Chapter XVIII
Utility–Cost Tradeoffs in the Design of Data Resources

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ABSTRACT

This chapter introduces a novel perspective for designing and maintaining data resources. Data and the information systems that manage it, are critical organizational resources. Today the design and the maintenance of data management environments are driven primarily by technical and functional requirements. We suggest that economic considerations, such as the utility gained by the use of data resources and the costs involved in implementing and maintaining them, may significantly affect data management decisions. We propose an analytical framework for analyzing utility-cost tradeoffs and optimizing design. Its application is demonstrated for analyzing certain design decisions in a data warehouse environment. The analysis considers variability and inequality in the utility of data resources, and possible uncertainties with usage and implementation.

INTRODUCTION

Data, along with information systems and technologies (IS/IT) that manage it, is a critical organizational resource. Advances in data management technologies and the growing diversity of data sources allow firms to manage large data repositories and benefit from using them for enabling new business processes, supporting decision making, and generating revenue as a commodity. Different aspects of data management such as design, quality improvement, and integration into business processes have typically been studied from technical and functional perspectives. Economic aspects, such as the benefits gained from the use of data resources and the costs associated with managing them, have not been

explored in depth. In this chapter, we suggest that economic considerations significantly affect data management decisions, hence, deserve further examination. As investments in data resources grow, it is important to better understand their contribution to economic performance and business benefits. By conceptualizing business benefits as utility, we propose a framework for assessing and maximizing the contribution of data resources to the firm's economic performance.

We specifically link economic contribution to the design of data resources. Designs that improve capacity have higher utility contribution, but are often more expensive to implement. Enhancing design may require higher investments in IT and labor, increasing costs to the point of offsetting the utility gained. To what extent can design affect economic performance? Can maximizing performance direct design? These questions highlight a gap in data management research—while functional and technical aspects of design are well addressed, economic aspects are rarely explored. In this study, we identify design characteristics that impact utility-cost tradeoffs, model their economic effects, and use the models to assess design alternatives. We refer to this approach as *economics-driven design*. Importantly, we view administration and maintenance of information systems and data resources as an integral part of the implementation lifecycle. Hence, we use the term *design* to refer not only to the efforts involved in implementing entirely new systems or data resources, but also to the formulation of data and system administration policies and the implementation of data maintenance, improvement, and enhancement solutions.

We examine economics-driven design in the context of a data warehouse (DW)—an IS environment that manages large data archives. The high implementation and maintenance costs associated with a DW have been examined, but their business-value contribution has been rarely assessed. This study contributes by examining the utility of data resources in a DW. It introduces the concept of "utility inequality"—the extent to which items within a data collection differ in their business contribution. Understanding inequality and the associated utility-cost tradeoffs can help improve data management decisions from an economic standpoint. We link these tradeoffs to DW design decisions. Understanding economic effects of these decisions can improve design outcomes and help justify associated investments.

In the rest of this chapter, we first review the relevant background. We then lay the theoretical foundations of our framework for economic assessment of design alternatives, focusing on design decisions in a DW. We introduce the concept of utility inequality and develop quantitative tools for assessing it in large datasets. Utility inequality is shown to introduce economic tradeoffs. We analyze these tradeoffs and their implications for design decisions in data management environments. Acknowledging uncertainties with the utility gained, we then frame certain high-level design strategies as real-options investments. We further model economic effects of some design decisions along these strategies, describing conditions under which a certain strategy can turn out to be superior. We conclude by highlighting contributions and limitations of this study and suggest directions for further research.

RELEVANT BACKGROUND

Design is defined as teleological and goal-driven activity, aimed at the creation of new artifacts (Simon, 1996). Design research seeks to extend the boundaries of human and organizational capabilities by creating new and innovative artifacts (March & Smith, 1995). It is particularly important to field of Information Systems (IS) management, as the success and the impact of information systems significantly depend on their design (Hevner, March, Park, & Ram, 2004). March and Smith (1995) differentiate between behavioral research as "knowledge producing" and design research as "knowledge using." While the key contribution