What becomes of research? Improving translation of earthquake engineering research to practice and policy

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ABSTRACT: Improving community resilience to natural disasters requires that the latest research findings in earthquake engineering are accessible and immediately usable for driving action in practice and policy. Despite significant research efforts, the earthquake engineering profession has been slow in adopting innovative structural technologies and performance-based design procedures. Many reasons exist for this, but one issue may be the translation of research findings to end users. Developments in other fields may provide a guide for how to bridge this gap. Over the past two decades, healthcare fields have made substantial progress implementing research findings in practice and policy. This paper presents the findings of a literature review on the practices in healthcare that have increased the use of research by practitioners and policymakers. Five general factors are found to improve translation of knowledge to policy and practice. This paper looks to apply these findings to earthquake engineering and identifies the needs for improving the application of earthquake engineering research in practice.

1 INTRODUCTION

For earthquake engineering research to have an impact on earthquake risk reduction it must be accessible and usable to practitioners and policymakers. Towards this end, science funding in New Zealand has moved to an outcome based evaluation system (Lillis 2000; NHRP 2012), but questions remain about whether earthquake engineering research is leading to significant changes in practice and policy (Uma 2013). The earthquake engineering profession has been slow in adopting innovative structural technologies and performance-based design procedures (May 2002; Uma 2013). Many reasons exist for this, but one issue is the translation of research findings to end users in a timely manner to facilitate its use in the design and construction of the built environment.

Overcoming the barrier between "what we know" and "what we do" is not unique to the earthquake engineering field. Other research fields such as health, public health, education, land use planning, and social science struggle to overcome this issue (Becker and Johnston, 2002; Caplan 1979; Cheek, et al. 2009; Cherney, et al. 2012; Eiser, et al. 2012; Glavovic, et al. 2010; Graham, et al. 2006; Knezovich 2013; Paton et al. 2005; Rajic, et al. 2013). The healthcare field in general and the Canadian Institutes of Health Research (CIHR) in particular have been at the forefront of developing ways to close this gap, using a framework generally called knowledge translation (CIHR 2004; Garnham, et al. 2009; Rajic, et al. 2013). The lessons learned in this and other fields may provide a guide for improving research uptake in earthquake engineering. This paper presents the findings of a literature review on the topic of knowledge translation, identifies five general practices that have increased the use of research by practitioners and policymakers in other fields, and comments on their application in earthquake engineering.

2 BACKGROUND

Knowledge translation focuses on turning knowledge into action and facilitating the use of research findings by practitioners, policymakers, and the public. Knowledge translation endeavours to ensure that the best available knowledge is used to inform practice and policy and to maximise the benefit of public research spending (CIHR 2012; Graham et al. 2006; Rajic et al. 2013). Over the past two

decades, the concept of knowledge translation has developed largely in the fields of medicine and public health out of a desire to improve the health of people using the best knowledge available (Graham et al. 2006; Rajic et al. 2013). At the same time, researchers in these and other fields are increasingly being asked to consider how their research findings will result in tangible impacts, and practitioners and policy makers are being asked to demonstrate the scientific evidence supporting a particular policy (Spilsbury and Nasi 2006). As a result, numerous studies have investigated ways to facilitate delivery of knowledge to end users (Cheek et al. 2009; Cherney and McGee 2010; Davies and Nutley 2008; Donovan 2007, 2008; Ketelaar et al. 2008; Witten and Hammond 2010).

Knowledge translation is important in the earthquake engineering field as well. It ensures that funding agencies are making the best possible use of their resources for the public good and that research is making its way to practice in a timely fashion, ensuring that practicing engineers are using the best available science and technology to improve the safety, reliability, and resilience of the built environment. To be sure, not all research can or should have a direct impact or influence on policy or practice. It is unrealistic and unnecessary for all research to strive to be implemented in practice or policy (Rajic et al. 2013). Blue sky or basic research, for example, serves to advance the profession beyond what is practical today and is intended to build a body of knowledge. The path from basic research to implementation may be indirect and take many years to develop to a stage where it can be applied in practice. However, even basic research can benefit from consideration of the potential research user (Tetroe 2007). Much of the research in the earthquake engineering profession is directed at finding ways to improve the design, construction, and assessment of the built environment and is intended to be practically useful. Research of this kind can benefit from finding new ways to translate the findings of that research to drive action in a timely manner.

3 METHODS

For this study a literature review was conducted using the initial search term "research uptake" in the SCOPUS and Web of Knowledge databases. After reviewing the literature, a second search was performed using the search term "knowledge translation." Several references from the selected articles were also reviewed. The majority of the results were in the public health and healthcare fields. Other fields represented were social science and education. A total of 29 articles were selected and reviewed. The selected literature in no way encompasses the full body of research on the topic of knowledge translation, but it provides a sample with which to identify trends and themes within the literature.

4 RESULTS

This section describes two major research models identified in the literature: the linear or passive research model and the knowledge translation model. Each is discussed in detail below.

4.1 Passive/linear research model: the traditional approach

Traditional research is a linear, uni-directional process where research is conducted and then the findings are transferred to end users, usually through publication in research journals and conference presentations. These modes of communication are primarily aimed at other researchers and are the best approach when research is in the early stages of discovery or when knowledge is not yet appropriate for application (CIHR 2012). If the communication of research findings stops here, however, it is up to the practitioner or policy maker to identify relevant research, read it critically, digest the findings, and apply them in regular practice. In this model, the research and the use of research are separate activities with little interaction between the two. Some attempts may be made once the research is completed to disseminate the findings to a wider audience, but this stage is not generally considered part of the research per se (Garnham et al. 2009).

There are many reasons that research may not make the jump to application on its own, such as lack of readily applicable research, lack of awareness and access to published research outputs, challenges in understanding and interpreting the literature, time constraints on the practitioner, and lack of organisational support or insufficient authority to implement research findings (Bedford 2012; Caplan

1979; Hutchinson and Johnston 2004; Knezovich 2013; Poulos et al. 2007). These papers and other explore ways to overcome these barriers and facilitate application of research primarily by making the findings of research more accessible and developing better dissemination strategies. Common strategies include preparing literature syntheses and policy briefs and developing guidelines for implementing and applying research (for example, DFID 2013). While better implementation of these strategies should be explored in earthquake engineering, when taken alone they focus only on the demand side of the equation. These strategies primarily rely on end users to identify and read published research and adapt it to their own needs. Studies suggest that the 'pushing out' of research does little to promote interaction between the research and practitioner communities and has not proven to be very effective, as the receipt of knowledge is not the same as use of knowledge (Caplan 1979; CIHR 2004; Garnham et al. 2009; Lavis et al. 2002; Lomas 1997).

4.2 Active/parallel research model: knowledge translation

In reality, practical application of knowledge happens within the context of institutional constraints, and economic and political environments that shape decision-making. These factors make it a challenge to simply insert and implement research conducted in a controlled setting into the complex and messy world of practice. An active or parallel research model places end users not as passive recipients and direct translators of knowledge, but as active and equal partners in the generation of research knowledge (Cheek et al. 2009; Garnham et al. 2009; Graham et al. 2006). This model gives equal importance to research-based knowledge and practice-based insight, valuing the perspective of practitioners and the ultimate benefactors of research (for example, building owners and tenants in earthquake engineering).

Often called knowledge exchange, knowledge transfer, knowledge translation, or research utilisation in the literature, this model emphasises collaboration, partnership, and on-going dialogue to ensure that research is relevant and responds to an identified need in practice or policy (Garnham et al. 2009; Graham et al. 2006; Godfrey et al. 2010). While knowledge exchange is the most appropriate term for the model, knowledge translation is used here to be consistent with the majority of works on the topic. It is important to emphasise, however, a focus on the collaborative research aspect of the definition, recognising that the worlds of research, practice, and policy are typically separate, distinct groups with distinct cultures and perspectives on research and knowledge, and that to successfully drive action the groups must come to understand each other and their respective needs (Graham et al. 2006).

Knowledge translation is a nonlinear, fluid process that has implications for all stages of the research process. Underpinning the success of knowledge translation are partnerships and collaborations to develop a research process that meaningfully involves end users throughout the process, beginning with the development of the research question (CIHR 2004). Knowledge translation strategies have the potential to help define research questions and hypotheses, select appropriate research methods, conduct the research itself, interpret and contextualise the research findings, and apply the findings to resolve practical issues and problems (CIHR 2004). These strategies increase the relevance of the research and ensure that it responds to a clearly identified need or question.

4.3 Knowledge translation case study

CIHR is the principal health research funding in Canada and was created with the dual mission of producing excellent research and ensuring that the findings of that research get into the hands of those that can use them to improve the health of Canadians (CIHR 2004). Knowledge translation, a specific and prominent part of the mandate, is included with the goal of significantly increasing the benefits to Canadians from their investment in health research, as well as placing Canada at the forefront of health-related knowledge translation.

Towards this end, CIHR developed a major initiative to build capacity for knowledge translation of health research and, importantly, included knowledge translation as a key part of its grant program. All grant applications are required to include a strategy for either integrated knowledge management or end-of-grant knowledge translation. These proposals must demonstrate that the proposed project was shaped by knowledge users and that it responds to their knowledge needs.

End-of-grant knowledge translation includes developing ways to disseminate research findings to end users of research and specifically involving those users to determine the appropriate strategy for the audience (CIHR 2012). This dissemination plan is not inherently different than one that might take place in a traditional research model, but the key difference is that a dissemination strategy is specifically included in the research plan and conducted as a part of the research program in partnership with those who will actually use and benefit from the research findings. Integrated knowledge translation requires, in addition to a dissemination plan, that end users are members of the research team and participate in many stages of the research process.

CIHR recently implemented a policy to make research findings more accessible to users of research by requiring that original research articles are freely available online as soon as possible after publication (Tetroe 2007). This can be achieved by depositing the article into an online archive or institutional repository or by publishing the results in an open-access journal. Grant recipients are also required to deposit research data into an appropriate data repository. While this policy helps to remove some of the barriers to use of research, the outputs published in a research journal may not be suitably presented or ready for application by the end user. Making translated research findings available through, for example, design standards or guidelines in earthquake engineering, may be more useful.

5 KNOWLEDGE TRANSLATION IN EARTHQUAKE ENGINEERING

While specific literature on the topic of knowledge translation in earthquake engineering is limited, a number of studies have examined barriers to implementing innovative technologies in practice and advocated for possible solutions (May 2002; Mander 2003; Uma 2013). Many of the identified challenges are centred on demonstrating benefits of new technologies to engineers and owners, and may be overcome through a knowledge translation research framework.

Knowledge translation literature suggests five basic themes that form a knowledge translation focused research programme, including stakeholder engagement, knowledge dissemination and exchange, organisational support and culture, and monitoring and evaluation of research uptake. In addition, special consideration is needed for research that is intended to inform policy (DFID 2013; Rajic et al. 2013). It should be noted that there is considerable overlap between each of the themes, and aspects of each theme occur at every stage of the research process. The importance of each theme will vary depending on the research programme.

The following sections discuss each of the five themes in more detail, present examples of how the theme is currently implemented in earthquake engineering, and make some recommendations for further research. The examples provided are not the only example available in earthquake engineering, but are intended to give an idea of what is currently being done.

5.1 Stakeholder engagement

Direct and on-going interactions between researchers and end users is found in the literature to be one of the most effective methods of facilitating the use of research in practice and policy (Rajic et al. 2013). Stakeholder engagement starts with identifying stakeholders early on in the research process and engaging them in refining the research question and designing the research plan to meet their needs. It is easy to forget about stakeholders during the research process, waiting until the results are neatly tied up and finalised, but stakeholders can play a role in informing the research as it develops. Engagement throughout the process will help stakeholders feel ownership over the final product and they will be more likely to pay attention and make use of the final results. Once the research is concluded researchers can take the results to the end users to discuss the findings in a two-way dialogue. It may be useful for the researcher to know how the results will be used, what challenges practitioners foresee in implementing findings or a new technology, and identify ways that researchers can help overcome these barriers.

Sustaining a relationship with end users is difficult for individual researchers or organisations as they move from project to project, but "boundary organisations" that specifically seek to bring these parties together can help bridge the gap and develop a sustained connection between end users and relevant

research. In earthquake engineering, organisations such as University of Canterbury Quake Centre, Structural Timbre Innovation Company (STIC), Steel Construction New Zealand (SCNZ), Association of Bay Area Governments (ABAG) in Oakland, California, and San Francisco Planning and Urban Research Association (SPUR) strive to provide support for establishing linkages between researchers, practitioners, policy makers, and the public through workshops, training, seminars, project taskforces, and public forums. Project advisory committees are commonly used by ABAG, SPUR, and others as a way for stakeholders and researchers to interact over the life of a project and work together towards a specific goal. Further research would be useful to understand the specific ways that stakeholders and the public can best engage in earthquake engineering research.

5.2 Knowledge dissemination and exchange

A strategy is needed for when and how to disseminate research results. Various messages and results can be communicated throughout the research process (DFID 2013). For example, synthesising the body of research already available on a topic can help support users to use existing research even before new results become available. In addition to publishing results in research journals, the outcomes of the research that are packaged and presented to end users in a relevant, timely, understandable, and accessible format will be more useful (Rajic et al. 2013).

In earthquake engineering, dissemination of results typically occurs at the conclusion of a research programme through guidelines and training to professional engineers. The Natural Hazards Research Platform (NHRP) has the potential to change this in New Zealand. NHRP (2012) research proposals are specifically judged on the likelihood of the research being implemented by end users and their plan for technology transfer beyond reporting and publication or research user involvement. Incorporating knowledge translation processes as a component of the research project, rather than after the fact is an important component of bridging the gap from research to action. This is beginning to happen for other perils in New Zealand (e.g. volcanoes (Doyle et al. 2014) and tsunami (Fraser et al. 2014)).

Researchers need to understand what forms of published information are most useful for engineers in their work, how they search for and access that work, and how aware they are of current peer-reviewed research (Bedford 2012). For example, Rajic et al. (2013) identified 23 methods for synthesis, dissemination, and exchange of knowledge, and identified the most suitable end user for each method. Adapting these methods for earthquake engineering research and stakeholders will provide a useful guide for disseminating research results in the most effective way possible in this field.

5.3 Organisational support and culture

Organisations need to encourage researcher to not just produce excellent research, but to engage with end users and come up with joint solutions to help facilitate use of new technologies. Engaging stakeholders in the research process and incorporating research findings into practice takes time and is difficult when organisations don't support or recognise these activities. Both research and practitioner organisations need to invest sufficient time and money in engagement with knowledge translation activities.

One of the key barriers to adoption of new technologies in earthquake engineering has to do with developing confidence in the benefits of new technologies among engineers and owners and the perceived cost of implementation (May 2002). Furthermore, extensive training and education is required for engineers and contractors to design and build structures in new ways. As seen with the adoption of technologies such as base isolation, it is a long process to normalise these new technologies in practice and it requires a supportive organisational culture that allows researchers and end user sufficient flexibility to engage in knowledge translation (Rajic et al. 2013).

In the engineering and construction industry where profit margins are low, there can be little incentive to experiment with new technologies whose benefit is uncertain. Some companies, however, seek to gain an edge in the marketplace and single themselves out for their creative and cutting edge use of technologies. DPR Construction in California, for example, with its core value "ever forward" has set itself apart by establishing an "Innovation Change Agents" team that specifically fosters innovation within the company and seeks ways to implement the latest technologies into practice (Tran 2013).

Case studies on companies like DPR can help document and understand the factors that drive organisations to seek out and implement new technologies and ideas.

5.4 Monitoring and evaluation of research uptake

A primary goal of research is to change practical understanding of a field over time. It follows then that researchers are evaluated not only on the intellectual merit of their work and the contribution to the body of knowledge through publications, but also through its practical impact. However, measuring impact that is often not immediately realised and attributing it to single researchers is difficult and remains in its early stages in health research fields (Tetroe 2007). The way impact is measured depends on how it is defined and who the intended users of knowledge are. Furthermore there are different degrees of impact. Research can be applied in a specific, direct way or it may indirectly inform general conceptual understanding. Sometimes research is used to legitimise and reinforce predetermined beliefs. In earthquake engineering, specific research is needed on appropriate and specific measures for evaluating research impact and to understand how end users make informed decisions about adopting research and innovative technologies in engineering.

5.5 Evidence-informed policy-making

The policy process takes place largely independently of researchers, scientists, and engineers (Spilsbury and Nasi 2006). In addition to research findings, internal and external influences, such as values, beliefs, stakeholder views, and social and economic implications also contribute to the policy-making process and influence political decisions (Rajic 2013). Understanding how policymakers use research in their decision making and how to present information in a useful way can help researchers more effectively engage in the policy process. For example, research will be of increased relevance to policy makers if it incorporates an analysis of contextual factors such as economics, public perceptions, and local applicability. Furthermore, research has a better chance of informing the policy process through on-going collaboration and interaction between researchers and policymakers and during a favourable political climate, such as immediately after an earthquake (Fig. 1).
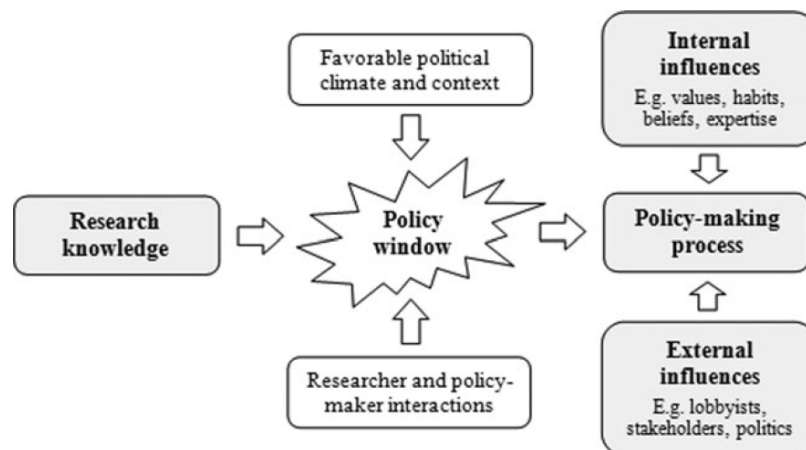

Figure 1. Overview of the evidence-informed policy-making process (Rajic et al. 2013)

In the aftermath of the Canterbury earthquakes, research programmes that were formulated with the objective of providing solutions to specific issues demonstrated their ability in implementing research findings within a short time frame through interactions and co-ordination with end users, particularly with the goal of informing policymakers. More research is needed on the specific needs of policy makers to aid decision making around issues of earthquake policy.

6 CONCLUSIONS

Improving the resilience of communities to natural disasters requires that advances in earthquake engineering research are disseminated and implemented in practice and policy in a timely manner. A knowledge translation framework has been successful in closing the gap between research, practice,

and policy in health and other fields, but more research is needed to adapt and implement this framework in the context of earthquake engineering and related fields.

Many pieces of the framework are currently being implemented on an ad hoc basis by various earthquake engineering and science research organisations, and case studies and lessons learned on the effectiveness of these existing knowledge translation strategies will help understand what works in this context. Earthquake engineering would benefit from a comprehensive knowledge translation strategy with guidelines for researchers on developing a knowledge translation programme following the five identified themes and effective engagement and dissemination strategies for various audiences, similar to those developed through DFID (2013) and CIHR (2012) and discussed in this paper.

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