Andrews University

School of Education

DATA WAREHOUSING AND DECISION MAKING IN HIGHER EDUCATION IN THE UNITED STATES

A Dissertation

Presented in Partial Fulfillment

of the Requirements for the Degree

Doctor of Philosophy

by

David Lester Heise

March 2006

> developed for information systems that measures and evaluates IS activities from the following perspectives: business value, user orientation, internal process, and future readiness. (Martinsons & Davison, 1999, Abstract)

A Taxonomy of Information by Management Level

Managers as Decision Makers

Decision makers are found at all levels in an organization, and this is a central aspect of all management roles. "All managerial activities revolve around decision making. *The manager is primarily a decision maker*" (Turban, Aronson, & Liang, 2004, p. 7).

The Management Pyramid

In attempting to categorize how and where information is used in an organization to support decision making, it is useful to define a taxonomy of terms. "One good starting point for building a framework is the Anthony Triangle, which diagrams operational activities, management control, and strategic planning" (Kanter & Miserendino, 1987, Abstract). These three levels of management activity are defined by Robert Anthony in his 1965 book, *Planning and Control Systems: A Framework for Analysis*. Hackathorn (2002) and Turban et al. (2004) summarize the three levels as shown in Table 2.

"The framework is often shown as a management pyramid, in which a few are engaged at the strategic level while many more are involved at the tactical and operational lower levels" (Hackathorn, 2002, p. 47). See Figure 1.

Kim and Courtney (1988, as cited in Wagner, 1990) recommend the use of Anthony's management triangle as a basis for a conceptual mapping of managerial

Table 2

Definitions of Level of Management Control

Level	**Hackathorn** (2002, p. 47)	**Turban** (2004, p. 13)
Strategic Planning	Definition of goals, policies; Determination of organizational objectives.	Defining long-range goals and policies for resource allocation
Management and Tactical Control	Acquisition of resources, tactics; Establishment and monitoring of budgets.	The acquisition and efficient use of resources in the accomplishment of organizational goals
Operational Planning and Control	Effective and efficient use of existing facilities and resources to carry out activities within budget constraints.	The efficient and effective execution of specific goals

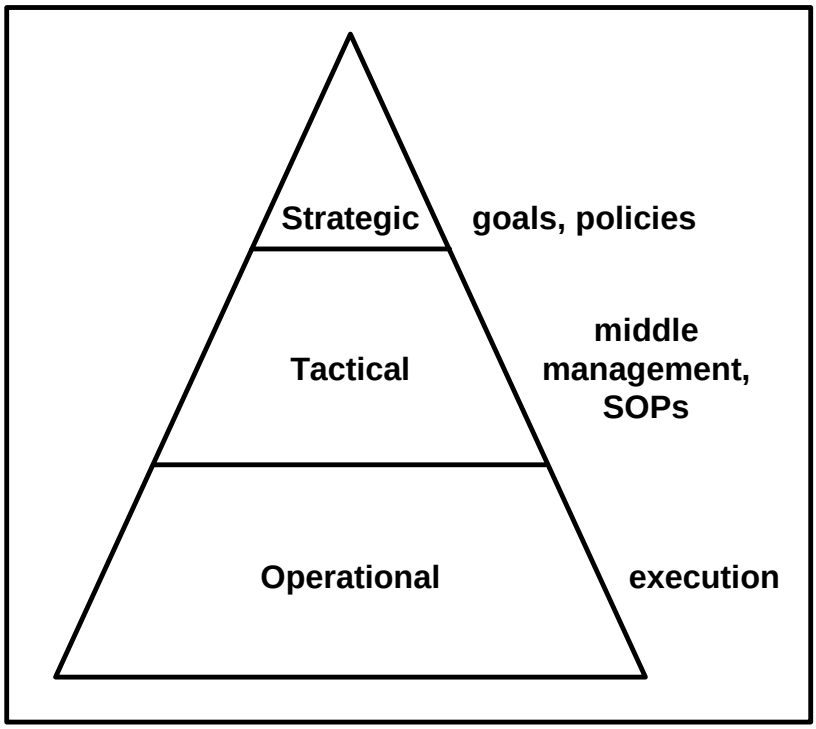

Figure 1. Anthony's Management Triangle.

Table 3

Taxonomy of Information Use and Management Levels

Characteristic	**Levels**		
Anthony's Taxonomy	Operational	Tactical	Strategic
Information users	Operational staff and supervisors	Middle managers, business analysts	Executives, senior analysts
Nature of decisions	Structured	Semi-structured	Unstructured
Scope	Narrow	Intermediate	Broad
Term focus / Time Horizon	Day-to-day, usually with immediate ramifications	Within the current 12-month plan	Future-oriented (2 year +), with trend analysis over time
Format of information	Standard reports, detailed	Exception reports, parameterized	Ad hoc, summarized, interactive
Interaction with information	Static reports	Online slice and dice, drill down	Online analysis, modeling, what-if scenarios, data mining
Summarization	Detailed	Exception and detailed	Multidimensional with drill-down to detail
Information systems	Transaction oriented (OLTP)	Online analytical systems (OLAP), Decision Support Systems (DSS)	Online analytical systems (OLAP), Executive Information Systems (EIS)
Interpersonal Relationships	Intradepartmental, internal	Interdepartmental, internal	Global, extra-enterprise, external & internal
Data relationships, source	Within datamart/ subject area, internal	Includes some related datamarts, internal	Cross enterprise integration plus external
Data refresh rate	Daily or more often	By relevant business period or cycle	Annually or by event
Examples	Managing expenses, cash flow, student interaction, fee collection, resource allocation	Choosing instructional technologies, recruiting, personnel development, strategy implementation, project management	New programs, markets, restructuring, strategic planning and prioritization

One example of the continuous nature of the spaces between the three levels is the degree of structure in the decisions being made.

> Simon (1977) distinguished two extremes regarding the structuredness of decision problems. At one end of the spectrum are well-structured problems that are repetitive and routine and for which standard models have been developed. Simon calls these **programmed problems**. Examples of such problems are weekly scheduling of employees, monthly determination of cash flow, and selection of an inventory level for a specific item under constant demand. At the other end of the spectrum are unstructured problems, also called **nonprogrammed problems**, which are novel and nonrecurrent. For example, typical unstructured problems include merger and acquisition decisions, undertaking a complex research and development project, evaluating an electronic commerce initiative, determination about what to put on a Web site. . . . Semistructured problems fall between the two extremes. (Turban et al., 2004, p. 55)

In comparing the kind of decision making made at the operational level with other levels of decision making, Thomsen (2002) uses the analogy of a spectrum of temperature differences between hot and cold water.

> It is popular and convenient to think of operations and decision-oriented analysis as two distinct categories, especially because they correspond to the two major emphases in physical optimization—update speed and access speed. That is why I use the distinction in this book. The distinction, however, is more appropriately thought of in terms of a spectrum, much like hot and cold are more accurately described in terms of temperature differences. The common denominator is decision-making for both forms of information processing; the difference is the scope of inputs and outputs. (Thomsen, 2002, p. 11)

Hackathorn (2002) was already drawing attention to the need for data-driven decision support throughout the entire management pyramid. He saw the need for decision support information to be embedded as closely as possible to the points within business processes where it would actioned, and he referred to this as “Active Business Intelligence” or ABI.

> The design of ABI should embed (as close as possible) intelligence into the appropriate business processes to support specific actions. As such, the key characteristics of ABI are:
>
> - Supporting tactical decision making,
> - Leveraging actionable intelligence and
> - Enabling the learning cycle. (2002, p. 47)

The traditional focus of data warehousing has been at the strategic level, but organizations are increasingly finding that the data warehouse provides a convenient and valuable source of actionable information at the tactical and operational levels. Hackathorn points out that this is as it should be.

> Emphasis on tactical decision making guides minute-by-minute business activities. This is an extension, not elimination, of the focus upon strategic decision making of traditional BI. Instead of being confined to executive suites for use by managers and business analysts, ABI has a presence on the shop floors, branch offices and even customer desktops.
>
> Most importantly, ABI impacts the tactical and operational levels of management, in addition to the strategic level. These levels of management activity are classic concepts in the IT industry. (2002, p. 47)

Hackathorn uses the Anthony framework to specify some of the information requirements, using Davis and Olson (1985, pp. 35, 36) as the source. This is illustrated in Figure 2.

	Operational	Tactical	Strategic
Data Source	Internal		External
Data Scope	Certain & Narrow		Vague & Broad
Aggregation	Detailed		Summarized
Time Horizon	Historical		Future
Data Currency	Highly Current		Quite Old
Required Accuracy	High		Low
Frequency of Use	Very Frequent		Infrequent

Figure 2. Information requirements by management level.

Note: From *Management Information Systems: Conceptual Foundations, Structure and Development* (pp. 35-36), by G. B. Davis and M. H. Olson, 1985, New York: McGraw-Hill. Copyright 1985 by McGraw-Hill. Adapted with permission.

Hackathorn (2002) concludes, “BI efforts have traditionally focused more on the right side [of Figure 2] with summarized analyses directed toward future business activities. ABI enables us to move toward the left and extend coverage across all three levels” (p. 47).

Applying Knowledge to the Managerial Problem Domain

Wagner (1990) refers to studies done by Kim and Courtney (1988) into knowledge acquisition as it relates to the managerial problem domain. They view knowledge in terms of concepts, heuristics, and reasoning, and studied the abilities of different knowledge acquisition (KA) methods to extract these three types of knowledge. “Based upon their findings, they propose a conceptual mapping of a managerial problem domain, using Anthony’s taxonomy, to a Knowledge base with appropriate KA techniques” (pp. 253, 254).

Wagner (1990) concludes that while it is difficult to come up with a satisfactory taxonomy of knowledge types, “the question of how we are to arrive at a taxonomy of our problem domain that would be satisfactory” is even more difficult (p. 256). He suggests that for a specific problem domain, such as managerial problem solving, one approach is to use Anthony’s taxonomy as Kim and Courtney did in 1988.

Decision-Making Theories, Thinking Styles, and Methods

Theories

The process of making decisions has been studied from a number of perspectives. One approach considers two models for decision making—how people should make decisions and how they actually do make decisions. The first is called the prescriptive or normative model, while the second is called the descriptive model. In the first model,