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EVALUATING THE EFFECTIVENESS OF VIEWPOINT SOFTWARE ON QUALITY ASSURANCE IN CONSTRUCTION

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Abstract

Some fairly recent high-profile safety-related failings have left a damaging mark on the construction industry's image. Two commonly referenced failings in the UK are the Oxfords Primary School masonry wall collapse in Edinburgh, and the Grenfell Tower fire. Both incidents were the results of systemic failures in delivering quality and safety on projects. The role of the Principal Contractor includes taking ownership and responsibility of delivering safe and high-quality projects. This necessitates the Principal contractor to implement safe methods of quality management that improves quality and safety culture. This paper evaluates the adoption of 'Viewpoint' - a construction technology package which is effective for quality assurance, with particular focus on 'Field View' and 'Viewpoint For Projects'. The study used existing projects as case study and engaged seven industry practitioners working for a UK based Principal Contractors through semi-structured interviews to evaluate the effectiveness of the adoption of Viewpoint for quality assurance. The findings demonstrate the benefits of the adoption of Viewpoint in terms of quality management, inspection check sheets and reporting non-conformance. Also, having a common data environment for sharing submissions and drawings significantly increased the quality of the Information Management and managing design for safety.

Keywords: Innovation, technology, research projects, etc.

1. GENERAL APPROACH

One of the most important issues facing the construction industry is related to poor quality in the buildings and the built infrastructure. Quality in construction have subjective interpretations by individuals [1], but fitness for purpose and conformance to specifications are generally used in the construction industry [2]. However, the perception of the Chartered Quality Institute (CQI) on quality means constantly pursuing excellence: making sure that what your organization does is fit for purpose, and not only stays that way, but keeps improving. The difficulty surrounding the issue of quality assurance in construction stems from the inability to have a unified or an exact definition of it [3]. That is why issues considered as below standard in construction are commonly labelled as defects, errors or non-conformance. Quality assurance has been a very topical subject in the construction industry with some recent events in the UK (The Grenfell Tower and Oxfords Primary School) highlighting the serious consequences of poor quality, resulting in reputational damage of the construction industry [3]. Quality installation failures in the cladding were found to be the primary cause of the rapid spread of flames at the Grenfell Tower [4], while the Oxford School wall collapse which resulted in the closure of other schools was linked to serious failures in procurement, design, and construction [5]. It is estimated that 6% to 15% of all construction costs are as a result of rework of defective components, and 5% of these costs are detected during maintenance [6]. The root cause of these errors is widespread and there are suggestions that 54% of these errors could be attributed to human factors e.g. poor workmanship or insufficient supervision [6].

Generally, quality management is conducted on site in the form of inspections, control, and assurance. Quality inspection is used during the construction timeline to identify errors which can be reported via a non-conformance or defect notice, while quality assurance is useful in eliminating the need for non-conformances and to allow for a smooth construction phase with any errors that are identified, swiftly resolved. Due to external pressures such as budget and sequencing of work or programme, quality assurance cannot always be guaranteed in the industry [1], and the lack of timely resolution could result in safety-related problems within the built environment. Creating a single 'synergistic' management system towards improving both safety and quality performance in construction could be the way forward [7], but this strategy can sometimes prove difficult to implement on site. Study shows that the nature of competitive bidding amongst contractors for construction projects (cutting safety and quality budgets to win the job) could have some impact on safety or quality management as the contractor strives towards

maintaining a healthy profit margin for the project [7]. This paper evaluates the efficiency of Viewpoint, a cloud-based construction technology and offline mobile solution used for snagging, SHEQ, non-conformance, to improve quality assurance in construction as opposed to the traditional pen and paper approach which is slow in terms of execution and decision making, prone to errors, and not timely.

2. BACKGROUND

Viewpoint is a collaborative project management solution that integrates team members during the lifecycle of projects regardless of role. 'Viewpoint for Projects' is a document management system that simplifies project documentation, while Viewpoint 'Field View' is used in the field for snagging, forms and permits, project delivery and handover; as an enabler of informed decision-making and enhanced project efficiency [8]. Viewpoint for projects is useful in enhancing the connection between the office and the field, by adding more value, increased transparency, reducing risk during design, construction, and handover. The document control feature allows for the sharing, controlling, and management of drawings, specifications and schedules, contracts, daily logs, and mission critical reports. Viewpoint for projects provides the tools and mobile capabilities to improve project profitability, visibility for clients, risk management, and allows for the effective collaboration of project teams in real-time throughout the entire project lifecycle [8].

From the contracts point of view, the Joint Contract Tribunal (JCT) which is an industry standard of contract that is traditionally used during the procurement phase allows for limited contractor design. With this type of contract, there is no standard for the contractor to provide specifications of quality, but the JCT outlines the contractor's requirement in providing a construction phase plan which outlines aspects of quality, although these plans do not guarantee a standard of detail that must be followed. Therefore, the JCT could potentially leave the employer in a scenario where they are not able to effectively configure a plan to manage and apply quality systems on site [9]. However, Clause 2.1 (in terms of quality) sets a standard of work to be expected by a skilled tradesperson or contractor and that all works must follow the supporting documents put in place by the contractor and designer. As opposed to the JCT, the New Engineering Contract (NEC) emphasizes the significance of quality and the contractor is required to implement site-specific Quality Management policy and plans. This plan allows the client to express their views in the process of establishing a standard for quality, and how quality issues should be achieved [10].

Quality management in construction encompasses the total management of quality and products, whilst ensuring the product is as per scope of works set out by the client and executed within budget and timeframe [11]. This includes ensuring quality control during construction, and compliance of the product in accordance with the material and workmanship outlined in the specification documents. It is suggested that 35% of people believe that poor management is the main reason for poor quality [11]. It is believed that devoting resources to preplanning, making available the requisite time to undertake tasks correctly the first time, engagement of leadership and involvement at the workplace, and encouraging and empowering workforce to take pride in their work are potential strategies that could promote both safety and quality concurrently [12, 13]. For quality management to be successful, inspections must be carried out by competent personnel with the right ability, skill, and knowledge of the product being inspected [14]. Competent Quality Managers should oversee quality management, and the quality department should work towards improving the standard of quality management, thereby improving the success of a company's projects. A Quality Manager should be responsible for overseeing the completion of quality audits, conducting and reviewing quality plans, and the training of on-site operatives [14, 15]. Therefore, promoting a positive quality culture, where workers and managers are encouraged to achieve high levels of quality assurance, and to remain motivated whilst addressing the challenges faced is fundamental to the successful application of quality control [3]. These could inherently improve overall site and project safety, health, and wellbeing of the workforce.

Quality culture is the pattern of habits, beliefs, and behaviour regarding quality [16], and these values, beliefs and hopes that are promoted and developed within members of an organisation in relation to their work leads to the delivery of high-quality products and services and improved total quality management [17]. The benefits of improved quality management which is reliant on efficient management of project delivery are associated to project profitability, improved company image, and safety which are some of the factors that the industry struggles with. Construction companies place significant emphasis on encouraging the self-reporting of safety issues and there is a general perception that the recording of non-conformances which is regarded as the failure to conform to specifications or requirements presents an image of poor quality and poor project management [18].

The adoption of the Inspection test plan (ITP) that details how the quality of a particular set of works is managed based on drawings and identifying a set of warranties, inspections, and specifications for ease of examination of the product is part of the overall project quality management system. An ITP could be considered as the job's quality assurance tool used to inspect all works that are undertaken to ensure compliance with the standards set out in the specification towards improving client-contractor relationships. Rumane (2017) suggests that inspections are an efficient and productive way to ensure all materials, systems, and workmanship applied on site are to the required standards. Although the sign off sheets are an efficient inspection method, they are however not adequate enough and it is ideal to accompany that with an Inspection Test plans throughout the process rather than at the end of the cycle [3]. With the use of ITPs and check sheets to manage quality, cases of onsite health and safety can be easily managed. Viewpoint allows for the digitized, consistent and automated quality processes (i.e. inspections and tests including associated drawings and specification sheets could be uploaded online) with the main contractor and client having real time update with the ability to evaluate performance, analyze trends, and access compliance [8]. The adoption of the ITPs throughout the build process rather than at completion allows for the defects/errors to be identified and rectified, resulting in lower costs and improved safety, quality, and duration of the construction project [12].

The cost of quality in construction is the value of incurred costs associated with the maintenance geared towards achieving high quality and client satisfaction. Existing study suggests that the benefits of better quality outweigh the costs, however, increased quality cannot be achieved without an increase in cost and the benefits to the company from increased quality will not necessarily compensate for the additional cost involved [19]. The cost of quality is considered to be much more than the cost of reworks, as it also translates to loss of customers, loss of market share, and other unforeseen costs [19]. The CIOB estimates that up to 2.5% - 5% of construction costs are associated with remedial works [3], and considering the tightly squeezed low profit margins of the construction industry of 1-3%, the costs of poor quality can have detrimental effect on the project's profit margins and the need to get it right the first time becomes invaluable [12]. Although it is almost impossible to get the full project right the first time, the most effective way to prepare for and counteract poor quality could be the adoption of Viewpoint towards improving the Total Quality Management (TQM) plan. This is important because quality in construction can often be viewed as time consuming and tedious (e.g. with under staffing), and this results in quality tasks being disregarded or rushed (lack of inspection) which results in poor workmanship [20]. The short durations that subcontractors have on specific projects and the lack of continuity [21] could potentially compromise the health and safety of the entire project if there are no structured approach in place to monitor quality. Therefore, the adoption of Viewpoint as a technology capable of improving the workers' efficiency [21] and making efficiency gains related to quality is considered significant in the construction industry [3, 22].

3. METHODS

This paper adopted the qualitative approach towards evaluating the effectiveness of Viewpoint for improving quality assurance [23]; whilst developing some level of understanding for the subject under consideration and to allow for more comprehensive response from the participants using semi-structured interviews [24, 25]. The involvement of participants reflecting on case studies was essential towards understanding the complexity of issues in a real-life scenario [26]. The participants' experiences were based on their direct involvement in case studies with a major UK principal contractor with established understanding into the effectiveness of Viewpoint for quality, quality assurance, snagging, and safety improvements. This builds on the detailed knowledge of the users and their organization's experiences in the adoption of the software across multiple projects. The profile of the participants involved in the semi-structured interviews (via MS Teams) include Senior Project Managers, Quality Managers, and Engineers involved in the regular use of the software across projects (Table 1). The participants were sent a description of the study, proposed interview plans, rationale for contacting them to participate in the study, privacy information, and a consent form regarding voluntary participation in line with approved ethical guidelines.

Table 1: Participant information

Participant	Role	Years with employer	Years of Experience
A	Quality Manager	2	22
B	Site Engineer	5	5
C	Senior Engineer/Mgr	3	20

D	Site Manager	5	5
E	Site Engineer	5	6
F	Senior Site Engineer	12	12
G	Head of Digital Construction	3	25+

The emerging themes from the semi-structured open-ended interviews were aligned to extant literature to develop a robust understanding of the effectiveness of Viewpoint as a software for improving quality assurance in construction. The interview questions focused on two aspects/features of Viewpoint – ‘Viewpoint for Projects’ and Viewpoint ‘Field View’ to reflect the participant’s own perceptions and experiences of using the software [27]. The Viewpoint for Projects is a cloud-based project collaboration tool deployed by contractors to communicate, control, manage, and share information with relevant parties such as the client, authorities, design teams, subcontractors, and the principal contractor. Field View is part of the organization’s aim to become fully digital whilst going paperless because it allows for the ease of information/data population and sharing of documents. As part of the organization’s quality management policy, Inspection Test Plan (ITP) are used to manage quality by highlighting the relevant specifications, drawings and contractual responsibilities in terms of tests, materials, and requirements of warranties of the product. Field View is used to develop the ITPs through the use of Inspection Check Sheets (ICS). The interviews were recorded on MS Teams with the live captioning feature enabled for the audio recordings. The live captioning allows for the automatic generation of transcripts when a meeting is recorded, and when the meeting language is set to English. Thematic analysis was used to explore the data by identifying themes relevant to the research topic and these themes were grouped into nodes with the array of nodes aggregated together to reflect the views of the participants [28]. The steps adopted in generating the themes involves patterns of shared meaning, underpinned by a central meaning-based concept that emphasizes a uniting idea on main contractor quality, quality assurance, health and safety, and snagging [29]. This concept is based on the six steps of data analysis proposed by [30] which includes familiarization of data by the researcher; generating codes; combining the codes into themes; reviewing the themes; determining the significance of the generated themes; and reporting the findings. This whole process involved a continuous questioning and querying of the assumptions made that are relevant in the interpretation and coding of the research data to generate creative and interpretive stories about the data based on the researcher’s thoughtful engagement with the interview transcripts and the analytical process [29].

4. FINDINGS AND DISCUSSIONS

4.1. Impact of Viewpoint on Main Contractor Quality

The participants’ responses on the impact of Viewpoint on quality issues from their perspective as main contractors focused on the adoption of the Field View and Viewpoint for Projects, see Table 2.

Table 2: Impact of Viewpoint on main contractors’ quality

Field View	Viewpoint For Projects
Quality Management	Common Data Environment
Inspection Check Sheets	Drawing control
Non-conformance Reports	

The participants believed the adoption of Viewpoint had a positive impact on quality indicating that the adoption of both Viewpoint for Projects and Field View were beneficial. However, the adoption of Viewpoint for Projects seemed to be most favoured as it is considered that the adoption of Field View offered marginal improvements on the quality of construction. The overall perception of the participants is that the impact of Viewpoint on quality is dependent on your site role and responsibilities. The benefit of adopting Viewpoint for Projects on quality in construction is evident on the available ‘common data environment’ useful for sharing submissions and drawings, thus improving communication and engagement amongst key duty holders resulting in significant increase in the quality of the Information Management and assessment of safety in design [31] in accordance with the UK Construction and Design Management (2015) Regulations. Due to the ease of real-time information sharing, there are consistency in the level of information being shared amongst the teams resulting in the management of quality issues, ease of communication with sub-contractors with any design changes, revisions or updates accessible to all parties involved. Therefore, the common data environment has positively

improved information sharing, quality of construction and safety of the construction projects and this could be a proactive approach geared towards managing construction safety [32].

However, the participants suggested that the adoption of Field View slightly improves quality when compared to Viewpoint for Projects. Although the integration of the quality check sheets within Field View is beneficial, it thus seems like a 'one size fits all' document, and integrating some level of flexibility or add-ons within the software might be more beneficial to the users in terms of tailored quality checks. Furthermore, the addition of the quality management features within Field View streamlines the processes and improves efficiency because the inclusion of inspection check lists and non-conformance reports can be easily recorded onsite with pictures, compared to the more traditional methods. Due to the common data environment, the inclusion of pictorial information improves the level of understanding and communication that allows members of the team to review the reports and design changes, making it easier and beneficial for addressing and managing any health and safety critical features identified [33]. The adoption of Field View provides flexibility in reviewing other existing works because of the common data environment capabilities within Viewpoint, and this allows non-site-based workers access to site information which is useful for raising technical queries (TQs), non-conformances, hot works permits and permits to dig thereby improving collaboration and conflict management within projects [34].

4.2. Viewpoint in Quality Assurance

The systemic quality-related failures within the construction industry have been addressed by [35, 36]. The perception of the participants on the role of Viewpoint in mitigating quality assurance issues for principal contractors and sub-contractors are shown in Table 3, with emphasis on quality culture, SHEQ and quality related tasks.

Table 3: Role of Viewpoint in Quality Assurance

Principal Contractor	Sub-contractor
Up-to-date Drawings: up-to-date building information; improved confidence when assessing quality	Little to no impact on sub-contractors quality
Quality records: inspection check sheets; Non-conformance reports	Potential for increased efficiency: sub-contractors do not use it enough to full potential; training requirements
Increased efficiency	

The practitioners strongly believe that Viewpoint for Projects have a major impact on quality assurance for their organization due to its ability to ensure that the site teams have real-time access to the requisite up-to-date information (including revised drawings) required to build to approved construction standards rather than changes and revisions communicated via emails. The emphasis on the adoption of technology in construction is considered pivotal to the future of the construction industry [3], and the participants believe that lack of adoption of these types of technology is not fit for today's industry. The use of Viewpoint for Projects contributes to efficiency gains within organizations when logging quality records and it is suggested to be highly beneficial for the organization and standard working practices, for example accessing up-to-date drawings and building information, and similarly SHEQ information via Field View.

Participants highlighted the significance of the adoption of Viewpoint as a quality assurance tool (based on ISO-19650) for principal contractors because of the common data environment but are yet to realise such gains with sub-contractors. The result of this could be traced to the lack of technological adoption, culture of resistance to change within the construction industry, and the heavy workload which can often impact on the commitment of sub-contractors to principal contractors' procedures [21]. Some of the limiting factors to these cultural changes could be associated with the lack of training and upskilling within the supply chain and the principal contractor's success or failure often relies heavily on sub-contractors and how they are managed. Overall, the participants agreed that the adoption of Viewpoint positively improved the organization's method of measuring quality in terms of transparency between principal contractor and sub-contractor, keeping track of what non-conformance reports were identified, what has been closed off, and what inspections have been conducted and when. This allows the principal contractor to evaluate site performance and that of the sub-contractors in terms of workmanship and onsite health and safety towards achieving optimum quality in project delivery. Participants also suggested that the impact that Viewpoint can have on subcontractors' quality is dependent on the sub-contractor's size, ability to adopt and understand the technology, and the quality standards.

The significance of creating and maintaining positive quality culture is key to achieving optimum total quality management [15], and improved onsite safety because many industry failings have been the direct result of poor-quality culture [37]. The participants broadly agreed that the adoption of Viewpoint by their organization has positively impacted their quality culture due to the ease of access to the quality records and trends. However, to maximize efficiency, businesses should be striving towards upskilling their workforce through training and education. The participants indicated that Field View has had major impact on SHEQ in terms of the versatility that Field View offers and the efficiency it adds to SHEQ forms (inclusion of drawings, pictures of quality issues) for non-conformance reports which can be communicated in real time with the subcontractors to action and resolve quality-related issues in a timely manner

4.3. Field View for Health and Safety

The capabilities of Field View include accessing health and safety information inherent to the project, inspections, quality control, daily reports and punch list issues. The adoption of Field View in the delivery of projects ensures greater project control, real time accurate information capture and transparency on safety-related issues, quality, and defect management. Whilst quality standards of assurance are key factors in the success of a job, continuously improving health and safety is fundamental to the success of any project. However, there are opposing views from participants that the high standards of health and safety that are imposed on workers can sometimes be considered a distraction to the quality plan. That is why the implementation of an integrated quality plan in synergy with the health and safety plan is crucial in the survival of a construction organization now more than ever [3]. The downside of the inspection test plans (ITP) to identify errors which are reported via non-conformance or defect notice during the construction timeline is the requirement for a competent team to keep up with the volume of information and details. ITPs are also thought to be time consuming, and can be difficult to strike a balance between the priorities of the contractor and subcontractor as per quality, health and safety, and project schedule issues. Therefore, issues of poor quality which negatively impacts the image and profits of the organization also impacts on the overall project health and safety. Participants therefore believe Viewpoint has positively impacted their method of measuring quality performance and also useful for assessing health and safety related issues including Safety Environmental Observation Reports.

4.4. Viewpoint for Snagging

Every construction project requires the cooperative effort of several workers and stakeholders with each one having their own perspectives and interests, and the coming together of these different actors for the successful completion of the project involves managing different expectations and most importantly, minimizing building defects [7]. It is suggested that the primary indicators of construction quality are percentage cost of rework and rate of construction defects [12]. It is important that defects are identified early and Field View is useful as a snagging tool integrated within the common data environment. Field View's level of transparency between contractors is the key to improved snagging because of its increased mobility, ability to pictorially capture the snag and the contractor is able to add evidence of the snag and the remedial works undertaken. This feature is also a driver for sub-contractors to undertake their works to a higher standard because the duty holders involved have real-time access to the information. The identification and ease of location of snags with increased detail is another major advantage as the snag can be superimposed onto a drawing to identify the exact location and the study participants believe this feature removes any potential conflict the contractor might have in their assigned jobs. This feature has improved communication and resolution between the principal contractor and sub-contractors on issues of non-conformance (resulting from design, poor quality culture, and poor workmanship) by increasing job profitability and improving safety while sticking to the project quality plan and reducing repair costs. It is important to state that the adoption of Viewpoint as a technology for snagging becomes useful and beneficial to organizations when competent people, right processes and positive change of culture are embedded as the norm within the organization.

5. CONCLUSIONS AND RECOMMENDATIONS

The adoption of Viewpoint for quality assurance for all parties involved from the principal contractor and subcontractor suggest that the implementation of the technology is fundamental to improving workers' efficiency and quality gains in construction projects. The focus on the adoption of Viewpoint (Field View) as a snagging tool for identifying and resolving defects early can result in savings in project cost, improved standards of quality, and improved project safety. However, the true potential and impact of Viewpoint on quality in construction can only be achieved when organizations revolutionize existing

quality culture that is endemic in the industry and work towards improving construction safety. The adoption of Viewpoint as a tool for identifying and resolving non-conformance resulting from design errors and poor workmanship is a significant development in quality management through the use of technology because recent quality failures from the construction industry has led to construction companies increasing the use and adoption of construction technology to maximise their performance, efficiency, and safety capabilities. Furthermore, there is perceived administrative burden on users that are site-based regarding the adoption of new technology, with older workers not keen to learn and embrace the adoption of the software. Similarly, sub-contractors struggle with the adoption of this technology due to time and resource pressures and the resistance of buy-in from operatives in learning new methods of quality assurance. This is why targeted and role-specific training is essential for operatives because of their differing levels of competency and their understanding of new technology useful for minimising information overload whilst maximising the capabilities of this software to improve quality and safety of projects.

Limitation – the data source for this study is limited to participants from same company but with slightly differing perspectives on the adoption of Viewpoint as a technology across multiple projects. Therefore, the views of the research participants may not be a fair representation of the industry as a whole.

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