# Research Models in Information Systems

By: Prashant Palvia, Vishal Midha, and Parveen Pinjani.

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**Keywords:** information systems (IS) | research models | journals

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Communications of the Association for Information Systems

# RESEARCH MODELS IN INFORMATION SYSTEMS

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**ABSTRACT**

The use of research models in driving scholarly investigation is of great importance in any field, including information systems (IS). As such, a taxonomy of IS research models should be of substantial value to the discipline. Such a taxonomy is developed in this article based on the IS research literature. Eleven model types are examined in detail in order to investigate how they are used by researchers, in articles published in seven leading IS journals during a recent six year period. Interesting results emerge in the use of models overall, as well as trends over time and relationships with specific methodologies and IS journals. Multi-tier influence diagram is the most used research model in IS research, while the no model, listing of variables, mathematical model, and simple influence diagram also find significant usage among the IS research community. Patterns of model use were also identified based on top journals and prevalent research methodologies.

**Keywords**: research models, frameworks, IS research, meta analysis.

## I. INTRODUCTION

The use of research models in driving scholarly investigation is of great importance and value in any field, including information systems (IS[1]). While early research in information systems in the sixties and seventies was primarily descriptive and did not explicitly use research models, much has changed in the last two decades. Today, much of the research published in the top IS journals have theoretical underpinnings and has some type of model or framework driving the research. In spite of this trend, there is little or no guidance available to researchers in the building of research models[2].

The objective of this paper, therefore, is to develop a taxonomy of research models which will be of value to IS researchers, based on the IS research literature. Specifically, we develop eleven model types and examine how they are used by researchers in articles published in seven leading IS journals during a recent six year period. Interesting results emerge in the use of models overall, as well as trends over time and relationships with specific methodologies and IS journals.

[1] See the appendix for a list of acronyms used in the article.
[2] This paper was motivated by the general lack of guidance in developing research models. The primary author of this paper was teaching a doctoral research seminar and could not find any ready sources.

## MODELS, THEORY, AND FRAMEWORKS

The purpose of research is to present essential information, not everything we know about the object of study. A research model is the *theoretical image* of the object of study. A model can be considered a useful way of describing or explaining interrelationships of ideas; it can be mental, physical, and/or verbal[3]. For example, a map is one of the most common models one encounters in daily life. Maps are considered models because they simplify reality by leaving out unneeded geographic details in order to highlight the important and needed features. Models are specific to the question at hand. For example, a state road map shows only major freeway, provides rough locations of cities, whereas a city map details the roads in the city. So, the map one chooses must be appropriate for the need. Similarly, a research model must be appropriate for the research question at hand.

It is important to note that not all theoretical treatises must contain figures or pictorial representation with relationships represented by arrows and constructs or variables shown in boxes, but a visual representation often clarifies the author's thinking and increases reader's comprehension [Whetten 1989]. It is useful in research as it provides a simplified representation or abstraction of reality. It aids the researcher by identifying the important variables, constructs, and relationships to be explored during the course of investigation.

Ideally, models should be theory based. While many theories exist in IS (e.g., normalization in database management, media choice theory, and technology acceptance theories), a widespread agreement exists that the IS field lacks well-developed theories that command acceptance. Due to the lack of universally accepted theories, many researchers employ frameworks. A framework, in the absence of theory, is helpful in organizing a complex subject, identifying the relationships between the parts, and revealing the areas in which further developments will be required [Sprague 1980].

For a researcher to represent abstract information, one decides how to partition real world knowledge into various constructs (represented graphically or otherwise) and how to position the various constructs onto the presentation space so that it is intuitive [Engelhardt et al. 1996]. The way a researcher represents an idea has a deep impact on how a reader manipulates those representations for understanding the idea and further using that idea for problem solving [Hahn and Kin, 1999]. Researchers in the field of cognitive sciences have shown that diagrammatic representation can facilitate problem solving by proving effective search and recognition cues, and also by enabling powerful perceptual inferences that are natural to humans [Larkin and Simon, 1987]. In this article, we take a very broad view of models in order to be comprehensive. Thus, the models may be represented textually or graphically via diagrams. At the same time, they may represent the objects of interest to various levels of detail and understanding. It may be a rudimentary framework or a fully-developed graphical representation. Essentially, the researcher builds and uses the model to enhance the understanding of the research question and different variables within its domain.

## A TAXONOMY OF RESEARCH MODELS

Many types of research models are utilized by IS researchers. The choice of a single or multiple models depends on several factors including the subject area, research question, research methodology, researcher's background and expertise, intended audience, and the target outlet for publication. Hundreds of research articles in the IS literature served as the basis for the taxonomy presented in this section.

### Classification of Models

Broadly, models can be classified as either descriptive or prescriptive as defined below:

1. *Descriptive Research Model (D)*: Descriptive models are bare minimum models which describe the research question and list the various dependent and independent variables without specifying the relationships among these variables.

[3] http://www.ncpublicschools.org/curriculum/science/glossary.htm

2. *Prescriptive Research Model (P)*: Prescriptive models are more complex, sometimes visual, representations which along with identifying dependent and independent variables, focus on the understanding of the explicit and implicit relationships among these variables.

*Model Categories*

We now present the detailed taxonomy along with examples. It consists of eleven categories. Note that the various model types identified below fall under one of the two broad classes noted above and are so labeled (either D or P).

1. *Listing of variables (D):* Only the variables relevant to the research question are listed. This representation is descriptive in nature and can be in tabular or non-tabular format. For example, Picture 1 shows the listing of variables of key drivers for web home page complexity.

2. *Listing of variables and levels (D):* In this model, the various levels of the variables are also included. This representation also falls under the descriptive type of model as it does not focus on the relationships among variables. Picture 2 shows the levels of various elements explaining the information privacy behaviors. Note that the three variables are listed in the first column; their levels are provided in third and fourth columns.

**Table 2. Experimental Treatment Variable Definitions**

| Variable | Definition |
|---|---|
| Amount of Web home page text | The total number of words in complete sentences on the home page |
| Number of Web home page graphics | The total number of graphics *other than* the company logo on the home page |
| Number of Web home page hyperlinks | The total number of hyperlinks, including e-mail addresses, on the home page |
| Length of Web home page | The approximate number of computer screens occupied by the home page |
| Use of animation on the Web home page | The inclusion or omission of animated graphics on the home page |

**Picture 1** Source: G. Geissler et. al. (2001)

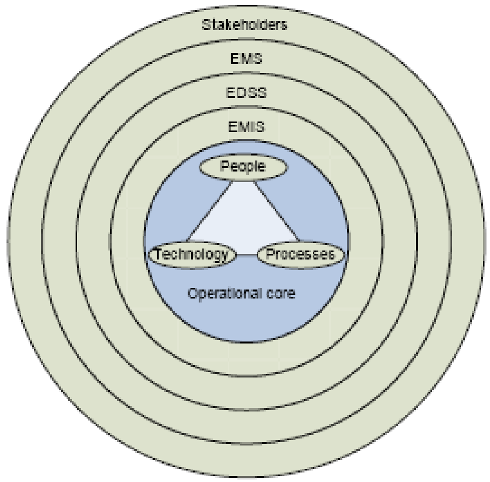
**Table 1. The Institutional Approach to Explaining Information Privacy Behaviors**

| Element | Explanation | Application to information privacy in organizations | |
|---|---|---|---|
| | | Acquiescent Approach | Proactive Approach |
| **Organizational goals** | Survival through the search for legitimacy | • Pragmatic<br>• Managerial | • Social<br>• Technical |
| **Ability and willingness to respond to pressure** | Influence of social network | Embeddedness | Agency |
| **Responses to pressures** | Compliance with established norms | Imitation of peer organizations | Impression management to yield "constrained leadership" |

**Picture 2** Source: Greenaway and Chan (2005)

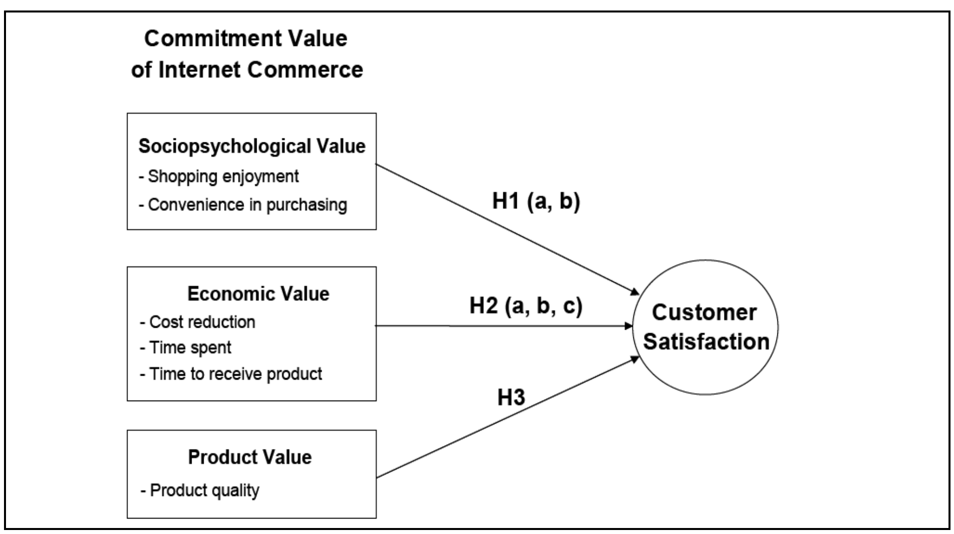
3. *Listing of variables and implicit relationships (D/P):* Along with specifying the variables, the relationships among (some of) these variables may be indicated implicitly. Thus, the model is both descriptive and prescriptive in nature. Picture 3 shows a framework for Environmental

Management Information Systems. The framework implies that the operation core is influenced by EMIS, EDSS, EMS and stakeholders.




**Picture 3** Source: El-Gayar and Fritz (2006)

4. *Simple Influence Diagram- 2 tier (P):* This model clearly delineates the dependent and independent variables and the relationships among them, usually in the form of a diagram. The simple influence diagram has two levels of variables: level 1 being the independent variables and level 2 the dependent variable(s). Each level can have more than one variable. Simple influence diagram is prescriptive in nature. An example is shown in Picture 4, which shows the model for commitment value in internet commerce.



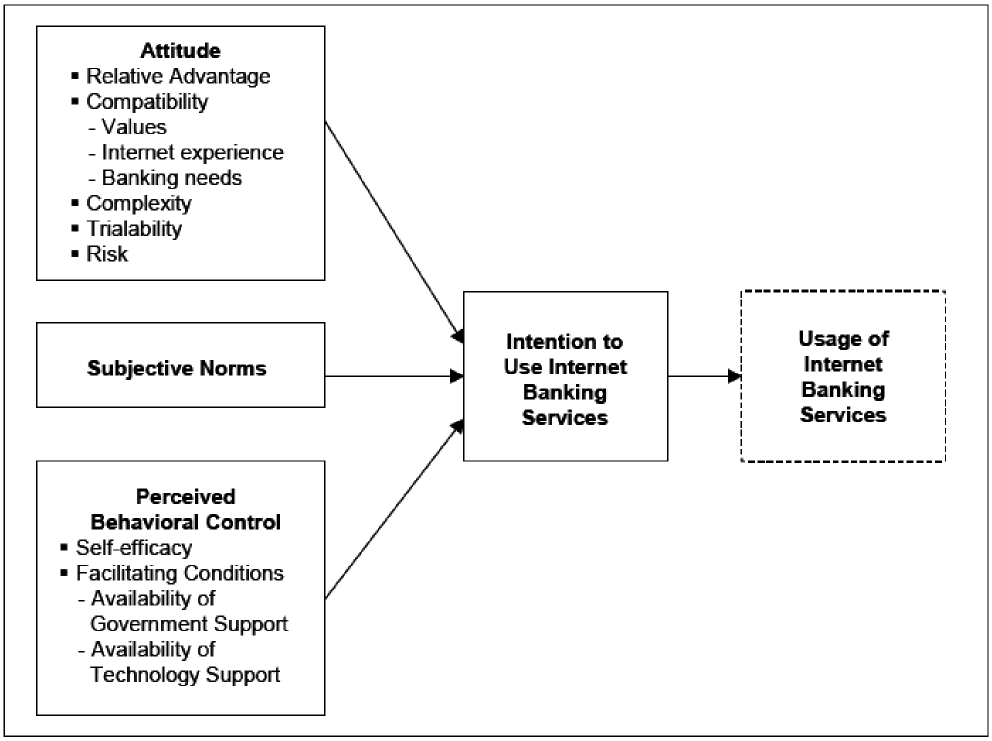

**Picture 4** Source: Lee et al. (2003)

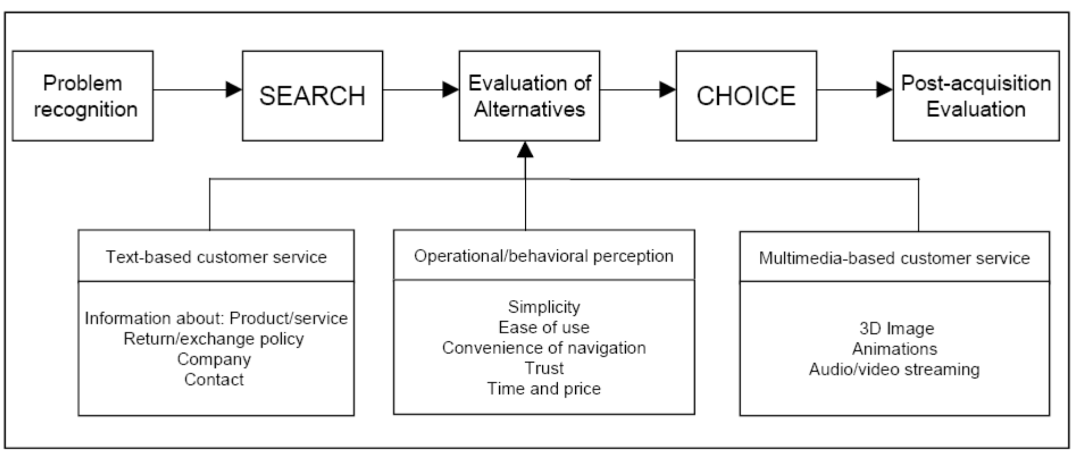
5. *Multi-Tier Influence Diagram (P):* Multi-tier influence diagram is an extension of simple influence diagram involving multiple levels. Level 1 consists of independent variables; the last level has the final dependent variables and other levels contain intermediate variables. Picture 5 illustrates

three levels in a multi-tier influence diagram for factors influencing the adoption of internet banking.

6. *Temporal Influence Diagram (P):* This type of model shows time related relationships between various variables. In other words, events are ordered by time and certain events cannot occur until the preceding events have materialized. Picture 6 shows an example.

**Picture 5** Source: Tan and Teo (2000)




**Picture 6** Source: Shim (2002)

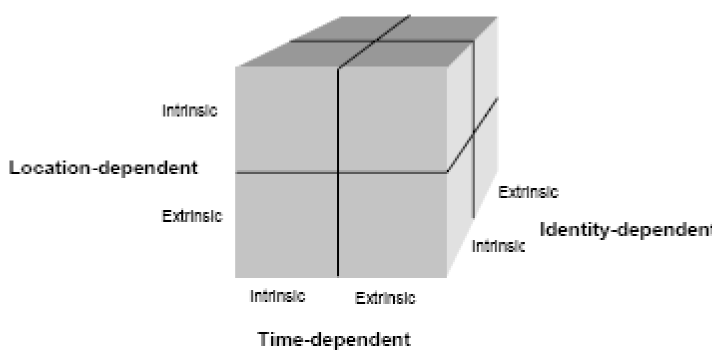
7. Simple Grid (D/P): A simple grid is an easy, yet powerful, way of examining the effects of two independent variables. It makes comparisons between alternatives with multiple characteristics. While each variable may have many levels, in its simplest and most common form, each variable

has only two levels giving rise to the 2x2 grid. In its graphical representation, a 2x2 grid shows the two levels of the two variables generating four cells for detailed examination. Each cell may be labeled and is examined for the effects of the two independent variables. Either a single or multiple effects may be examined in each cell; their relationships are not necessarily predefined. Picture 7 represents an example of a simple 2x2 grid.

| | | **Optimistic framing** (market share captured) | **Pessimistic framing** (market share not captured) |
|---|---|---|---|
| **Positive feedback** | (bigger than expected market share) | Emphasize the bigger than expected market share captured | Emphasize the smaller than expected market share not captured |
| **Negative feedback** | (smaller than expected market share) | Emphasize the smaller than expected market share captured | Emphasize the bigger than expected market share not captured |

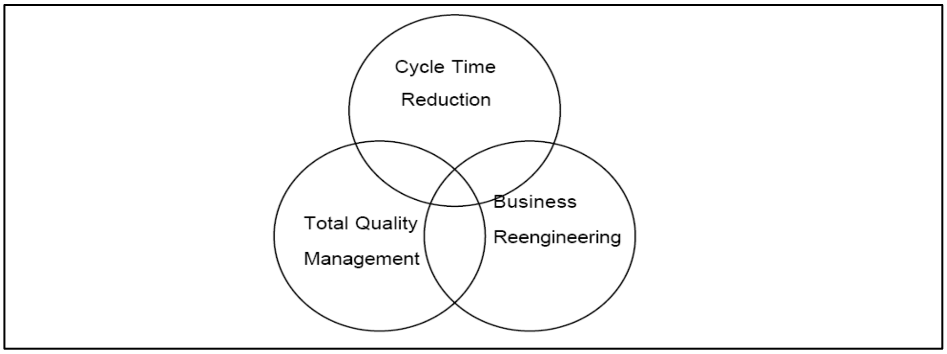
**Picture 7** Source: Heng, Tan, and Wei (2003)

8. *Complex Grid (D/P):* A complex grid is an extension of the simple grid. When a simple grid is extended to three or more variables, it becomes a complex grid. Once again, each variable may have several levels. While three variables are seen in the literature, going to four or more levels makes the grid cumbersome and unwieldy. Picture 8 shows a 2x2x2 grid, which has eight different combinations among three different variables.




**Picture 8** Source: Junglas and Watson (2006)

9. *Venn-Diagram (D/P):* Venn diagrams, adapted from the field of mathematics, offer a graphical representation of not only the objects/variables of interest, but also the interaction among them. Each object or group of objects is typically represented by a circle, with interactions between the groups shown by the overlap or intersection of the corresponding circles. In Picture 9, cycle time reduction, total quality management, and business reengineering are the three variables/groups of interest. The three slices formed by the intersection of the three circles represent interaction effects between two groups at a time, and the innermost intersection represents the three-way interaction.

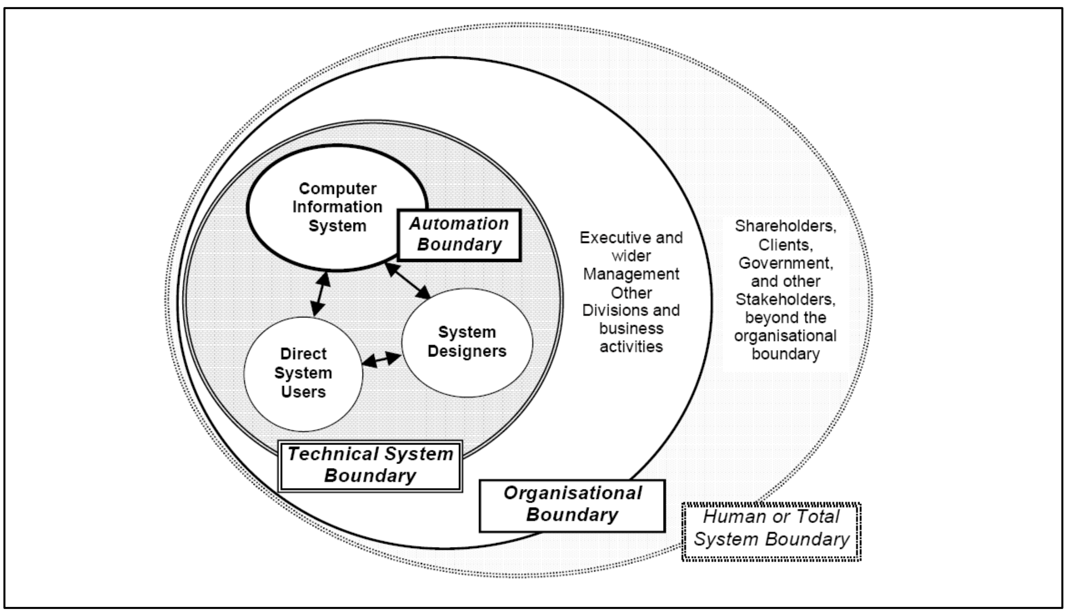



Picture 9 Source: Wheterbe and Frolick (2000)

10. *Mathematical Model (P)*: This type of model uses mathematical functions or equations, contrary to a pictorial view in most models, to explain the relationships among various variables. An example in Picture 10 shows a simple appearing mathematical forecasting model based on existing knowledge of diffusion and connectionist theories.

$$W_i = (1/\ MSE_i)\ /\ \sum_{\forall i}\ (1/\ MSE_i)$$

**Picture 10** Source: Mukhopadhyay (2006)




**Picture 11** Source: Coakes and Elliman (1999)

11. *Combination of above (D/P):* As the name suggests, this model is a combination of two or more of the research models discussed above. Typically, such models are fairly complex and may represent a large research agenda rather than a specific project. An example is shown in Picture 11.

Table 1 summarizes the proposed taxonomy of research models.

Table 1. Research Model Taxonomy

| Number | Description |
|---|---|
| 0 | No Model |
| 1 | Listing of Variables |
| 2 | Listing of Variables & Levels |
| 3 | Listing of Variables & Implicit Relationships |
| 4 | Simple Influence Diagram |
| 5 | Multi-Tier Influence Diagram |
| 6 | Temporal Influence Diagram |
| 7 | Simple Grid |
| 8 | Complex Grid |
| 9 | Venn Diagram |
| 10 | Mathematical Model |
| 11 | Combination |

## II. RESEARCH METHOD FOR THIS STUDY

Extensive content analysis was conducted for this study. Articles published in selected leading MIS journals were coded to capture the relevant data. Table 2 presents the journals reviewed for this study.

Table 2. Selected MIS Journals Used in this Study

- *Communications of the ACM (CACM)*
- *Decision Sciences (DS)*
- *Information and Management (I&M )*
- *Information Systems Research (ISR)*
- *Journal of Management Information Systems (JMIS)*
- *MIS Quarterly (MISQ)*
- *Management Science (MS)*

All articles published between 1998 and 2003 were reviewed. Following the procedure outlined by Grover, Lee and Durand (1993), MIS and related articles were selected by examining the title for information systems keywords. A total of 1226 articles were selected, reviewed, and coded using content analysis. Table 3 depicts a snapshot of the scope of this study.

The research models employed in each article were identified and coded based on the classification scheme presented in Table 1. Occasionally, there was more than one model used in a single article; so our coding allowed for two models. The topic or subject area of each article was also identified. The classification scheme by Barki, Rivard, and Talbot (1998) was the starting point. This scheme presents the most comprehensive classification of MIS topics and was used in previous studies (e.g., Alavi and Carlson, 1992). The classification contains seven levels. The first level presents the broadest classification while lower levels incrementally refine the topic. The three top levels were selected as the basis for subject classification in this study. Continual developments in IT have broadened the scope of MIS to include subjects that were not listed in their classification. Our classification also relied heavily on the scheme used by Palvia et al. (2003). In addition, several topics were added as identified in the initial review. The final subject classification list is shown in Table 4. Note that an article may deal with multiple subjects; therefore, the coding allowed for up to three subjects. Because of possible multiple subjects per article, the total count was 2012.

Table 3. Scope of the Study

| **Journal (Total Issues/ yr)** | **# of Issues** | **From-To** | **# of articles** |
|---|---|---|---|
| CACM(12) | 72 | Jan 98 41(1) – Dec 03 46(12) | 329 |
| DS (4) | 24 | Wtr 98 29(1) – Wtr 2003 34(4) | 71 |
| I&M (6 - 8) | 52 | Mar 98 33(4) – Dec 03 41(2) | 298 |
| ISR (4) | 24 | Mar 98 9(1) – Dec 2003 14(4) | 128 |
| JMIS (4) | 23 | Sum 98 15(1) – Wtr 2003 20(3) | 190 |
| MIS-Q (4) | 24 | Mar 98 22(1)-– Dec 03 27(4) | 114 |
| MS(12) | 72 | Jan 98 44(1)– Dec 03 49(12) | 96 |
| Total | | | 1226 |

Table 4. Subject Classification

| | |
|---|---|
| 1. Theory of MIS | 19. IS Development/Methods and Tools |
| 2. Artificial Intelligence /Expert System/ Neural Networks/Knowledge Management | 20. IS Implementation |
| 3. Global Information Technology (GIT) | 21. IS Usage |
| 4. Hardware | 22. End User Computing |
| 5. Software /Programming Languages | 23. Executive Information Systems |
| 6. Networks/ Telecommunications | 24. Decision Support Systems |
| 7. Internet | 25. Group Decision Support Systems |
| 8. Electronic Commerce /EDI | 26. IS Function Application |
| 9. Multimedia | 27. IS Education |
| 10. Databases/DBMS | 28. IS Research |
| 11. Internal/External Environment | 29. Supply Chain Management (SCM) |
| 12. Organizational design /BPR | 30. Outsourcing |
| 13. Innovation | 31. IT Value |
| 14. Resource Management /IS Management Issues | 32. Media and Communications |
| 15. IS Planning | 33. Customer Relationship Management (CRM) |
| 16. IS Staffing | 34 Enterprise Resource Planning (ERP) |
| 17. IS Evaluation | 35 Workflow Systems |
| 18. Security | |

In addition, we captured the methodology used in each article. A research methodology may be viewed as the "overall process guiding the entire research project" and is the “primary evidence generation mechanism”. The classification scheme for methodologies was used as recommended by Palvia, et. al. (2003), with the addition of content analysis (Table 5). Note that each article may employ multiple methodologies. Therefore, the coding allowed for up to two methodologies. Because of possible multiple methodologies per article, the total methodology count was 1474.

The articles were coded by three doctoral students over a period of one semester. To ensure uniformity of coding and to reduce ambiguity, the coders were trained in the coding method as a part of seminar course on research methodologies. The inter-coder reliability was calculated on the coding of subjects and methodologies over a two phase process. Under phase I, the three coders independently coded the same set of 50 articles. Table 6 presents the result of inter-coder reliability for these initial 50 articles for subjects (S) and methodologies (M).

Table 5. Methodologies Used

| No. | Methodology | Definition |
|---|---|---|
| *1* | Speculation/commentary | Research that derives from thinly supported arguments or opinions with little or no empirical evidence. |
| 2 | Frameworks and Conceptual Model | Research that intends to develop a framework or a conceptual model. |
| 3 | Library Research | Research that is based mainly on the review of existing literature. |
| 4 | Literature Analysis | Research that critiques, analyzes, and extends existing literature and attempts to build new groundwork, e.g., it includes meta analysis. |
| 5 | Case Study | Study of a single phenomenon (e.g., an application, a technology, a decision) in an organization over a logical time frame. |
| 6 | Survey | Research that uses predefined and structured questionnaires to capture data from individuals. Normally, the questionnaires are mailed (fax and electronic means are also used). |
| 7 | Field Study | Study of single or multiple and related processes/ phenomena in single or multiple organizations. |
| 8 | Field Experiment | Research in organizational setting that manipulates and controls the various experimental variables and subjects. |
| 9 | Laboratory Experiment | Research in a simulated laboratory environment that manipulates and controls the various experimental variables and subjects. |
| 10 | Mathematical Analysis | An analytical (e.g., formulaic or optimization model) or a descriptive model (e.g., simulation) is developed for the phenomenon under study. |
| 11 | Qualitative Research | Qualitative research methods are designed to help understand people and the social and cultural contexts within which they live. These methods include ethnography, action research, case research, interpretive studies, and examination of documents and texts. |
| 12 | Interview | Research in which information is obtained by asking respondents questions directly. The questions may be loosely defined, and the responses may be open-ended. |
| 13 | Secondary Data | A study that utilizes existing organizational and business data, e.g., financial and accounting reports, archival data, published statistics, etc. |
| 14 | Content Analysis | A method of analysis in which text (notes) are systematically examined by identifying and grouping themes and coding, classifying and developing categories. |

Table 6. Phase I Inter Coder Reliability

| Coder | 1 | 2 | 3 |
|---|---|---|---|
| 1 | | | |
| 2 | 94% (S)<br>65% (M) | | |
| 3 | 76% (S)<br>60% (M) | 74% (S)<br>70% (M) | |

As seen in Table 6, the inter coder reliability was not always at the 90% target recommended in the literature. A discussion was held based on individual coding outcomes and consensus was reached regarding the final coding scheme. Under Phase II, the coders individually coded another set of 25 articles. Table 7 shows that this time we achieved adequate inter coder reliability. This method ensures that the coders were properly trained in the coding methodology and had a common understanding of the subjects and methodologies, thereby minimizing ambiguity from the coding process

Table 7. Phase II Inter Coder Reliability

| **Coder** | **1** | **2** | **3** |
|---|---|---|---|
| **1** | | | |
| **2** | 93% (S)<br>95% (M) | | |
| **3** | 92% (S)<br>90% (M) | 89% (S)<br>100% (M) | |

## III. RESULTS

### MODEL USAGE

Table 8 presents the model usage frequency for the different models. The total number of models is greater than the number of articles coded because certain articles used more than one model to represent their research variables. Note that 78.5% of the articles coded made use of a model and 21.5% contained no model.

Among the journals studied and the period studied, the multi-tier influence diagram was the most widely used research model visual representation (34.9%). The second highest frequency was for no model at all (21.5%). This is an interesting finding given the increasing maturity of the IS field. Possible explanations are that IS is still a new field compared to other established academic disciplines and there are always new developments in IT, which require exploratory pursuits. Other models that registered respectable amount of use are: listing of variables (12.7%), mathematical model (9%), simple influence diagram (7.7%), simple grid (4.4%), and temporal influence diagram (4.1%).

It is also worthy to note the types of models not so frequently used by MIS researchers. Using 2% as cut off point it is evident that Listing of variables and levels (1.7%) and Venn diagram (1.4%) have been scarcely used by MIS researchers. Low frequency (below 1%) is seen for complex grid (0.8%), combination (0.8%), and listing of variables with implicit relationships (0.9%). These five categories make up a mere 5.6% of the model usage in MIS research.

Table 8. Research Model Frequency

| Model | Frequency | Percentage |
|---|---|---|
| No Model | 283 | 21.5% |
| Listing of Variables | 167 | 12.7% |
| Listing of Variables & Levels | 22 | 1.7% |
| Listing of Variables & Implicit Relationships | 12 | 0.9% |
| Simple Influence Diagram | 102 | 7.7% |
| Multi-Tier Influence Diagram | 460 | 34.9% |
| Temporal Influence Diagram | 54 | 4.1% |
| Simple Grid | 58 | 4.4% |
| Complex Grid | 11 | 0.8% |
| Venn Diagram | 18 | 1.4% |
| Mathematical Model | 119 | 9.0% |
| Combination | 11 | 0.8% |
| **Total** | 1317 | 100% |

Note: The order of model type is that used in Table 1.

**MODEL USAGE TRENDS**

By analyzing the data year-by-year during the period of study (1998-2003), we found some interesting results. Overall, the results show that the multi-tier influence diagram and no model have remained at the top of the preference list of MIS researchers. The multi-tier diagram has shown an upward trend. However, through the years, some models have become more frequently used while others fallen in usage. Figures 1 and 2 depict the trend in research model usage over the study period.

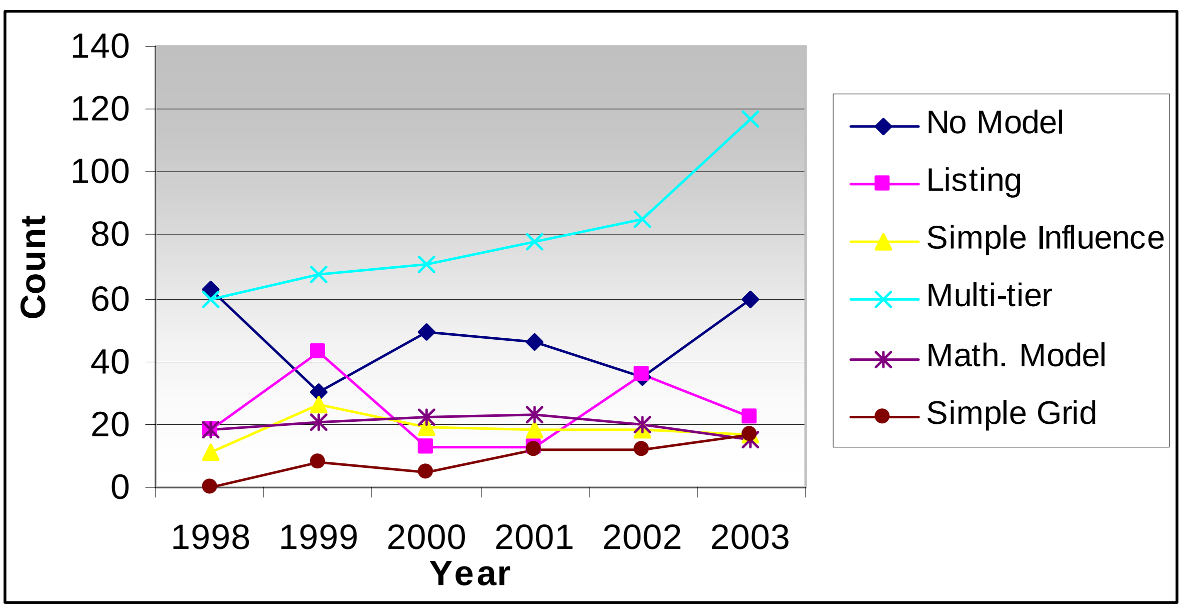



Figure 1. Model Usage Trends

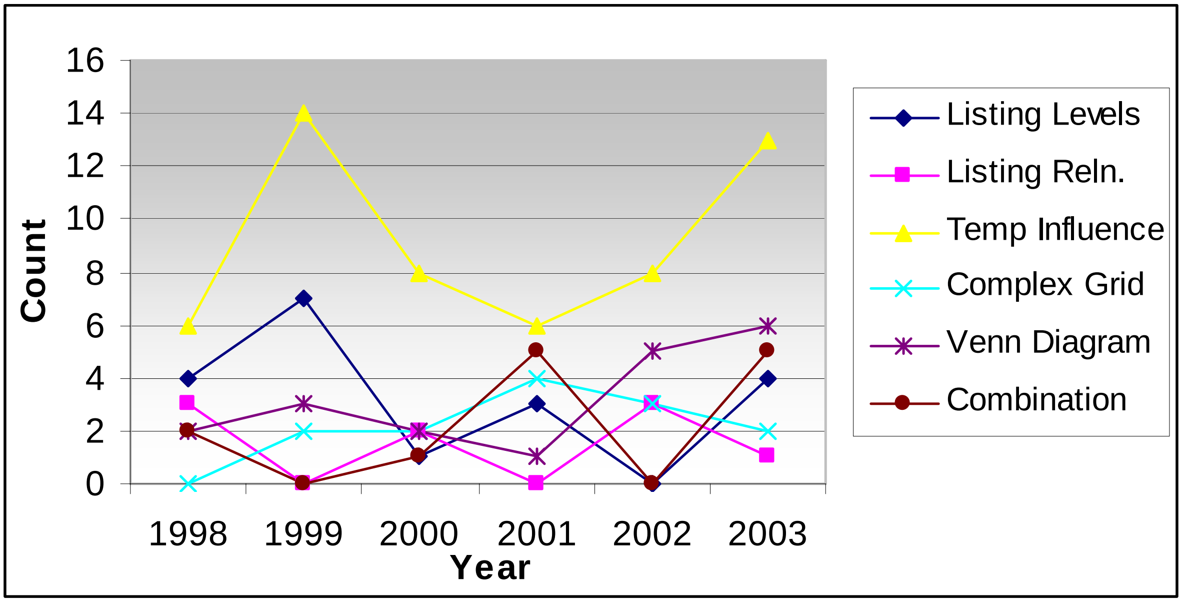



Figure 2. Model Usage Trends

Listing of variables gained a very steep increase in year 1999 and almost reached the second position. It again was preferred in the year 2002, but remained well in third place overall. Other research models have enjoyed much less use over the years. It seems that there is a dichotomy in MIS research. On the one hand, there are many articles published without using any model (21.5%), presumably exploratory research investigating emerging trends and innovations in IT. On the other hand, there are many articles that use theory/models and they tend to use the multi-tier influence diagram (34.9%).

**MODELS BY JOURNAL**

Each column of Table 9 presents the distribution of the various models for a specific journal. These model frequencies clearly indicate that different journals favor certain types of models. For example, *CACM* clearly has a preference for journal articles that contain no model (33.1% of published articles over observed time frame); their second preference is the multi-tier influence diagram (29.6%). *CACM* is known for its practitioner focus; thus, they are more interested in highlighting emerging trends in technology. Most journals are about equally divided between no model and multi-tier diagram. The one exception is *MISQ*, which has the multi-tier influence diagram as #1 (43.8%) and listing of variables as #2 (18.5) – reflecting their more theoretical focus.

We conducted tests to see whether these differences in model frequencies are statistically significant. Initially, we tested all possible combinations of journals, two at a time, for a total of 21 combinations. The results showed that *ISR* has the same distribution of models as *I&M*, *JMIS*, and *DS*. *JMIS* and *DS* also have the same distribution of models. The remaining combinations were statistically different at the 95% confidence level.

Many regard *MISQ*, *JMIS*, *ISR*, and *MS* as the top-tier journals in the information systems discipline. Their model distribution was statistically different from the remaining three journals (*I&M*, *DS*, *CACM*) journals. In another test, as expected, we found that *CACM* (representing a practitioner focus) also has a very different distribution when compared to rest of the journals.

It is worth noting that the multi-tier influence diagram is the most published model in all of the journals with the exception of *CACM*, where it is the second most published model. No-model articles are published primarily in *CACM* and are relatively less common in other journals. In *CACM*, almost half of the articles either had no models or used simple variable listings. This is in accordance with *CACM*'s practitioner focus and the need for communicating emerging developments quickly. Another interesting finding was that the mathematical model was the second most published model in top-tier journals, with *Management Science* taking the lead. In *MS*, almost half (48%) of the articles were published with a mathematical model, while *MISQ* used the mathematical model sparingly.

Table 9. Research Model Frequency within a Journal

| **Journal** | ***MISQ*** | ***I & M*** | ***JMIS*** | ***DS*** | ***ISR*** | ***CACM*** | ***MS*** |
|---|---|---|---|---|---|---|---|
| **Model** | | | | | | | |
| No Model | 12<br>9.2% | 81<br>26.0% | 38<br>19.1% | 6<br>7.7% | 26<br>19.4% | 120<br>33.1% | 0<br>0.0% |
| Listing of Variables | 24<br>18.5% | 37<br>11.9% | 16<br>8.0% | 9<br>11.5% | 15<br>11.2% | 53<br>14.6% | 13<br>12.7% |
| Listing of Variables & Levels | 3<br>2.3% | 8<br>2.6% | 4<br>2.0% | 1<br>1.3% | 1<br>0.7% | 5<br>1.4% | 0<br>0.0% |
| Listing of Variables & Implicit Reln's | 2<br>1.5% | 1<br>0.3% | 0<br>0.0% | 1<br>1.3% | 1<br>0.7% | 6<br>1.7% | 1<br>1.0% |
| Simple Influence Diagram | 18<br>13.8% | 29<br>9.3% | 12<br>6.0% | 9<br>11.5% | 7<br>5.2% | 21<br>5.8% | 6<br>5.9% |
| Multi-Tier Influence Diagram | 57<br>43.8% | 113<br>36.2% | 80<br>40.2% | 33<br>42.3% | 54<br>40.3% | 107<br>29.6% | 16<br>15.7% |
| Temporal Influence Diagram | 3<br>2.3% | 15<br>4.8% | 5<br>2.5% | 3<br>3.8% | 8<br>6.0% | 10<br>2.8% | 10<br>9.8% |
| Simple Grid | 2<br>1.5% | 12<br>3.8% | 9<br>4.5% | 1<br>1.3% | 4<br>3.0% | 26<br>7.2% | 4<br>3.9% |
| Complex Grid | 1<br>0.8% | 1<br>0.3% | 0<br>0.0% | 1<br>1.3% | 2<br>1.5% | 4<br>1.1% | 2<br>2.0% |
| Venn Diagram | 3<br>2.3% | 2<br>0.6% | 4<br>2.0% | 1<br>1.3% | 1<br>0.7% | 6<br>1.7% | 1<br>1.0% |
| Combination | 3<br>2.3% | 3<br>1.0% | 1<br>0.5% | 0<br>0.0% | 1<br>0.7% | 3<br>0.8% | 0<br>0.0% |
| Mathematical Model | 2<br>1.5% | 10<br>3.2% | 30<br>15.1% | 13<br>16.7% | 14<br>10.4% | 1<br>0.3% | 49<br>48.0% |
| **Total** | 130<br>100% | 312<br>100% | 199<br>100% | 78<br>100% | 134<br>100% | 362<br>100% | 102<br>100% |

Note: Highlighted cells represent the maximum published model for corresponding column (journal)

Another useful way of looking at the data is the distribution of each model by the seven journals. However, the data need to be normalized in reporting the relative frequencies. As an example, the total number of articles published in *CACM* is 329 and in *DS* is only 71. Such uneven distribution of number of articles across journals will bias the frequency distribution of models across different journals. To avoid this bias, we normalized the data for each journal by dividing the frequency of a model in a journal by the total number of articles in that journal. After normalizing, we computed the relative frequency distribution across different journals, as shown in Table 10.

The striking observations from Table 9 are that more than 50% of the total number of mathematical model based articles were published by *MS*; 43.2% of articles using combination model, 24% of articles using simple influence diagram, and 24% of articles using Venn diagram were published by *MISQ*; and 28.9% of no-model articles and 28.4% of simple grid articles were published by *CACM*.

Table 10. Normalized Research Model Frequency Across Journals

| Journal | MISQ | I & M | JMIS | DS | ISR | CACM | MS | Total |
|---|---|---|---|---|---|---|---|---|
| **Model** | | | | | | | | |
| No Model | 8.1% | 22.7% | 16.7% | 6.7% | 16.9% | 28.9% | 0.0% | 100.0% |
| Listing of Variables | 20.9% | 13.4% | 9.1% | 13.0% | 12.7% | 16.5% | 14.4% | 100.0% |
| Listing of Variables & Levels | 22.4% | 24.9% | 19.5% | 12.5% | 7.3% | 13.4% | 0.0% | 100.0% |
| Listing of Variables & Implicit Reln's | 23.6% | 4.9% | 0.0% | 19.6% | 11.4% | 25.4% | 15.0% | 100.0% |
| Simple Influence Diagram | 24.0% | 16.1% | 10.5% | 20.0% | 9.1% | 10.1% | 10.2% | 100.0% |
| Multi-Tier Influence Diagram | 17.7% | 14.6% | 16.2% | 17.1% | 16.2% | 11.9% | 6.3% | 100.0% |
| Temporal Influence Diagram | 7.2% | 15.0% | 7.8% | 12.0% | 18.7% | 8.6% | 30.6% | 100.0% |
| Simple Grid | 6.1% | 15.2% | 17.9% | 5.1% | 11.8% | 28.4% | 15.5% | 100.0% |
| Complex Grid | 11.1% | 4.6% | 0.0% | 18.5% | 21.5% | 15.9% | 28.3% | 100.0% |
| Venn Diagram | 24.0% | 6.7% | 20.9% | 13.3% | 7.8% | 17.2% | 10.2% | 100.0% |
| Combination | 43.2% | 18.0% | 9.4% | 0.0% | 14.0% | 15.5% | 0.0% | 100.0% |
| Mathematical Model | 1.6% | 3.4% | 15.8% | 17.5% | 11.0% | 0.3% | 50.4% | 100.0% |

### MODEL BY METHODOLOGY

Some useful insights can be obtained by examining the models used by different methodologies (Table 11). We observe that some methodology/model combinations are utilized more than others. For example, many of the "no model" articles are speculations/commentaries and provide no data. This explains why 22.7% of the papers with no model were defined as speculations.

Articles using the survey methodology are the largest group in the "listing of variables" category. This is perhaps due to the descriptive nature of the survey method and its ability to provide quick snapshots of current events. However, survey methodologies also make up the largest group of multi-tier influence diagrams. We also see that most of the models use survey as the top methodology used for data collection. This result can be explained by the fact that the survey methodology is the most popular in IS research.

Another observable pattern is that the temporal influence diagram is most likely to use frameworks and field studies.

### MODEL BY SUBJECT AREA

Table 12 shows the usage of models by subject areas. The dominance of the "no model" and "multi-tier influence diagrams" continues in this breakdown. Most subjects have these two model types as the first and second most popular choice. Generally, the "listing of variables" is the third most popular.

## IV. DISCUSSION

### LIMITATIONS

Prior to discussing the results, we state some limitations of the study. The primary limitation is that only seven journals were targeted for the study. Even with the seven journals, this is a massive data collection effort and we had to constrain it in some manner. But the fact that all highly acclaimed top-tier journals were included can also be considered a strength of the study, as our study provides the best practices in IS research.

Another limitation is the classification scheme used for coding the articles. The coders found that the subject list was not exhaustive and some of the articles were not easy to fit into it. Though some new subjects were added, the list was still not sufficient to accurately represent some articles. Given the breadth of what can be called MIS, we had to draw a line for the number of subjects to be included in the scheme.

## RESULTS

Results show that there is almost a dichotomy in the use of models in MIS research. On the one hand, there are many articles (about one-third) published without using any model, presumably exploratory research investigating emerging trends and innovations in IT. On the other hand, two-thirds of the published articles use some kind of model to guide the investigation. Among these, the multi-tier influence diagram is the choice of most researchers. With a few exceptions, this pattern is seen across all subject areas and various methodologies utilized for research. After the dominant use of multi-tier diagram, the “listing of variables” was the next most often used. Other models showing low but still significant use are: simple influence diagram, temporal influence diagram, and the simple grid. Various other models have been used only rarely.

Trends by journals may help authors properly target their submissions. For example, *CACM* has a preference for journal articles that contain no model; their second preference is the multi-tier influence diagram (29.6%). *CACM* is known for its practitioner focus. Thus they are more interested in highlighting emerging trends in technology. Most journals are about equally divided between no model and multi-tier diagram. The one exception is *MISQ*, which has the multi-tier influence diagram as #1 and listing of variables as #2, reflecting a more theoretical focus.

As explained, some methodology/model combinations are observed more often than others. For example, many of the “no model” articles are speculations/commentaries and provide no data. Articles using the survey methodology are the largest group in the “listing of variables” category. This is presumably due to the descriptive nature of the survey method and its ability to provide quick snapshots of current events. However, survey methodologies also make up the largest group of multi-tier influence diagrams. We also see that most of the models use survey as the top methodology used for data collection. This result can be explained by the fact that the survey methodology is the most popular in IS research. Another observable pattern is that the temporal influence diagram is most likely to use frameworks and field studies.

Table 11. Model by Methodology

| Model→ / Methodology↓ | No Model | Listing of Variables | Listing of Variables & Levels | Listing of Variables & Implicit Rel'n | Simple Influence Diagram | Multi-Tier Influence Diagram | Temporal Influence Diagram | Simple Grid | Complex Grid | Venn Diagram | Combination | Mathematical Model | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Speculation | 74 | 20 | 3 | 2 | 5 | 49 | 3 | 7 | 0 | 1 | 1 | 1 | 166 |
| Framework | 26 | 11 | 2 | 3 | 11 | 62 | 13 | 10 | 5 | 3 | 4 | 2 | 152 |
| Lib. Res. | 5 | 6 | 0 | 0 | 1 | 7 | 1 | 2 | 0 | 1 | 0 | 0 | 23 |
| Lit. Ana. | 10 | 12 | 2 | 1 | 4 | 23 | 1 | 3 | 2 | 1 | 1 | 1 | 61 |
| Case Study | 25 | 21 | 4 | 1 | 10 | 57 | 5 | 7 | 0 | 3 | 3 | 9 | 145 |
| Survey | 59 | 42 | 6 | 1 | 46 | 122 | 10 | 16 | 1 | 3 | 1 | 7 | 314 |
| Field Study | 27 | 15 | 3 | 1 | 9 | 41 | 9 | 0 | 0 | 2 | 0 | 6 | 113 |
| Field Exp. | 13 | 9 | 0 | 0 | 1 | 11 | 2 | 1 | 0 | 1 | 0 | 7 | 45 |
| Lab. Exp. | 32 | 23 | 2 | 0 | 9 | 62 | 9 | 4 | 2 | 1 | 0 | 17 | 161 |
| Math. Analysis | 6 | 10 | 1 | 2 | 9 | 36 | 7 | 9 | 2 | 4 | 1 | 94 | 181 |
| Qual. Res. | 4 | 3 | 1 | 2 | 2 | 1 | 0 | 1 | 0 | 0 | 0 | 2 | 16 |
| Interview | 18 | 8 | 2 | 1 | 8 | 39 | 4 | 3 | 1 | 1 | 0 | 1 | 86 |
| Sec. Data | 19 | 14 | 1 | 2 | 8 | 17 | 2 | 3 | 0 | 1 | 1 | 19 | 87 |
| Content Ana. | 9 | 34 | 4 | 3 | 13 | 37 | 7 | 13 | 1 | 4 | 1 | 1 | 127 |
| Total | 327 | 228 | 31 | 19 | 136 | 564 | 73 | 79 | 14 | 26 | 13 | 167 | 1677 |

Table 12. Model by Subject Area

| Model → / Subject Area ↓ | No Model | Listing of Variables | Listing & Levels | Listing & Implicit Rel'n | Simple Influence Diagram | Multi-Tier Influence Diagram | Temporal Influence Diagram | Simple Grid | Complex Grid | Venn Diagram | Comb-ination | Mathe-matical Model |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Theory of MIS | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| AI/ES/NN/KM | 17 | 5 | 2 | 1 | 7 | 37 | 3 | 5 | 0 | 1 | 0 | 13 |
| GIT | 10 | 7 | 0 | 0 | 0 | 5 | 5 | 4 | 0 | 0 | 1 | 0 |
| Hardware | 3 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Software/Prog. Languages | 13 | 1 | 0 | 0 | 4 | 24 | 4 | 2 | 0 | 1 | 0 | 5 |
| Networks/Telecomm | 7 | 4 | 0 | 0 | 5 | 14 | 0 | 2 | 0 | 0 | 0 | 4 |
| Internet | 22 | 12 | 2 | 1 | 6 | 17 | 2 | 4 | 2 | 1 | 0 | 2 |
| E-Commerce | 20 | 13 | 0 | 1 | 10 | 38 | 4 | 7 | 0 | 1 | 0 | 16 |
| Multimedia | 5 | 1 | 1 | 0 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 1 |
| Database/DBMS | 10 | 1 | 0 | 0 | 1 | 14 | 4 | 3 | 1 | 0 | 0 | 3 |
| Internal/Ext Env. | 5 | 1 | 1 | 0 | 1 | 4 | 1 | 1 | 0 | 0 | 0 | 6 |
| BPR | 5 | 7 | 2 | 0 | 3 | 14 | 2 | 3 | 0 | 0 | 1 | 3 |
| Innovation | 5 | 2 | 0 | 0 | 1 | 14 | 2 | 2 | 0 | 1 | 0 | 1 |
| Res. Mgt./ IS Mgt. Issues | 8 | 11 | 1 | 1 | 10 | 28 | 4 | 5 | 1 | 1 | 0 | 10 |
| IS Planning | 2 | 5 | 1 | 1 | 4 | 11 | 1 | 2 | 0 | 0 | 2 | 0 |
| IS Staffing | 11 | 3 | 0 | 0 | 4 | 13 | 0 | 1 | 0 | 0 | 0 | 1 |
| IS Evaluation/ Control | 9 | 11 | 0 | 0 | 2 | 23 | 4 | 2 | 0 | 1 | 1 | 8 |
| Security | 7 | 3 | 0 | 0 | 2 | 9 | 0 | 0 | 0 | 1 | 0 | 0 |
| IS Development | 18 | 14 | 1 | 1 | 8 | 28 | 4 | 2 | 0 | 0 | 2 | 4 |
| IS Implementation | 6 | 1 | 1 | 2 | 4 | 6 | 2 | 0 | 1 | 1 | 1 | 0 |
| IS Usage | 22 | 10 | 2 | 1 | 3 | 33 | 2 | 3 | 0 | 2 | 1 | 3 |
| EUC | 3 | 7 | 4 | 0 | 6 | 15 | 0 | 0 | 1 | 1 | 0 | 3 |
| EIS | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DSS | 5 | 5 | 1 | 0 | 2 | 15 | 2 | 0 | 1 | 2 | 0 | 10 |
| GDSS | 20 | 13 | 1 | 0 | 0 | 25 | 1 | 1 | 0 | 0 | 0 | 2 |
| IS Function App. | 4 | 0 | 0 | 0 | 1 | 3 | 0 | 1 | 0 | 1 | 0 | 6 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IS Education | 7 | 3 | 0 | 0 | 1 | 1 | 0 | 1 | 2 | 0 | 0 | 0 |
| IS Research | 18 | 9 | 0 | 2 | 9 | 9 | 0 | 1 | 1 | 1 | 0 | 0 |
| SCM | 2 | 5 | 0 | 0 | 2 | 19 | 1 | 2 | 1 | 0 | 1 | 11 |
| Outsourcing | 2 | 1 | 0 | 0 | 2 | 7 | 3 | 1 | 0 | 1 | 0 | 1 |
| IT Value | 6 | 3 | 1 | 0 | 3 | 13 | 1 | 0 | 0 | 0 | 1 | 4 |
| Media & Communication | 7 | 7 | 1 | 0 | 0 | 12 | 1 | 2 | 0 | 1 | 0 | 1 |
| CRM | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 1 | 0 | 0 | 0 | 1 |
| ERP | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| WorkFlow Systems | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |

## V. CONCLUSION

One of the primary contributions of this article is the development of a useful taxonomy of research models in IS. With the increasing emphasis in rigor, it is expected that this taxonomy will help young researchers in the selection and development of proper models to guide their investigations. It may also help the more established and mature researchers in assessing their current efforts and making any necessary adjustments. We do not claim that our taxonomy is exhaustive or completely accurate, yet we do believe it captures the essential elements of the types of models available to us as researchers.

Our meta-analysis helps us understand the paradigms used in research published in some of our best top-tier journals. Thus, researchers can observe the current standards in order to either conform to the standards or to explore any obvious deficiencies. For example, while the multi-tier diagram has enjoyed heavy use, other models have been only sparingly used. In any case, a careful examination of our analysis should help improve the quality of future studies in information systems.

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## ABBREVIATIONS AND ACRONYMS

| | | | |
|---|---|---|---|
| AI | Artificial Intelligence | GDSS | Group Decision Support Systems |
| BPR | Business Process Re-engineering | GIT | Global Information Technology |
| CACM | Communications of the ACM | I&M | Information and Management |
| CRM | Customer Relationship Management | IS | Information Systems |
| D | Descriptive Research Model | ISR | Information Systems Research |
| DBMS | Data Base management System | JMIS | Journal of Management Information Systems |
| DS | Decision Sciences | KM | Knowledge Management |
| DSS | Decision Support Systems | MIS | Management Information Systems |
| EDI | Electronic Data Interchange | MISQ | MIS Quarterly |
| EIS | Executive Information Systems | MS | Management Science |
| ERP | Enterprise Resource Planning | NN | Neural Networks |
| ES | Expert Systems | P | Prescriptive Research Model |
| EUC | End User Computing | SCM | Supply Chain Management |

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