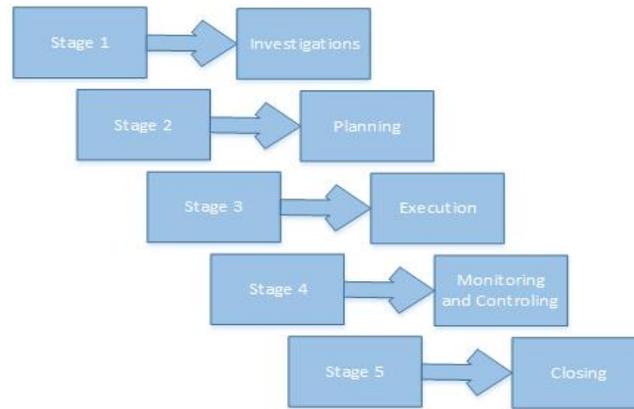
Form ID	Form Names	Functional	Frequency	Purpose of the Forms
F001	Handover Certificate	Operational	Once or Twice	Anyone can hand over the Site to the contractor
F002	Initial Works	Operational	Until the site is ready for Piling	To report the ongoing site preparation work
F003	Piling Works	Quality	Until Piling is complete	During the progress of the piling work
F004	Pile Load and Integrity Test	Quality	Until the Testing is complete	Report Pile Load and Integrity Tests
F005	Concrete Works	Quality	Until Concreting Works	Report Concrete Works for Sub / Super Structure
F006	Brick and Plaster Works	Quality	During Brick and Plaster Works	Report Brick and Plaster Works by Floors
F007	Electrical and Solar Works	Quality	During Electrical & Solar Works	Report Electrical and Solar Works
F008	Plumbing and Sanitary Works	Quality	During Plumbing & Sanitary Works	Report Plumbing and Sanitary Works
F009	Finishing Works	Quality	During Finishing Works	Report Tiling, Painting, Doors-windows, Tube well, Landscaping and etc. Works
F010	Roads Culvert and Palisading Works	Quality	Roads, Culvert & Palisading Works	Report Roads, Culverts and Palisading Works
F011	Furniture Works	Quality	Furniture Works	Report Furniture Works
F019	Daily Work Log	Operational	Daily Work Log	Report Daily Works Reported in the Site Order Book and MB Book
F020	Completion Certificate	Operational	Once or Twice	When the Site is ready for takeover from the Contractor
F021	Financial Progress	Financial	Monthly as needed	Report the amount billed by the contractor
F022	Lab Tests	Quality	As Needed	Report All the tests performed for the project
F023	Visit Resource	Operational	As new materials are delivered	Site Visit Report and Resource Inventory
F024	Physical Progress	Financial	Monthly as needed	FRE / UE Sends the report with the Physical Progress at the end of the month
F025	Social Survey	Social	As Needed	Report Focus Group Discussions for Social Issues
F026	Environmental Survey	Environmental	As Needed	Report Field Group Discussions for Environmental Issues
F027	Sub_Soil_Investigation	Social	As Needed	Report Sub Soil Investigation Works

The field level information is sustained to the brought together database to run the web application where the specialists from headquarter evaluate the information (webpage data, work data, remarks, photographs, GPS and date-time-stamp), give criticism to the territorial/website level assets to enhance quality, guarantee wellbeing, address website issues/abnormalities and perceive the benevolent acts [6]. The remarks and input from the architects; area and locale are put away in the database server by means of web application. This web application functions as a stage that gives work check component where a bit of development work is put together by website supervisor, through pertinent work review shapes.

**D. Quality Management in Construction**

Working under the banner “Quality and Safety First”, the CQMMS places top priority to Quality Management throughout all its stages, processes and outputs, with the aim of offering a set of best quality construction structures to the beneficiaries. The system will also ensure successful project completion within the agreed time and cost, and increased stakeholder satisfaction. CQMMS identifies and governs four main processes in its Quality Management practice. The first of these is Quality Planning, followed by Quality Assurance, Quality Control and Quality Acceptance. Quality Management is one component of the overall Project Management Process of MDSP, which has the following Stages:

**Figure: 4, Checklists embedded in the CQMMS to facilitate superior quality construction works**



Quality Management Approach adopted in CQMMS

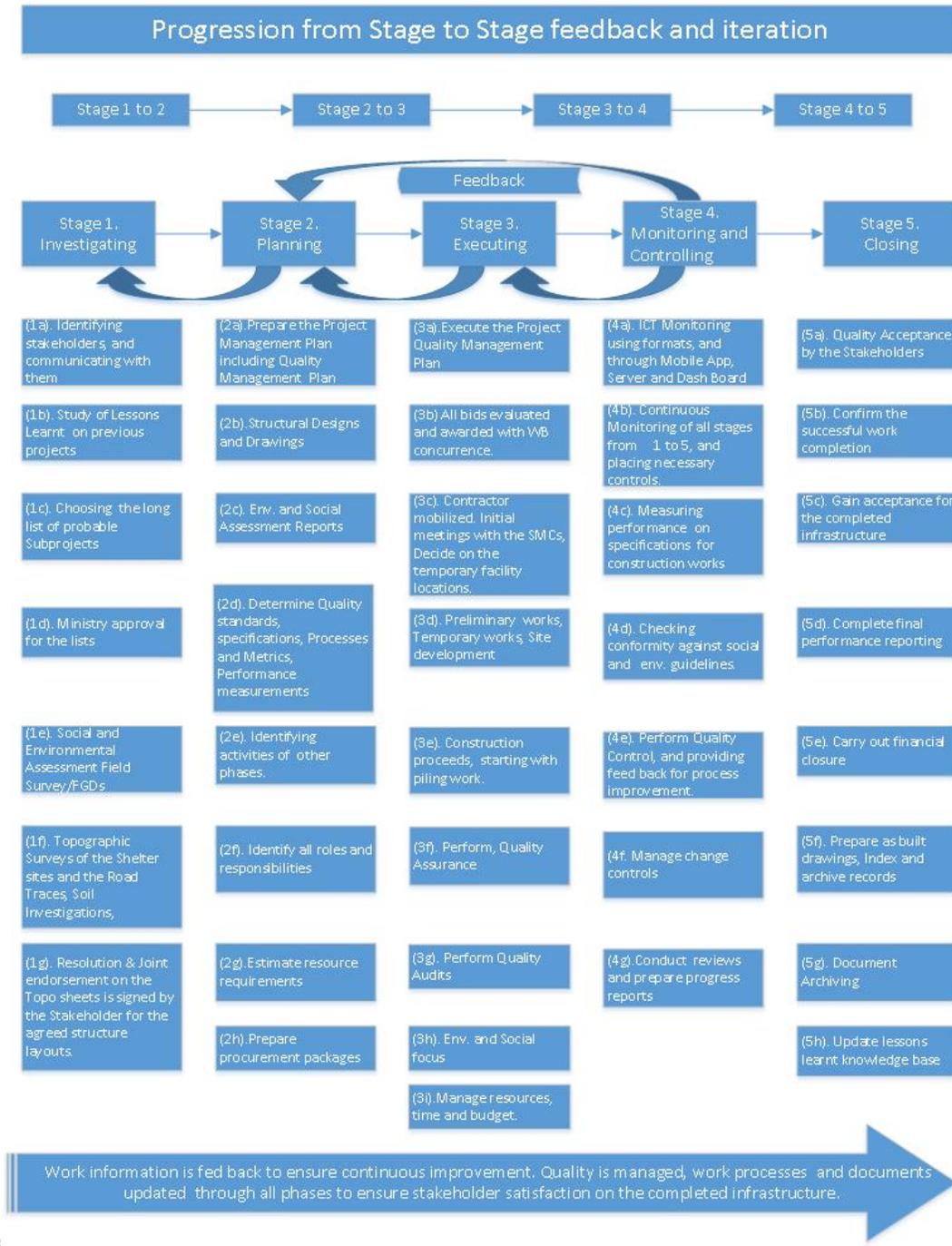
4. Quality Acceptance	Closing
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The above 5 stages are used to interpret the progress of any individual sub project, any single package or else the overall MDSP as a whole, and the four components of Quality Management in MDSP mainly fall into different stages of the Project Management Process as follows: According to PMBOK Guide following mapping

The Quality Management	Relevant Stage of Project Management Process
1. Quality Planning	Investigating/Planning
2. Quality Assurance	Executing
3. Quality Control	Monitoring and Controlling

The diagrammatic representation in the following page demonstrate the relationship between the Quality Management components (several other functions closely related to them) and the general Project Management Process Stages as prescribed by PMI. While many activities function within each stage of the Project Management Process, only some of those directly related to the Quality function are shown under each Stage in the diagram.

**Figure: 5, Checklists embedded in the CQMMS to facilitate superior quality construction**

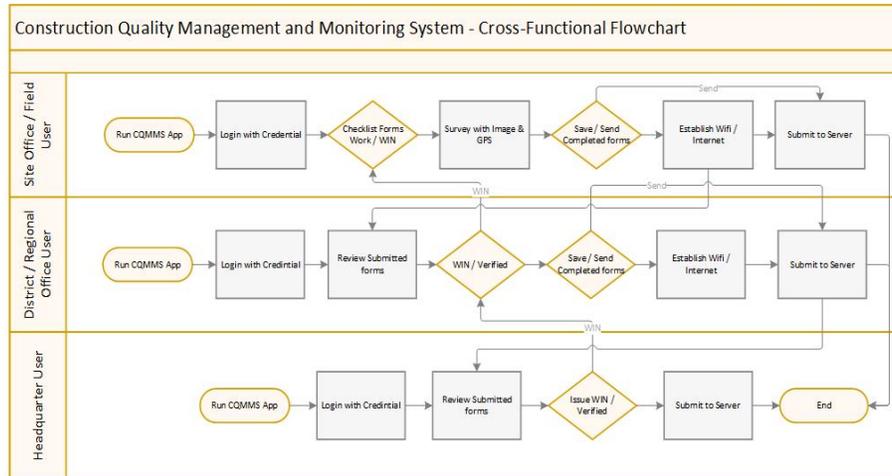


**works**

The submitted frames are in a split second looked into and commented by field and provincial architects. On the off chance that the concurred development quality is met the entries are checked and remarked by headquarter engineers are recorded and put something aside for future evaluating [7]. This multitier

check steps guarantees straightforwardness and responsibility among the key partner and specialist’s dynamic investment to guarantee the quality development. The previously mentioned process is delineated in the figure underneath.

**Figure 6; Collaboration among the cross functional team flowchart introduced in CQMMS**



Later the information from the database server is shown in the detailing stage to infer the different predefined reports that cause us to track the task execution.

- Site Visit Summary Report – by Project and Personnel
- Package Progress Report - by Physical and Financial
- Quality Control Report – Number of tests directed and dissentions
- Work Improvements – by locales and work stages

Keeping in mind the end goal to figure the physical advance of the development for a site, following table is created. This table information is started from singular Bill of Quantities (BoQ). Additionally, each pertinent ICT frame relate to the mapped rate advance. In this way, we can rapidly decide the collected advance of a task in light of the structures submitted for the venture. Normal development of the building is generally stay indistinguishable where just shifting parts are profundity of heaping length, earth work to level the building up to ground level (EGL) [8].

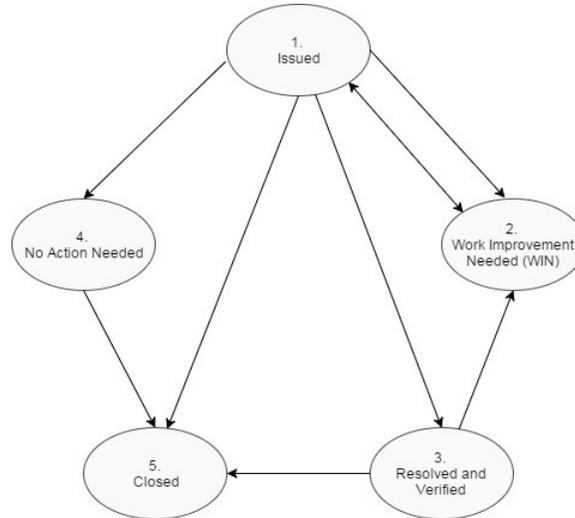
**Figure: 7, Breakdown of the progress based on completed work phases / tasks**

#	Major Work Items for the construction	Corresponding CQMMS Forms	Work %	Accumulated %
1	Site facilities, including labor shed, Site Office etc	Initial Works	2%	2%
2	Layout & Setting Out	Initial Works	0%	2%
3	Piling - Pile boring - casting	Piling Works and Concrete Works	22%	24%
4	Pile Integrity Test	Pile Load and Integrity Test	1%	25%
5	Pile Load Test	Pile Load and Integrity Test	0%	25%
6	Pile Cap - Excavation and Concreting works	Piling Works and Concrete Works	4%	29%
7	Grading Beam, Bracing Beam & Short Column	Concrete Works	3%	33%
8	Ramp, GF Mat, Drop wall and others	Concrete Works	8%	40%
9	Ground Floor roof Slab	Concrete Works	5%	45%
10	Pedestrain & Ground floor column	Concrete Works	3%	48%
11	Ground Stairs	Concrete Works	0%	49%
12	All Top floor column	Concrete Works	2%	51%
13	All Top floor Roof Beams	Concrete Works	3%	54%
14	Top roof slab	Concrete Works	7%	61%
15	Top stair	Concrete Works	1%	62%
16	Top drop wall parapet sunshade	Concrete Works	5%	67%
17	Ground Floor Brickwork	Brick and Plaster Works	1%	68%
18	1st & 2nd Floor Brickwork	Brick and Plaster Works	2%	69%
19	Plumbing and Sanitary Works	Plumbing and Sanitary Works	6%	75%
20	Electrical and Solar Works	Electrical and Solar Works	7%	82%
21	Collapsible Gates, Doors, Windows, Glass, Grills and Stair Railings	Finishing Works	4%	86%
22	1st and 2nd Floor Plastering Completed	Brick and Plaster Works	3%	89%
23	Tiles - All floors Completed	Finishing Works	2%	91%
24	Paints - Interior and Exterior Completed	Finishing Works	1%	92%
25	Furniture Completed	Furniture Works	2%	94%
26	Tube well Work Completed	Finishing Works	4%	98%
27	Social and Environmental Facilities	Social Survey, Environmental Survey	2%	100%

Information submitted through the ICT Monitoring App keeps up unmistakable phases of the works. Here are the stages – Issued, Work Improvement Needed (WIN), Resolved and

Verified, Closed or No Action Needed. It would be ideal if you see beneath pictorial portrayal of the stages.

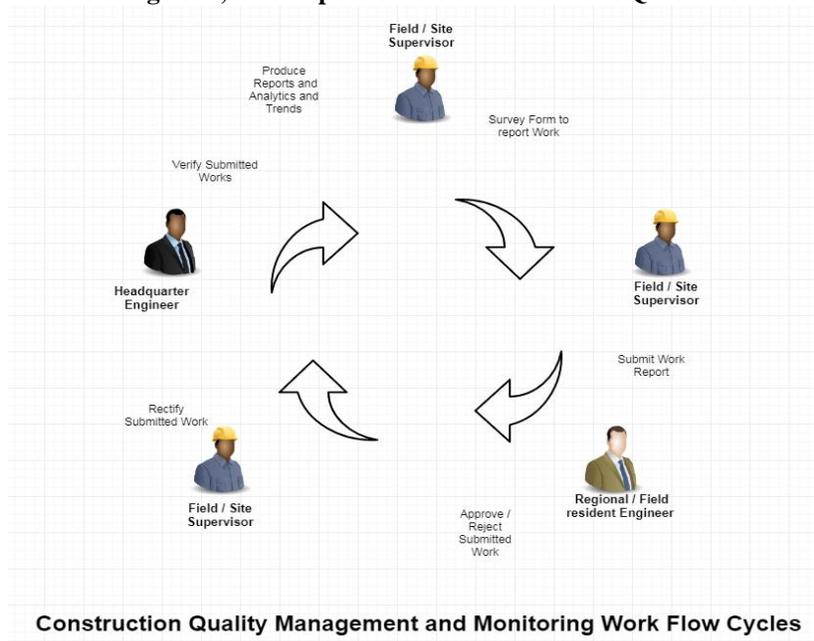
**Figure: 8, Life cycle of the submitted works in CQMMS to ensure quality and accountability**



Starting from Issued when the Site Supervisor rounds out the overview shapes catching the photos, recordings, GPS arranges and fitting data [9]. Work Improvement Needed (WIN): Work change see is issued when the locale, territorial or headquarter colleagues audits the work study put together by the site chief from the field and recognizes that the work quality should be enhanced or extra data is required. Site level colleagues will audit the WIN recognized by District, Regional or Headquarter level clients and take after the directions and play out the enhancements or errands. Refresh the status to Resolved and Verified. Surveys the notes, related pictures and

investigations the accommodation by the site manager, once fulfilled they can close the ticket or sends back to the field level staff to enhance the work promote for the second round. The will sit tight for the site/field level staffs to make fitting changes until the point when they are happy with the work quality. Once the work quality is accomplished, remarked and guaranteed by anybody from area, locale or headquarter it is respected that the work is occurrence is finished. This alternative is acquainted with track the portion of the non-noteworthy things as these could critical to keep it in the radar.

**Figure:9, Role dependent work flow of the CQMMS**



**Construction Quality Management and Monitoring Work Flow Cycles**

In the framework while presenting the structures utilizing ICT Monitoring Mobile Application, geographic spatial information is consequently caught for 5 m or less; more often than not the frameworks acknowledges the perusing if the precision is around 50 m. That implies the site manager or the field specialist ought to be with the 50 m range of the site while rounding out the study frames. Once spared the GPS arranges in a finished and spared review form, the Longitude and Latitude values are not editable [10].

The portable checking application of the CQMMS in view of ICT doesn't require online availability to work the versatile application, for the most part to gain information with GPS facilitates, pictures apropos information. Point to take note of the GPS framework does not require web or versatile availability to catch the GPS code. However the AGPS chipset (Assisted GPS) empowered telephones couple with the cell phone network catches GPS code quickly as it speed up the catch procedure [1]. Therefore one can finish the study at a remote area where web association is not accessible. Once the frame is spared with GPS code, information and photograph prove are gathered in the versatile application is sent to the brought together database through web association (for the most part 3G and 2G information bundles).

**E. Use of Mobile Phone Technology:**

Literature review conducted for the thesis work indicate that there are various systems already in place in the developed countries such as building information management systems (BIM), not only these systems are extremely expensive, difficult to learn and requires dedicated connectivity and power to run the hardware machines such as computers, monitors, routers and networks. [12].

In this study introduced a Mobile phone application that is secure. The mobile phone does not require dedicated power at the site to operate. With the vision 2020 goal, Bangladesh has over 99% mobile phone and internet coverage through 2/3 G network. Total number of subscriber count for the mobile internet usage have increased to 63 million plus by February

2017, according to the recent update by Bangladesh. [14]. Telecommunication Review Commission (BTRC). This has become a tipping point to develop the system with mobile phone technology.

**F. GPS Technology**

Since the introduction of the mobile smart phones from early nineties the technology has evolved many folds, [13] with the blessing of globalization many local brands are manufacturing smart mobile phones and price of these smart mobile phones have significantly dropped. Technology has miniature everything in this device starting from mobile phones, power of a computer - word processing, calculator, e-mail, internet browsing, global positioning systems (GPS), accelerometer, gyroscope, radar, various sensors, finger print and retina scanner.

**G. Touch Screen and Power Independence**

The touch screen interface has made the smart mobile phone very easy to operate. Hence launching of an mobile application to use / operate an important task like construction quality management and monitoring become seamless to the modern user-base. [13]

These smart mobile phones are as powerful as a personal computer and do not need live electricity connection to operate. And all the tasks that have been performed with PC can be performed with this device without the overhead pc being bulky, occupies valuable space, ect.

**H. Construction Best Practices and Quality Management Systems**

There are three main parties involved in general construction works; usually owner desires a building structure to be constructed, consulting firms with architects and engineers are appointed to design the building structure to the desired specification of the customer and then contractors are awarded to complete the work to deliver the vision of the owner or the customer ensuring the quality of the work. Usually for a large scale project there could be other players involved such as Donors, Implementation Agencies, Monitoring and

Evaluation Teams and Sub-contractors. Below is the hierarchical structure how a construction project work is executed, ultimately engineer of the consultant responsible for the successful completion of the construction work.

1. Headquarter Engineers;
2. Regional Engineers;
3. Site Supervisors;

Team members at the site level reports to regional Engineers. And engineers at region reports to the engineers at headquarter and ultimately all engineers in headquarter report the team leader of the project or the project manager of the consultant side. Team Leader delegates some of his tasks / signing authority to the engineers in the regions and fields.

Individual team members from each of the teams (consultants, contractors and owner/implementation agencies) have been consulted to design the features of Construction Quality Management and Monitoring System. Based on their inputs supervision tasks / activities are broken down for the buildings or any construction works in the following sequential manner.

1. Site Development Works
2. Sub-Structure Works
3. Super Structure Works
4. Finishing Works.

In order to ensure quality, detail checklists are created for each phases of the construction work with close consultation of the Engineers from Consultant, Contractor and Implementation firms. Detail of the check list of the above mentioned work phases are provided in the appendix section.

#### ***I. Integrated Workflow***

These checklists are in the brain of the Construction Quality Management and Monitoring System, mobile application. Site engineers are given smart phones with the CQMMS mobile application installed. Site Supervisor / Engineers will visit construction sites and report the quality of the work performed with photo evidence, through the CQMMS, mobile app by selecting the appropriate work stage. A

notification will be sent to the corresponding hierarchy (field resident engineer) to assess the work and further comment on the quality of the reported work based on the submission. If the FRE is NOT satisfied with the work; an work improvement notice (WIN) will be issued and site supervisor should followup the WIN work until FRE is satisfied with the work. Otherwise the submitted work is noted as approved and verified. A small number of work submissions are reviewed by headquarter engineers to ensure proper quality management process are adhered by site supervisor and field resident engineers.

#### ***J. Application Security / Authentication and Fraud proofing mechanism***

The CQMMS has to be fraud proof and secure. Latest web security technology is introduced in the CQMMS to make it impenetrable to hackers and crackers alike. The data collected from the field are secure and tamper proof. SQL injection, Cross site scripting, website redirection are prevented through structure coding and utilization of the Model View Controller (MVC) framework.

Two factor authentication mechanism is introduced in the CQMMS, mobile application - to ensure authenticity of the submissions by the field supervisor and field resident engineers. A pin code is generated after successful logins. This approach of layered security is widely practiced to ensure highest level of security in the commercial business applications. [16]

#### ***K. Innovative work flow mechanism***

Further to aforementioned security features while submitting data through the survey forms team members are required to take selfies showing the work-site in the background, fill-out appropriate check list for the completed works items with photo evidence and GPS location code.[15] This process ensures that the team members have visited work site, performed the tasks according to specified requirements (as per check list), schedule and date - times of the submission matches with the data - meta data of the photo evidence submitted. This is process significantly enhances accuracy and quality of the work as site level team members are bound to report irregularity [11].

**Figure: 10, Work component submission by FRE with data and timestamp with GPS Code**



#### ***L. Education, Training and Further Career Advancement***

This CQMMS is working as a vehicle to improve the quality of the construction personnel in Bangladesh. The survey form checklists in the CQMMS mobile app is the results of the many years of field and construction experience of the project team members - consultants, contractors and owners accumulated. Through the checklist the field supervisors are guided to execute work like a pro with many years of experience. In the eyes of the contractor and subcontractor this junior engineers are regarded very highly because of the intelligence of the CQMMS tool. This recognition works as a motivating factor for the site supervisor to pursue higher education in the field of construction.

Regular use of the CQMMS to submit work enhances the ability of the team members to read and write in English. The practice of English prepares the workforce to elevate their standard to international level.

CQMMS provides the due transparency to the headquarter / management to appreciate work performed by the field level team members.

The CQMMS helps to identify and address any substandard work performed by the contractor. Therefore it works as a voice of the engineers to as not only field engineer but regional and headquarter engineers stand by the field engineer to improve the quality of the work performed by the contractor.

#### ***M. Effective and Optimized Utilization of Resources***

This tool allows will engineers to be assigned effectively and efficiently based on the work schedule hence reducing the cost of the construction operation.

This CQMMS tool is essentially extends the eyes and ears of the team leader and project director, headquarter engineer that enhances the quality of the construction quality of the work.

Thorough the implementation of the CQMMS tools - project work is executed in the systematic manner. This tool allows effective allocation of the resources based on the nature of the work.

Although this tool only concentrate on the items quality of the construction work which accounts for almost 22% for overall project success but almost 50% for the internal influencing factors that are with in the control of the project implementation team.

This tool helps headquarter to closely monitor the supervision work conducted by the team members responsible for regular site visits.

Availability, quality and quantity of the construction materials, machinery and manpower (resources) are at the site during the applicable construction work phases.

Dashboard Submissions Gallery Reports Operations  
Settings Logout

### Set Project Stage for BHP06 [<< Back to index](#)

<input type="checkbox"/> Handover	<input type="checkbox"/> Initial Work	<input type="checkbox"/> Sub-Structure - Piling
<input type="checkbox"/> Pile Load & Integrity Test	<input type="checkbox"/> Sub-Structure - Pilecap, Grade Beam & Short Column	<input type="checkbox"/> Super-Structure - Column, Staircase & Ramp
<input type="checkbox"/> Super-Structure - Groud Floor Beams & Roof Slab	<input type="checkbox"/> Super-Structure - First Floor Short Column & Staircase	<input type="checkbox"/> Super-Structure - First Floor Roof, Beams and Slab
<input type="checkbox"/> Super-Structure - Second Floor Short Column & Staircase	<input type="checkbox"/> Super-Structure - Second Floor Roof, Beams, Slab, Watertank	<input type="checkbox"/> Super-Structure - Other Concrete Works
<input type="checkbox"/> Super-Structure - Ground Floor Slab on grade	<input type="checkbox"/> Brick Works	<input type="checkbox"/> Electrical Works - Cabling
<input type="checkbox"/> Plumbing Works - Piping	<input type="checkbox"/> Tiles & Patent Stones Works	<input type="checkbox"/> Doors, Grills, Windows, MS Gate, Collapsible Gate, & Railings
<input type="checkbox"/> Plastering Works	<input type="checkbox"/> Plumbing Fittings	<input type="checkbox"/> Painting Works, Interior & Exterior
<input type="checkbox"/> Electrical Fittings	<input type="checkbox"/> Environmental Impact Assessment	<input type="checkbox"/> Solar Panel Works
<input type="checkbox"/> Social Impact Assessment	<input type="checkbox"/> Resource - manpower, materials & matchnaries	<input type="checkbox"/> Quality Control - Lab Test
<input type="checkbox"/> Visitors Log	<input type="checkbox"/> Culvert & Bridge Works	<input type="checkbox"/> Landscape Works
<input type="checkbox"/> Palisading/ Protection Works	<input type="checkbox"/> Site Completion Certificate	<input type="checkbox"/> Road Works
<input type="checkbox"/> Tubewell		<input type="checkbox"/> Furniture Works
		<input type="checkbox"/> Defect Log

## Manage Project Stages

Home / Operations / Manage Project Stages

### Set Project Access for Zia Hussain , ICT Monitoring Rep - Headquarter , D&SC [<< Back to index](#)

<input type="checkbox"/> NOAP96	<input type="checkbox"/> NOAP94	<input type="checkbox"/> NOAP85	<input type="checkbox"/> NOAP77	<input type="checkbox"/> NOAP47	<input type="checkbox"/> NOAP38
<input type="checkbox"/> NOAP376	<input type="checkbox"/> NOAP375	<input type="checkbox"/> NOAP374	<input type="checkbox"/> NOAP366	<input type="checkbox"/> NOAP364	<input type="checkbox"/> NOAP363
<input type="checkbox"/> NOAP349	<input type="checkbox"/> NOAP336	<input type="checkbox"/> NOAP304	<input type="checkbox"/> NOAP269	<input type="checkbox"/> NOAP237	<input type="checkbox"/> NOAP235
<input type="checkbox"/> NOAP229	<input type="checkbox"/> NOAP204	<input type="checkbox"/> NOAP203	<input type="checkbox"/> NOAP200	<input type="checkbox"/> NOAP199	<input type="checkbox"/> NOAP186
<input type="checkbox"/> NOAP176	<input type="checkbox"/> NOAP175	<input type="checkbox"/> NOAP154	<input type="checkbox"/> NOAP150	<input type="checkbox"/> NOAP137	<input type="checkbox"/> NOAP133
<input type="checkbox"/> NOAP132	<input type="checkbox"/> NOAP122	<input type="checkbox"/> NOAP119	<input type="checkbox"/> NOAP114	<input type="checkbox"/> NOAP100	<input type="checkbox"/> LAX89
<input type="checkbox"/> LAX34	<input type="checkbox"/> LAX337	<input type="checkbox"/> LAX336	<input type="checkbox"/> LAX335	<input type="checkbox"/> LAX334	<input type="checkbox"/> LAX333
<input type="checkbox"/> LAX331	<input type="checkbox"/> LAX330	<input type="checkbox"/> LAX316	<input type="checkbox"/> LAX310	<input type="checkbox"/> LAX301	<input type="checkbox"/> LAX300
<input type="checkbox"/> LAX294	<input type="checkbox"/> LAX284	<input type="checkbox"/> LAX279	<input type="checkbox"/> LAX275	<input type="checkbox"/> LAX268	<input type="checkbox"/> LAX261
<input type="checkbox"/> LAX259	<input type="checkbox"/> LAX258	<input type="checkbox"/> LAX257	<input type="checkbox"/> LAX252	<input type="checkbox"/> LAX24	<input type="checkbox"/> LAX23
<input type="checkbox"/> LAX163	<input type="checkbox"/> LAX156	<input type="checkbox"/> LAX144	<input type="checkbox"/> LAX141	<input type="checkbox"/> LAX134	<input type="checkbox"/> LAX125

<input type="checkbox"/> BP623	<input type="checkbox"/> BP621	<input type="checkbox"/> BP604	<input type="checkbox"/> BP581	<input type="checkbox"/> BP574	<input type="checkbox"/> BP549
<input type="checkbox"/> BP528	<input type="checkbox"/> BP517	<input type="checkbox"/> BP515	<input type="checkbox"/> BP504	<input type="checkbox"/> BP459	<input type="checkbox"/> BP431
<input type="checkbox"/> BP426	<input type="checkbox"/> BP423	<input type="checkbox"/> BP421	<input type="checkbox"/> BP405	<input type="checkbox"/> BP382	<input type="checkbox"/> BP381
<input type="checkbox"/> BP376	<input type="checkbox"/> BP365	<input type="checkbox"/> BP330	<input type="checkbox"/> BP313	<input type="checkbox"/> BP303	<input type="checkbox"/> BP299
<input type="checkbox"/> BP298	<input type="checkbox"/> BP296	<input type="checkbox"/> BP293	<input type="checkbox"/> BP290	<input type="checkbox"/> BP280	<input type="checkbox"/> BP264
<input type="checkbox"/> BP263	<input type="checkbox"/> BP260	<input type="checkbox"/> BP252	<input type="checkbox"/> BP246	<input type="checkbox"/> BP226	<input type="checkbox"/> BP220
<input type="checkbox"/> BP215	<input type="checkbox"/> BP213	<input type="checkbox"/> BP209	<input type="checkbox"/> BP206	<input type="checkbox"/> BP186	<input type="checkbox"/> BP174
<input type="checkbox"/> BP157	<input type="checkbox"/> BP152	<input type="checkbox"/> BP120	<input type="checkbox"/> BP113	<input type="checkbox"/> BHP77	<input type="checkbox"/> BHP76
<input type="checkbox"/> BHP75	<input type="checkbox"/> BHP45	<input type="checkbox"/> BHP438	<input type="checkbox"/> BHP433	<input type="checkbox"/> BHP43	<input type="checkbox"/> BHP425
<input type="checkbox"/> BHP420	<input type="checkbox"/> BHP42	<input type="checkbox"/> BHP413	<input type="checkbox"/> BHP408	<input type="checkbox"/> BHP407	<input type="checkbox"/> BHP404
<input type="checkbox"/> BHP403	<input type="checkbox"/> BHP397	<input type="checkbox"/> BHP394	<input type="checkbox"/> BHP379	<input type="checkbox"/> BHP377	<input type="checkbox"/> BHP373
<input type="checkbox"/> BHP369	<input type="checkbox"/> BHP359	<input type="checkbox"/> BHP344	<input type="checkbox"/> BHP341	<input type="checkbox"/> BHP328	<input type="checkbox"/> BHP317
<input type="checkbox"/> BHP313	<input type="checkbox"/> BHP308	<input type="checkbox"/> BHP302	<input type="checkbox"/> BHP288	<input type="checkbox"/> BHP279	<input type="checkbox"/> BHP27
<input type="checkbox"/> BHP263	<input type="checkbox"/> BHP24	<input type="checkbox"/> BHP227	<input type="checkbox"/> BHP212	<input type="checkbox"/> BHP207	<input type="checkbox"/> BHP177
<input type="checkbox"/> BHP173	<input type="checkbox"/> BHP134	<input type="checkbox"/> BHP123	<input type="checkbox"/> BHP06		

Set Project User Cancel

Complicated work component measurements can be reported, measured and verified through tri-party (contractor, consultant and owner) submission with photo evidence and tests results, hence making the bill approval mechanism a breeze at the headquarter.

#### N. Lesson learns

Computerization process is introduced utilizing triggers and put away techniques to abridge the information from Open data kit tables to the Web Applications tables in the database. Different reports are produced in light of the outlined and changed information. Difficulties of Software Development with any open source instruments are comparative and Open data kit is no special case to that. Likewise improvement of construction supervision and quality administration framework in light of an open source instrument is testing. Here are few lesson learnt.

- System created a great deal of unstructured and excess information set aside critical opportunity to correspond the information so keep the overview shape straightforward. Strict information approval could dissuade the beginner clients from receiving the framework
- Any change in the structures and work process requires huge adjust.
- Version contrariness with the incessant arrival of android telephone forms requires retrofitting work.
- Database structure in the open source arrangement is not effective outline in this way database size will develop exponentially so design the information development estimation deliberately.
- Get a reasonable information authentic/maintenance assertion – build up a system to occasionally information cleansing/recorded instrument.
- Open data kit has irritating screen invigorates and outline inside edges that can be agonizing with work with when you have loads of information.

- Dedicated arrangement, support and upkeep of Open data kit required consistent supervision with qualified assets.

#### IV. CONCLUSION AND RECOMMENDATIONS

In spite of being essentially a developing and creating economy in Asia, the development business in Bangladesh is well set and exceptionally development centered because of a few reasons, essential among which are: Abundant and shabby work, great infra structure, solid, development situated administration and its help for development organizations and furthermore great inflows of FDI in the Construction Industry in Bangladesh. Be that as it may, the principle issues besotting Bangladesh is not innovation, as such, but rather its use, sending and authorization, particularly utilization of high innovation for cutting edge, convenient, quality and enforceable CQMMS inside ICT, with the end goal that private business people, open private supplier organization firms and joint government extends in provincial Bangladesh are viably overseen, for better and snappier outcomes [1].

#### REFERENCES

- [1] Álvaro Rocha, .(2017) .M .Recent Advances in Information Systems and Technologies. London: Cengage learning.
- [2] Ariwa, E. (2011). Digital Enterprise and Information Systems: International ... - Page 206. London: John Wiley.
- [3] Ermolayev, V. (2013). Information and Communication Technologies in Education, Research. New York: Springer.
- [4] Forbes, L. (2010). Modern Construction: Lean Project Delivery and Integrated Practices. New York: Cengage learning .
- [5] James Sommerville, .(2006) .C .Implementing IT in Construction. London: Cengage learning .
- [6] Li, X. (2015). Software Engineering and Information Technology: Proceeding. New York: Cengage learning .
- [7] Maier, R. (2007). Knowledge Management Systems: Information and Communication. London: Springer .

- [8] Pertierra, R. (2017). *The Social Construction and Usage of Communication Technologies*. London: John Wiley.
- [9] Srinath Perera, .(2017) .I .*Advances in Construction ICT and E-Business*. london : cenage learning .
- [10] Van Slyke, C. (2008). *Information Communication Technologies: Concepts, Methodologies*. Sydney: Springer.
- [11] Albert P. C. Chan; David Scott; and Ada P. L. Chan (2004) *Factors Affecting the success of a Construction Project*, Hong Kong, J. Const. Eng. Manage. 2004. 130:153-155
- [12] Nguyen Duy Longa, Stephen Ogunlanab, Truong Quangc, Ka Chi Lama (2004), *Large construction projects in developing countries: a case study from Vietnam*, Hong Kong : Elsevier
- [13] Sze-wing Leung, Stephen Mak, Bill L.P. Lee, (2008), *Using a real-time integrated communication system to monitor the progress and quality of construction works*, Hong Kong : Elsevier
- [14] <http://www.btrc.gov.bd/content/internet-subscribers-bangladesh-february-2017>
- [15] Tao Cheng, Jochen Teizer (2013), *Real-time resource location data collection and visualization technology for construction safety and activity monitoring applications*, Atlanta: Elsevier
- [16] N. Harini and Dr. T.R Padmanabhan (2013), *2CAuth: A New Two Factor Authentication Scheme Using QR-Code*, International Journal of Engineering and Technology. Vol 5 No 2 Apr-May 2013. 1087: 1094

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