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Investigating the Practice of Improvisation in Construction

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Abstract: Improvisation is a spontaneous and impulsive, but rational, decision-making process. Although unpopular, given that it indicates deviation from plans, improvisation is unavoidable in construction planning because it helps address emerging nonstandard issues or unexpected problems. While the results of improvisation are understandable, the decision process is spontaneous. Therefore, a construction project will benefit from applying an adaptive planning system that uses improvisation. After conducting a review on practices of improvisation, a decision-making model illustrating how construction employees can properly improvise and reach their desired decisions or actions was proposed. Aiming to investigate the practice of improvisation in construction, this study considered 28 large-sized projects, in which 120 surveys were conducted via semistructured interviews with blue- and white-collar employees. Thereafter, statistical analyses and hypotheses testing were performed to highlight important insights. The study would greatly benefit construction companies and professionals because it offers recommendations that influence improvisational outcomes and enhance the corresponding decision-making process. **DOI: 10.1061/(ASCE)ME.1943-5479.0000652.**

Introduction

Construction planning is indispensable in maintaining a project's objectives related to time, cost, quality, safety, and so forth. However, construction environments are known to encounter uncertain circumstances for which planners or decision-makers have not planned.

In fact, planners usually make decisions based on analysis, investigations, and predetermined information. Unfortunately, while passing through unexpected or emergent situations, they are obliged to make decisions swiftly and without having the optimal resources, hence relying on their improvisational skills (Ciborra 1999).

Improvisation is considered to be a helpful skill that guides decision-makers under time pressure and in the absence of required resources (Ciborra 1999). Historically, improvisation has been used in different fields, including but not restricted to education, music, sports, and organizational management. Musicians have interpreted the practice of improvisation in jazz and illustrated the process in a well-defined cognitive model (Moorman and Miner 1998). Particularly, Pressing's model views musical improvisation as a set of generation, selection, and execution of novel melodic processes (Pressing 2001). As for organizations, improvisation has recently become a management tool that compensates for the shortcomings of planning and responds to unplanned or emergent situations (Trotter et al. 2013). Furthermore, organizational uncertainty, dynamism, and complexity are the main factors provoking the use of improvisation (Trotter et al. 2013). Therefore, managers, planners, and employees must count on improvisation to make essential decisions during uncertain or emergent circumstances.

Particular to construction, improvisation is perceived as an interesting practice to prepare for the dynamism and glitches resulting from unexpected uncertainty. However, few contributions are made in the literature to explain improvisation in the context of construction operations. Similar to other industries, construction individuals can benefit from improvisation to resolve emergent problems, management errors, breakdowns, and interruptions (Cunha 2005; Mendonca and Wallace 2007; Chelariu et al. 2002; Verjans 2005). Therefore, improvisation in construction is perceived as complementary to planning in preparing for unforeseen problems of uncertainty (Hamzeh et al. 2012).

While improvisation has been thoroughly explained in different organizational contexts, few research studies have addressed improvisational practices in the field of construction, which is a highly dynamic work environment incorporating unforeseen problems. This study models the practice of improvisation within construction operations as a decision-making process. The purpose of this study is to guide construction employees toward attaining their desired improvisational outcomes through a methodical framework related to improvisation, with the overall aim of better management of unforeseen uncertainties in construction. This paper proceeds with a literature review of improvisational practices in different fields of application and accordingly presents a decision-making model related to improvisation in construction. Then, the authors propose a set of hypotheses related to the developed model, explain the research methodology followed in investigating the practice of improvisation in construction, and test the proposed hypotheses on a set of projects. Afterward, results and statistical analyses are presented and discussed. Finally, conclusions and recommendations for improvisers in construction are highlighted.

Background

Improvisation has recently gained a wide interest in the field of organizational management due to its promising benefits (Hadida et al. 2015). The contribution of improvisation in dealing with rapidly changing and uncertain environments has continued to exist in

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Note. This manuscript was submitted on January 16, 2018; approved on May 4, 2018; published online on August 7, 2018. Discussion period open until January 7, 2019; separate discussions must be submitted for individual papers. This paper is part of the ***Journal of Management in Engineering***, © ASCE, ISSN 0742-597X.

several organizational settings (Hadida et al. 2015). Researchers have analyzed the practice of improvisation by looking at different aspects of improvisation and, accordingly, have come up with various definitions. After investigating different definitions of improvisation presented in the literature, four main criteria describing improvisation are considered in reaching a comprehensive understanding. First, some scholars define improvisation by referring to the *method* used to improvise. For instance, improvising is to generate new combinations and solutions under wicked conditions (Ciborra 1999). Second, other scholars explain improvisation as the action of formulating and implementing solutions simultaneously (Perky 1991), thus emphasizing the *time* aspect of improvisation. Third, the *spontaneity* of improvisation has been the interest of many scholars who have elucidated improvisation as involving extemporaneous and deliberate organizational actions (Cunha et al. 1999). Finally, some studies have linked improvised actions to *innovation*, therefore relating improvisation to creativity and ingenuity (Magni et al. 2009). Table 1 presents the classification of different definitions of improvisation according to the previously mentioned criteria.

For a comprehensive understanding of improvisation in organizations, Cunha et al. (1999) developed a general definition that explains improvisation as "the conception of action as it unfolds, by an organization and/or one of its members drawing on available material, cognitive, affective and social resources." Cunha et al. (1999) distinguished four different resources in their definition. Material resources include all resources except for individuals and the external social system. As for the cognitive resources, they comprise the expertise and the learning earned by the entire organization. On the other hand, affective resources incorporate the emotional state of the improvisers. Last of all, social resources include all the formal and informal communication within an organization (Cunha et al. 1999).

In most of the literature, novelty, time pressure, and speed are the major characteristics of improvisation. Novelty is the extent to which improvisation diverges from original plans (Chelariu et al. 2002). Ryle (1979) have suggested a positive correlation between the novelty of emergent situations and that of improvisation. While novelty is a necessity for an action to be classified as improvisational in a jazz setting, it is different in the case of organizations where a repetitive or a sudden response to any emergent or unplanned situation is declared to be improvisation (Berliner 2009). Additionally, time pressure and speed are other significant characteristics of improvisation (Chelariu et al. 2002). According to Chelariu et al. (2002), the speed of improvisation increases when members of the organization disclose a wider range of information.

In addition to these characteristics, numerous influencing factors for successful improvisation in organizations are deemed essential. Having experience is considered a key factor that contributes to successful improvisation given that it helps improvisers identify undesired situations and generate different alternatives (Trotter et al. 2013). Moreover, education that enriches improvisers with enough knowledge, as well as training that aims at enhancing the improvisational skills of personnel, can dramatically affect improvisational outcomes (Klein 2007; Størseth et al. 2010). Additionally, numerous studies have discussed other improvisational factors that can be briefly listed as follows: situational awareness (Smith and Hancock 1995), teamwork (Vera and Crossan 2005), information flow (Størseth et al. 2010), organizational structure (Cunha et al. 2003), organizational memory (Mendonca and Wallace 2007), organizational culture (Vera and Crossan 2005), and the extent of authority mitigation in a certain organizational system (Størseth et al. 2010).

The importance of improvisation in organizational management has been emphasized in several research studies (Trotter et al. 2013). According to Brown and Eisenhardt (1997), improvisation is the most robust practice that effectively copes with rapidly changing environments. A further emphasis has been made by Chelariu et al. (2002) that planning can lead to complications, and such complications require improvisational efforts to resolve them. Similarly, advocating the role of improvisation, a study showed that only one

Table 1. Classification of different definitions of improvisation

Emphasis	Definitions	Reference
Method	Efficiently generating new combinations of resources, routines, and structures which can match the present and turbulent circumstances	Ciborra (1999)
	Combining known and unknown routines in different contexts	Leybourne (2006)
	Pitting an acquired competence or skill against un-programmed opportunity, obstacle, or hazard	Ryle (1979)
Time	Merging the composition and the performance contemporaneously	Kamoche and Cunha (1997)
	Converging composition with execution	Moorman and Miner (1998)
	Creating in a real time emergent synergy	Pasmore (1998)
	Formulating and implementing strategies simultaneously	Perky (1991)
	Thinking both compositionally and spontaneously	Weick (1999)
Spontaneity	Extemporaneous and deliberate organizational action	Cunha et al. (1999)
	Intentional but extemporaneous, rational decision-making	Ciborra (1999)
Innovation	Inventing, adopting, and implementing new ideas within the context of shared awareness of the group performance as it unfolds over time	Bastien and Hostager (1988)
	Making decisions and developing ideas in new and creative ways	Crossan et al. (1996)
	Organizing in a way so that actors adaptively innovate and efficiently execute	Brown and Eisenhardt (1997)
	Using the structure in creative ways that enable altering the structural foundation of performance	Hatch (1999)
	Guiding actions intuitively and spontaneously	Hatch (1997)
	Enacting an ongoing series of local innovations that embellish structure, respond to spontaneous departures and unexpected opportunities, and iterate over time	Orlikowski and Hofman (1997)
	Disciplined imagination	Weick (1999)
	Inventing a substitute immediately when one organizational order collapses	Weick (1993)
	Mind in action	Scribner (1986)
	Creative and spontaneous behavior of managing an unexpected event	Magni et al. (2009)
	Immediate and spontaneous process of creation	Sharron (1983)

J. Manage. Eng., 2018, 34(6): 04018039

of a hundred respondents did not support the use of improvisation in organizations (Leybourne 2006). On the other hand, improvisation has played an important role in competing with other organizations and responding to emergent market conditions (Miles et al. 2007). Particularly, improvisation can be perceived as a real-time foresight, acting as a crucial component in the process-based competition among organizations (Cunha et al. 2012). Furthermore, since improvisation is considered to be an indispensable practice under emergent and/or uncertain conditions (Trotter et al. 2013), a research study was performed to check the correctness of Rasmussen's Risk Management Framework and Accimap methodology for examining the influencing factors of improvisation in critical safety situations, rendering improvisation an effective management tool (Trotter et al. 2014).

For a profound understanding, Mendonca and Wallace (2007) illustrated improvisation through a process divided into two main stages. The first stage includes identifying the lack of appropriate procedures, while the second stage represents the development and the implementation of the newly improvised plans. Additionally, considering improvisation as a decision-making practice, Klein's recognition-primed decision (RPD) model is useful in understanding the process. The model starts by assessing the uniqueness of the situation and then proceeds with the mental simulation of different alternatives in order to reach a suitable solution (Klein 1999).

As for construction, several studies have proposed solutions to manage uncertainty, especially during execution. For instance, the use of the Observe, Orient, Decide, and Act (OODA) loop along with the Last Planner system are advocated as a viable option to better control unexpected situations (Abdelhamid et al. 2009). Similarly, input control methods are proposed to be used in construction projects such as building capabilities as well as securing enough experience and knowledge (Desai and Abdelhamid 2012). Aiming to understand the construction workers' daily disruptions and decisions, an ecological momentary assessment shows that a worker's improvisational skill is required to address disruptions and to maintain a continuous flow of work (Menches and Chen 2013). On the other hand, some researchers have studied the possible use of improvisation to complement lookahead planning in construction projects. Exploratory analyses reveal that the dominant culture may prevent blue-collar employees from creating new improvised procedures even when the plans fail to address emergent situations (Hamzeh et al. 2012). In addition, construction planners are advised to enhance their improvisational skills to complement their lookahead planning and compensate for some limitations of their traditional practices (Hamzeh et al. 2012).

Similar to other organizational settings, improvisation in construction is usually observed in the case of emergent, unplanned, and/or unexpected situations. Individuals who are in charge of executing, supervising, or planning for construction tasks are those who may face unexpected or unplanned work and eventually may end up improvising to solve the problem at hand. For instance, "improvisation in the use of equipment" to execute a certain task, "improvisation of ladders and scaffolding," and "anchor improvisation for hanging chairs" are some improvisational incidents within construction operations (Tavares et al. 2015, p. 6114). However, knowledge about how to properly practice improvisation is required to avoid poor improvisational practices, safety problems, and task failures (Tavares et al. 2015).

While some studies have analyzed the practice of improvisation in construction, none seem to provide a detailed representation of the method used to improvise. However, a thoughtful understanding of the process is necessary due to its unavoidable presence while managing construction operations. This study models improvisation as a decision-making process that explains how construction planners can reach their desired outcomes. The importance of this paper lies in guiding construction professionals to practice successful improvisation by applying an effective decision-making cycle. In this case, improvisation may pose a suitable opportunity to reap the desired outcomes rather than perceiving an unexpected situation as a threat that often leads to failure.

Decision-Making Model

After the authors reviewed the practice of improvisation in different applications and analyzed the factors shaping improvisational outcomes, they developed, based on the conducted review, a decision-making model that illustrates how construction employees can reach successful decisions through improvising. Construction experts were informally consulted to check the correctness and rationale of the developed model. The model provides an opportunity to effectively practice improvisation and make use of its benefits. A detailed explanation of the model is presented in the following subsections to prudently guide improvisers and clarify the flow of the improvisational process.

To begin with, the authors divided the model into six main stages, as shown in Fig. 1. The process starts by scanning the need for improvisation, during which decision-makers may acknowledge the presence of an unplanned or emergent situation. Then, preparing for improvisation takes place to analyze the current situation (Advance 2). Otherwise, decision-makers start their normal execution of the already-planned decision in the case in which they have not detected any unplanned or emergent situation (Advance 1). In the case of Advance 2, an improvised decision is made, and asking for a second opinion is done whenever it is applicable. Afterward, the process proceeds with executing the previously improvised decision, and it ends up with documenting the method used as well as the obtained results before moving on to the next task. During execution, the team may fail to implement the planned procedures due to unplanned or emergent conditions. In this case, the need for improvisation is triggered during execution, and thus the process of improvisation is launched again starting with the stage of preparation. In this study, improvisation in construction is studied at the level of individuals who are trying to execute a certain task or endeavor. These individuals are called *planners*, irrespective of their position since they always have to plan in case they execute, supervise, or manage the work. The following subsections illustrate the stages of the decision-making model shown in Fig. 1.

Scanning the Need for Improvisation

Construction planners may identify the need for improvisation under different circumstances. In general, the readiness of the prerequisites of a certain task is essential for a successful execution. Thus, if one of the prerequisites is not ready at the time of execution, planners can resort to improvisation in order to resolve the situation and avoid wasteful interruptions in their workflow. In this case, improvisation plays an important role in managing the shortcomings of traditional planning practices. Moreover, if planners do not have enough confidence that the prerequisites would be ready at the planned time, improvisation may appear as an alternative to successfully reach the desired outcomes without delays or cost overruns. Furthermore, planners might be motivated to improvise if they detect a possible opportunity to improve the preplanned actions or tasks. Such improvisation may lead to a beneficial implementation of the required work or even to a better outcome. Fig. 2 shows the steps followed while scanning the need for improvisation. First,

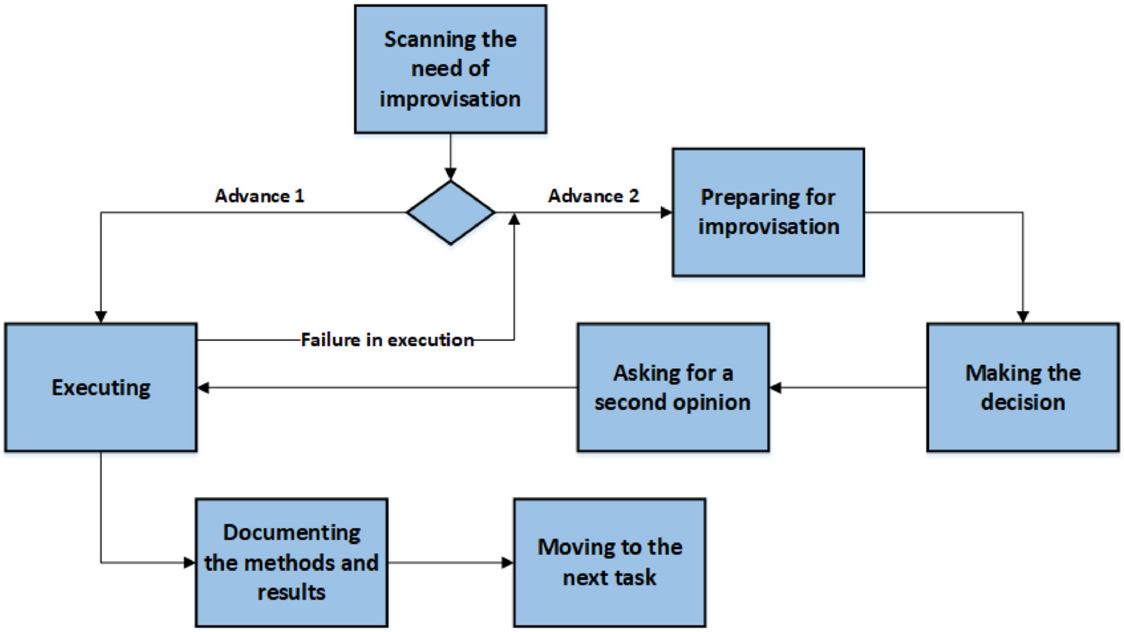

Fig. 1. Decision-making model for improvisation.

Fig. 2. Scanning the need for improvisation.

identifying the need of improvisation starts by checking the prerequisites of the planned tasks or actions. If one of the prerequisites is not ready, planners examine whether they are confident about making it ready at the time of execution. If they do not have such confidence, they may directly acknowledge the need to improvise. On the other hand, the readiness of the prerequisites or the confidence of making them ready does not prevent the planners from identifying an opportunity to improve. If an opportunity of improvement is identified, planners can resort to improvisation to implement this improvement (Advance 2). Otherwise, they can immediately start with the execution of the original plans (Advance 1).

Preparing for Improvisation

After acknowledging the need for improvisation, improvisers start analyzing the current situation and brainstorming several possible solutions. This stage represents the core of the improvisational process since it generates different solutions and thoughts for developing a suitable improvised decision. Planners usually prepare for improvisation differently. They may prefer to share the relevant information with other teams completely or partially so the other teams can benefit from their recommendations and suggestions. On the other hand, they may look at different available resources within their environments, such as referring to the firm's core values or to formal documents recording the past experimental data. In addition, they may recall information from previous personal experience and ask other teams for help. Resorting to the least demanding approach, planners may reformulate the goals to suit the available solutions or they may simply pass the current problem to upper management. Another option for improvisers is to refer to standard operating procedures. In this case, they can adapt existing procedures to the new situation by either defining new procedural parts or introducing new relevant ideas.

On the other hand, improvisers may choose to brainstorm outside the box by either breaking down the conventional methods or introducing an entirely novel procedure that does not resemble any previous one. Furthermore, recombining resources in a different way and benchmarking the procedures of competitor firms can provide the opportunity for developing innovative solutions for the current situation. Fig. 3 summarizes the possible practices carried out while preparing for improvisation.

Making the Decision

At this stage, improvisers have reached either a set of different alternatives or a single satisfactory solution, as shown in Fig. 4. In both cases, improvisers have to mentally simulate the possible results and/or perform a first-run study to assess the risk of failure associated with the improvised solution. The risk of failure represents the possibility of ending up with an incomplete task or a high level of emerging waste. Waste is defined as an activity or action that does not create any value to the final task's completion or the planned product (Jasti and Kodali 2015). In the case of different alternatives, improvisers choose a suitable solution after assessing the risk of failure and looking at the available constraints that could be related to time or different resources. Accordingly, they choose either a satisfying solution or an optimum one that entails the lowest level of waste. In the end, improvisers usually commit to executing the improvised decision unless the associated risk of failure is unacceptable.

Asking for a Second Opinion

During this stage, improvisers proceed to check others' opinion on the improvised decision. They might consult different teams within their firm or construction project in order to support their decision and get approval from upper management. If high internal agreement is found, improvisers would probably move into implementing the decision. However, if the teams do not agree on the improvised decision, improvisers have to be accountable for the consequences of their improvised action. Therefore, this stage ends up either with executing the improvised decision or with a delay, as shown in Fig. 5. Note this stage is only applicable whenever adequate time is available. In addition, not all improvisers necessarily seek a second opinion on their decisions. Fig. 5 shows the process for those who actually consider a second opinion.

Documenting the Method and Results

Documenting the method used as well as the results obtained is an important step in sharing the necessary information. Construction companies can enhance the improvisational skills of their employees by keeping records of improvisational results and lessons learned from previous practices. As shown in Fig. 6, unsatisfactory improvisational outcomes initiate the search for corrective actions. In addition, successful outcomes can be recorded before proceeding to the next task.

Proposed Hypotheses

Based on the developed model, the authors hypothesized several practices about how construction employees improvise. Six main

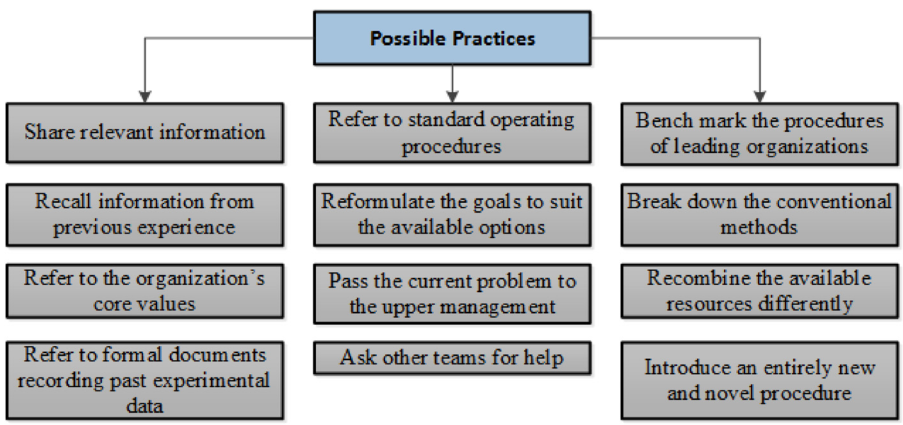

Fig. 3. Preparing for improvisation.

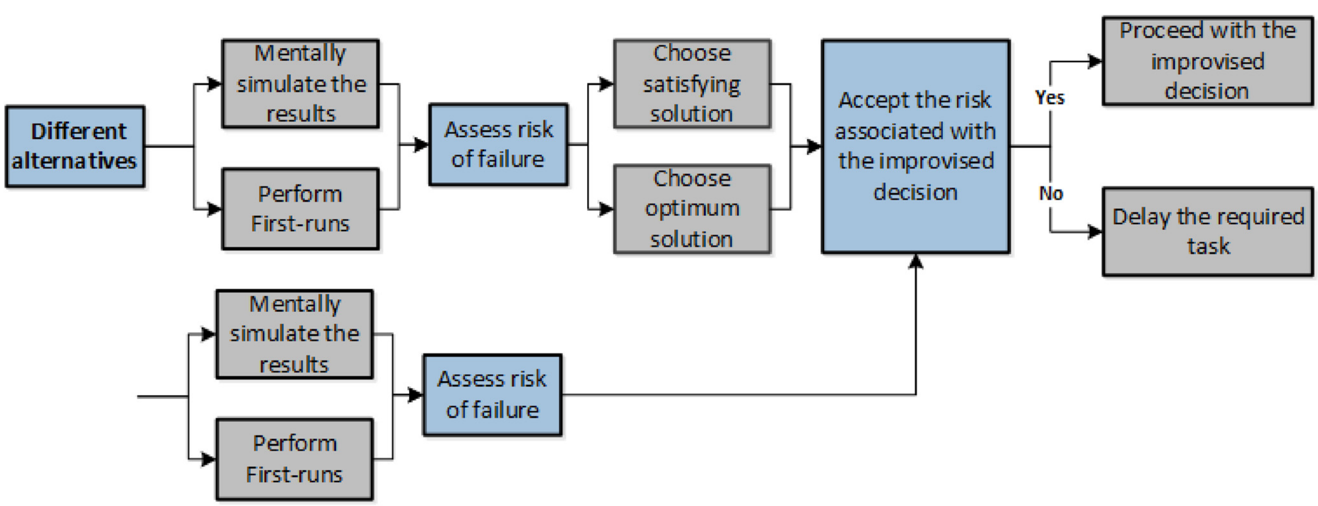

Fig. 4. Making the decision.

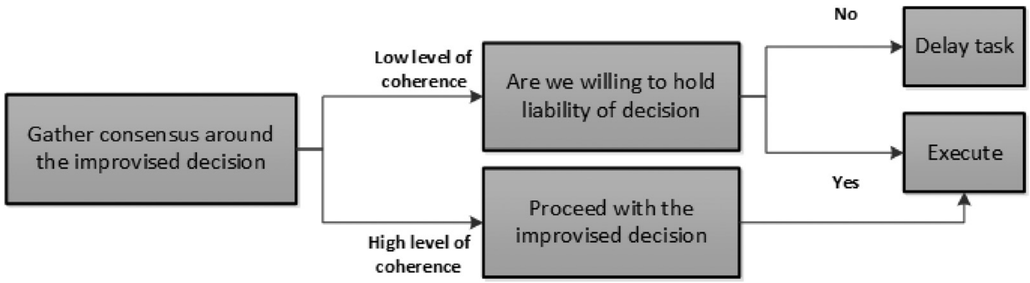

Fig. 5. Gathering consensus.

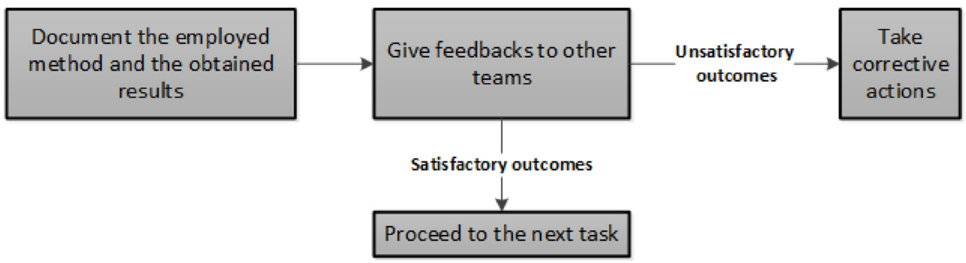

Fig. 6. Documenting the used method and results.

hypotheses are formulated to be tested through a methodology described in the next section. Hypothesis 1 addresses the most frequent way of preparing for improvisation: The corresponding null hypothesis H_0 (1) assumes that all methods of preparation are equally manifested in improvisational processes.

Hypothesis 2 investigates whether improvisers consider different alternatives while making the decision: The null hypothesis H_0 (2) postulates that improvisers do not consider different alternatives while improvising. As for Hypothesis 3, which evaluates risk assessment, the null hypothesis H_0 (3) states that improvisers do not assess risks while improvising. On the other hand, Hypothesis 4 examines the possibility of gathering consensus or taking a second opinion before executing the improvised decision. The corresponding null hypothesis H_0 (4) assumes that improvisers do not gather consensus or take a second opinion while executing improvised decisions.

Moreover, Hypothesis 5 addresses the status of documenting the outcomes and feedbacks resulting from improvisation. The null hypothesis H_0 (5) postulates that improvisers do not document the outcomes of improvised decisions. Finally, Hypothesis 6 studies the identity of the improvisers to identify the degree to which improvisation spreads in construction projects. Improvisers could be managers, workers, or collaborative teams: The null hypothesis H_0 (6) states that improvisers from all three groups have equal frequency of improvisation.

Methodology

To investigate the practice of improvisation in construction, the authors carried out a survey among construction employees to gather data describing how they improvise. The survey also aimed at testing the proposed hypotheses related to improvisation. Blue- and white-collar employees working on large construction projects were the target population of the designed survey. In this study, a project was considered to be large whenever it incorporated more than a hundred working employees and used standard planning practices and procedures. This selection was made to guarantee that a considerable number of improvisational instances exist within each project, hence giving more credibly and depth to the survey.

First, a pilot survey was conducted among a group of 10 blue- and white-collar employees, working on large-sized projects, in order to evaluate the efficiency of the survey questions. Then, several adjustments were introduced to improve the clarity of the questions and to avoid biased responses. Second, 28 large-sized projects, located in metropolitan Beirut, were selected to conduct the survey. The city combines significant residential, commercial, and industrial areas with a population of around 1 million. The surveys were filled out during semistructured face-to-face interviews with different groups of blue- and white-collar employees. The interviews were completely anonymous and held in the local language of the employees so that participants would express their opinions freely and honestly.

During a 4-month period, 120 surveys were completed after visiting the sites of the selected construction projects. The survey focused on different stages of the decision-making model, each of which was conveyed by a separate question in the survey. Respondents would answer each question using a Likert scale ranging from 1 to 5 based on the degree of agreement with each statement: 1 being strongly disagree, and 5 being strongly agree. Both blue- and white-collar professionals participated in this study; the distribution of the participants was 42.5 and 57.5%, respectively. White-collar employees had a response rate of 82%, which was higher than that of blue-collar employees, which was around 36%. The level of experience varied among the respondents: 29% had less than 5 years of experience, 30% had between 5 and 10 years of experience, and 41% had more than 10 years of experience. Regarding the occupation of the respondents, 31.7% of the respondents were site engineers, while 38.3% of them were foremen. The remaining 30% of the pool comprised section engineers; project managers; quality controllers; area managers; mechanical, electrical, and plumbing (MEP) coordinators; and construction managers, with each group constituting around 5% of the respondents. The surveyed projects incorporated 15 different construction firms or organizations that participated in the survey.

The survey mainly addressed the stages of the developed decision-making model. Accordingly, it included six areas, each of which was represented by separate questions in the survey. Area 1 investigated the way improvisers usually prepare for improvisation and involved nine statements representing different ways of preparation. Preparing for improvisation is variously manifested in the nine ways listed:

1. recalling information from previous personal experience,
2. asking another team within the firm to share their experience,
3. asking other firms to share their knowledge,
4. referring to standard operating procedures,
5. passing the current problem to the upper management,
6. breaking down the conventional methods,
7. hiring new experts to solve the problem,
8. benchmarking the procedures of leading firms, and
9. reformulating the problem to suit the available solutions.

Moreover, Area 2 of the survey studied whether improvisers consider different alternatives while making a decision. The corresponding question included two statements; one stated that different alternatives were assessed while making the decision, and the other considered the execution of the first encountered solution even if it were not the optimum one.

Area 3 of the survey examined whether improvisers assessed the risk of failure before execution. Area 4 analyzed the degree to which improvisers ask for a second opinion; it suggested that a second opinion or consensus may be considered among teams or managers responsible for execution. Area 4 also included the possibility of not gathering consensus around the improvised decision before execution. Note that consensus had been explained to the interviewees as a one-to-one agreement and not necessarily a collective agreement.

Area 5 tackled the issue of documenting the results of improvisation. Three main alternatives for documenting the results were presented in the survey. They were expressed as follows: documenting results and giving a degree of satisfaction, storing the results via computer-based network, and sharing the feedback and giving enough time for corrective actions. Last of all, Area 6 investigated the most frequent identity of improvisers. Respondents were asked to rank the frequency of improvisation being practiced by managers, workers who were informed about the problem, or collaborative teams.

Hypothesis Testing

Before testing the proposed hypotheses, the mode of each response was calculated to gain insight about the frequent practices adopted by construction employees as they improvise. The mode is an appropriate measure of the central tendency in the case of ordinal data, in which numbers represent different degrees of agreement on certain statement (Jamieson 2004). Table 2 lists the modes of the responses to questions corresponding to the six areas of the survey. The authors have noticed that most of the modes are either 4 or 2. This indicates that practices of the proposed decision-making process gain either considerable agreement or disagreement among the construction employees; hence, the results break the stalemate of neutrality in illuminating how individuals improvise in construction.

Hypotheses corresponding to the six areas of the survey were tested using several statistical approaches. Initially, assuming a normal distribution of data and equal variances, the ANOVA (analysis of variance) test was used to analyze variances and identify whether a significant difference exists between the data sets under study. If normality of the data was not found, the Kruskal-Wallis rank sum test was performed as a nonparametric test. Then, using the Wilcoxon rank sum test, a pair-wise comparison was performed using the Holm-Bonferroni method as the p-value adjustment method to detect which data sets were significantly different. The authors applied the t-test to examine significant difference, assuming a normal distribution of data, as well as the Shapiro test to study the normality of data. In addition, the authors performed the Mann-Whitney test to examine the significant difference between two data sets without assuming any distribution, but assuming equal variances. Moreover, the Bartlett test was applied in the case of more than two data sets having equal variances.

Table 2. Summary of survey results

Test	Responses	Mode
Preparing to improvise	Recalling information from previous personal experience	4.00
	Asking another teams in the organization to share their knowledge and experience	4.00
	Asking other organizations to share their knowledge	4.00
	Referring to standard operating procedures	4.00
	Passing the current problem to the upper management	2.00
	Breaking down the conventional methods	4.00
	Hiring new experts to solve the problem	3.00
	Benchmarking the working procedures of the leading organizations	4.00
	Trying to redefine the problem to fit available solutions	4.00
Considering alternatives	Generating and assessing different alternatives	4.00
	Executing the first encountered solution even if it is not the optimum	2.00
Risk of failure	Assessing the risk of failure before execution of the improvised decision	4.00
Gathering consensus	Gathering consensus among managers who are responsible for executing the task	4.00
	Gathering consensus among all team members	4.00
	Not gathering consensus	2.00
Documenting the results	Documenting the results and giving a degree of satisfaction	4.00
	Storing the information using a computer-based network	4.00
	Sharing the feedback about improvisational outcomes and giving enough time for corrective actions	4.00
Identity of improviser	Managers who are responsible for executing the task	2.00
	Workers who are informed about the problem	4.00
	Collaborative teams	4.00

For Hypothesis 1, respondents ranked several ways of preparation, which are represented through nine different statements in Table 2. Results show that respondents frequently prepare for improvisation by recalling information from previous experience (A), and they seldom pass the problem to upper management (E). This indicates a heavy dependence on existing knowledge and an absence of innovative thinking while improvising. On the other hand, after performing the necessary statistical tests for Hypothesis 2, results reveal that improvisers usually do consider different alternatives before executing the improvised decision as shown in Table 3. However, this test might include a high degree of desirousness, given that most of the construction employees preferred to claim that they always consider alternative solutions for the encountered problem.

As for Hypothesis 3, statistical testing shows that assessing the risk of failure before proceeding to execution is a common behavior among improvisers. Moreover, for Hypothesis 4, after the respondents ranked 3 for possible practices of gathering consensus or opinions, statistical testing shows that consensus or second opinions are frequently gathered only among managers. Therefore, the opinions of workers and other team members regarding the improvised decision are usually discarded prior to execution.

Regarding Hypothesis 5, statistical tests reveal that improvisers frequently document the outcomes of their improvisations. Therefore, improvisers are acutely aware of the importance of their feedback in improving their improvisational practices. Finally, the results of testing Hypothesis 6 affirm that workers are considered to practice improvisation more often than managers. Therefore, the practices of improvisation are more common among those who actually execute the work. The distribution of the collected ranks of the three groups (manager, teams, and workers) is shown in Fig. 7. Table 3 summarizes the statistical analyses corresponding to the six hypotheses.

Fig. 7. Identity of improvisers.

Discussion

Results show that improvisers frequently recall information from previous personal experience while preparing for improvisation. In addition, they seldom pass the problem to upper management without trying to solve it. Therefore, they either rely on existing knowledge or consult higher managers to achieve an improvisational outcome. However, as mentioned in the decision-making model, improvisers have plenty of practice preparing for improvisation. Notably, improvisers do not disregard the innovative approach while solving problems. Improvisation should be recognized as an opportunity to bring out novel solutions and to think outside the box when planning and executing in the construction industry. This is similar to what Magni et al. (2009) recognized in other industries: Improvisation can be used as method for injecting creativity for managing unexpected events in organizations. Therefore, a shift of focus toward innovation beyond the realm of previous knowledge should not be dreaded during the process of improvisation.

Fortunately, results confirm that most improvisers consider different alternatives while making a decision and assess the risk of failure associated with the improvised action before execution. During improvisation, exploring a wider range of alternatives and evaluating the risk of failure are essential requirements in seeking the most optimum or desired outcome. Results from investigating the degree to which improvisers gather consensus before moving on to execution show that consensus is frequently gathered only among managers. The authors encourage white-collar professionals to have greater appreciation for the opinions of the workers and to address the practicality aspects of an improvised decision. Although white-collar professionals can deeply analyze unplanned or emergent situations, they might fail to evaluate the practicality or constructability of the improvised decisions.

The practice of documenting the results of improvisation seemed to be a common habit among most improvisers. Confidently recording the feedbacks and the outcomes resulting from improvisation can contribute to the enhancement of the improvisational practices within construction firms because it ensures that future improvisers will not repeat an unfavorable scenario. The latter inference comes to an agreement with Chelariu et al. (2002) who insisted that when improvisers share more information and feedbacks, future improvisational practices are expected to be more productive and faster. Besides, in this study, the survey results show that workers practice improvisation more than managers. This ensures that improvisation is a workable and dependable practice that leads teams to find suitable solutions rather than considering it only a theoretical approach to solving emergent problems.

Table 3. Summary of statistical analyses and hypotheses testing results

Area	Statistical tests	p-Value	Results
Preparing for improvisation	Kruskal-Wallis rank sum test, Wilcoxon rank sum test	$<2.2 \times 10^{-16}$	• Reject the null hypothesis H_0 (1) • Significantly different groups (A) and (E)
Considering alternatives	Paired Wilcoxon signed rank test	1.65×10^{-13}	• Reject the null hypothesis H_0 (2) • Significantly different groups
Assessing the risk of failure	one sample sign t test	7.00×10^{-13}	• Reject the Null Hypothesis H_0 (3) • Significantly, mean is different from 3
Gathering consensus	Kruskal-Wallis rank sum test, Wilcoxon rank sum test	2.20×10^{-16}	• Reject the null hypothesis H_0 (4) • Significantly different groups
Documenting the results	one sample sign t test	8.3×10^{-11}	• Reject the null hypothesis H_0 (5) • Significantly, mean is different from 3
Identity of the improviser	Kruskal-Wallis rank sum test, Wilcoxon rank sum test	4.39×10^{-15}	• Reject the null hypothesis H_0 (6) • Significantly different groups

Note: (A) = recalling information from previous personal experience; and (E) = passing the current problem to upper management.

Based on the preceding discussion, the authors suggest that construction companies should invest in training their crews on proper ways to use improvisation. This model is deemed important to guide improvisers in construction for better performance. Construction planners have to explore different means to improvise so they can act accordingly whenever these means are needed. Besides, improvisational performance would improve if planners were more knowledgeable about assessing the need to improvise. In addition, establishing improvisation as a clear methodical process that planners can learn and practice in a certain construction company would greatly impact improvisational practices in that company. The authors are not suggesting abandoning traditional planning practices to embrace improvisation. On the contrary, improvisation is here recommended as an essential type of decision-making to accompany current planning practices in addressing the volatile issues of uncertainty and dynamism. However, the benefits of improvisation will not be properly reaped unless construction companies make efforts to enhance the improvisational skills of their employees.

Conclusions and Further Research

As the need for improvisation increases within construction operations, a thoughtful understanding of the process is indeed essential in the field of construction management. This study analyses the process of improvisation through the development of a decision-making model that demonstrates the method that practitioners use when improvising. The developed model plays an important role in guiding different construction planners to follow a methodical thinking while improvising, thus leading to successful improvised decisions. As part of the study, the authors have conducted a survey of 120 blue- and white-collar professionals on 28 construction projects to investigate the practice of improvisation in construction as well as to test the proposed hypotheses, which are mainly based on the developed model.

Current planning procedures have failed to completely manage the inevitable problems of uncertainty and emergency, and construction professionals are starting to appreciate the role of improvisation. This study has developed a useful decision-making model that guides construction professionals toward successful improvisational practices. For a comprehensive analysis of improvisation, further studies are required to evaluate the different factors that shape the improvisational practices in construction processes.

Acknowledgments

This research was supported by the university research board (URB) under grant 22264 and by the Civil and Environ-mental Engineering Department at the American University of Beirut. All support is gratefully acknowledged. The authors thank all the practitioners who participated in the interviews and provided vital information related to their construction experience. This research would not be possible without their help.

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