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Organisational Size Metrics in IS Research: A Critical Survey of the Literature 1989 - 2000

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Abstract

A number of disciplines pursue research into organisations. This organisational research serves to improve knowledge regarding the interaction, behaviour and direction of humans and groups. Many of these disciplines use proprietary methods for and approaches to such research. Because Information Systems (IS) has drawn on several of these disciplines for foundation, a number of research approaches exist for examining organisations within the IS domain. Organisational size measurement, as one research approach in the IS literature, has received considerable application but little critical examination. This study examines six leading IS journals over an eleven year period in order to document and classify the metrics used for organisational size measurement in the IS research literature. The results show a large number of metrics in scholarly use, with studies offering little supportive discussion regarding the application of these metrics. The findings raise a number of issues that are out of the scope of this study: these issues merit further research.

INTRODUCTION

Theoretical multiplicity is common in many disciplines[1]. For example, authors in domains such as accounting (Watts and Zimmerman 1979), science (Cat 1995) and empirical finance (Fama 1965) have thoroughly documented (and, at times, vigorously defended) competing theories in their respective disciplines. Competing theories abound in the IS discipline also. Information Systems, having grown out of Management Science, Computer Science, Psychology and Organisational Science (Claver et al. 2000) has a rich variety of research approaches available to its scholars: a number of authors note this (Keen 1980, Massetti 1998). This diversity, however, can mean that competing and conflicting theories exist for the analysis of a given phenomenon. Consider, for example, the many approaches to comparing system development success (Olle et al. 1988), quantifying software engineering productivity (Fenton and Neil 1999) or frameworks for strategic systems implementation (Lee and Adams 1990). While circumstances such as this may not be uncommon in scholarly environments, competition between methods can serve to undermine the validity, reliability and comparability of both the scholarly analysis and practical application of research. In general, the steady resolution of such conflict benefits both practitioners and researchers alike.

This paper is concerned with better understanding the nature and use of the organisational size metric in information systems research and is motivated by several important issues. First, whereas many research metrics have received considerable analytical attention in the literature, organisational size has received relatively little rigourous scholarly concern. Despite this, the metric continues to receive critical application in many studies and the continual application of the size metric suggests an *a priori* need to better understand its nature. Second, while some studies have successfully relied on organisational size, other studies have delivered inconclusive results, prompting some researchers to call for a reassessment of the phenomenon (Duncan 1995). Third, many practitioner models (such as those concerning productivity assessments) make judgments based on organisational size. However, models developed using large companies may have tenuous application in small organisation environments (Fayad and Laitinen 1997). The discrepancy associated with size analysis coupled with the popularity of the research area suggests that the sober re-assessment of the metric makes fertile ground for research. To quote March and Smith (1995),

> *"Metrics define what we are trying to accomplish. They are used to assess the performance of an artifact. Lack of metrics and failure to measure artifact performance according to established criteria result in an inability to effectively judge research efforts".*

A study such as this represents a significant undertaking, and this paper documents the first stage of such a study by determining those size metrics that are in use in IS research. This leads to this paper's central research question:

[1] The difference between conditions of theoretical diversity and theoretical conflict should be noted. The former is argued by authors such as Cheon et al. (1993) to demonstrate disciplinary maturity and cohesion; the latter represents disagreement and discrepancy. Indeed, some disciplines thrive on such theoretical dichotomy (Palvia and Nosek 1993).

What Metrics Do IS Researchers Use To Measure Organisational Size?

The rest of this paper is structured as follows. First, the paper gives an overview of research metrics and measurement. Then, the paper discusses the importance of size measurement in IS research, making specific reference to extant research into small and large organisational differences. The research approach and results are then detailed. Limitations and an overview of the next stage of the study are then considered.

METRICS AND MEASUREMENT IN RESEARCH

The nature of scientific enquiry is that observations are made about phenomena. This study is concerned with observations about the relationship between reality (for example, the true, unobserved size of an organisation) and the scientific research construct used to measure this reality (for example, the *measure* of the *perceived* size of an organisation). In order to conduct sound science, researchers are generally bound by two main requirements. First, research should be internally and externally valid: observations are comparable within and between experiments. Second, research should be reliable: similar observations can be made across experiments (Cook and Campbell 1979). Accurate measurement underpins both validity and reliability. The use of inaccurate measurement methods compromise validity by compromising the researcher's ability to make intra-study comparisons. Likewise, inaccurate measurement also compromises a researcher's ability to make *inter se* comparisons to other studies. While many argue that research can never be completely valid and reliable, agreement upon consistent measurement methods lies at the heard of all science, including IS as a social science.

IS researchers and practitioners alike are typically interested in being able to quantify and measure a given phenomenon, largely so that these phenomena can be compared across time or space. This is one of the fundamental reasons for which systems analysts use Entity Relationship Modeling and Dataflow Diagrams when examining information systems: these methods provide analysts with a standardised way of representing the phenomenon under examination. Similarly, the analysis of semantic and relational data models assist in the examination of database effectiveness (Chan et al. 1991). A range of studies in IS pursue the development and analysis of metrics, for instance software development (Fenton and Neil 1999), use of hypertext interfaces (Otter and Johnson 2000) and parallel system efficiency (Cremonesi et al. 1999). In addition, the accurate measurement of system effectiveness (Srinivasan 1985), system performance (Brancheau and Wetherbe 1987) and system success (Delone and McLean 1992) remain areas of substantial debate in the IS literature. These observations underline the importance of standardised metrics in research pertaining to the analysis of the real world.

ORGANISATIONAL SIZE IN THE IS LITERATURE

Examination of the behaviour of organisations (and, macroscopically, groups of organisations) remains a pivotal component of many research domains: this scholarly attention is echoed in the IS research literature (Lucas and Baroudi 1994). This organisational research comes in a variety of forms, including social organisations, governmental organisations, managerial groups and commercial organisations, with particular attention given to the analysis of social organisations (Holsapple and Luo 1996).

The examination and use of size in the IS literature has also received widespread attention. Size, as a measure of capacity, has been applied to a variety of environments: Igbaria and Greenhaus (1991) examined computer departments (number of IT employees), Kappelman et al. (1998) and Wrigley and Dexter (1991) examined software inventories and information system size respectively (lines of code), Gopal and Sanders (1997) examined software piracy clubs (number of members), Mukhophadyay and Kekre (1995) examined production plants (thousands of vehicles produced per year), Choudhury (1998) examined airlines (number of aircraft component purchase orders per year), and Schwartz and Wood (1993) examined email administrative domains (number of email users). The number of studies involving the size metric suggests two issues. First, it emphasises the variety of research environments in which size metrics are applied. Second, it emphasises the range of potential metrics available to the IS researcher. A number of authors make similar observations (Jenkins 1985, March and Smith 1995).

Given the importance of size and organisations, organisational size has been held as the most important characteristic in the analysis of technology (Lind et al. 1989) and it has been found to apply equally well to large and small business groups (Raymond 1985). This research has made a number of observations concerning small and large organisations. Some studies suggest that technology adopters tend to be larger than non-adopters (Montazemi 1989). possibly because larger businesses can allocate greater financial and personnel resources to the adoption and use of new technology. Larger organisations, it is argued, typically have more complex developmental approaches (Raymond 1991) and greater risk (Ivancevich et al. 1998), often requiring greater information support networks (Yap 1990) or products such as CASE tools (Hayley and Lyman 1990). Larger

organisations also typically have more slack resources (Damanpour 1987), and can hence adopt technology earlier than smaller organisations (Zmud and Applegate 1992). Small organisations, on the other hand, may be able to adopt technology because they are more flexible (King 1996) or can adapt to changing environments more quickly than larger businesses (Grover and Teng 1992). Smaller businesses may experience more successful IT use through CEO intervention (Delone 1988) and may place more emphasis on customer care than larger organisations (Butler 1999).

In contrast to these arguments, some studies have argued that organisational size has been a poor indicator of behaviour, with inconclusive or inconsistent findings. For instance, Grover and Teng (1992) observed similar adoption characteristics between larger and smaller organisations. Sampler and Short (1994) and Ewusi-Mensah (1997) note similar findings with regard to project and system development failure respectively. Brynjolfsson et al. (1994) delivered inconclusive results with respect to size and technology use; Ettlie et al. (1984) argue that, ultimately, only extremely large organisational size is a useful predictor of adoption or behaviour. This issue remains unresolved.

Because the research conducted so far in this area has yielded inconsistent results (both large and small organisations have been related to technology adoption, for example), there is substantial need to understand the nature and application of the different metrics. The anomalies in these studies may be due to the use of different metrics. This paper aims to examine the organisational size metric by reviewing research papers in the IS discipline in order to identify the most common metrics. The paper also aims to identify those variables to which organisational size has been applied in the literature.

RESEARCH APPROACH

In order to determine the metrics used for measuring organisational size in IS research environments, a substantial review of the literature was conducted. A core group of six important IS journals was selected from those available: *MIS Quarterly*, *Information Systems Research*, *Information and Management*, *Information Systems Management*, *Journal of Management Information Systems* and *Communications of the ACM*. It was felt that this selection would give a healthy indication of the metrics in use and was similar to other studies in the IS literature such as Delone and McLean (1992), Baroudi and Orlikowski (1989), Holsapple and Johnson (1994), Straub (1989) and Chan (2000).

A collection of all theoretical and empirical papers that referred to organisational size was derived. For the purposes of this study, organisations were included if they constituted separate commercial entities (organisations such as hospitals and educational institutions fell into a grey area, and were admitted to the study on a case by case basis). Studies had to make use of the term, “size”, “larger” or “smaller” in an organisational context. Papers that examined some facet of an organisation as opposed to using it as a proxy for size were disallowed. For example, studies that examined total assets as a proxy for size were admitted to the study; those that simply examined a firm’s total assets were not. The search was conducted by the author and a research assistant. As Delone and McLean (1992) argue, cases of ambiguity and imprecision inevitably arise when conducting taxonomic analysis of this kind. In cases of ambiguity, the opinion of another senior academic staff member was sought.

The time interval for the search was restricted to eleven years: expressly, the period 1989 – 2000. Research from this (relatively short) period encompasses more traditional firms in addition to those that have not followed “classical” growth patterns (such as electronic commerce organisations) and those that are subject to unconventional technology-enabled operating environments (such as virtual offices and telecommuting). It is envisaged that, in future developments of this study, this period will be extended back to the inception of these journals.

RESULTS

The results show, over the eleven year period under examination, 25 metrics in use in the IS literature in 214 studies. In the main, papers offered little in the way of supportive discussion regarding their choice of metric, despite the importance of this procedure as argued by March and Smith (1995). Additionally, some discrepancy was noted between the online and print versions of research papers. The online versions occasionally saw volume numbers out of synchronisation, and, frequently, missing author names and editorial content.

These metrics were grouped into categories, as shown in Table 1. Each of these groups is examined briefly below. For each metric, the study, research environment, and the nature of the metric’s application are noted. For brevity, only those studies that made use of the size metric as a research variable (as opposed to a classifier) are shown.

Sales/Revenue Measures	*Resource Measures*	*Other Measures*
Annual Revenue	Number of Employees	Patient Days
Gross Revenue	Total IS Employees	Self Nominated
Sales Revenue	Total IT Users	Fortune 500
Total Sales	Total Assets	Geographical Spread
Net Sales	Book Value of Assets	
Annual Sales	Fixed Assets	
Sales Volume	Production Assets	
Annual Turnover	IS Budget	
Premium Income	Operating Expenditure	
	IS Expenditure	
	Number of Beds	
	Total Annual Budget	

Table 1: Metrics for Organisational Size in the IS Literature

Resource Measures

Table 2 shows those studies that used resource-related metrics. Number of Employees (NOE) was by far the most common metric, a finding consistent with the arguments of Raymond (1985), Delone (1988) and Choe (1996). NOE has, for some time, been seen as a suitable indicator of capacity. Additionally, NOE is relatively easy to determine from official documents, particularly for large firms (Miller 1991). The use of NOE, however, has tenuous application to those work environments that experience substantial fluctuation, such as telecommuting, virtual offices (Snizek 1995) and network organisations (Ching et al. 1996). Total assets was the next most popular metric in use. Kim and McLeod (1999) argue that total assets represents firm stability and credibility. It is also interesting to note that, almost unanimously, studies that examined hospital environments used "Number of Beds" as their metric.

Citation	*Description*	*Metric*	*Dependant Variable*	*Significant*
Nabali (1991)	IS in hospitals	Number of Beds	IT adoption	No
Ahituv et al. (1989)	Distributed computing policy	Number of Employees	Hardware distribution	No
Al-Khaldi and Wallace (1999)	Attitude towards PC use	Number of Employees	Attitude ranking	Yes
Choe (1996)	AIS performance and evolution	Number of Employees	User satisfaction	Yes
Coakes and Merchant (1996)	Expert system use	Number of Employees	ES use	No
Grover and Teng (1992)	DBMS adoption	Number of Employees	IT adoption	Yes
Harrison and Farn (1990)	IS management issues	Number of Employees	IT adoption	Yes
Hitt (1999)	IT and firm boundaries	Number of Employees	IT use	Yes
Li and Ye (1999)	IT and firm performance	Number of Employees	IT performance	Yes
Maansaari and Iivari (1999)	CASE usage	Number of Employees	Technology expectations	Yes
Palvia and Palvia (1999)	IT satisfaction	Number of Employees	IT satisfaction	No
Poon and Swatman (1999)	Small business Internet issues	Number of Employees	Internet use	Yes
Riemenschneider and Mykytyn (2000)	IT management knowledge	Number of Employees	Knowledge item	No
Ryan and Harrison (2000)	IT Investments and firm performance	Number of Employees	Social group cost	No
Swanson and Dans (2000)	System life expectancy	Number of Employees	System size	Yes
		Number of Employees	System age	No
		Number of Employees	Complexity	Yes
		Number of Employees	Life expectancy	Yes
Teo et al. (1995)	EDI benefits	Number of Employees	Inventory control	Yes
Thong (1999)	IS adoption in small business	Number of Employees	Likelihood and extent of	Yes

			IS adoption	
Torkzadeh and Xia (1992)	Telecommunications management	Number of Employees	Use of formalised planning	Yes
Udo and Davis (1992)	DSS benefits	Number of Employees	Communication benefits	Yes
Zeffane (1992)	Structural control in organisations	Number of Employees	IT usage intensity	No
Ang and Straub (1998)	IS outsourcing	Total Assets	Outsourcing	Yes
Shao (1999)	Expert system diffusion	Total Assets	Adoption date	Yes
Straub and Nance (1990)	Computer abuse	Total Assets	Severity of discipline	No
Pick (1991)	IS in nonprofit organisations	Total Annual Budget	Funding intensity	No
		Total Annual Budget	Hardware complexity	Yes
		Total Annual Budget	Software complexity	Yes
		Total Annual Budget	Staff professionalism	Yes
		Total Annual Budget	IS control	Yes
		Total Annual Budget	IS morale	No
		Total Annual Budget	IS satisfaction	No

Table 2: Resource Measures for Organisational Size

Sales/Revenue Measures

Table 3 details those studies that make use of sales or revenue measures of organisational size. The most popular Sales/Revenue metric, based on frequency of application, is Annual Sales. Of particular interest is the inconsistent degree of significance between this metric and IT adoption across studies.

It could be argued that sales and revenue measures may only be suitable in certain circumstances. While large firms may have to lodge financial documentation with the relevant regulatory body (such as the ASX in Australia), smaller firms are not necessarily bound by this formality: determining such figures for these firms may be difficult. The application of financial measures to firms in financial sectors is seen by some as error-prone (Grover and Teng 1992), either because these firms do not sell physical products or they exhibit fluctuating revenue streams which may obscure size analysis. Additionally, several authors note the fervency with which firms may seek to downplay unfavourable financial aspects, such as operating costs, and exaggerate favourable aspects, such as revenues (Mitchell et al. 1996).

Citation	***Description***	***Metric***	***Dependant Variable***	***Significant***
McLean et al. (1993)	Use of end-user computing	Annual Revenue	IT adoption	No
Ahituv et al. (1998)	IS and new product introduction	Annual Sales	Application success	No
Katz (1993)	IT and business value	Annual Sales	IS performance measurement	No
Li and Rogers (1991)	IS profile of US firms	Annual Sales	Hardware expenditure	Yes
		Annual Sales	Computing expenditure	Yes
		Annual Sales	Telecomms expenditure	Yes
		Annual Sales	Analysis effort	Yes
		Annual Sales	Programming effort	Yes
		Annual Sales	Data processing mode	Yes
		Annual Sales	IS resource structure	Yes
		Annual Sales	Data organisation benchmarks	Yes
		Annual Sales	Statistical software usage	Yes
Lind et al. (1989)	Size impact on IT adoption	Annual Sales	IT adoption	Yes
Mendelson and Pillai (1998)	Businesses and IT use	Annual Sales	IT Use	No
Yap (1990)	Firm use of IT	Annual Turnover	IT adoption	Yes
Harris and Katz (1991)	Size and IT investment intensity	Premium Income	IT expenditure	No
Truman (2000)	Electronic exchange integration	Premium Income	EDI volume	No
		Premium Income	EDI diversity	Yes
		Premium Income	No. of professional employees	Yes
		Premium Income	No. of admin employees	Yes

Premkumar and King (1994)	IS planning	Sales Revenue	Quality of planning	No
Grover and Goslar (1993)	IT initiation and adoption	Total Sales	IT adoption	No
Mitra and Chayam (1996)	IT spending and cost-effectiveness	Total Sales	IT cost returns	No

Table 3: Sales/Revenue Measures for Organisational Size

Compound Measures

Some studies pursued a more comprehensive approach to examining organisational size, either by using a multivariate proxy or using two separate metrics to measure the same proxy. Table 4 details the use of such compound measures in the literature. Particularly interesting is Iacovou and Benbasat (1985), which uses two separate measures of organisational size to test for EDI adoption: of Number of Employees and Total Sales, only the latter metric was found to be significant.

Reference	***Description***	***Metric***	***Dependant Variable***	***Significant***
Conrath and Mignen (1990)	User satisfaction	Number of Employees, Annual Revenue	User satisfaction measurement	No
Grover et al. (1994)	IS outsourcing	Number of Employees, Annual Sales	IS outsourcing	No
Karimi and Gupta (1996)	Competitive strategy	Number of Employees, Annual Sales	Strategy type	Yes
Lai (1994)	Computing in small business	Number of Employees, Annual Sales	IT adoption	No
Palvia et al. (1994)	Computing in small business	Number of Employees, Annual Sales	Computer use	Yes
Pavri and Ang (1995)	Strategic planning practices	Number of Employees, Annual Sales	Strategic planning	Yes
Yang (1996)	Information management issues	Number of Employees, Annual Sales	Issue importance	Yes
Teo et al. (1997)	IS strategic planning	Number of Employees, Annual Sales, Number of IS Employees, IS Expenditure, Operating Expenditure	Strategic IS planning	Yes
He et al. (1998)	IS in manufacturing	Number of Employees, Annual Sales, Production Assets	IS adoption	Yes
Meyer (1997)	Visual information acceptance	Number of Employees, Annual Turnover	Manager attitude	Yes
Wang (1994)	IS management issues	Number of Employees, IS Budget, IS Employees	Issue importance	Yes
Kivijarvi and Saarinen (1995)	IS investment and firm performance	Number of Employees, Net Sales	IS investment	Yes
Chengular-Smith and Duchessi (1999)	Client-server adoption	Number of Employees, Total Sales	IT adoption	No
Iacovou and Benbasat (1995)	EDI adoption	Number of Employees	EDI adoption	No
		Total Sales	EDI adoption	Yes
Talmor and Wallace (1998)	CEO salary	Total Sales, Total Assets	CEO salary	Yes

Table 4: Compound Measures for Organisational Size

Other Measures

Five studies used metrics that did not fit into any of these three categories. In the main, these studies were specific to certain industries or business types. The metrics used included number of patient days (used in a study about hospitals), Fortune 500, geographical spread and respondent-nominated. Only Law and Gorla (1996) used organisational size as an experimental variable: in that study, geographical spread was found to be significantly related to IS productivity. No studies offered convincing discussion as to why they chose unconventional metrics for size as opposed to those more established in the literature. It is interesting to note

the frequency with which studies used unaudited self reported measures for firm size: responding organisations were typically asked to classify themselves as either "small", "medium" or "large". The effect of this on experimental reliability is unknown.

No Measure

In total, 27 studies (over 10%) did not declare the metric used, with five of these studies using organisational size as an experimental variable. A number of authors (such as Miller 1991) note the importance of variable and parameter declaration when conducting scientific analysis and these omissions may undermine the scientific approach taken and conclusions made in these papers.

CONCLUSIONS

The study's main finding is that a large number of organisational size metrics are in use. Broadly, these can be categorised into resource, revenue and other metrics. The main metrics in use include the firm's number of employees and annual sales. Further analysis of the research in this area suggests little homogeneity of approach, and a dearth of supportive discussion. This finding suggests that the IS discipline is unsure as to the ideal metric to use.

While the time period used may be too narrow to make generalisable observations regarding the success of the metric, the anecdotal evidence presented in some studies suggests that the use of multivariate metrics may be a promising avenue. The use of fewer but more multi-faceted, generalisable and hence robust metrics in IS research, as argued by Delone and McLean (1992) and Weill and Olson (1989) may give a better indication of organisational size under a variety of circumstances, reinforcing IS in both a philosophical and scientific regard. This contention would be consistent with that of Galliers (1992): that a policy of research pluralism may be most suitable for the IS discipline if it really is fragmented. Banville and Landry (1989) concur. To paraphrase Delone and McLean, "It is unlikely that any single, overarching measure of [organisational size] will emerge, and so multiple measures will be necessary, at least in the foreseeable future".

The study is subject to a number of limitations. First, it is possible that the search method used did not capture every paper that made use of the size metric. While every effort was made to reduce the number of missed papers, the researchers cannot rule out the possibility of missed papers due to human or technical error. Triangulation and confirmation procedures were used to minimise this, however the size and effect of the error is, unfortunately, unknown.

A second source of potential error lies in the selection of journals. First, only six journals were selected from the hundreds that are available to the IS researcher and practitioner. Given the human and technology resources available to the researcher, it would have been unfeasible to pursue a substantially larger number of journals. Additionally, there is no guarantee that these journals provide a representative (or even indicative) sample of the research involving size metrics. The effect of this error has hopefully been alleviated somewhat through the careful traversal of journal references and the sheer number of journal articles examined (over 2,000). The inclusion of a wider selection of journals in future iterations of this study should at least partially address this issue. Additionally, a degree of inconsistency was found between the print and online versions of some papers: the effect of this, while unknown, should be borne in mind by scholars in this area.

A third area of research limitation lies in the timeframe selected. Eleven years represents but a small portion of the total life of the IS discipline, the advent of which is estimated by some to be during the mid sixties (Holsapple and Johnson 1994). While focusing on such a small timeframe does allow for more microscopic analysis, the study misses a substantial amount of previous IS research. The study would no doubt benefit from the inclusion of this sizeable period: it is anticipated that future work should bring this to fruition.

This particular time period presents another source of limitation and potential error that merits some brief discussion. This study is motivated, in part, by the discrepancies apparent in the contemporary research application of size metrics. The findings of this study bear out this discrepancy: an analysis of research from the past decade has shown that the use of a univariate size metric is inconsistently suited to the analysis of the contemporary organisation This finding has been cleaned through the analysis of a time period that has been witness to terrific organisational growth and unorthodox structure and business process. The effect of this is unknown and, without a larger time frame to moderate this period, the true nature of the size metric will remain, at least partly, a matter of some scholarly conjecture.

The findings, while moderated to some degree by the limitations discussed above, present several fertile avenues of further research. First, the study beckons a wider selection of journals. In particular, the inclusion of publications not wholly devoted to information systems (such as *Management Science* or *Decision Sciences*) would make a valuable contribution to the robustness of the study. Second, the study would welcome the

examination of a larger time period: the formative years of the late 1970s and early 1980s (Robey 1981), when computer technology was moving into the realms of widespread affordability, would provide valuable insights into the behaviour of the organisational size metric. In tandem, these two research extensions would make for a formidable and informative study. A third avenue for research concerns the deeper examination of the size metric itself. Specifically, an examination of the ways in which different interpretations of the metric affect research outcomes would be of benefit (which metrics suit which industries or research domains, for instance). These three extensions constitute part of the next stage of this study. The discussion of intra-study discrepancy has highlighted the duplicity that can arise when pursuing research into abstract phenomena: the careful examination of these circumstances would be of indubitable benefit to the IS research, practitioner and policy-making groups.

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