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Obstacles and Solutions to Implementing Job Hazard Analysis in Construction: A Case Study

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ABSTRACT

Construction workers experience a disproportionately high rate of work-related injuries. However, if hazards are properly recognized and addressed, most of these incidents are preventable. Job hazard analysis (JHA) is a method for identifying and mitigating workplace hazards that emphasizes proactive risk control. Despite its importance, the construction industry currently lacks comprehensive guidelines on how to effectively design and implement JHA on a consistent basis. To fill this gap, this case study pursued two objectives: (1) to explore challenges and shortcomings of current practices in developing and implementing JHA in construction and (2) to identify effective practices and interventions employed by contractors to address these challenges. To this end, 30 sample JHA documents were analyzed, and 23 semi-structured interviews were conducted with construction safety professionals representing 17 companies. Findings of this study identified a lack of worker involvement in the process, lack of buy-in, management absence, complacency, and inadequate coordination and communication as major issues. Solutions explored to address these challenges included incorporating visual aids, rotating JHA meeting leaders, and continuously updating JHA information to reflect the current work conditions. The practical implications of these findings and the path forward for further research are discussed.

KEYWORDS

Job hazard analysis; job safety analysis; JHA; construction safety; pre-task planning

Introduction

Construction work carries a high risk of occupational incidents and injuries. According to the U.S. Bureau of Labor Statistics (BLS), the construction industry remained one of the highest-risk sectors in the U.S. in 2019 with a fatality incidence rate of 9.7 per 100,000 full-time employees (FTEs) and a nonfatal recordable injury and illness incidence rate of 2.8 per 100 FTEs (Bureau of Labor Statistics, 2021a, 2021b). While construction workers made up about 5.8% of the U.S. labor force in 2019, they experienced close to seven percent of all recordable injuries (Bureau of Labor Statistics, 2021c, 2021d). It is more alarming to realize that approximately 25% of all work-related fatalities occurred in the construction industry, more than any other U.S. sector (BLS, 2021a). However, research findings suggest that most of these incidents are preventable if proper planning is implemented to recognize and address hazards before the job starts (Occupational Safety and Health Administration, 2012).

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Job hazard analysis (JHA) is a process in construction project planning that aims to proactively identify the steps in a task, assess the risk level of each step, and take appropriate action to control the risk (Rozenfeld et al., 2010). If performed regularly and effectively, pre-task JHA can enhance safety and health outcomes on construction jobsites (Hallowell & Gambatese, 2009). There is wide agreement in the literature that JHA is most effective when it involves all stakeholders, especially the workers performing the task (Albrechtsen, 2019; Glenn, 2011; Jones et al., 2020; Morris & Wachs, 2003).

However, despite the importance and proven benefits of JHA, there is a lack of comprehensive guidelines on how to develop and implement JHA on a consistent basis across the industry. This lack of guidelines leaves contractors and work crews excessive degrees of freedom in how to design and conduct JHAs. Given the dynamic nature of construction jobsites, involvement of multiple stakeholders, and large number of tasks, a loosely defined JHA process can lead to inconsistency and conflicts (Memarian & Mitropoulos, 2016). As a result, the number of undetected hazards, worker exposure to hazards, and the likelihood of incidents increase.

To create a better understanding of commonly used JHA practices and facilitate the development of comprehensive guidelines across the construction industry, this study pursued two objectives: (1) explore challenges and shortcomings of current practices in developing and implementing JHA and (2) identify effective practices and interventions employed by contractors to enhance the quality of the JHA process.

Literature review

Job hazard analysis

Job Hazard Analysis (JHA), also known as job safety analysis and activity hazard analysis, is an integral component of on-site safety programs (Hallowell & Gambatese, 2009). JHA is intended to identify and address the existing or potential safety and health hazards associated with each step of work and recommend actions and procedures to eliminate or mitigate these hazards and the risk of a workplace injury or illness (OSHA, 2002). When implemented successfully, pre-task JHA is associated with better project outcomes in terms of quality, cost, and safety (Abbas et al., 2016; Albrechtsen, 2019; Larsen et al., 2018; Ponticelli et al., 2015).

JHA documents are typically developed by management teams and used by frontline supervisors and work crews before they start a task at the beginning of their shift or whenever the task or work condition changes (Roughton & Crutchfield, 2011). In this context, the JHA document highlights potential hazards associated with the task and the controls in place to mitigate them.

JHA and safety performance

There is a consensus in multiple industries including construction, healthcare, and manufacturing that JHA is most effective when the process actively involves the workers who are performing the task (Albrechtsen, 2019; Glenn, 2011; Jones et al., 2020; Morris & Wachs, 2003; Ramsay et al., 2006). Razuri et al. (2007) found that the frequency of pre-work hazard identification by the crew positively correlated with project safety performance and reduced the injury rate. Other research findings also suggest that spending more time communicating hazards with workers on jobsites is associated with a lower incident rate (Chang et al., 2019).

Optimizing JHA

Frontline workers interface directly with the tools, materials, and equipment and associated hazards during task performance. As such, they should be able to easily locate, understand, and apply the information presented to them during pre-task JHA. However, the current body of knowledge focuses largely on hazard recognition approaches that are more applicable at the organizational level rather than the crew level. For example, ontological and semantic modeling (Wang & Boukamp, 2011; Zhang et al., 2015) and text classification algorithms (Chi et al., 2013) have been suggested as ways of automating the JHA process at the organizational level. Risk prediction methods that consider spatial and temporal aspects, such as the Construction Hazard Assessment with Spatial and Temporal Exposure technique, as well as human factors analysis and classification, have also been discussed to help project planners more effectively allocate safety resources (Garrett & Teizer, 2009; Rozenfeld et al., 2010).

However, despite the importance of JHA and its ability to prevent work-related incidents and injuries, there is limited guidance in the literature on how to enhance the quality and efficacy of JHA content and delivery. To fill this gap, an examination of all aspects of JHA development and implementation and how they affect craft workers' ability to recognize and mitigate safety and health hazards is warranted.

Methodology

The exploratory nature of this study led to using a case study methodology, which enables an in-depth examination of challenges and effective practices when conducting JHA in a real-world context (Eisenhardt, 1989). To this end, the following activities were performed: (1) gather and analyze sample JHA documents, (2) identify and interview project management teams, and (3) conduct a comparative analysis of findings.

Sample JHA document analysis

To identify the gap and examine consistency and variations in the type, content, and format of commonly used JHA documents, a total of 30 sample documents were gathered and analyzed. These documents were collected from online sources and construction contractors. Documents were categorized as: (1) a blank template, (2) a checklist, or (3) a prepopulated JHA document. For analysis purposes, each section and subsection of a JHA document was assigned a descriptive code. These codes were developed to identify and standardize analogous form fields despite inconsistencies in language and wording. For example, the code "Activity" was used to group fields labeled "Task steps" and "Process steps." A total of seven codes were developed: (1) Activity, (2) Hazard, (3) Controls, (4) Instructions, (5) Photos and Visuals, (6) Federal and Consensus Standards, and (7) Other. After all codes were assigned, the frequency of each code was counted to explore similarities and differences between the documents.

Interviews with project management teams

A semi-structured interview approach was employed to conduct interviews. An instrument with five major questions was developed, which inquired about: (1) methods used to conduct JHA, (2) challenges and shortcomings in developing and conducting JHA, (3) changes or modifications made to enhance the process, (4) methods used to gather and reflect workers' feedback and comments, and (5) effective work practices and interventions employed to enhance the JHA process. The final version of the instrument was submitted to the Center's Institutional Review Board for their review and approval to ensure the protection of participants.

Using the convenience sampling approach, interview participants were selected through the research team's partners in the construction industry. To enhance the reliability of findings, participants were recruited from the management teams of construction companies of various sizes and trades. Out of 36 individuals contacted, 23 participated in the interview. They represented 17 construction companies ranging from large national level general contractors to small specialty sub- contractors sized between 75 and 22,000 employees. Participants served in various roles including safety manager (11), safety director (5), project manager (3), superintendent (2), vice president (1), and general foreman (1). Participants' median years of experience was about 16 with a minimum of two years and maximum of 45 years.

All interviews were conducted in a three-month timeframe, and each interview took about 30 minutes. Interviews were conducted through phone or video conference platforms depending on the participants' preferences. To minimize potential bias in data collection, the investigators avoided "Yes – No" questions. When needed, interviewees were asked scenario-based questions to elaborate on their responses and provide practical examples.

Interviews were not recorded, and no software was used to transcribe and analyze interviews. All the interviews were transcribed by the research team for analysis purposes. The initial descriptive codes were developed based on the research questions, as mentioned earlier, and findings were analyzed and summarized based on those themes.

Findings

JHA document analysis

As the first step, the 30 sample JHA documents were analyzed for formatting type. Three different JHA document formats were identified: (1) a *prepopulated JHA form* developed and completed by management and given to work crews to use (83%), (2) a *checklist* to be completed by crews at the work location (10%), and (3) a *blank template* to be filled out by crews at the work location (7%). After analyzing all the sample JHA documents using descriptive codes, as explained earlier, the major sections and sub-sections were identified. Table 1 summarizes the key components of these documents and their frequency.

The activity, hazard, and control sections were the only components present in all the JHA documents examined in this study. The specificity of information within each field also varied widely. For example, listed personal protective equipment (PPE) ranged from generic to highly task-specific. While some JHAs required "rubber insulated electrical gloves, arc flash suit, and hood," others simply stated, "wear proper PPE." Similarly, reference

Table 1. Key JHA components.

JHA component	Frequency
Activity	100%
Hazard	100%
Control	100%
Instructions on how to conduct JHA	27%
A Risk Assessment Matrix	20%
Photos or other visual representations	7%
A recommendation to fill JHA at the work location	7%
Federal or consensus standards as a reference	7%

information for control recommendations such as OSHA or ANSI standards was not consistently provided. Only seven percent of the documents examined contained either a designated references field or the name of a specific standard such as NFPA 70E.

The risk assessment matrix is a framework initially used by the US Army to assign an overall level of risk to an activity based on the probability and severity of potential adverse outcomes (Department of the Army, 2014). It was available in 20% of the documents examined, demonstrating its growing popularity among civilian contractors. However, the remaining 80% of documents had no standardized method for assigning level of risk.

Other photos and visual representations such as manufacturer's photos, photos of similar processes on other worksites, and reproductions of permits and signage were available in seven percent of the documents examined. They depicted the safe usage of specific tools, controls, and PPE as well as recommended body postures.

Interviews with management teams

JHA implementation and delivery methods

Two distinct approaches to develop and deliver JHA on construction jobsites were identified: (1) traditional paper forms and (2) application of technology.

Over half of the respondents, mainly smaller contractors, preferred using paper forms over application of technology to conduct JHA. This was mainly attributed to the feasibility of purchasing, implementing, and maintaining tools such as software packages and mobile applications, especially for smaller contractors with limited resources. The requirement of the overseeing general contractor was also mentioned as the reason for using paper copies.

Respondents identified some disadvantages of using paper copies including (1) challenges carrying multiple forms on the jobsite while performing the task, (2) problems maintaining and archiving paper copies, and (3) difficulties accessing JHA documents for revisions when job conditions change. The remainder of the respondents preferred to employ some form of technology when conducting JHA on jobsites. Project delivery applications were favored because they can be integrated with the company's safety program and enable the up-to-date access of permits, safety data sheets, JHA documents, and toolbox talks in one streamlined platform. This form of digital recordkeeping offers the benefit of updating records in real-time. An in-house digital repository that catalogs JHA documents was also recognized. This system facilitates the archival and creation of JHA documents, as users can conveniently select the appropriate templates or modify archived forms based on the work conditions. Although using these electronic tools has streamlined the jobsite safety management process, some drawbacks were pointed out: (1) internet connectivity issues on jobsites, (2) training, and (3) the reluctance to adopt new technology, especially among an aging construction workforce. In some cases, contractors may use a combination of traditional hard copies and some form of technology to facilitate the JHA process.

Optimizing JHA content

A lack of reading proficiency and the language barrier were recognized as two major issues to consider when developing JHA documents. In addition to craft worker complacency and lack of attention to details, problems understanding task assignments and associated hazards were also identified as major concerns with long, wordy JHA documents. To avoid these potential issues, over half of the respondents suggested optimizing JHA documents by only providing task-specific information rather than high-level, general information.

One solution identified by respondents was to provide mini-JHA cards, or one-page summaries, pertinent to the immediate task being performed, in addition to the main JHA document. These summaries provided four to five simple steps, known as "Life-Saving Actions," for each hazardous condition. For example, for dropped object prevention, the following steps were provided on the summary sheet: (1) all tools must be tied off, (2) tie-offs must be inspected, (3) all materials must be tied off, and (4) the area/platform must be safe (netting on handrails). Moreover, these mini-JHA cards specify the exact PPE required for each task and provide concise guidelines on how to properly use it.

The use of visual aids was also recognized as an effective concept to enhance the quality of JHA documents. When possible, visuals should be incorporated in lieu of text. Some important visual aids used by respondents included: (1) manufacturer drawings of the tools and equipment, (2) photos or illustrations of the task in stepwise order, and (3) pictograms showing safety and hazard categories. Jobsite maps could also be used as visual guides to help contractors and craft workers coordinate daily activities. For instance, a unique color code was assigned to each contractor on one jobsite to visualize where they would be working, and icons were used to depict high-risk activities and muster points for emergency evacuations on the map.

Lack of buy-in to the JHA process

Lack of buy-in to the JHA process by both craftworkers and some field supervisors was recognized as a major issue. With aggressive schedules and multiple competing responsibilities, some crew members may perceive JHAs as unnecessary paperwork, especially if they appear wordy, complicated, or time-consuming. Respondents also noted that JHA forms were frequently "pencil whipped," or completed superficially without digesting and understanding the content.

More experienced respondents confirmed that the push for regular JHA is a recent initiative. Low craft buy-in, especially among experienced workers, was mainly attributed to a resistance to change and the impression that completed JHA documents will sit unused on a bookshelf or get lost in the process or discarded.

Several practices were employed by participating companies to improve buy-in to the JHA process: (1) encourage workers to personalize the JHA process by sharing pictures and stories of the family and loved ones who would be affected by an injury, (2) incorporate real-life experiences into JHA augmented with video footage of real-life near misses and incidents when possible, (3) designate specific craftworkers as rotating safety representatives to serve as liaisons between craftworkers and management, and (4) facilitate mutual communication by actively soliciting worker feedback.

Communication and coordination gap

A lack of effective communication was cited as a major challenge in conducting JHA. This issue highlighted the role of upper management, as communication is largely perceived as a top-down issue. The major communication issues identified by respondents included: (1) the lack of a systematic approach in frequently and adequately communicating jobsite changes and updates with craft workers, (2) the lack of communication skills in some team members leading JHA sessions, which reduces their ability to effectively convey key concepts, (3) spending inadequate time mentoring less experienced workers, and (4) the language barrier.

To overcome communication challenges, respondents encouraged active coordination and frequent cross-checking between all parties. Engaging frontline supervisors, safety representatives, and craft workers equally in safety activities introduced a layer of redundancy that guarded against accidents and injuries. This was accomplished through the following practices: (1) Use a position hazard analysis to specify and mitigate hazards arising from adjacent crews or concurrent tasks, (2) ensure that safety representatives double-check JHA documents after they are filled out by work crews and have them perform jobsite audits to ensure JHA documents match actual jobsite conditions, (3) a higher safety representative to craft worker ratio on jobsites, and (4) matching work crews with limited English skills with bilingual foremen and safety representatives.

JHA content and task consistency

Inconsistency between JHA content and the actual task requirements was found to be a major issue. It was learned that JHA documents are usually developed by mid- or upper-level managers who are not regularly present on the jobsite or physically involved in task performance. As a result, some JHAs may not match the most recent job conditions. Moreover, JHA documents are typically driven by regulatory and consensus standards rather than the actual task requirements and workers' input.

An interactive JHA approach

One of the participating companies identified and implemented an interactive process as a potential solution for mitigating the challenges in creating and administering JHA and pre-task briefings. During pre-task briefing sessions, work crews take the following steps before starting the work: (1) define the scope of work, (2) analyze hazards, (3) develop and implement hazard controls, and (4) solicit feedback from everyone present. These meetings are conducted every day by the crew at the work location before starting the work. Unlike traditional JHA meetings conducted by crew supervisors, the role of meeting leader is rotational, and each crew member has the opportunity to lead the meeting. Moreover, instead of traditional JHA documents as identified earlier, they use a whiteboard to present necessary information and gather and record crew members' feedback.

Discussion of findings

JHA delivery methods & coordination

As the findings of this study indicated, the choice of JHA delivery method varies due to several factors. Larger contractors show a tendency to adopt advanced technology or at least employ a combination of traditional methods and technology. In contrast, smaller contractors show more desire to use traditional paper copies. In line with Cunningham and Sinclair's (2015) findings, this was mainly attributed to a lack of sufficient resources to allocate to employ new technology and support its use.

General contractors and sometimes project owners may require contractors to follow specific predetermined JHA guidelines, rather than using their own JHA documents. However, the findings of this study indicated that there are a variety of JHA formats including blank templates, prepopulated JHA documents, and checklists. Therefore, it should be noted that requiring contractors to use an unfamiliar JHA format may hinder the hazard identification process. Alternately, contractors may provide their own JHA documents to the general contractor for approval before the work starts. Nonetheless, allowing contractors to use their own JHAs can create discrepancies in hazard awareness and control implementation. Moreover, an inconsistent approach in implementing JHA by different contractors can lead to confusion and conflicts on jobsites. This issue highlights the need for upfront coordination and agreement among project stakeholders to avoid future confusion and conflicts.

Safety climate & JHA

Safety climate is defined as employees' shared perceptions of how well safety management systems are implemented, and a positive safety climate is a leading indicator of favorable health and safety outcomes (Casey et al., 2017; Zohar 2010). To strengthen safety climate, a company needs to improve features of its safety management system (Beus et al., 2010; Hecker & Goldenhar, 2014). JHA is an integral component of safety management systems that, if implemented successfully, can contribute to the prevention of work-related accidents and injuries. However, findings of this study indicate that the importance of JHA may not be fully realized by work crews. Wordy and time consuming JHA forms were identified as major factors contributing not only to lack of buy-in by workers, but also complacency and lack of attention to details. This finding further highlighted the role of management in optimizing the content, design, and delivery of the JHA process. Information accessibility and ease of use are two critical factors that should be the centerpieces of this effort. Developing JHA pocket-cards, sometimes referred to as "Mini-JHA," would be recommended as a practical solution.

Hispanic workers account for approximately 34.3% of the US construction industry, and some members of this population may not feel comfortable communicating solely in English (CPWR 2018). Neglecting to acknowledge and accommodate this language diversity in the construction workforce can lead to an increase in injuries and fatalities (De Jesus-Rivas et al., 2016). Incorporating drawings, photos, and pictograms into JHA documents can improve JHA comprehension among all workers, especially those who are not native speakers (Vigoroso et al., 2020). However, only seven percent of the JHA documents analyzed in this study included some form of visual aid, demonstrating the need for more attention from construction practitioners and scholars.

Management involvement & worker empowerment

Demonstrating management commitment to site safety programs and worker empowerment are also recognized as two key leading indicators of positive safety climate (Schwatka et al., 2016). Being present and visible on the jobsite is an important indicator of management commitment to site safety programs, which allows them to gain a more accurate understanding of site conditions. In line with this fact, the findings of this study attributed the poor quality of JHA documents, at least in part, to the isolation of upper management from jobsites. This is alarming, as JHA documents are usually developed by upper-level managers. To fill this gap, management should conduct frequent visits to the jobsite and interact with craft workers to better understand task requirements, site conditions, and existing and potential hazards.

Worker involvement in the site safety program fosters a sense of responsibility for the safety and health of themselves and their coworkers (Hallowell & Gambatese, 2009). Despite this fact, the JHA document analysis findings revealed that 83% of the JHA documents examined were prepopulated, highlighting the lack of opportunity for craftworkers' input and feedback. This was consistent with the interview findings. To empower workers and get them actively involved in the process, it is critical to seek their input on hazard recognition and reduction practices and establish joint worker-management safety committees to expand craft worker opportunities to raise safety and health concerns (Albrechtsen, 2019; Glenn, 2011; Morris & Wachs, 2003; Ramsay et al., 2006). Moreover, rotational role setting and giving the opportunity to all crew members to take a leadership role and lead daily JHA meetings are some practical approaches to improve worker involvement in different aspects of the JHA process.

Continuous improvement

As the Deming Cycle explains, to address changes and continuously improve a process, the four-step cycle of Plan-Do-Check-Act (PDCA) should be repeated several times to reach a favorable outcome (Dudin et al., 2015). Construction jobsites are dynamic and working conditions constantly change. Therefore, in line with the Deming Cycle, to address emerging hazards and employ appropriate controls, JHA processes need to be continuously monitored, examined, and updated. To this end, it is critical to gather and document end-of-shift information, especially workers' feedback, to address newly emerged hazards and whether the work process deviated from the JHA discussed at the beginning of the shift. Moreover, the effectiveness and failures of controls need to be evaluated and necessary changes should be made accordingly. Since some hazards might be posed by other crews working nearby, it is also crucial to coordinate activities to avoid potential clashes. Using advanced technologies such as Building Information Modeling can facilitate coordination among trades.

Conclusions

The goal of the study presented in this paper was to first identify gaps in common methods used in developing and implementing JHA on construction jobsites and then explore effective practices and interventions to fill these gaps. To this end, 30 sample JHA documents were gathered and analyzed, and 23 members of management teams representing 17 construction contractors of various sizes were interviewed.

To ensure construction workers' safety and health, it is critical to proactively identify hazards associated with each task, communicate the hazards to workers, and employ proper controls. An effective JHA process can play a major role in addressing these requirements and can help facilitate the day-to-day management of worker safety and health on construction jobsites. However, as the findings of this study highlighted, a lack of comprehensive guidelines has introduced significant discrepancies in the design and implementation of JHA across the construction industry, which impacts its effectiveness. This issue calls for closer collaboration between construction health and safety practitioners and researchers to develop more comprehensive guidelines for enhancing the quality of JHA.

JHA is typically developed and implemented by management teams. The major findings of this study recommend that management: (1) proactively coordinate the use of a consistent format among all project stakeholders, (2) strengthen site safety climate by optimizing JHA content and format for ease of use by craft workers, (3) perform regular field audits and solicit craft worker feedback, and (4) institute a continuous improvement cycle to ensure that JHA content reflects current jobsite conditions in the dynamic construction environment.

On construction jobsites, work crews are typically interdependent. Therefore, it is crucial to create a holistic JHA process that provides both immediate task information and a higher-level project overview to enhance situational awareness. To this end, general contractors have a vital role in facilitating and coordinating the JHA process throughout the project lifecycle.

Limitations and future research

The findings of this case study were limited to interviews with 23 construction safety and health practitioners and an analysis of 30 sample JHA documents, which may not be considered a representation of the whole construction industry. Furthermore, due to COVID-19 jobsite restrictions, frontline workers were precluded from participating in this study. Therefore, more research is needed to further explore and examine different aspects of JHA processes, particularly from the frontline workers' perspectives, to lead the effort in developing comprehensive JHA guidelines.

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