Chapter 1.37
Computational Experimentation

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INTRODUCTION

Systematic development of new knowledge is as important in the developing field of knowledge management (KM) as in other social science and technological domains. Careful research is essential for the development of new knowledge in a systematic manner (e.g., avoiding the process of trial and error). The problem is, throughout the era of modern science, a chasm has persisted between laboratory and field research that impedes knowledge development about knowledge management.

This article combines and builds upon recent results to describe a research approach that bridges the chasm between laboratory and field methods in KM: computational experimentation. As implied by the name, computational experiments are conducted via computer simulation. But such experiments can go beyond most simulations (e.g., incorporating experimental controls, benefiting from external model validation). And they can offer simultaneously benefits of laboratory methods (e.g., internal validity, lack of confounding) and fieldwork (e.g., external validity, generalizability). Further, computational experiments can be conducted at a fraction of the cost and time associated with either laboratory experiments or field studies. And they provide a window to view the kinds of meta-knowledge that are important for understanding knowledge management. Thus, computational experimentation offers potential to mitigate many limitations of both laboratory and field methods and to enhance KM research. We discuss computational modeling and simulation as a complementary method to bridge the chasm between laboratory and field methods—not as a replacement for either of these methods.

BACKGROUND

To appreciate the power of computational experimentation, we draw heavily from Nissen and Buettner (2004) in this section, and outline the key relative advantages and disadvantages of laboratory and field methods. To begin, the laboratory provides unparalleled opportunity for controlled experimentation. Through experimentation the researcher can manipulate only a few variables of interest at a time and can minimize the confounding associated with the myriad factors affecting complex systems and processes in the field (Box, Hunter, & Hunter, 1978; Johnson & Wichern, 1992). However, limitations of laboratory experimentation are known well (Campbell & Stanley, 1973) and are particularly severe in the KM domain. In KM experimentation such limitations center on problems with external validity. Laboratory conditions can seldom replicate the complexity, scope, and scale of the physical organizations and systems of interest for research. KM experiments also include problems with generalizability. Many experiments utilize samples of convenience (esp. university students) instead of working professionals. This practice calls into question how closely the associated experimental results are representative of KM behavior in operational organizations.

Alternatively, field research provides unparalleled opportunity for realism (Denzin & Lincoln, 1994). The researcher in the field can study full-scale artifacts in operational environments (Yin, 1994) and can minimize the abstraction away from working people, systems, and organizations (Glaser & Strauss, 1967). However, limitations of field research are known well also (Campbell & Stanley, 1973) and are particularly severe in the KM domain also. In KM field research such limitations center on problems with internal validity. Field research affords little opportunity for controlled experimentation (cf. Cook & Campbell, 1979). Also, confounding results often from the myriad influences on complex systems and organizations that cannot be isolated in the field. This practice makes it difficult to identify and trace the causes of differential behaviors—better as well as worse—in KM. In addition, field research can be very expensive, particularly to support researchers' efforts to enhance internal validity and ameliorate confounding. And many research designs for fieldwork (e.g., case study, ethnography, natural experiment) require considerable time for planning and analysis.

As implied by the name, computational experiments are conducted via computer simulation. As such, they offer all of the cost and time advantages of computational analysis (see Law & Kelton, 1991). But computational experiments go beyond most simulations. Rigorous experimental designs are employed to capture the benefits of laboratory experimentation. The variables affecting physical systems and organizations in the field can be isolated and examined under controlled conditions. This also addresses the internal validity and confounding limitations of field research. Yet computational experiments can be conducted at a fraction of the cost and time required to set up and run experiments with human subjects in the laboratory. Further, through external validation, computational models can emulate key qualitative and quantitative behaviors of the physical systems and organizations they represent with "good" fidelity (e.g., good enough to have confidence that results of computational experiments will track those of physical experiments in the laboratory or field). This mitigates the problems of external validity and generalizability noted above.

Figure 1 illustrates the essential elements of computational experimentation as a research method. The top of the figure includes a shape to depict the bridge metaphor associated with this method. It spans a wide gap between laboratory and field methods. From the left side of this "bridge," two arrows represent inputs to describe the behaviors of computational models. Organization theory, which is predicated upon many thousands of studies over the last half century, provides the basis for most such behaviors. Behaviors pertaining to organizational factors such as centralization, division of labor, task interdependence, function, coordination, formalization, technology, and information processing are captured from organization theory. Where extant theory does not address a behavior of interest (e.g., knowledge flows) well, ethnographic