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Research article

A Structural Equation Modeling approach to water quality perceptions

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ABSTRACT

Researches on water quality perceptions have used various techniques and models to explain relationships between specific variables. Surprisingly, Structural Equation Modeling (SEM) has received little attention in water quality perceptions studies, and reporting has been inconsistent among existing studies. One objective of this article is to provide readers with a methodological example for conducting and reporting SEM. Another objective is to build a model that explains the different relationships among the diverse factors highlighted by previous studies on water quality perceptions. Our study focuses on the factors influencing people's perceptions of water quality in the Appalachian region. As such, researchers have conducted a survey in a mid-sized city in northcentral West Virginia to assess residents' perceptions of water quality for drinking and recreational purposes. Specifically, we aimed to understand the relationships between perceived water quality, health risk perceptions, organoleptic perceptions, environmental concern, area satisfaction and perceptions of surface water quality. Our model provided a good fit that explained about 50% of the variance in health risk perceptions and 43% of the variance in organoleptic perceptions. Environmental concern, area satisfaction and perceived surface water quality are important factors in explaining these variances. Perceived water quality was dismissed in our analysis due to multicollinearity. Our study demonstrates that risk communication needs to be better addressed by local decision-makers and water managers.

1. Introduction

A large amount of public researches in developing countries have demonstrated evidence of a misconception regarding tap water quality. For instance, many studies reported that the general public believes bottled water to be of higher quality, to have lower health risks and to taste better than tap water (Anadu and Harding, 2000; Hu et al., 2011; Raj, 2005; Zivin et al., 2011). Researchers identified several factors that explain the variation of public perceptions of tap water quality (Doria, 2010; Syme and Williams, 1993). More specifically, several studies showed that perceived tap water quality is positively influenced by organoleptic perceptions and negatively influenced by health risk perceptions, with health risk perceptions being negatively influenced by organoleptic perceptions (Doria et al., 2005; Proulx et al., 2012; Turgeon et al., 2004). Different methods of analysis have been used in the past to investigate water quality perceptions, but only a few studies proposed the use of a Structural Equation Modeling (SEM) approach: Doria et al. (2005, 2009). Notably, these two studies did not investigate the relationships between tap water quality perceptions and other factors such as environmental concern. In fact, several studies have linked environmental concern, perceptions of the water quality of streams, rivers and lakes or ground water quality in the area with tap water quality perceptions (Hu et al., 2011; Merkel et al., 2012; Syme and Williams, 1993). Including these variables in an SEM model increases current knowledge on water quality perceptions as SEM is a technique that can assess different relationships between variables at the same time (Hu and Bentler, 1999; Kline, 2015). Ultimately, SEM is used to analyze the discrepancy function between the covariance matrix of the sample under study and the fitted covariance matrix by a specified model that is based on these relationships (Hu and Bentler, 1999). This technique is a powerful statistical tool because it accounts for measurement error in the model, which is not possible in traditional regression approaches (Kline, 2015). Additionally, SEM allows researchers to investigate direct and indirect paths in their models (Kline, 2015).

In West Virginia, water management is critical, as many different human activities have the potential to affect the water quality. The Elk River pollution that occurred in Charleston (West

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Virginia) in early 2014 is an example of water contamination that directly impacted residents and their use of tap water (Whelton et al., 2015). In the context of global climate change and population growth, water management appears to be one of the most challenging issues for the 21st century (World Bank, 2016). Yet, the impacts of water quality are many, not only for ecosystems but also for populations (World Bank, 2016). Merkel et al. (2012) demonstrated that environmental risks associated with human activities such as mining and gas drilling can increase risk perceptions linked with drinking tap water. In contrast to natural disaster risks, these risks are linked to technological risks (Flint and Luloff, 2005). Therefore, implementing preventive measures and risk management can reduce the likelihood of these risks. As a result, public risk perceptions may increase or decrease support for preventive measures and lead to behavioral changes. In comparison, Fessenden-Raden et al. (1987) explained the psychology of water consumption for US citizens: "if people have seen, tasted, or smelled something different about their water, whether or not the change is related to the contamination, they tend to exaggerate the risk. But if their own senses have given them no clue that a problem exists, people may feel that the risk they are being told about has been exaggerated" (p.97).

2. Study purpose

In summary, a first goal of our study is to help other researchers by designing an SEM model with an analyses report that follows SEM guidelines. Hurlimann et al. (2008) pointed to the existence of variability among the studies that report SEM results. A second goal of our study is to explain the water quality perceptions in a community of West Virginia. In order to proceed, we build on Doria et al.'s SEM model (2009) and propose to modify it by adding other factors such as environmental concern (Dutcher et al., 2007; Syme and Williams, 1993), area satisfaction (Syme and Williams, 1993), and the perceived surface water quality (Hu et al., 2011). We created the item "the likelihood of a chemical spill" in order to better understand risk perceptions. Results of this study will help further research in the region and will enable targeting risk communication and general communication about water quality and environmental protection. These are important factors in a period of elections.

More specifically, we were interested in depicting the following relationships:

Hypothesis 1. Perceived water quality (PWQ) is negatively influenced by perceived health risks (PHR) (Doria et al., 2005), the likelihood of a chemical spill (CS) and environmental concern (EC) (Dutcher et al., 2007); positively influenced by organoleptic perceptions (OR) (Doria et al., 2005), the perceived surface water quality in the area (PSWQ), the satisfaction with living in the area (AS) (Syme and Williams, 1993) and the context (CTX) (Doria et al., 2005).

Hypothesis 2. Perceived health risks are negatively influenced by organoleptic perceptions, the perceived surface water quality in the area, the satisfaction with living in the area and the context; positively influenced by environmental concern the likelihood of a chemical spill.

Hypothesis 3. Organoleptic perceptions are negatively influenced by the likelihood of a chemical spill and environmental concern; positively influenced by the perceived surface water quality in the area and the satisfaction with living in the area.

Hypothesis 4. Context is positively influenced by organoleptic perceptions (Doria et al., 2009) and we supposed it is also

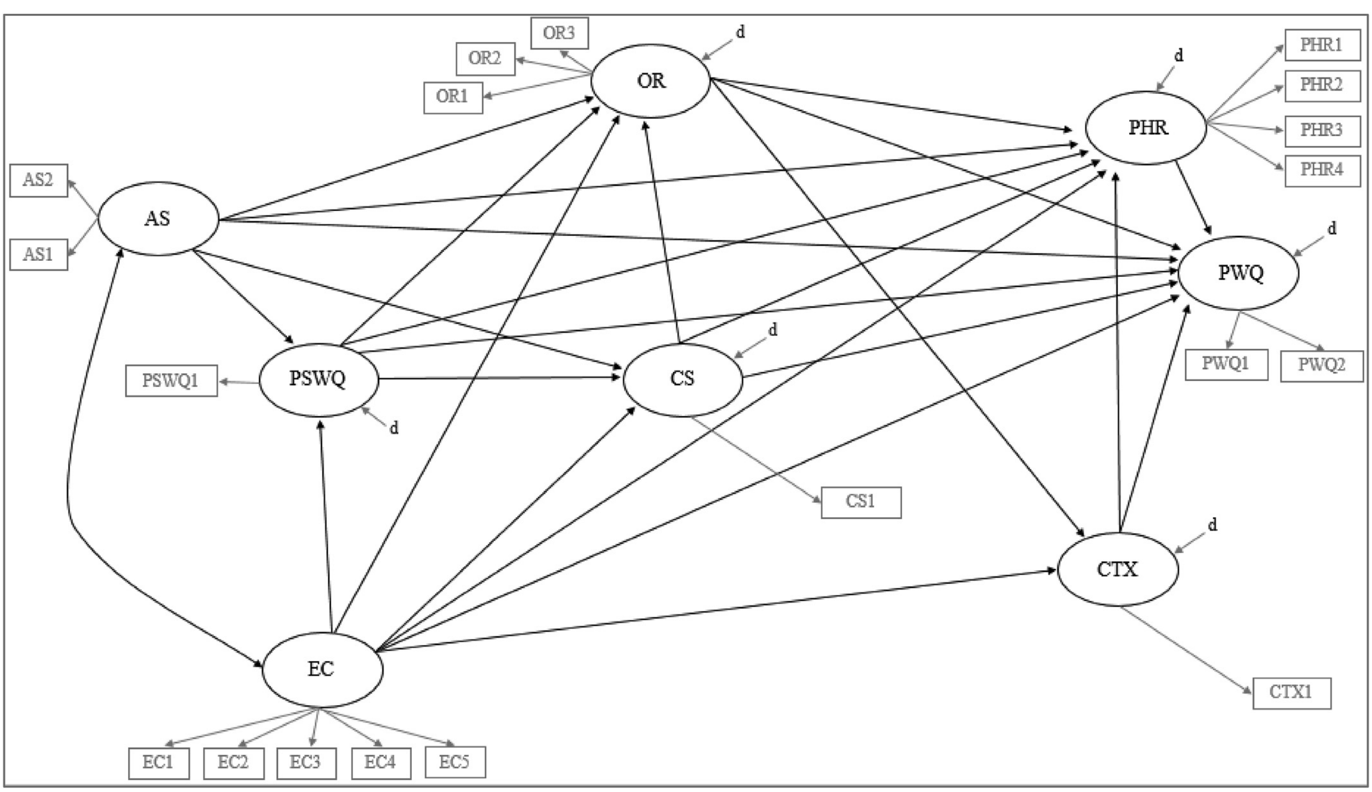

Fig. 1. Full Structural Model. Latent constructs are shown in ellipses. Observed variables are shown in rectangles. d represents the disturbances from the endogenous latent constructs.