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Factors influencing residents' acceptance (support) of remediation technologies

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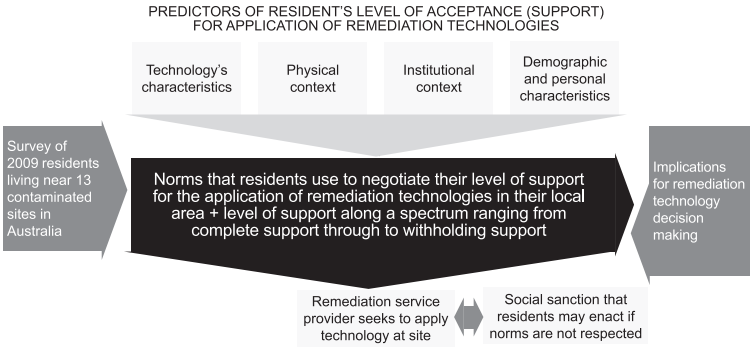
HIGHLIGHTS

- Conceptualises residents' acceptance (support) for remediation technologies.
- Builds insights through survey of 2009 residents living near 13 contaminated sites.
- Identifies diverse predictors of residents' level of acceptance (support).
- Reveals norms and sanctions (rules) residents use to negotiate acceptance (support).
- Maps relationship between predictors, norms and sanctions (rules).

GRAPHICAL ABSTRACT



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ABSTRACT

An increasing diversity of technologies are being used to remediate contaminated sites, yet there remains little understanding of the level of acceptance that residents living near these sites hold for these technologies, and what factors influence their level of acceptance. This lack of understanding hinders the remediation industry's ability to effectively engage with these residents about remediation technology selection, at a time when such engagement is become part and parcel of remediation policy and practice. The study develops on wider research into public acceptance of technologies, using data from a telephone survey of 2009 residents living near thirteen contaminated sites across Australia. Within the survey acceptance is measured through residents' level of support for the application of remediation technologies in their local area. Firstly, a regression analysis of closed-ended questions, and coding of open-ended questions are combined to identify the main predictors of residents' support for remediation technologies. Secondly, coding of open-ended questions was analysed using Crawford and Ostrom's Institutional Grammar Tool to identify norms and sanctions guiding residents' willingness to negotiate their support. The research identifies factors associated with the residents' personal and demographic characteristics, their physical context and engagement with institution during remediation processes, and the technologies themselves which predict residents' level of support for the application of remediation technologies. Bioremediation technologies had higher levels of support than chemical, thermal and physical technologies. Furthermore, the paper identifies a core set of norms and sanctions residents use to negotiate their level of support for remediation technologies.

1. Introduction

Over the next few decades governments and industry are expected to remediate millions of contaminated sites across the European

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Union (European Environment Agency, 2014), the United States (United States Environment Protection Agency, 2016; United States Environment Protection Agency and Office of Superfund Remediation and Technology Innovation, 2004), China (Hou and Li, 2017) and Australia (Carbonell, 2013) using a growing diversity of remediation technologies. These technologies continue to move far beyond the traditional techniques of capping pollution in-place and off-site removal (Kennen and Kirkwood, 2015), to include biotechnologies, chemical technologies, thermal technologies and physical technologies (Henry et al., 2013; Kennen and Kirkwood, 2015; Prasad et al., 2010). Until recently the identification, selection and application of these remediation technologies has been the domain of experts, however in the past decade there has been increased attempts to engage broader stakeholders, including affected residents in the selection of remediation technologies for nearby contaminated sites, with broader stakeholder engagement becoming part and parcel of remediation policy and practice. The increased importance of public acceptance within remediation processes has resulted in public acceptability being adopted as a metric (e.g. Likert scales) within remediation guidelines and decision support tools (Harclerode et al., 2016; Schädler et al., 2011; Sorvari and Seppälä, 2010). This emergence of public acceptance as an evaluation criteria informing remediation decisions acknowledges firstly, a growing understanding that technology decisions can be improved through the bringing together of the diverse knowledges of all those affected by the application of a technology (Delgado et al., 2011; Irwin, 2006; Hou and Al-Tabbaa, 2014), secondly, that a lack of understanding of the public's acceptance hinders the ability of those within the remediation industry to effectively engage with the public about the selection of technologies, and thirdly, that ignorance of the public's level of technology acceptance can lead to significant socio-political risks to technology applications (de Groot et al., 2013; Horst, 2005; Siegrist and Visschers, 2013; Steg et al., 2006; Hou et al., 2014a).

Whilst research has focused on regulatory and practitioner acceptance of remediation technologies (Fan et al., 2017; Focht and Albright, 2009; Gerhardt et al., 2017; Gillespie and Philp, 2013; Grieger et al., 2010; Hou et al., 2014b; Kocher et al., 2002; Marinovich et al., 2016; Morillo and Villaverde, 2017; Page and Atkinson-Grosjean, 2013; Pollard et al., 1994; Ramirez-Andreotta et al., 2016; Zhang et al., 2016; Zhu et al., 2016), there has been little consideration of the public's acceptance of remediation technologies (Kim, 2016; Wolfe and Bjornstad, 2002). This paper addresses this research gap by presenting an original study that systematically develops a framework for understanding the diverse factors that affect a resident's level of acceptance of remediation technologies, and the norms and sanctions (rules) that guide a resident's willingness to negotiate that acceptance. Within this study a resident's acceptance is explored through their level of *support* for the application of remediation technologies in their local area.

This paper begins by outlining a conceptual framework for residents' support for remediation technologies that was developed through reference to broader technology acceptance research (Allansdottir et al., 2000; Bonfadelli et al., 2002; Clothier et al., 2015; Connor and Siegrist, 2010; Cowell et al., 2011; de Groot et al., 2013; Fischhoff et al., 1978; Frewer et al., 2004; Gilbert, 2007; Gupta et al., 2012; Jenkins-Smith et al., 2011; Krause et al., 2014; Luo et al., 2010; Marques et al., 2015; Siegrist, 2000; Siegrist et al., 2007; Ganesh Pillai and Bezbaruah, 2017; Siegrist and Visschers, 2013; Slovic, 1987). The paper then explains how the framework was tailored to residents' support for remediation technologies using data from a telephone survey of 2009 residents living near thirteen contaminated sites across Australia. First, regression analysis of closed-ended survey questions and coding of open-ended survey questions were combined to identify key predictors of a resident's level of support for remediation technologies. Identified factors included residents' personal and demographic characteristics, their physical context and engagement with institutions during remediation processes, and the technology's characteristics. Secondly, open-ended survey questions were coded using Crawford and Ostrom's Institutional Grammar Tool (IGT) to systematically identify norms and sanctions (rules) that residents utilise to negotiate their support for the application of remediation technologies in their local area (Basurto et al., 2010; Crawford, 2004; Crawford and Ostrom, 1995; McGinnis, 2011; Roditis et al., 2014; Schluter and Theesfeld, 2010; Siddiki et al., 2011).

The study acknowledges that remediation embodies a suite of potential technology types that can be used to address specific contaminants (Prior et al., 2017). One significant challenge in exploring how residents support the application of technology types is their diversity. To facilitate the study, we worked with industry experts to develop a high-level typology that could be used within the study: chemical technologies, physical technologies, thermal technologies and biotechnologies (see Appendix A for the array of technology types and applications used in this study).

The study is part of a broader research project exploring residents' perceptions and acceptance of different types of technologies that are used to remediate contaminants in their local area (Huynh et al., 2017; Prior, 2016; Prior et al., 2017; Prior et al., 2014; Prior and Rai, 2017). This broader research project has provided unique insights into factors that affect residents' *worry* about remediation technologies (Prior et al., 2017), their *risk and benefit perceptions* about remediation technologies (Prior et al., 2017), and their *choice* of remediation technologies (Huynh et al., 2017). This study adds to and extends this broader research project through its focus on factors that affect residents' *support* for those remediation technologies.

2. Conceptualizing residents' support

The conceptual framework for residents' support of remediation technology presented in this section is built upon broader research into technology acceptance (Clothier et al., 2015; Connor and Siegrist, 2010; Cowell et al., 2011; de Groot et al., 2013; Flynn, 2007; Focht and Albright, 2009; Ganesh Pillai and Bezbaruah, 2017; Siegrist et al., 2007; Siegrist and Visschers, 2013; Todt, 2011) and is a starting point for the study presented within this paper. The meaning of acceptance varies for different stakeholders involved in remediation contexts, for government regulators it may mean approval as set out in remediation legislation, for a remediation service provider it may be that the technology addresses a set of technical criteria before being applied at a given site, for a resident it may mean that they support the application of a technology in their local area because it has been successfully proven in other contexts. Within the context of the framework, residents' acceptance of remediation technology is not equated with the formal approval, direct-use or application of remediation technologies (Rogers, 1995; Venkatesh and Davis, 2000), these are the responsibility of regulatory authorities and remediation service providers. Residents' acceptance within the context of this framework is based about the resident's level of *support* for the application of the remediation technology in their local area. Support is understood as occurring along a spectrum that is an expression of the resident's perception of a technology's sufficiency or lack (Eagly and Chaiken, 2007; Whitfield et al., 2009), for example, this spectrum can range from complete support, through to finding a technology tolerable through to withholding support for the technology, and/or resisting the technology being applied or protesting against the technology's application.

Within the framework, a resident's level of support is understood as being guided by diverse predictors and norms, and acted on through sanctions (rules) (See Fig. 1). The conceptual framework groups predictors into four key dimensions, each contain several attributes (See Fig. 1). These dimensions include the physical context, institutional context (e.g., trust for organizations communicating with residents), as well as technology characteristics, and demographic and personal characteristics (e.g. values) that have been shown in broader technology research to influence people's acceptance of technologies. Furthermore, within the framework, a resident's level of support for a technology is