Computer Supported Workgroup Systems

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ABSTRACT

*This study focus on the evaluation of computer supported systems designed to support work group - **C**omputer **S**upported **W**orkgroup **S**ystems (CSWS). The evaluation of this new kind of systems is considered in a multiperspective and comprehensive way. The evaluation perspectives are: system quality, information quality, use, user satisfaction, individual impact and organisational impact.*

The model of success as presented by DeLone and McLean (1992) was then extended to CSWS, which extension, in its turn, resulted in a model of success for those systems.

On trying to come up with measures to evaluate the success of CSWS, the present work involved a selection and analysis of studies on the evaluation of the success of those systems. Its findings were as follows: (1) measures to evaluate the impact (or effect) of CSWS on groups were obtained; (2) research methods (e.g., field studies, case studies, laboratory experiments and field experiments), such as those employed in the evaluation of the remaining computer supported systems were identified. A new perspective on the evaluation of the success of CSWS - group impact - was brought about by a systematisation of the measures which were arrived at.

1. Introduction

In its everyday life organisations need to deal with ever rapidly changing markets. Information needs have increased, as the organisational environment becomes more competitive and dynamic, asking for rapid answers. Studies have proved that modern problems faced by organisations can better be solved by groups than by individuals and hardly solved without powerful tools for gather and analyse information. Therefore, organisations have been delegating a great number of activities (mainly management activities) on work groups. These activities lead to the emergence of particular computer based systems to support them [DeSanctis and Gallupe 1987, Kraemer and King 1988, George et al. 1990, Saaksjarvi and Talvinen 1996, Serafeimidis et al. 1996, Oliveira 1997]. Work group activities are increasingly assuming an important role within organisations and in its daily life. Aiming to improve group work (and consequently organisations) productivity and performance, researchers have tried to develop systems that take advantage on information and communication technologies. Such aims brought about computer supported systems specifically designed to support work groups - **C**omputer **S**upported **W**orkgroup **S**ystems (CSWS) [Kraemer and King 1988, Beauclair and Straub 1990, Ackermann and Eden 1994]. CSWS are computer supported systems particularly designed to help groups of persons, with common goals, to accomplish common tasks. These applications provide a shared environment interface, managing to solve many time restrictions associated to group work (e.g., messaging systems, decision support systems, multi-user editors, electronic meeting systems, teleconferencing systems) [Ellis et al. 1991, Ishii and Miyake 1991].
As referred by Renkema (1996): “throughout the last decades, organisations have become increasingly dependent on information technology (IT) in their search for corporate success and survival”. Therefore, management should ensure the capacity of the adopted information

technologies to satisfy organisational information needs, guaranteeing its profitable side. Nowadays, decisions about computer supported systems selection and adoption taken without a previous detailed and severe study should be unacceptable. A question raises up on what should this study be all about. Computer supported systems and information systems evaluation might be a possible answer [Corso et al. 1995, Renkema 1995, Costa 1996, Oliveira 1996].

Evaluation studies on computer supported systems can be considered a good way of finding out if these systems fit in with their surrounding physical, social and organisational context [Preece et al. 1994]. They are also used to justify investments and facilitate the selection between alternative and competing projects. The assessment process might work as a control mechanism (allowing the attribution of responsibilities) and as a way of learning to evaluate and develop new systems [Ballantine et al. 1996].

The aim of this study was to define/identify (based on a determined computer supported system success evaluation framework) measures to assess CSWS success.

2. The Study

The motivation for this work was to identify ways of assessing a CSWS. A first step was taken to find out a theoretical framework that could possibly evaluate computer supported systems success. The computer supported systems success model, proposed by DeLone and McLean (1992), was chosen. This model encompasses and synthesises a series of aspects about computer supported systems evaluation success, ranging from product internal quality to its impact on the overall organisation performance. The model was also preferred due to the comprehensive perspective of evaluation success it presents. In this study, success is considered as “an outcome measure, or measures” (the dependent variable) for the computer supported systems; to measure this variable an evaluation process is needed.

2.1 Computer Supported Systems Success Model

The previous referred model tries to cover different aspects (categories or dimensions, of its base taxonomy) of computer supported systems success evaluation, such as: system and information quality, use and user satisfaction, individual and organisational impact; each of these aspects includes a series of measures.

The model also includes a series of causal influences to determine computer supported systems success.

Figure 2.1 presents the six categories rearranged to suggest success as a process construct, representing success interdependencies among each element, and keeping temporal and serial dimensions of information flow and impact, which can be seen as follows [DeLone and McLean 1992]:

i) System Quality and Information Quality affect jointly and separately Use and User Satisfaction,
ii) The amount of Use can affect the degree of User Satisfaction (positively or negatively), with the reverse also being true,
iii) Use and User Satisfaction directly precede individual Impact,

iv) The Impact on Individual performance may, eventually, cause some Organisational Impact.

The categories and the structure of the model let the authors organise a sample of studies from the literature they have reviewed, and provided, at the same time, a logical way of showing how those categories interact.

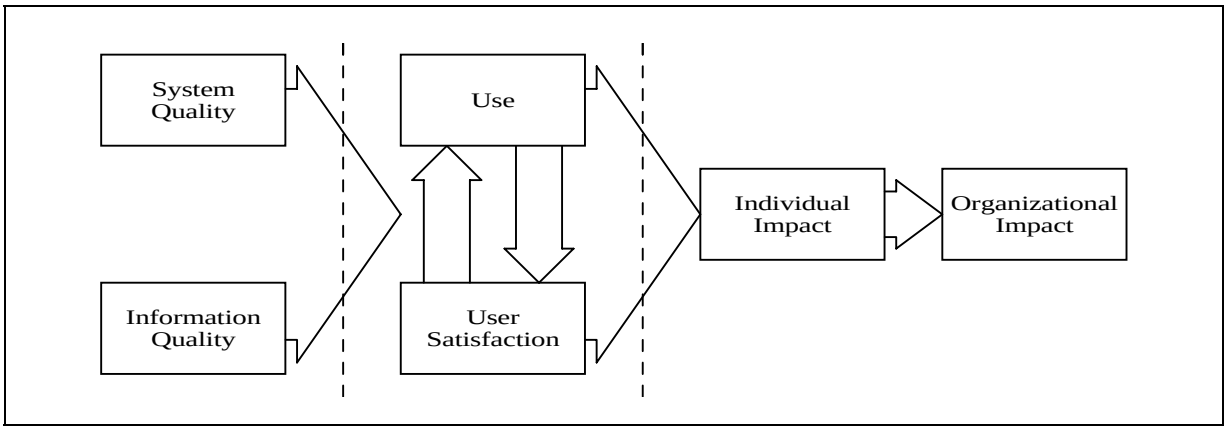

Figure 2.1 - Computer Supported Systems Success Model
(Source: DeLone and McLean, 1992 (Adapted))

However, the model does not mention any measures to evaluate computer supported systems' impact on work groups. This motivated a research and an analysis of other studies in order to identify measures specifically destined to evaluate CSWS success.

2.2 Selection and Analysis of CSWS Evaluation Studies

The research and analysis mentioned at the end of section 2.1 led to a survey of empirical studies on CSWS evaluation. The objective of this survey was to identify variables used to measure those particular systems, and to determine which investigation methods can be utilised. Among the empirical studies found, some were selected and analysed. The survey did not intend to be exhaustive.
Both the selection process and the analysis process tried to follow similar criteria to those used by DeLone and McLean (1992) in their study.
The survey included a set of ten papers published during the nineties. On the selection of this group of papers care was taken to include studies employing different research methods.

The steps that follow build the process of analysis; (1) ascertain the chosen study type, i.e., to verify if the study exclusively focused on group impact assessment (of a CSWS) or if it tried to measure something else (like, e.g., user satisfaction, individual and/or organisational impact); (2) determine the research method used (e.g., field study, case study, laboratory or field experiment); make a summarised description of the study being reviewed, and (3) identify the measures proposed by the study authors to evaluate the CSWS in question.

In studies focusing more then one computer supported systems evaluation aspect, a separation was made to isolate measures specifically destined to assess group impact from the remainders.

The terminology used to name many of the identified measures differed from study to study, despite the purpose of that measures being similar - to evaluate the same aspect of the system group impact. This fact justifies the attempt to unify the designations found.

3. Measures to Evaluate CSWS

In this section are presented the analysed studies. The main concern of this analysis was to encompass the objectives, the measures and the research methods used in each study.
Altogether ten studies were analysed. The main objective of these studies was to compare electronic group meeting environments with "manual" ones (environments not electronically supported). Most of these studies work with small groups of persons (with group size ranging from 3 to 9 elements); others involved group sizes of 15 [Alavi 1993] and 60 [Aiken et al. 1994] elements, considered big relatively to the former. As the delimiting break point between small and big group sizes is not clear, the dimension "small" and "big" are treated as relative values, in this study [Hwang and Guynes 1994]. In a general way, the computer supported systems, the decision processes and the kind of tasks used in each of the analysed studies vary.
Table 3.1 tries to sketch the examined empirical studies in what concerns to the overall success measures found.

Table 3.1

Empirical measures of Group Impact, used in the analysed studies (continues next page)

No.	Description of Study	Description of Measure(s)	Study	Author(s)
1	GDSS (VisionQuest); maximum group size: 8; 72 students enrolled in an Introduction to Computers class at a large public university in the USA.	(1) Number of original solutions (2) Number of comments (3) Satisfaction w/ GDSS environment (4) Quality of decision	Lab	Yellen, Winniford & Sanford (1995)
2	GDSS; group size: 3 vs. 9 persons; 192 undergraduate and graduate students;	(1) Decision time (2) Number of alternatives (3) Satisfaction w/ decision making processes (4) Decision satisfaction (5) Decision quality	Lab	Hwang & Guynes (1994)
3	EBS (GroupForm); group size ranging from 7 to 63 elements; 242 undergraduate students enrolled in a MIS course at the University of Mississippi.	(1) Perceived production blocking (2) Evaluation apprehension (3) Group overall satisfaction	Lab	Aiken, Krosp, Shirani & Martin (1994)
4	EMR/EBS (GroupSystems); 14 groups of 5/6 elements; final-year business administration students at Karl-Franzens-University Graz.	(1) Quantity of results (2) Quality of results (3) Group attitudes towards: - results - processes and - technologies (4) Average time resulting in: - wages - travel costs and - organisation expenses	Lab	Petrovic & Krickl (1994)
5	GDSS (SAMM); 5 element group size; 80 first-year computer science undergraduates at the National University of Singapore.	Influence distribution: (1) amount of influence behaviour (2) influence inequality (3) dominance significance	Lab	Lim, Raman & Wei (1994)

Table 3.1 (conclusion)

No.	Description of Study	Description of Measure(s)	Study	Author(s)
6	GDSS (SAMM); 134 groups of 4 elements each; undergraduate and MBA students enrolled in business and communications classes.	(1) Satisfaction w/ meeting process: - discussion quality - discussion effectiveness - discussion outcome (2) Solution satisfaction	Lab	Cass, Heintz & Kaiser (1992)
7	EMS (CaptureLab); group size: 4/5 elements; 34 groups of graduates and undergraduates from Business and Engineering schools of a large university; 2 experiments.	(1) Equality of participation (2) Degree of task focus (3) Decision quality (4) Member assessments of group performance and satisfaction	Lab	McLeod & Liker (1992)
8	EMS (VisionQuest); group size ranging from 3 to 15 elements; 167 individuals representing a range of different departments, of a Fortune 500 company.	(1) Quantity of ideas generated (2) Quality of ideas generated (3) Time required to generate ideas (4) Time required to rate ideas (5) Group process satisfaction: - level of comfort expressing ideas in the meeting - perceived stress during the meeting - ease of use of the computer - willingness to use EMS again (6) Group cohesiveness: - extent to which the individual felt a part of the group - degree to which the group worked well together	Field	Alavi (1993)
9	EMS (Plexsys); functional work groups of different sizes and constitution, from a manufacturing plant - System Integration Division of IBM.	(1) Length of project (2) Number of meetings per project (3) Length of meeting (4) Administrative costs (5) Man-hour dollar costs (6) Group cohesiveness (7) Group unfamiliarity w/ generated information	Field	Martz, Jr., Vogel & Nunamaker (1992)
10	TQM and GDSS (SAMM); a group of 5 individuals from Texaco Inc.	(1) Use frequency (2) Group comfort w/ technology (3) Member attention and interest (4) Objective group discussions (5) Negotiation (6) Participation (7) Openness of communication (8) Group systematic process (9) Progress tracking and goal management (10) Sense of accomplishment (11) Group productivity	Case	Vician, DeSanctis, Poole & Jackson (1992)

Not all the measures shown in Table 3.1 are intended to assess CSWS impact on work groups. Some of them belong to the categories of computer supported systems success model, presented in the previous section; for example, “Satisfaction w/ GDSS environment”, in the first study of the Table 3.1, can be included in User Satisfaction set of measures; measures

like “Administrative costs” and “Man-hour dollar costs”, from study number nine, can be considered as measures of Organisational Impact; finally “Use frequency”, from the last study, has to do with Use category. The measures of the ninth study numbered from (1) to (3) are to evaluate group performance. Therefore they were converted in a single measure called “Group performance” (see Table 4.1).

Altogether the set of previous reviewed studies includes three different kinds of research methods in the following proportions: one case study, two field experiments and seven laboratory experiments. However, this does not mean that the number and kind of research methods presented here might be spread out to the whole CSWS evaluation impact on work groups.

Many investigators [Gallupe and McKeen 1990, Lewis and Keleman 1990, Vogel and Nunamaker 1990, Alavi 1993] claim that different research methods should be used on CSWS evaluation studies.

4. Discussion

On trying to organise the studies reviewed, an attempt was made to distribute them among the different categories of success showed in Figure 2.1. Despite some of the resulting measures from the analysed studies felt within one or another category, most of them (e.g., equality of participation, group cohesiveness, number of alternatives generated by the group) do not. In fact, the literature reviewed by DeLone and McLean (1992), which made them propose a computer supported systems success model, does not include studies about CSWS. However, and just like happens with any other computer supported system, the measurement of CSWS success should be comprised within the model of success proposed for the former (see Figure 2.1).

To evaluate CSWS, a measurement of their effect, or impact, on work groups is needed. A new category (aspect), of group impact, should then be added to the computer supported systems success model. Such a dimension of success will encompass the range of group impact measures presented on Table 4.1.

Table 4.1
Empirical Measures of Group Impact

• Number of comments • Perceived production blocking • Evaluation apprehension • Group overall satisfaction • Time required to generate alternatives • Cohesiveness • Decision efficiency: - decision time - dollar average decision time - number of alternatives • Decision effectiveness: - number of alternatives - group process satisfaction - decision satisfaction - satisfaction w/ technology - decision quality - quality of alternatives • Group systematic process	• Influence/Persuasion: - amount of influence behaviour - influence inequality - dominance significance • Equality of participation • Member attention and interest • Degree of task focus • Member assessments of group performance and satisfaction • Time required to rate alternatives • Group comfort w/ technology • Objective group discussions • Negotiation • Openness of communication • Group performance • Progress tracking and goal management • Sense of accomplishment • Group productivity • Unfamiliarity w/ generated information

As documented by Figure 4.1, the introduction of this new category shall cause some changes to DeLone and McLean's (1992) computer supported systems success model.

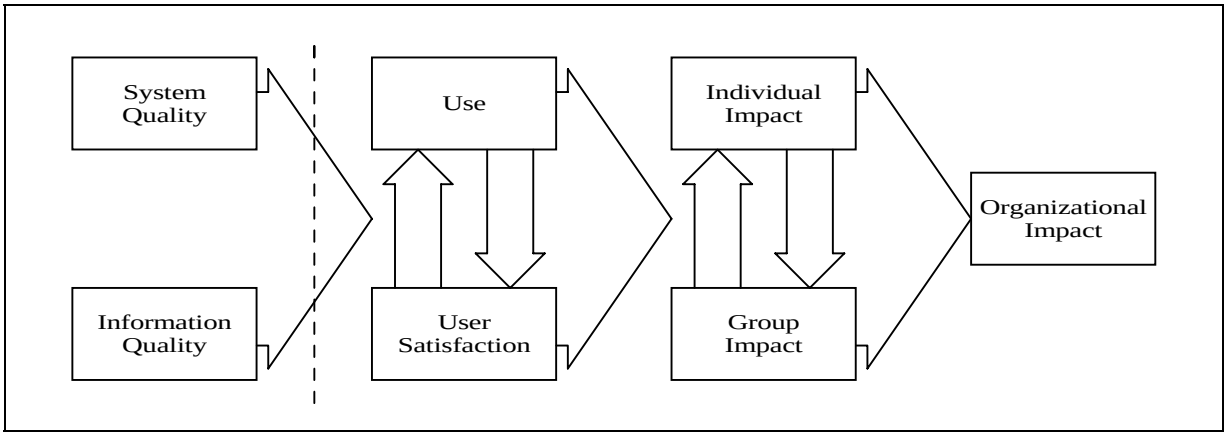

Figure 4.1 - CSWS Success Model

The group interacts as a whole, affecting each participant separately [Chiavenato 1987]. If the group is using a CSWS, this might probably have some kind of influence (impact), not only on group performance, but also on each of its elements in particular.

On the other hand, the way a group interacts (jointly), the actions that take place within the group when it is using a CSWS partially depend on the individuals involved. It is generally accepted that individual differences cause a certain impact at different levels: group, group process, and participants level [Yellen et al. 1995].

Because of the participants' impact on groups and because some of the group impact measures are based on CSWS effect at individual level, the measurement of group impact can be seen as an extension of individual impact to work groups. The Individual Impact provoked by a CSWS might then affect the degree of Group Impact (positively or negatively); the reverse is also true.
Considering that individual and group impact directly precede Organisational Impact, they both can, eventually, affect or influence it.

As previously mentioned, organisational activities are accomplished by individuals, and increasingly by work groups (particularly decision activities or processes). If work group and individual activities change, the organisation within which those changes take place (as a whole) might also see its performance being affected.

Generally, CSWS are idealised and designed to improve all kind of group work efficiency and effectiveness. If the individuals and, particularly, the work groups get their performance and productivity improved, i.e., suffer a positive impact by using one of those systems, the same can happen to the organisation in which those activities take part. Thus, one might say that the implementation of a specific CSWS provoked a positive impact on the organisation. The same can happen if individual and group impacts are negative. The office automation implementation, for instance, showed the impact on the organisation productivity could even be different at various levels, i.e., positive at operational level and negative at other administration levels [Oliveira 1994].

The model of Figure 4.1 mentions: (a) an entity (the group), distinct from both the individual and the organisation reality; and (b) a series of measures to evaluate CSWS success, specifically destined to the group.

The evaluation of interactions between emergent technologies (like those destined to support group work) and complex human processes (like group processes), can guide the development of more specific systems, contributing therefore to a better overall understanding of human performance in electronic environments. However, assess the emergent technology effects on complex processes makes researchers deal with uncertain interacting objectives and subjective or complicated measurement instruments [Marchionini and Crane 1994].

The conduction of studies on this kind of systems aims mainly to: (i) evaluate the overall effects of CSWS, (ii) identify CSWS items that can be improved and (iii) find out new opportunities to develop more CSWS tools [Lewis and Keleman 1990].

A more careful observation reveals that most studies on CSWS group impact evaluation try to examine the new information technologies capacity to support group activities processes and results [Watson et al. 1988, Zigurs et al. 1988], in terms of their effectiveness, efficiency, group and group elements satisfaction.

The kind of success measures, qualitative and quantitative, which has been studied (e.g., number of alternatives generated, equality of participation among group elements, decision time, amount of influence behaviour of group elements, decision quality, group decision process satisfaction, satisfaction with the final result/decision) demonstrates that.

The CSWS success model (see Figure 4.1) tries to cover all the range of measures through Group Impact aspect. Therefore, the number of variables that can affect group work and the organisations within which it takes place, is considerable [Gallupe and McKeen 1990, George et al. 1990, Vogel and Nunamaker, Jr. 1990, Easton et al. 1992].

CSWS success evaluation should not be limited to the measurement of group impact, it should also bring together all the other aspects (and its measures) represented in CSWS success model. However, the whole number of success measures encompassed by that model can not be tested/validated. The model should be completed with sets of measures (chosen among its various categories) that could be adopted in practice to determine a CSWS success [Ballantine et al. 1996].

In Lewis and Keleman's (1990) opinion, an appropriate way of dealing with CSWS success evaluation problem should include the identification of items, from those systems, that could be better looked into under controlled laboratory or field experiments (and/or field studies). However, the complex nature of CSWS evaluation, the vagueness of the measures used to evaluate those systems, the fact of many field studies being accomplished just to improve and test laboratory experiments results (using, e.g., different tasks and technologies, from those used in laboratory environments), make such an identification process difficult. Therefore, it is hard to point out "the right" item(s) to be assessed under one or another research method [Gallupe and McKeen 1990, Vogel and Nunamaker 1990, Alavi 1993].

The comprehensive, detailed, and (at the same time) simple perspective of evaluation that Figure 4.1 attempts to reveal, might be beneficial because it tries to interrelate a large range

of factors that jointly affect CSWS. Such advantageous features make it difficult to get mechanisms to operate the model.

5. Conclusion

The principal aim of this study was to identify measures to evaluate CSWS success.

First of all, DeLone and McLean's study (1992) was reviewed, i.e., its computer supported systems success model, and taxonomy and measures were analysed. The literature reviewed by those authors did not cover studies addressing CSWS success assessment. This caused a survey to be made in order to find out studies concerning that subject. Some of the studies from the survey were then selected and analysed.

The analysis of those studies brought about a considerable number of success measures. Most of these measures reveal the researches' concern on how CSWS influence group work (in terms of group processes efficiency, effectiveness, and final results). Therefore, the measures found can conceptually be included in a single success category - The Group Impact [DeLone and McLean 1992].

But CSWS are a new kind of computer supported systems. The analysis of studies revealed that the most common research methods used to evaluate any kind of computer supported systems can also be employed on CSWS success evaluation (e.g., field studies, case studies, laboratory and field experiments). On the other hand, CSWS success evaluation is not limited to its group impact measurement. This caused the proposal of an adaptation and extension to CSWS, of computer supported systems success model and its base taxonomy; a CSWS success model was presented. On a CSWS success evaluation study, this model tries to make visible group impact positioning and interrelation (interdependency) with the other DeLone and McLean's (1992) success model categories. Studies on the various categories and its interactions will, probably, contribute to a better and comprehensive understanding of CSWS success.

Throughout this study the difficulty of measuring computer supported systems success became clearer, as one has to deal with complex and subjective aims. Computer supported systems evaluation can not be faced as a simple set of tools and measurement techniques. Because of its multiple aspects, it should be viewed as a whole and continuous process so it can be effective [Marchionini and Crane 1994, Ballantine 1996].

Considering the taxonomy (see Table A.1 annexed) and the CSWS success model proposed in this study, it should be interesting to know how to conduct a computer supported system's evaluation. In other words, given: (1) a certain computer supported system, (2) its context and (3) the aims of the study's evaluation, it should be possible to determine what and how to measure. Both the sets of the most appropriate categories and its measures (from the proposed model) should then be selected and the research method to apply to that particular evaluation. To accomplish this, it would be necessary to define a "methodology" to measure any kind of computer supported system.

The existence of other research methods (different from those pointed out in this study) to be used in CSWS evaluation studies, should also be ascertained; it would help finding out the possible most appropriate research methods to use on CSWS success measurement.

It would also be interesting to validate and confirm the model and the taxonomy presented in this study (possibly through the analysis of a greater number of studies on CSWS assessment).

Despite the number of analysed studies being small, it served to highlight that specific measures need to be taken into account on trying to evaluate a CSWS.

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Annex A

Table A.1

Summary of CSWS Success Measures by Category (continues next pages)

System Quality	Information Quality	Use	User Satisfaction	Individual Impact	Group Impact	Organisational Impact
Data accuracy Data currency Database contents Ease of use Ease of learning Convenience of access Human factors Realisation of user requirements Usefulness of system features and functions System accuracy System flexibility System reliability System sophistication	Importance Relevance Usefulness Informativeness Usableness Understandability Readability Clarity Format Appearance Content Accuracy Precision Conciseness	Amount of use/duration of use: - number of inquiries - amount of connect time - number of functions used - number of records accessed - frequency of access - frequency of report requests - number of reports generated - charges for system use - regularity of use Used by whom? - direct vs. chauffeured use Binary use: - use vs. non-use Actual vs. reported use	Satisfaction with specifics Overall satisfaction Single-item measure Multi-item measure Information satisfaction: - difference between information needed and received Enjoyment Software satisfaction Decision making satisfaction	Information understanding Learning Accurate interpretation Information awareness Information recall Problem identification Decision effectiveness: - decision quality - improved decision analysis - correctness of decision - time to make decision - confidence in decision - decision-making participation Improved individual productivity Change in decision	Number of comments Perceived production blocking Evaluation apprehension Group overall satisfaction Time required to generate alternatives Cohesiveness Decision efficiency: - decision time - dollar average decision time - number of alternatives Decision effectiveness: - number of alternatives - group process satisfaction - decision satisfaction - satisfaction w/ technology - decision quality - quality of alternatives	Application portfolio: - range and scope of application - number of critical applications Operating cost reductions Staff reduction Overall productivity gains Increased revenues Increased sales Increased market share Increased profits Return on investment Return on assets Ratio of net income to operating expenses

Table A.1 (continues next page)

System Quality	Information Quality	Use	User Satisfaction	Individual Impact	Group Impact	Organisation Impact
Integration of systems System efficiency Resource utilisation Response time Turnaround time	Sufficiency Completeness Reliability Currency Timeliness Uniqueness Comparability Quantitativeness Freedom for bias	Amount of use/duration of use: - number of inquiries - amount of connect time - number of functions used - number of records accessed - frequency of access - frequency of report requests - number of reports generated - charges for system use - regularity of use Used by whom? - direct vs. chauffeured use Binary use: - use vs. non-use Actual vs. reported use		Causes management action Task performance Quality of plans Individual power or influence Personal valuation of IS/IT Willingness to pay for information	Influence/Persuasion: - amount of influence behavior - influence inequality - dominance significance Group systematic process Equality of participation Member attention and interest Degree of task focus Member assessments of group performance and satisfaction Time required to rate alternatives Group comfort w/ technology Objective group discussions Negotiation	Cost/benefit ratio Stock price Increased work volume Product quality Contribution to achieving goals Service effectiveness

Table A.1 (conclusion)

System Quality	Information Quality	Use	User Satisfaction	Individual Impact	Group Impact	Organisation Impact
					Openness of communication Group performance Progress tracking and goal management Sense of accomplishment Group productivity Unfamiliarity w/ generated information	