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THE CENTER FOR CONSTRUCTION  
RESEARCH AND TRAINING

## **Exploring Potential Methods to Evaluate Impact and Outcomes of Construction Safety and Health Research**

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## Project Summary

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Evaluating the impact of construction safety and health research findings and interventions is an ongoing research to practice (r2p) challenge due to the complex and fragmented nature of the industry. While evaluation approaches such as tracking the number of units sold, auditing project records, and observing use of an intervention on jobsites may work within a small market, with one employer, or with one manufacturer, these approaches would be too resource intensive to be practical on a national scale or for multiple interventions.

CPWR-The Center for Construction Research and Training's (CPWR) r2p initiative supports all of the Center's research projects and currently uses metrics on the use of translational products (e.g., web metrics, distribution of print materials, requests from stakeholders) to measure awareness, and surveys of industry stakeholders to gather information on the use of research findings and interventions. While these approaches provide some important information on awareness and use, they offer limited insight into whether an intervention is penetrating the market and becoming the norm on job sites.

The aim of this project was to support ongoing efforts to identify new and effective ways to evaluate CPWR's r2p initiatives. Specifically, there was a focus on dissemination and implementation (D&I) science and determining if establishing stakeholder evaluation panels, based on the Delphi Method, would be an appropriate approach or if there is a more sustainable option or combination of approaches to better gauge the r2p impact.

This project involved three main elements:

- Conducting a literature review on the use of Delphi Panels in construction research and their potential use in assessing whether construction safety and health research findings are being used by target audiences of workers and contractors to reduce injuries and illnesses (r2p).
- Conducting a concept mapping study to understand researchers' and practitioners' perspectives on the best ways to find out whether evidence-based safer tools, work practices, and other resources are being used on construction jobsites.
- Using the findings from the literature review and concept mapping to determine if panels are the appropriate approach and to inform how such panels could be designed to evaluate impact, including the structure, membership composition, how the panels would interact and be assessed, and recruitment.

**The findings from these steps include:**

- The Delphi Method has potential for engaging construction stakeholders in assessing the extent to which research findings are being adopted on construction sites and influencing safety and health outcomes.
- Although the concept mapping study did not engage the cross-section of stakeholders anticipated, the results supported the need to engage stakeholders in measuring impact and outcomes and identified other approaches that should be considered.

## Introduction

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Despite ongoing efforts to improve site safety, the construction industry still accounts for a disproportionate injury rate and remains one of the most dangerous industries for workers. Evaluating the impact of construction safety and health research findings and interventions is an ongoing research to practice (r2p) challenge due to the complex and fragmented nature of the industry. For example, the construction industry involves many different types of tasks and project types; no fixed work sites; job sites that employ anywhere from 1 to thousands of construction workers; a predominance of employers with fewer than 20 employees; multiple manufacturers marketing variations of similar tools and equipment; and a diverse and mobile workforce. Evaluation approaches to measure adoption and use of research findings and interventions such as tracking the number of units sold, auditing project records, and observing use on jobsites may work within a small market, with one employer, or with one manufacturer. However, on a national scale or for multiple interventions, these approaches would be very resource intensive and may not be practical or feasible.

For example, significant research has been conducted on how use of a sequential trigger instead of a bump trigger on a nail gun can reduce injuries and fatalities, and CPWR, NIOSH and OSHA have developed resources to promote use of the safer trigger option (move the research into practice). While metrics are readily available on use of the promotional resources, there is a lack of information on whether the research and related r2p efforts are resulting in increased use of the safer trigger option on jobsites. This gap in information on the impact could be because nail guns are frequently used on small projects and by contractor and worker populations that are difficult to reach, and manufacturers' not sharing sales information.

The aim of this project was to support ongoing efforts to identify new and effective ways to evaluate CPWR's r2p initiatives. This included a focus on dissemination and implementation (D&I) science and determining if establishing stakeholder evaluation panels based on the Delphi Method (also called Delphi Panels or the Delphi technique) would be an appropriate approach or if there is a more sustainable option or combination of approaches that can be used to better gauge the r2p impact.

### Dissemination and Implementation Research

Broadly, D&I science is the study of the translation of research findings into practice in order to improve health outcomes in the broader community (Lobb and Colditz, 2013). The National Institutes of Health (NIH) has determined more specific definitions of each. NIH defines dissemination research as “the scientific study of targeted distribution of information and intervention materials to a specific public health or clinical practice audience. The intent is to understand how best to spread and sustain knowledge and the associated evidence-based interventions.” NIH defines implementation research as “the scientific study of the use of strategies to adopt and integrate evidence-based health interventions into clinical and community settings in order to improve patient outcomes and benefit population health” ([NIH website](#), accessed 2018).

## Washington University in St. Louis' Dissemination and Implementation Research Core

The Dissemination and Implementation Research Core (DIRC) at Washington University in St. Louis is a core within the Institute for Clinical and Translational Science (ICTS) that provides methodological expertise to D&I researchers within the Washington University community (i.e., faculty and their collaborators). For this project, DIRC helped CPWR determine if ongoing panels are an appropriate mechanism of data collection to assess outcomes and impact of r2p activities, and how such panels could be structured to serve as a surveillance system to assist in tracking the impact of r2p dissemination and implementation efforts.

## Methods

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DIRC researchers conducted a literature review on the use of the Delphi Method in construction research and a concept mapping study was conducted in coordination with CPWR researchers. The methods for these two pieces of this project are described briefly below. The reports can be found at <https://www.cpwr.com/research/research-practice-library>. The findings from these two studies were used to address a need identified by CPWR to find new and effective ways to measure the use of construction safety and research findings and interventions and evaluate their impact. These studies were used to determine if evaluation panels are the appropriate approach, to inform how Delphi Panels could be structured to evaluate impact, and to identify other actions to consider to supplement the work of such panels.

### Delphi Panel Literature Review

The Delphi Method is a systematic procedure that is employed to achieve a reliable consensus among a selected panel of experts. This project's purpose was to review relevant papers and research on Delphi Panels and their potential use in assessing whether construction safety and health research findings are being used (e.g., research to practice) by target audiences of workers and contractors, including their managerial staff, to reduce injuries and illnesses. A secondary objective of this review was to understand the parameters of panel selection, composition, and analysis. A trained research assistant under the direction of DIRC faculty members conducted this review.

To identify relevant papers for the main review, the reviewer used currently available tools to search both the published literature and the "grey literature" of unpublished manuscripts, dissertations, and reports. Original research and review articles were reviewed and summarized. The following databases were searched using relevant search terms: Academic Search Complete, ArticleFirst, Business Search Complete, Proquest, Google Scholar, and ScienceDirect. A broader net was cast to capture a larger number of studies that were judged to be relevant (i.e., those that included the Delphi Method in any construction research area – not solely construction safety).

An additional search was conducted based on a 2016 review, "Application of Delphi Method in construction engineering and management research: A quantitative perspective" by Amenyaw and colleagues. This review included articles from researchers such as Gambetese, who have done extensive

research on safety and health in construction. Additional papers published since the review were identified using the same method as Amenyaw et al. The literature review can be found at <https://www.cpwr.com/sites/default/files/publications/SS2018-Delphi-Panels-Narrative-Review.pdf>.

## Concept Mapping

Concept mapping is a participatory approach to organizing ideas using a mixed methods (i.e., combining qualitative and quantitative data) approach (Kane & Trochim, 2007; Rosas & Kane, 2012). This methodology engages diverse stakeholders in a multistep process to generate ideas, organize them into distinct categories, and rate the ideas according to a set of criteria, for example how feasible or important is each idea (Rosas & Kane, 2012). Once participants organize the ideas into different groupings, these related concepts are clustered visually (concept maps) and statistically (Rosas & Kane, 2012). This project's purpose was to provide insights into researchers' and practitioners' perspectives on the best ways to find out whether evidence-based safer tools, work practices, and other resources are being used on construction jobsites.

Concept mapping for this project was conducted online using the Concept Systems Global Max platform (<https://conceptsystmsglobal.com/index.php>). This tool allowed the methodology to be used to engage with a geographically diverse group of stakeholders. Key steps in the concept mapping process included: (1) generating statements; (2) sorting statements and developing the concept maps (i.e., visual representation of the statements); and (3) rating and prioritizing statements and clusters.

The survey link for this project was shared with participants in safety and health meetings occurring when the project was undertaken and sent via email to a larger convenience sample of stakeholders. All responses were anonymous – no personal identifiers were requested, and no attempts were made to connect an individual or organization with a response. The initial step in the process was intended to take less than ten minutes, and participants were given a two week window to respond with ideas. A reminder was sent at the end of week one.

The number of individuals who clicked on the link to participate exceeded the 100-minimum goal, and 53 volunteered to participate in the sorting and rating steps. Of those, 20 completed the sorting step and 21 completed the rating step. One individual started, but did not complete the sorting step, before moving ahead to the rating step.

The results of the concept mapping can be found at <https://www.cpwr.com/research/research-practice-library>.

## Results and Next Steps

The DIRC team identified evidence-based findings from the literature review and insights gained from the concept mapping study to determine the appropriateness of evaluation panels and to inform the design of the panels, how they would be evaluated, and other approaches that could be used to supplement these efforts.

## Delphi Panel Literature Review

Based on the literature review, the Delphi Panel approach is considered appropriate for evaluating whether safety and health research findings and interventions are being used. There were more than 50 studies identified that used the approach in various segments of construction research. Thus, we can conclude that the methodology is considered acceptable to stakeholders (i.e., potential expert panelists) even though few of these studies were specifically in construction safety research. Also, because of its widespread use we can conclude that the methodology is rigorous enough to meet the standards of researchers. Further, there was enough literature to synthesize a literature review published in a peer-reviewed journal (Ameyaw et al., 2016), which indicates that there is enough interest behind the methodology in the field. Last, the method is considered promising because there was sufficient consensus on parameters such as panel composition from the Ameyaw review as well as the additional papers that were identified by the DIRC literature review.

## Concept Mapping

The concept mapping project was successful in recruiting stakeholders from a broad range of categories to participate in the brainstorming step. These participants generated 61 unique ideas (statements) for evaluating the translation of research into practice. Twenty of these stakeholders participated in the next step to sort these statements into groupings, and 21 participated in the final step to rate statements on usefulness and feasibility. Participants for sorting and rating were primarily those working as safety and health trainers or professionals. Stakeholders grouped the 61 ideas into seven distinct groups: observe jobsites; evaluate safety plans; compile data; develop innovative tracking methods; survey employees and experts; engage stakeholders; and implement and evaluate training.

While the findings were somewhat limited by the narrow range of stakeholders who participated in the sorting and rating steps, concept mapping confirmed both the usefulness and feasibility of engaging stakeholders in finding out whether safer tools, work practices, and other resources that result in safety and health research are being used on construction sites. The two categories that participants felt were both the most useful and feasible for finding this information were “Survey employees and experts” and “Engage stakeholders” – both focus on involving stakeholders and support the idea of establishing Evaluation Panels of industry stakeholders to help measure use of selected interventions.

## Key Recommendations for Establishing and Implementing Evaluation Panels

### Panel membership

In order to be considered a Delphi Panel study, according to the literature review, panelists must be qualified as experts using stated criteria prior to starting the first round of data collection. “Experts” in this regard refers to professionals and/or researchers that have special and relevant knowledge and experience and who meet a set of criteria established by the primary investigators including relevant publications, professional qualifications, and work experience (Hallowell, 2008). Broadly speaking the main qualification criteria used were education, experience, size of organization, professional qualifications (e.g., member of a national committee), and authorship. Based on the concept mapping results, a diverse group of experts can and should be engaged to understand if evidence-based safer tools, work practices, and other resources are being used on construction jobsites from a broad set of

perspectives. For the proposed Evaluation Panels, it is recommended that criteria for selecting panel members be established at the beginning of the project, and then experts are identified who meet the desired criteria. Criteria to define an expert should include knowledge of the industry, the task the intervention is designed for, and direct knowledge of practices on job sites.

#### Panel size

The literature review indicates that the size of Delphi Panels can range from 10 participants into the hundreds and that satisfactory results have been found with small, homogeneous panels with between 10 and 12 members. While existing construction research literature is inconclusive regarding the ideal size of a Delphi Panel, Hallowell and Gambatese have advocated for a minimum panel size of between 8 and 12 individuals. Based on the fact that the proposed Evaluation Panels would be homogeneous groups and Hallowell and Gabatese's experiences in the construction industry, we recommend that each panel range in size from 8 to 12 participants.

#### Data collection procedures

Data collection for the rounds of Delphi Panels was most frequently completed through questionnaires sent to panel participants by email. Additionally, some used focus group discussions and key informant interviews to triangulate quantitative data with qualitative data that provided important contextual information. The amount of time between each round (e.g., one week/month) took into consideration the number of items in the questionnaires to reduce burden.

Based on these procedures in the literature, collecting data by email and online questionnaires, and providing feedback through email is recommended to accommodate panel members that are geographically separated and reduce overall participant burden.

One month intervals between rounds is recommended as a starting place to reduce burden and allow r2p staff to synthesize results and provide feedback to expert panelists. It is also recommended that data collection and feedback procedures be established and made clear to participants at the beginning of the project to ensure they are feasible and reduce attrition.

In addition, once data collection has been completed for each round, it is recommended that feedback be provided to allow expert panelists to anonymously consider the opinions and experiences of other members. The literature review found that feedback is usually provided in writing and includes quantitative statistics from previous rounds.

#### Number of rounds needed to reach consensus

Iteration is a critical quality of the Delphi Panel results, because through each round the group can be brought to a consensus. The literature reviewed showed that there was no clear and specific guidance on the ideal number of rounds, but most studies found consensus after two rounds and diminishing benefits with additional rounds. Thus, it is recommended that two rounds be used to achieve member consensus on a topic. Factors such as participant attrition and membership composition should be

considered in light of this recommendation; for example, more rounds may be needed when panels are more diverse.

## Additional Considerations for Future Work

Beyond the knowledge gained from the literature review, there are additional considerations for the formation and use of evaluation panels.

### Number of panels

The literature review did not yield information on the use of sequential Delphi Panels to investigate separate ideas. It seems feasible to use this approach to investigate multiple questions, although considerations should be made for the time, financial, and staffing resources involved. It is recommended that CPWR begin with two pilot panels and synthesize results to determine the value of this approach for evaluation. If they are found to be valuable and, if there are resources available and a need, additional panels can be established.

### Focus of the panels

There should be an intentional organization to the sequence and focus of the panels. CPWR should prioritize the specific interventions to evaluate. During a pilot phase, it is recommended that the first pilot panel seek to understand an intervention that has broad application in the industry, and the second pilot panel could be used to understand how to measure another intervention that has a narrower group of end-users.

### Recruiting panel members

The literature did not provide guidance on methods to recruit panel members; instead focusing on the considerations for selecting panel members. Because the goal with Delphi Panels is to identify experts, regardless of how those coordinating the panels define experts, recruitment will likely require recommendations and help from industry stakeholders. Working with stakeholders to nominate panel members and assist with recruitment will be crucial to ensuring that the panels are composed of appropriate participants.

### Assessing the Evaluation Panels

A number of indicators were identified to evaluate the proposed Evaluation Panels. These include

- **Recruitment:**
  - Number of participating experts
  - Percent of invited experts who agreed to participate (number enrolled / number invited \* 100)
  - What methods were most successful for recruitment?
- **Retention:** percent of experts who agreed to participate who remained in the panels (number remaining at end / number enrolled \* 100)

- **Responsiveness:** How many follow-up prompts (emails or calls) did it take to yield an adequate response?
- **Feasibility:** Were the number of rounds initially planned successfully completed?
- **Acceptability:** If using qualitative data collection methods, questions can be asked about whether they liked the Evaluation Panel process, thought it was useful to the field, and what they would change about it from the perspective of a participant.
- **Impact:** Were the Evaluation Panels effective in assessing use of an evidence-based intervention? Impact could be assessed by determining if CPWR is able to learn about changes in use of an intervention as well as any information on why intervention use changed.

### Other approaches to consider

Participants in the Concept Mapping project suggested several other methods that could be used to complement information gathered from the proposed Evaluation Panels. There was a focus on learning from trainers what interventions are being used in their training programs and if there are opportunities to include key innovations in their trainings. Another suggestion was to review required (e.g., OSHA) and voluntary standards (e.g., American National Standards Institute) to identify whether they include or have been changed to require evidence-based equipment and practices. For a more distal, worker-level outcome, a suggestion was made to collaborate with the insurance industry to examine changes in workers compensation data to see if injuries that an intervention was intended to prevent have gone down. Last, it was noted that it would be helpful to compile a database of survey results and information from other sources that provide insights into use of interventions.

## Conclusions

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This report provides recommendations for establishing Evaluation Panels, based on the Delphi Method, to assess the effectiveness of CPWR's r2p efforts. The recommendations build upon existing literature demonstrating that the Delphi Method is a promising tool for identifying, evaluating, and forecasting in construction research. Currently, the Delphi Method has not been used widely in construction safety and health research; however, the method has potential for greater use in this type of research to assess the extent to which research findings are being adopted on construction sites and influencing safety and health outcomes. Based on these recommendations, the next steps in this line of inquiry would be to establish and pilot test panels using the Delphi Method and determine their success based on the process and impact outcomes described above.

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