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Universal or Conditional Measures of System Use?

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ABSTRACT

Extant research on information system use in organizational settings has relied extensively on measures such as *frequency of use* and *time of use*. These may be considered universal measures of system use that fit a variety of contexts. System use, however, can be contingent on various factors. In organizational settings, for instance, different classes of information systems (e.g. stand-alone systems, communication systems with network externalities, group systems, etc.) are being used by different types of end-users (e.g. executives, managers, administrative assistants, etc.). The extent to which these individuals use a system may be dependent on the extent to which the system allows them to accomplish their tasks associated to their roles. Universal measures of system use would generally not account for such contingencies. This paper presents a conditional measure of system use called *extent of relevant use* to address these limitations.

Keywords

Information Systems, System Use, Measures.

INTRODUCTION

The measurement of system use has been of enduring interest to information systems research and practice. Several measures of information system use such as frequency of use and time of use have been proposed over the years (e.g. DeLone and McLean, 1992). These measures have been employed in organizational settings almost universally: they have served to capture system use for a variety of information technologies such as computers, decision support systems, and executive information systems by individuals in a variety of roles such as senior executives, managers, and frontline employees. Such universal measures provide an understanding of the extent to which different individuals use information systems. However, universal measures of system use do not consider the extent to which individuals can accomplish tasks specific to their roles using those information systems. This paper presents a conditional measure, named *extent of relevant use*, which overcomes this limitation of universal measures¹.

ORGANIZING FRAMEWORK: UNIVERSAL OR CONDITIONAL MEASURES?

The arguments for universal or conditional measures of system use may be motivated by the organizing framework depicted in Figure 1.

- § Information systems are generally designed to fulfill different needs. A variety of information systems such as decision support systems, executive information systems, and expert systems are commonplace in organizational settings today (Jessup and Valacich, 2003). Despite such differences, information systems exhibit certain commonalities: virtually all information systems possess features or functions that allow individuals to accomplish their tasks (Jasperson, Carter, and Zmud, 2005).
- § Individuals generally occupy different positions in the organization hierarchy and enact various roles. A variety of roles such as senior executive, middle manager, frontline manager, and administrative assistant are commonplace in organizational settings today (Jessup and Valacich, 2003). Despite such differences, individuals in organizations share commonalities: they all perform certain information-related tasks in their respective roles and generally use information systems to accomplish their tasks (Goodhue and Thompson, 1995).

¹ This paper deals with measures of system use in organizational settings, specifically, information systems designed for internal organizational members.

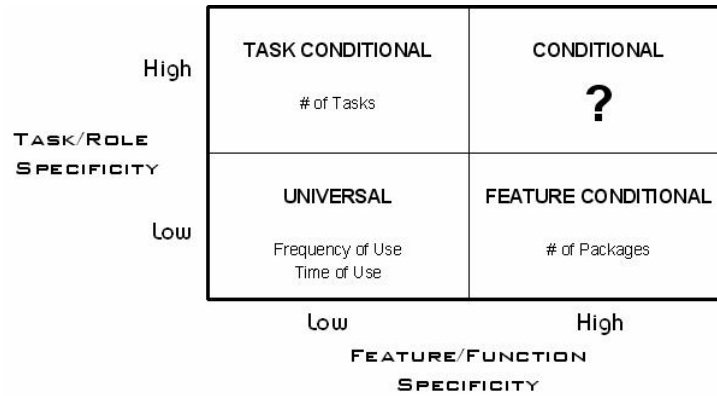


Figure 1. Contingencies underlying Measures of System Use

The extent to which measures of system use contend with these two contingencies provides the basis for formulating universal or conditional measures.

- § **Feature/function specificity** is the extent to which measures of system use account for the various features possessed by the information system. Features may be considered as the components that enable an individual to interact with the information system (Jaspersen et al., 2005). For instance, creating form letters is a feature of word processing systems whereas running queries is a feature of database management systems. The feature/function specificity dimension represents the degree to which the system use measure used in a study specifically deals with the features of the system.
- § **Task/role specificity** is the extent to which measures of system use account for the various tasks performed by individuals in their respective roles. Tasks are the activities that an individual typically performs in the role occupied within the organization (Vecchio, 2003). For instance, strategic planning is typically done by senior executives whereas internal budgeting is done by middle managers. The task/role specificity dimension represents the degree to which the system use measure employed in a study specifically deals with the tasks performed by individuals in their roles.

The foregoing gives rise to the 2x2 matrix in Figure 1, in which UNIVERSAL measures do not account for either contingency, FEATURE CONDITIONAL and TASK CONDITIONAL measures account for one of the two contingencies, and CONDITIONAL measures account for both contingencies.

UNIVERSAL MEASURES: THE EXTANT VIEW

Universal measures, on the bottom left-hand quadrant on Figure 1, are low on feature/function specificity as well as task/role specificity. By their very nature, since they do not account for the specific information system under study nor do they consider the roles enacted by individuals using the system, they can be used in a variety of contexts.

Prior research has focused widespread attention on universal measures of system use such as frequency of use and time of use (Refer to columns FoU and ToU on the Appendix)². Frequency of use refers to the number of times an individual works with an information system over time. It has generally been operationalized on a scale ranging from “less than once a month” to “several times a day” (e.g. Igarria, 1993). Time of use refers to the amount of time an individual works with an information system on a typical work day. It has typically been operationalized on a scale ranging from “almost never” to “more than 3 hours per day” (e.g. Igarria, 1993).

As seen from the Appendix, prior research has employed frequency of use and time of use in a variety of contexts. These universal measures have been used to measure the use of a variety of information systems such as personal computers (Thompson, Higgins and Howell, 1991), decision support systems (Barki and Huff, 1985), executive information systems (Bergeron et al., 1995), expert systems (Guimaraes, Yoon and Clevenson, 1995), and business process applications (Venkatesh and Davis, 2000), used by a variety of individuals such as senior executives, middle managers, and frontline managers (e.g. Igarria, Iivari and Maragahh, 1995).

² Other universal measures such as length of use (Sanders and Courtney, 1985) are also found in prior literature but are not nearly as widespread as frequency of use and time of use.

Despite their inherent attractions and convenience, universal measures of system use have certain limitations. A basic assumption underlying the universal measures of system use is that all individuals, irrespective of their positions in the organizational hierarchy, would use the same information systems similarly.

- § An organization is typically comprised of senior executives, managers, and frontline employees who are considered to operate at the strategic, tactical, and operational levels of the organization's hierarchy (Jessup and Valacich, 2003). Information needs at the strategic, tactical, and operational levels, and by implication, of the senior executives, managers, and frontline employees are usually not similar. Whereas frontline employees may rely on transaction processing reports, managers may find more use for exception reports, while senior executives may prefer forecasts and trends. Hence, even when senior executives, managers, and frontline employees work with the same information system, they are likely to rely on different aspects of the system, which may or may not involve the same amounts of time or frequency.
- § The frequency of such information needs at the strategic, tactical, and operational management levels are not similar (Jessup and Valacich, 2003). For instance, transaction reports, which are more common at the operational level, are generated more frequently than others such as ad hoc or on-demand reports, which are seen at the higher levels of the organization. Hence, even when senior executives, managers, and frontline employees use the same information system, they are likely to have different levels of system use.
- § The roles enacted by senior executives, managers, and frontline employees demand different skills (Jessup and Valacich, 2003). As a result, the specific functions they are required to perform would most likely be unique to their roles. In the context of word processing, for instance, tasks such as mailmerging (i.e. preparing form letters for multiple individuals) are more likely to be performed at the secretarial levels than executive levels. Hence, executives, managers, and frontline employees are likely to use the same information system to accomplish different objectives.

FEATURE CONDITIONAL AND TASK CONDITIONAL MEASURES: THE EXTANT VARIANTS

Feature and task conditional measures, on the bottom right-hand and top left-hand quadrants on Figure 1 respectively, are high on one specificity and low on the other. Whereas feature conditional measures are high on feature/function specificity, task conditional measures are high on task/role specificity. These non-universal variants of system use may be used in specific situations that account for one of the contingencies.

There is some evidence in extant literature that non-universal variant measures of system use such as number of packages and number of tasks have been developed, albeit for limited situations (Refer to columns #Pkg and #Tsk on the Appendix). Number of packages refers to the numerical count of the different packages such as spreadsheets, statistical tools, word processors, and communication tools actually used by an individual (e.g. Igarria, 1992). Number of tasks refers to the numerical count of the different tasks such as data analysis, auditing, budgeting, and decision-making an individual actually accomplished using information systems (e.g. Igarria, 1992).

The Appendix reveals that prior research has used these non-universal variants in a limited set of contexts. Both variants, number of packages and number of tasks, have been used to measure the use of personal computers and end-user computing. While these measures are more focused than the universal measures of system use, they do have some limitations.

- § The obvious limitation is that both feature and task conditional measures account for one contingency at the expense of the other. The feature conditional measures help us understand the system features used by individuals but prohibit us from understanding if the features used were in congruence with the tasks performed by those individuals. The task conditional measures enable us to understand the tasks for which the individuals used the information systems but do not inform us on those features that were useful for those individuals. Thus, feature and task conditional measures can only provide a partial view of system use.
- § The feature conditional measures have been formulated at the macro level. For instance, "packages" in the variable 'number of packages' refers to the software applications or tools available on a personal computer. If we consider the personal computer as the "information system" being examined, then packages can be considered as "features" provided by the information system. Thus, number of packages may be specific to personal computers and may not extend to other systems³. Moreover, the extent to which these features were used by individuals to accomplish their tasks is not accounted by these variables.

³ Prior studies have employed a measure of system use that overcomes this limitation. It is a feature conditional measure designed for capturing the use of an e-mail system. The measure includes several items that deal with the major features of e-mail systems such as messages received, messages sent, messages forwarded, etc. (e.g. Fulk, 1993).

§ The task conditional measures have been designed at the macro level as well. For instance, “tasks” in the variable ‘number of tasks’ deals with the activities that an individual can accomplish using a personal computer. Thus, number of tasks may be specific to personal computers as well. Furthermore, even when the tasks are defined in terms of the information system, the extent to which these tasks are relevant for the particular roles performed by individuals is not accounted by these variables. For instance, in the context of database management systems, individuals in the “database administrator” role may have the need to perform the task of creating table structures more extensively than individuals in the “senior executive” role.

CONDITIONAL MEASURES: THE ALTERNATE VIEW

Conditional measures, on the top right-hand quadrant on Figure 1, are high on feature/function specificity as well as task/role specificity. Conditional measures of system use account for both the information system being examined and the tasks accomplished by individuals using those systems⁴. By nature, conditional measures of system use are ideal for measuring an individual’s use of a specific information system for accomplishing a set of information-related tasks.

Consider, for instance, an information system that is available for use by individuals in different roles. The individuals in these different roles generally use different aspects of the information system. Stated differently, the extent to which individuals require the use of specific features of the information system is dependent on the tasks to be accomplished for the roles they play in organizational settings. In the context of database management systems, for instance, a senior executive may require canned reports only 10% of the time but may require adhoc reports for 50% of the time. However, a middle manager may require canned reports 70% of the time and adhoc reports only 10% of the time. The key is to understand the extent to which these individuals, in their roles, use the system for a specific purpose (say, adhoc reporting) (and by implication, a specific feature of the system), given that the specific task (i.e. adhoc reports) is needed differentially in the two roles (50% for the senior executive and 10% for the middle manager). This is very different from what is captured by universal measures.

To overcome these limitations, a conditional measure called extent of relevant use is developed here. *Extent of relevant use* may be defined as the extent to which an individual used features of the information system that were directly relevant for accomplishing tasks in a particular role.

§ The information system can be virtually anything; however, it may be beneficial to develop conditional measures for specific *classes* of information systems (e.g. word processing systems, presentation tools, etc.) rather than specific systems (e.g. Microsoft Word, Corel Presentations, etc.). Such a scheme would enable the formulation of conditional measures at a somewhat micro level of reference compared to personal computers (as was the case with feature and task conditional measures). The features for a specific class of information systems can then be used for the measurement of system use. Figure 2 illustrates the features for database management systems.

To what extent do you use [say, Microsoft Access] to perform the following functions?	Almost Never							Almost Always						
	1	2	3	4	5	6	7	1	2	3	4	5	6	7
1. Database Table														
2. Database Query														
3. Database Report														
4. Database Form														
5. Database Macro														

Figure 2. Hypothetical Features

⁴ Prior studies have combined feature conditional (i.e. number of packages) and task conditional (e.g. number of tasks) measures into a composite measure (Refer to column Comp? on the Appendix). These composite measures may resemble conditional measures of system use. However, there are substantive differences between the composite measures found in prior literature and the conditional measures explained here. Composite measures merely aggregate the separate items into a single measure whereas conditional measures account for contingencies.

If Figure 2 were used as a measurement instrument, we would be able to obtain an index of the extent to which individuals use different features of the particular information system being examined. Figure 3 provides hypothetical responses that may be provided by various individuals participating in the survey.

To what extent do you use [say, Microsoft Access] to perform the following functions?	Senior Exec	Database Admin	Customer Specialist	Admin Assistant	Floor Manager
1. Database Table	1	4	3	1	1
2. Database Query	3	1	1	2	6
3. Database Report	5	1	6	6	7
4. Database Form	1	1	5	2	1
5. Database Macro	1	3	2	1	4

Figure 3. Hypothetical Responses for Use of Features

§ The tasks can be any set of activities performed by individuals in their various roles; however, the more important consideration is that, given the same set of tasks, the extent to which individuals need to perform those tasks may be dependent on their roles. Thus, conditional measures of system use would also account for the variance in usage as a result of performing different roles. Figure 4 provides an illustration of the tasks, related to managing data, which may be performed by individuals in their assigned roles.

To what extent are you required to accomplish the following tasks in your role?	Almost Never							Almost Always						
	1	2	3	4	5	6	7	1	2	3	4	5	6	7
1. Creating tables and structures	1	2	3	4	5	6	7	1	2	3	4	5	6	7
2. Running ad hoc queries	1	2	3	4	5	6	7	1	2	3	4	5	6	7
3. Printing pre-designed reports	1	2	3	4	5	6	7	1	2	3	4	5	6	7
4. Entering data on the tables	1	2	3	4	5	6	7	1	2	3	4	5	6	7
5. Automating database functions	1	2	3	4	5	6	7	1	2	3	4	5	6	7

Figure 4. Hypothetical Tasks

If Figure 4 were used as a measurement instrument, we would be able to obtain an index of the extent to which these tasks are relevant for the particular roles played by the different individuals. Figure 5 contains hypothetical responses that may be provided by individuals participating in the survey.

To what extent are you required to accomplish the following tasks in your role?	Senior Exec	Database Admin	Customer Specialist	Admin Assistant	Floor Manager
1. Creating tables and structures	1	7	1	1	1
2. Running ad hoc queries	6	2	1	1	4
3. Printing pre-designed reports	3	2	5	4	5
4. Entering data on the tables	1	1	7	2	1
5. Automating database functions	1	3	2	1	5
Column Sum	12	15	16	9	15

Figure 5. Hypothetical Responses for Tasks Required

The conditional measure of system use can then be computed based on the two components illustrated in Figure 3 and 5: a) the extent to which an individual used the information system, and b) the extent to which those tasks were required in that individual's role. A two-step computation may be adopted: first, the extent of use of each feature, given the extent to which

the task is required, is computed; next, an overall use index is computed. The computation relies on the idea that individuals would have an ideal amount of use for each feature depending on the extent to which the use of that feature is required in their roles. Figure 6 details the computations of the extent of relevant use of an information system.

Extent of Relevant Use of each Feature by each Individual	Senior Exec	Database Admin	Customer Specialist	Admin Assistant	Floor Manager
1. (Row_1_Figure_5 / Column_Sum_1_Figure_5) * (Row_1_Figure_3 / ScaleMax)	0.01	0.27	0.03	0.02	0.01
2. (Row_2_Figure_5 / Column_Sum_2_Figure_5) * (Row_2_Figure_3 / ScaleMax)	0.21	0.02	0.01	0.03	0.21
3. (Row_3_Figure_5 / Column_Sum_3_Figure_5) * (Row_3_Figure_3 / ScaleMax)	0.18	0.02	0.27	0.38	0.31
4. (Row_4_Figure_5 / Column_Sum_4_Figure_5) * (Row_4_Figure_3 / ScaleMax)	0.01	0.01	0.31	0.06	0.01
5. (Row_5_Figure_5 / Column_Sum_5_Figure_5) * (Row_5_Figure_3 / ScaleMax)	0.01	0.09	0.04	0.02	0.18
Extent of Relevant Use = (Sum of column)	0.43	0.40	0.65	0.51	0.72

Figure 6. Extent of Relevant Use (for Hypothetical Data on Figures 3 and 5)

Notes:

- ScaleMax is the maximum value on the Likert scale used for measurement. ScaleMax = 7 here.
- Extent of relevant use accommodates the differences in the use of each system feature, and hence the entire system, in each role. For instance, the senior executive responded with a “1” [on Figure 5] for extent to which task-1 was required. This means that task-1 was required $1/12 = 0.08$ of the time (since the sum of all tasks required = 12; See Figure 5; 0.08 is the ideal for that senior executive.) The senior executive also responded with a “1” [on Figure 3] for extent of use of feature-1. This means that feature-1 was used $1/7 = 0.14$ of the time (since 7 is the maximum possible use). The extent of relevant use of feature-1, based on task-1, is then computed as $1/12 * 1/7 = 0.01$. [Note that the senior executive had an ideal use index of 0.08 but had an actual use index of only 0.01, indicating that feature-1 was not used to the fullest extent, even when examined in light of the tasks for that role.]
- This is done for each feature-task combination for the senior executive. Finally, the extent of relevant use of the system is computed as the sum of the relevant use of all features.

IMPLICATIONS FOR RESEARCH AND PRACTICE

Specific classes of information systems. Conditional measures of system use depend on the extent to which we can identify specific classes of information systems. Jasperson et al. (2005) give one example of different classes of information systems such as business process applications, communications and collaboration systems, computers, office applications, system software, and World Wide Web or internet. A general consensus on the classes of information systems may be required if conditional measures are to be developed.

Specific roles performed by individuals. Conditional measures of system use also depend on the extent to which the various roles performed by individuals can be identified. While roles such as senior executives and middle managers are easily recognized and agreed upon, identifying other roles may not be an easy proposition. A possible way in which to accomplish this is to begin by identifying the potential users of each class of information systems and then identify the various roles that may be affected by it.

Features and Tasks. Specific classes of information systems would possess specific features common to all members of that class. This is crucial since the measurement for extent of system use is highly dependent on identifying the extent to which the various features were used by individuals. Similarly, the specific tasks belonging to each role should be identified, since there will typically be a one-to-one correspondence between the tasks to be performed and the features that may be used to accomplish those tasks.

CONCLUSION

Prior research has relied extensively on universal measures of system use such as frequency of use and time of use. However, such universal measures do not account for the specific features of the information system used or the specific tasks performed by individuals in their respective roles in organizational settings. This paper developed a conditional measure of system use that accounts for both contingencies and overcomes the limitations of universal measures.

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APPENDIX

Study	IT Type	Industry Type	Participant Type	FoU	ToU	#Pkg	#Tsk	Comp?
Al-Khaldi & Wallace (1999)	Personal Computers	Manufacturing, Construction, Agriculture, Services, Oil and Energy, Trade, Retailing, Leasing	Knowledge Workers (i.e. Controllers, General Managers, Engineers, Production Analysts, Corporate Planners)	x	x	x		Yes
Amoroso & Cheney (1991)	End-user Computing (EUC)	Airlines, Food Manufacturers, Distributors, Banks, Electronics, Insurance	All types				x	No
Ang & Soh (1997)	Computers	Transportation, Banking, Insurance	Senior, Middle, Junior, Professional, Professional Assistant, Clerical	x				No
Barki & Huff (1985)	Decision Support Systems (DSS)	Banking, Insurance, Utility	Junior Manager, Senior Manager, Vice President, President	x				No
Bergeron et al. (1995)	Executive Information System (EIS)	Insurance, Pulp and Paper, Utilities, Government	Top Level (CEO, Vice Presidents, Directors), Middle Managers	x				No
Burkhardt (1994)	Computers	Nutrition	All types		x			No
Guimaraes, Yoon & Clevenson (1995)	Expert Systems	Du Pont	Staff, Clerical, Blue Collar, Supervisors, Middle Managers, Top-level Managers, Engineers	x				No
Igbaria & Iivari (1995)	Computers	Manufacturing, Merchandising, (Others)	Non-Managers, Professionals, First-level Supervisors, Middle Management, Top Management, Executives, (Unclassified)	x	x			Yes
Igbaria & Nachman (1990)	End-user Computing (EUC)	Banking, Food Production, Manufacturing, Education	Professionals, Managers				x	No
Igbaria & Tan (1997)	Computers	Government R&D	Professional, Managers			x	x	Yes
Igbaria (1992)	Computers	Trading	Managers, Non-Managers	x	x	x	x	No

Study	IT Type	Industry Type	Participant Type	FoU	ToU	#Pkg	#Tsk	Comp?
Igbaria (1993)	Microcomputers	Manufacturing, Service, Merchandising, Insurance, Financial	Middle Management, Line Managers, Supervisors, Directors, Assistant Vice Presidents, Presidents	x	x	x	x	Yes
Igbaria et al. (1997)	Personal Computers	Manufacturing, Engineering	Middle Management, Lower Management, Top Management, Non-Supervisory Positions	x	x	x	x	Yes
Igbaria, Guimaraes & Davis (1995)	Microcomputers	Manufacturing, Service, Merchandising, Financial Services, Government	Professional Staff, First-level Supervisor, Department Heads, Middle Managers, Strategic Management, Executives	x	x	x	x	Yes
Igbaria, Iivari & Maragahh (1995)	Computers	Manufacturing, Merchandising, (Others)	Non-management, Professional, First-level Supervisor, Middle Management, Top Management, Executives, (unclassified)	x	x		x	No
Igbaria, Parasuraman & Baroudi (1996)	Microcomputers	Manufacturing, Service, Merchandising, Insurance, Financial	Middle-level Management, First-level Management	x	x			Yes
Igbaria, Pavri & Huff (1989)	Microcomputers	Manufacturing, Service, Merchandising, Insurance, Finance	First-line Manager, First-level Supervisor, Department Head, Middle Management, Strategic Management, Executives	x	x	x	x	No
Lee (1986)	Personal Computers	Banking, Service, Insurance, Medical, Accounting Consulting	Non-Professional Support Staff, Professional Staff, First-line Supervisors, Department Heads, Executives		x	x		No
Robertson (1989)	System designers' Workbench, Mac Paint, Project Managers' Workbench, Lotus 123, Word Processing	Management Consulting	Secretary, Staff Consultant, Senior Staff Consultant, Manager, Principal, Partner	x				No
Schiffman, Meile & Igbaria (1992)	End-user Computing (EUC)	Engineering	Secretarial, Managerial, Professional	x	x	x	x	No

Study	IT Type	Industry Type	Participant Type	FoU	ToU	#Pkg	#Tsk	Comp?
Thompson, Higgins & Howell (1994)	Personal Computers	Telecommunications, Aerospace R&D, Software Development, Government	Staff Specialist, Engineer, Professional, Managerial, Supervisor, Executive	x	x	x	x	Yes
Thompson, Higgins & Howell (1991)	Personal Computers	Manufacturing	Managers, Professionals	x	x	x		Yes
Venkatesh & Davis (2000)	Proprietary System, Windows, Customer Account Management System, Analysis Software	Manufacturing, Financial Services, Accounting Services, Investment Banking	Floor Supervisors, Various Levels, Various Levels, Various Levels		x			No
Winter, Chudoba & Gutek (1998)	Computers	Manufacturing, Services	Professionals, Managers, Technicians, Secretaries, Clerks	x			x	No

Notes:

- FoU: Frequency of Use; ToU: Time of Use; #Pkg: # of Packages; #Tsk: # of Tasks; Comp: Composite Measure
- Complete citations of articles in the Appendix are available from the authors upon request.