Developing a long-range information architecture

by JAMES C. WETHERBE and GORDON B. DAVIS

University of Minnesota
Minneapolis, Minnesota

ABSTRACT

A methodology is presented for eliciting enterprise information requirements and developing a long-range information architecture. The methodology is based on a combination of business system planning, critical success factors, and ends/means analysis. The methodology is independent of organizational structure, personnel, and hardware and software; and it has been successfully implemented in a variety of organizational settings.
INTRODUCTION

Few argue that good planning is not difficult. Planning for organizationwide management information systems can be overwhelming. The Management Information Systems (MIS) Research Center at the University of Minnesota conducts an annual survey of the major corporations that sponsor it to determine the key issues that concern MIS executives. MIS planning is consistently among the top three issues.

Accordingly, the MIS Research Center conducts ongoing research in MIS planning. In earlier research conducted by the authors, a stage model of MIS planning was developed that prescribes the major steps of MIS planning and provides a framework for the more popular planning methodologies. Figure 1 is an illustration of the model that categorizes well-known planning techniques in the stages of the model.

In this paper a brief overview of the planning model is provided. The second stage of the planning model, organizational information requirements analysis, is further examined; and techniques for conducting it are described. An approach to developing a long-range information architecture from the requirements is then presented.

OVERVIEW OF MIS PLANNING MODEL

The major problems of MIS planning can be defined as follows:

1. Alignment of MIS strategy with organizational strategy
2. Developing an information architecture
3. Resource allocation
4. Selecting appropriate methodologies for the previous three steps

These problems are addressed directly by the MIS planning model. The first three problems correspond to the three stages of the model. Given the framework of the model, the set of appropriate methodologies is specified for each stage; this process aids in selecting a methodology for each stage.

Practical guidance for MIS planning can be gained from the model. It can help in recognizing the nature of the MIS planning problems and in selecting the appropriate stage of planning. Too often, however, these processes are not carried out. For example, some organizations may view their MIS functions as making minimal contributions to organizational objectives. In seeking to resolve this problem, some organizations have installed a chargeout system (resource allocation planning) to make MIS pay its own way. Other organizations have conducted a business systems planning (BSP: a type of organizational information requirements analysis planning) exercise to resolve the same problem. Though these activities may result in improved MIS services, the MIS planning model suggests they are probably not the appropriate methods in this situation. If the MIS effort is not responsive to the organization, the three-stage MIS planning model indicates that a strategically oriented planning effort should precede organizational information requirements planning and resource allocation planning exercises.

SELECTING A PLANNING METHODOLOGY

The three-stage planning model provides considerable insight into MIS planning issues and reduces confusion among com-
peting planning methodologies. However, the planning model does not indicate which of several methodologies categorized in a planning stage should be used for that planning stage.

Almost no research has evaluated the comparative advantages of one technique or combination of techniques. The methodology for conducting the organizational information requirements analysis (OIRA) stage presented in this paper is based on comparative research involving three methods of enterprise requirements analysis: BSP, critical success factors (CSF), and ends/means analysis.

**CONDUCTING AN OIRA**

Figure 2 portrays the model for conducting an OIRA. To make the methodology concrete, the results of a case study are used to illustrate documents generated during the study. The company agreeing to share the results of an OIRA study is EPIC Realty Services Inc., lessors of single-family dwellings. Headquartered in Washington, D.C., with offices in major cities throughout the United States, the company manages over 6,000 homes.

**Define Underlying Organizational Subsystems**

The first phase of the OIRA is to define underlying organizational subsystems. An organizational subsystem is a fundamental organizational activity necessary to the operation of the organization. For EPIC Realty Services Inc., the major subsystems are as follows:

<table>
<thead>
<tr>
<th>1. Credit</th>
<th>6. Advertising</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Leasing</td>
<td>7. Accounts receivable/collections</td>
</tr>
<tr>
<td>5. Marketing</td>
<td>10. Client reporting</td>
</tr>
<tr>
<td>6. Advertising</td>
<td>11. Appraisal</td>
</tr>
<tr>
<td>7. Inspections</td>
<td>12. Insurance</td>
</tr>
<tr>
<td>8. Audit</td>
<td>13. Sales</td>
</tr>
<tr>
<td>10. Client reporting</td>
<td>15. Inspections</td>
</tr>
<tr>
<td>11. Appraisal</td>
<td>16. Audit</td>
</tr>
<tr>
<td>12. Insurance</td>
<td>17. Inventory</td>
</tr>
<tr>
<td>13. Sales</td>
<td>18. Legal</td>
</tr>
</tbody>
</table>

These subsystems are obtained by an iterative process of discussing all organizational activities and defining them as belonging to broad categories of subsystems. As new activities are considered, they should either be placed in categories previously defined or in a newly created category.

**Develop Subsystem/Manager Matrix**

Once the underlying organizational subsystems are defined, the next phase of the OIRA planning exercise is to relate specific managers to organizational subsystems. The resulting document, called a manager subsystem matrix, is illustrated in Figure 3. Note that the subsystems across the top of the matrix are the same as those identified in Phase 1.

The matrix is developed by reviewing the major decision responsibilities of each middle to top manager and relating the decision making to specific subsystems. The matrix documents the managers having major decision-making responsibility for each specific subsystem. Note that personnel changes or organizational changes can easily be reflected in an adjusted matrix.

**Define and Evaluate Information Requirements for Organizational Subsystems**

This phase of the planning model obtains the information requirements of each organizational subsystem by group interviews of managers having major decision-making responsibility for each subsystem. Merely asking managers to define their information requirements is frequently not satisfactory. The reasons for this are the limits of human beings as information processors. Because of these limitations it is necessary to provide some structure to aid the managers in thinking about information requirements. Various methods for eliciting information requirements are basically different structures for aiding managers in the process of formulating requirements.

Research has been conducted to evaluate three approaches to structuring the set of questions for information requirements interviews. Questions based on three methods—BSP,
CSF, and ends/means analysis—were tested. The conclusions were interesting:

1. Different managers liked different methods. No one method was dominant.
2. The methods were additive. Using more than one approach (in any order), the first method obtains the most requirements, but each additional method brings out additional requirements.
3. Since it is not possible (at this time) to know in advance the method that the manager will favor, the most efficient procedure is to use all three methods.
4. The order of use of the three techniques is in order of cognitive difficulty (the strain it puts on the managers' thought processes) and comprehensiveness.

The interview method is therefore a structured interview using questions based on BSP, CSF, and ends/means analysis. Interviews typically take 2 to 4 hours per subsystem. The maintenance subsystem at EPIC illustrates the steps of the structured interview.

**Statement of purpose**

The first step of the interview is to get the managers to agree on a statement of purpose for the subsystem under consideration. For example, the purpose of maintenance was defined as follows: Maintain rental property at satisfactory availability level with minimal cost and process vendor payments.

**Subsystem mapping**

The second step of the group interview is to define the relationship of the subsystem to all other subsystems internal to the organization or entities external to the organization. It is constructed by drawing the subsystems under consideration in the center of a chalkboard or flip chart pad and around them drawing the subsystems and entities with which they interact. Next, directional arrows are labeled and used to define the types of transactions or information flow that occurs (Figure 4).

The subsystem mapping serves as an excellent tool for making the managers aware of the full scope of the subsystem under consideration. Most interviews of this nature provide considerable enlightenment to the managers involved, since they are usually not aware of the array of activities that occur with subsystems they are familiar with.

**BSP; CSF; ends/means questionnaires**

After the subsystem mapping is complete, information requirements are elicited by using questions based on BSP, CSF, and ends/means analysis. The specific questions and the way they are asked are a key issue.

After interviewing several hundred managers in different organizations, we have found that the obvious question—What information do you need?—is the wrong question. It is the less obvious but properly asked indirect questions that do the job. For example, a good series of questions to ask is as...
A/P MAINTENANCE
Maintain rental property to satisfactory availability level with minimal cost and to process vendor payments.

Figure 4—Subsystem mapping for maintenance
follows: (1) What are the major problems that this subsystem has in accomplishing its purpose? (2) How could they best be solved? (3) Can better information help? The third question reveals information requirements, but the preceding questions set the stage for the third question.

Figure 5 portrays the framework for the information requirements interview, using the three techniques: BSP, CSF, or ends/means analysis. Note that all questioning leads to the information required. The specific questions asked during the group interview are as follows:

1. Business systems planning (problems and decisions)
   a. What are the major problems encountered in accomplishing the purposes of this subsystem?
      (1) What are good solutions to those problems?
      (2) How can information play a role in any of those solutions?
   b. What are the major decisions in managing this subsystem?
      (1) What improvements in information could result in better decisions?
2. Critical success factors
   a. What are the critical success factors of this subsystem? (Most executives have four to eight of these.)
   b. What information is needed to insure that critical success factors are under control?
3. Ends/means analysis
   a. What makes goods or services provided by this subsystem effective to users?
      (1) What information is needed to insure that the subsystem is being effective at providing those goods or services?
   b. How do you define efficiency in providing goods or services in this subsystem?

   (1) What information is needed to evaluate the efficiency of this subsystem?

   The interview will result in the citing of a variety of information requirements as being needed by the subsystem. A separate interview is conducted for each organizational subsystem.

Define Major Information Categories and Map Interviews into Them

The process of categorizing information is an iterative one similar to that used for defining organizational subsystems. By placing the information categories that were defined in the organizational subsystem interviews into broad, generic categories of information, an overall profile of information categories needed by the organization can be developed. Figure 6 illustrates this process.

Develop Information/Subsystem Matrix

By mapping information categories against the organizational subsystems, an information-categories-by-organizational-subsystem matrix can be developed. Figure 7 illustrates such a matrix for EPIC.

Note that at the intersections of information categories and subsystems there are coded values, defined as follows:

<table>
<thead>
<tr>
<th>Utilization/Source</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>S = Source</td>
<td>1 = Low priority</td>
</tr>
<tr>
<td>U = Use</td>
<td>2 = Medium priority</td>
</tr>
<tr>
<td>B = Both</td>
<td>3 = High priority</td>
</tr>
</tbody>
</table>

Managers are asked during the interview the value of different types of information and where it might be acquired, and
Figure 6—Interviews mapped to information categories

their responses can be coded into the table. The scores can be
totaled and used as a rough indicator of the composite value
of a category of information to all subsystems with which it
intersects. The utilization/source also indicates whether a sub­
system can generate the information needed within its own
boundaries or whether it needs to obtain the information from
another subsystem.

As shown in Figure 7, the source and use of information
involves different subsystems. This stresses the importance of
an organizationwide planning effort for information require­
ments analysis to avoid redundant internal generation of in­
formation among subsystems.

USE OF THE OIRA PLANNING RESULTS

The results of the OIRA exercise are twofold:

1. It identifies high payoff information categories.
2. It provides an architecture for information projects.

Identifying High Payoffs

By evaluating composite scores for information categories,
the categories with the highest scores can be given first consid­
eration for feasibility studies. Note that the information-cate­
gory-by-subsystem matrix does not tell the user whether it is
technically, economically, or operationally feasible to im­
prove an information category. The matrix only indicates the
relative value of the information. Feasibility studies and
project definitions must still be made as usual.

Providing Architecture

By clearly defining the intersection of information and sub­
systems, an organization can avoid the problem of building
separate, redundant information systems for different organi­
zational subsystems. When an organization decides to im­
prove information for one organizational subsystem, other
subsystems that need such information can be taken into con­
sideration. This avoids building separate information systems
for each subsystem, which often requires reworking or dupli­
cating what has already been done. By doing the conceptual
work first an organization can identify information system
projects that will do the most good and lead to cohesive,
integrated systems. This is far better than randomly selecting
projects that result in fragmented, piecemeal systems that are
continually being reworked or abandoned because they do not
mesh with the organization's overall requirements. This
means planning from the top down rather than from the bot­
tom up.

Executive's Perspective

Perhaps the best way to illustrate the value of an organiza­
tion's having an organizational information architecture for
MIS is to quote the president of EPIC a year after he person­
ally led the development of their architecture:

I had worked in top management in one of our other sub­
sidiaries and experienced the disappointment that comes from
developing systems in the traditional FIFO, piecemeal way with
the consequences of redundant, non-integrated and inaccessible
information.

When I took over a new subsidiary, I decided there must be a
better way. There was. By developing an information architec­
ture before developing systems we have been able to pull all our
systems together. Our short run system decisions are dovetailing
into our long range systems. We know where we are going and
getting there.

Beyond that, just the process of going through an organiza­
tional information requirements analysis gave me and my man­
age very valuable insight into our business.

REFERENCES

    Planning." Information and Management, forthcoming.
    Methodologies." Proceedings of the Conference on Information Systems
5. IBM Corporation. Business Systems Planning—Information Systems Plan­
**ORGANIZATIONAL SUBSYSTEMS**

<table>
<thead>
<tr>
<th>Information Categories</th>
<th>Leasing</th>
<th>Maintenance</th>
<th>A/R</th>
<th>Credit</th>
<th>Evictions/Deficient</th>
<th>Inspection</th>
<th>Inventory</th>
<th>Marketing</th>
<th>Advertising</th>
<th>Insurance</th>
<th>Sale</th>
<th>Audit</th>
<th>Appraisal</th>
<th>Personnel/Administration</th>
<th>Legal</th>
<th>Market &amp; Product Analysis</th>
<th>Corporate Accounting</th>
<th>Client Reporting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contract</td>
<td>B/3</td>
<td>U/3</td>
<td>B/2</td>
<td>U/3</td>
<td>U/2</td>
<td>B/3</td>
<td>B/3</td>
<td>U/1</td>
<td>U/3</td>
<td>B/3</td>
<td>U/3</td>
<td>B/3</td>
<td>B/3</td>
<td>B/3</td>
<td>U/3</td>
<td>U/3</td>
<td>U/3</td>
<td>U/3</td>
</tr>
<tr>
<td>Policy/Training</td>
<td>U/3</td>
<td>U/3</td>
<td>U/2</td>
<td>B/3</td>
<td>B/3</td>
<td>U/3</td>
<td>U/3</td>
<td>U/3</td>
<td>U/3</td>
<td>B/3</td>
<td>B/2</td>
<td>U/2</td>
<td>B/2</td>
<td>B/2</td>
<td>U/2</td>
<td>U/2</td>
<td>U/2</td>
<td>U/2</td>
</tr>
<tr>
<td>Customer Financial</td>
<td>B/3</td>
<td>B/3</td>
<td>B/3</td>
<td>B/3</td>
<td>B/3</td>
<td>U/3</td>
<td>B/3</td>
<td>U/2</td>
<td>B/3</td>
<td>B/3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Customer Demographics</td>
<td>B/3</td>
<td>U/2</td>
<td>U/2</td>
<td>U/2</td>
<td>B/3</td>
<td>U/3</td>
<td>B/3</td>
<td>B/3</td>
<td>B/3</td>
<td>B/3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complaint</td>
<td>S/2</td>
<td>B/3</td>
<td>B/2</td>
<td>U/2</td>
<td>U/2</td>
<td>B/3</td>
<td>U/3</td>
<td>S/2</td>
<td>B/2</td>
<td>U/2</td>
<td>B/3</td>
<td>B/2</td>
<td>B/2</td>
<td>B/2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leasing/Transactions</td>
<td>B/2</td>
<td>U/3</td>
<td>S/3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vendor</td>
<td>B/3</td>
<td>B/2</td>
<td>B/3</td>
<td>B/3</td>
<td>B/3</td>
<td>B/3</td>
<td>B/3</td>
<td>B/2</td>
<td>B/3</td>
<td>B/3</td>
<td>U/2</td>
<td>B/3</td>
<td>B/3</td>
<td>B/3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A/P</td>
<td>U/2</td>
<td>B/1</td>
<td>B/2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A/R</td>
<td>U/1</td>
<td>B/3</td>
<td>S/3</td>
<td>B/3</td>
<td>B/3</td>
<td>S/3</td>
<td>S/3</td>
<td>U/3</td>
<td></td>
<td></td>
<td>U/3</td>
<td>B/3</td>
<td>B/3</td>
<td>B/3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance</td>
<td>S/3</td>
<td>S/3</td>
<td>B/3</td>
<td>B/3</td>
<td>B/3</td>
<td>B/3</td>
<td>S/3</td>
<td>S/2</td>
<td></td>
<td></td>
<td>U/1</td>
<td>S/2</td>
<td>U/2</td>
<td>B/2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Warranty</td>
<td>B/2</td>
<td>B/2</td>
<td>B/3</td>
<td>B/3</td>
<td>B/3</td>
<td>U/2</td>
<td>U/2</td>
<td></td>
<td></td>
<td></td>
<td>U/2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inventory</td>
<td>B/3</td>
<td>U/2</td>
<td>B/2</td>
<td>B/3</td>
<td>B/3</td>
<td>B/3</td>
<td>B/3</td>
<td>U/2</td>
<td>B/3</td>
<td>U/1</td>
<td>U/3</td>
<td>B/3</td>
<td>B/2</td>
<td>B/2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Key:**
- S=Supply
- U=Use
- B=Both
- 1=low
- 2=medium
- 3=high

Figure 7—Information categories by organizational subsystems matrix