

VISUALISING AND REPRESENTING HOW ORGANISATIONS WORK FOR A BETTER ANALYSIS OF HOW IT CAN CONTRIBUTE

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ABSTRACT

This research project investigated the relationships between IS staff and other organisational actors in four organisations. Using a network-based approach borrowed from Sociology, the key actors, groups and institutional mechanisms that organisations relied upon when deploying and using IT were investigated and represented in a series of diagrams. Specific techniques to visualise and represent how organisations operate and how information circulates within them were developed. This helped the researcher analyse the key components in the interaction between IS and the rest of the organisation and make suggestions for a better contribution of IS staff to the management of organisations.

1. CONCEPTUAL FOUNDATIONS OF THE NETWORK APPROACH

Network Analysis, a body of research that concentrates on the networks of firms, has been found to have many applications in areas where researchers struggle to understand the complex workings of organisations (Nohria, 1992). It acknowledges that individuals are characterised just as much by their relationships with one another as by their specific attributes (Knoke and Kuklinski, 1982). It is the study of these relationships that has been labelled Network Analysis.

Roethlisberger *et al.* (1939) used an early form of network analysis in the 30's in their famous studies of the Western Electric's Hawthorne plant to emphasise the importance of the webs of informal relations in organisations. Subsequently, network researchers have focused on the development of essentially quantitative methods and the use of standard statistical analysis to investigate the design and structure of networks. Wasserman *et al.* (1994) have regretted that this overly quantitative approach has limited research perspectives and they have called for the development of new concepts and tools to broaden the scope of Network Analysis.

A number of areas of research have greatly benefited from the use of the network perspective (Nohria, 1992). Its strength is that it allows a close examination of the structure and patterns of relationships that establish amongst organisational actors. It also enables researchers to collect large amounts of data regarding managers, their linkages to each other, the usage of the information exchanged and the managerial activities served by these exchanges. Thus, network analysis supports the development of comprehensive models of organisations that capture the essence of their networks and analyse some of their quantitative and qualitative

characteristics. Network analysis is also particularly suited to the study of decision making because it implicitly recognises the dynamic and changing nature of networks and provides the tools and techniques for measuring and evaluating this change.

Finally, network analysis enables researchers to transcend the problems identified by previous research, namely that some managerial processes sometimes appear to be without order (Cohen *et al.*, 1986) and that the preferences of managers are often vague and contradictory, even when there is agreement on the objectives of the firm (March, 1987). It can also help solve the problems brought about by the on-going nature of managers' information needs and the duration of certain decision making processes (Carlsson, 1994; Laumann, 1994; Murphy, 1994).

2. DIFFICULTIES WITH NETWORK REPRESENTATION AND VISUALISATION

One appealing feature of Network Analysis is that it enables researchers to represent networks of actors in a graphical fashion and to code their observations and integrate it with their analysis of network structure. However, traditional network researchers have used such graphical representation infrequently. Knoke *et al.* (1982) have noted that while many terms used in the theory of network analysis evoke geometric representation (e.g. distance, boundaries, centrality), diagrammatic representations often have limited usefulness. Thus, many graphical displays used by network analysts do not attempt to represent the spatial configuration of networks, but merely graph quantitative measurements based on matrix analyses (Burt, 1976).

The lack of interest in using diagrams is due in a large measure to the complexity and size of the networks studied so far (Knoke and Kuklinski, 1982). To date, network research has involved very large groups where not all nodes are known and a random sample of actors is studied (e.g.: decision making cliques in large cities), which precludes meaningful graphical representations of the entire network. To deal with this level of complexity, researchers have sought to reduce networks to a limited number of typical positions which many actors occupy. Knoke *et al.* (1982) gave the example of a study of a medical practice where a vast network was simplified into a four-position network involving nurses, doctors, patients and receptionists. The criterion used in such simplification is called *structural equivalence*, because the aggregated actors have similar roles and similar connections with the other actors in the overall network. In other cases, sub-groups with high levels of cohesion or well-established cliques can be taken as one entity even though they involve many individuals (Burt, 1976). The criterion used for such simplification is called *social cohesion*.

The complication which raises the greatest doubts in relation to using graphs in network analysis resides in the multiplicity of radically different diagrams that can be drawn based on one data set. The variety of graphs that can arise from network data can lead to a variety of interpretations of the structure of networks. Thus, Knoke *et al.*'s (1982) opinion of such diagrams is not very positive:

Sociogram construction is essentially an art form, despite sporadic and unsuccessful efforts to specify invariant procedures (p.38).

Nevertheless, there is evidence that visual displays can have a dramatic impact on viewers and can be used for the purpose of getting feed-back from interviewees. A survey of landmark papers in network analysis also reveals the powerful effect diagrams can have on understanding organisations. Simple diagrams can be used to illustrate typical positions of power in which individuals can be found such as *cut points* (actors who play a major liaison role), *bridges* (crucial relations linking two clusters) (Granovetter, 1973) or *Obligatory Passage Points* (OPP) these situations where key individuals must be used as intermediaries by all actors seeking access to certain resources or lobbying for issues to be raised (Callon, 1986, 1991). To conclude, visual displays can play a significant role in network analysis assuming that researchers set themselves strict ground rules that must be applied consistently for the layout of the diagrams.

3. DISCOVERING OR SETTING NETWORK BOUNDARIES

Network analysis is based on the assumption that the behaviour of individuals may be explained in the context of their interaction and their relations with certain other key actors. Thus, it is of paramount importance that network researchers specify inclusion rules for different network elements. Laumann *et al.* (1983) have noted that this was often overlooked by researchers adopting the network approach to organisations; a tendency that makes it very difficult to assess the validity of both research design and results. They concluded that it is no longer sufficient to “appeal to common sense” (Laumann *et al.*, 1983) or to limit the study to the data available in published form, as if this guaranteed the completeness of the network observed (Burt, 1982).

In most cases, the complexity and the size of networks require a rigorous research design. Burt (1982) advocates the “snowball” strategy where researchers select a small core of key individuals and interview them to identify additional key players. Even then, it may prove difficult to adhere to one’s boundary setting rules. The reluctance of some of the nodes to volunteer names and information can make it impossible to establish the true extent of a network (Laumann *et al.*, 1983). Also, the sheer size of a network may force the researcher to select a random sample of nodes and to hope for representativeness.

Laumann *et al.* (1983) concluded that an analytical approach where researchers consciously adopt a conceptual framework constructed to serve their own analytical purposes is required. In this case, the network boundaries reflect the goals of the research and the delineation of the network “has no ontologically independent status” (p.22). Thus, Knoke (1994) identified four main strategies for boundary setting:

- *Positional method* where people and organisations occupying the key roles in the system studied are interviewed,
- *Decisional methods* where actors involved in making or influencing fundamental decisions constitute the core element of the sample,
- *Reputational methods* where actors who are widely believed by knowledgeable observers to occupy key positions are targeted and
- *Relational methods* where the researcher interviews the key people named by other key people and the network is uncovered in a snowball fashion (pp 280-281).

Network approach also extends to the examination of the relationships between organisations and their environments. As described by Starbuck (1976):

One should stop thinking of organisations as sub-set of society, and start thinking of them as hills in a geography of human activities. Social groups and networks would appear as mounds and ridges on the organisational hills, and societies and economies would appear as islands and continents (p. 1078).

Thus, for the purpose of research, networks may span outside the boundaries of formal organisations to include nodes which are part of their *extended network*. This happens when interviews with identified nodes in a network lead to the identification of other nodes with which the individuals interviewed are in contact. The inclusion of these nodes extends the organisational network and provides new boundaries for this network.

4. RESEARCH MOTIVATION, OBJECTIVES AND METHODS

The objective of this research was to use a network approach to capture the essence of the exchanges of information amongst certain organisational actors and, more specifically, to investigate the relationship between IS staff and their colleagues in other areas. This objective was achieved by focusing on groups of managers involved in complex decision making processes in order to attempt to re-create overall pictures of how organisations work. In these pictures, the researcher tried to isolate the contribution of IS staff and

understand how it could be improved. IS can represent many different things in the context of an organisation, namely: the IS department, the use of computer systems, expertise with the handling of information or the array of systems that support the business activities of organisations. For the purpose of this study, and particularly in the context of a *network perspective*, it was decided to classify and analyse the contribution of IT in terms of:

- the formal missions and roles of the IS department, the structure put in place to fulfil these roles and the linkages between IS staff and other actors,
- the role actually played by IS staff and their integration in the decision making processes of the organisation and
- the distribution and control of IT expertise in and around the organisational network in a wider sense.

This research project studied four organisations where repeated access to top level managers was obtained. The case study method (as in Miles and Huberman, 1994; Stake, 1994; Yin, 1994) was used to collect and analyse the network data required for the study. Over the 12 months of the empirical study, 40 interviews were carried out with 30 different informants during 20 site visits. The informants represented a broad spectrum of functional areas, but IS staff were interviewed in all four sites. Diagrams representing the networks studied were drawn and submitted to the informants who commented on them and provided the researcher with richer explanations that were used to further refine these organisational pictures.

5. FIELD STUDY FINDINGS

5.1. Synthesis of Organisational Characteristics

The organisations studied constitute a broad and varied sample. In particular, they differ in size, ownership, turnover, activities, level of expertise with IT, and number and type of customers – all tangible attributes - as well as, more subtly, in terms of culture and relationship with their customers. The more tangible differences between these four organisations are synthesised in Table 1 below.

The IS Departments of the four organisations have very different sets of roles and missions but there were also fundamental differences between the way IS was regarded by organisational actors in the different sites and this seemed to be somehow related to the degree of importance and the scope of the roles and missions of information systems, although it was impossible to conclude as to which was the cause and which was the effect.

After analysing all the data collected, the organisations were placed on a continuum of decreasing business support from Distribution Ltd, where IT could be seen to be in total support of the entire business at operational and decision making levels, to University, where there was some uncertainty as to how IT could help organisational actors at all, especially in their research activities, but also in operational matters. In between these two extremes, Newspaper Ltd presented an example of an IS Department in the process of developing the systems on which the competitiveness and effectiveness of the business would rest and also becoming a crucial source of expertise for the organisation and. In Utility Ltd, managers and directors had just realised the operational importance of IT and were figuring out how it could be used to help the company re-structure itself. This continuum of organisational support is formalised in Table 1.

It may be hypothesised that these stages correspond to common stereotypes of how organisations utilise IT for operational and for decision making support. The case of University is interesting because this organisation acquired one of the first mainframes in Ireland in the early 70s, but lost its early maturity by leaving the expertise of its IS staff become obsolete.

However, the researcher found that focusing on the missions of the IS Department in a formal sense did not capture the reality of the contribution of IT. The novelty of this study was to investigate the role of IS in a network analysis perspective and to take advantage of the researcher's knowledge and understanding of the

networks of the organisations studied in order to evaluate (1) the current impact of IS staff and IS expertise in supporting the circulation of information, the communication and the decision making of organisational actors and (2) how the impact of IS on the key managerial processes of an organisation could be increased. This analysis is presented in the following sections.

	Utility Ltd.	Distribution Ltd.	Newspaper Ltd.	University
Turnover	£ 271 million	£ 1 billion	£ 20 million	£ 70 million
Number of employees	700	2000 in seven locations	350 on the payroll	1751 full time and 1000 student helpers
Number of customers	295,000	20,000 customers and 440 franchisees	350 accounts holders + 90,000 sales daily	<i>In excess of 10,000 students</i>
Nature of activity	- Development of utility network - Distribution to customers	- Management of a franchised line of supermarkets - Cash and Carry	- Production of two newspaper titles - Sales of ads - Publishing	- 3 rd level education - Research - Other related activities
User Population	1000 internal and 440 external	350 but only 200 simultaneously	450	2500 PCs
IS staff	65	6 ½ Staff	22 + 2/3 contract staff	25 in Computer Centre + local support staff.
IS budget	N/A	£900K (inc. £300K capital expenditure).	£3.3 m (inc. £1.5m for capital expenditure)	£1.6m in Computer Centre + £300K locally
IS staff to Employee	3.25%	1.86%	3.57%	1.42%
IS staff to User Population	4.33%	3.25%	5.5%	1% *
IS budget to turnover	N/A	4.5%	1.21%	2.71%
Head of IS	IS Director member of Board of Directors	MIS manager member of Mgt Committee	<i>CIO member of Mgt Committee</i>	Head of Computer Centre reports to Finance Officer
Importance of IS	Key to efficiency of business; support for all transactions.	Mission critical IS has just replaced many existing skills.	<i>Support and recording of the transaction of the business.</i>	Support of some central transactions, some local support in departments.
Future of IS	Dynamic pro-active evolution of importance of IS role.	Increasingly crucial role with scope for more computerisation.	<i>IS must support re-structuring and develop competitive edge.</i>	Vast scope for more support for depts and central administration.
Degree of support provided by IS				

Table 1: Synthesis of Differences Between Organisations

5.2 Integration of IS Staff and IS Expertise in Organisational Networks

The integration of IS staff in organisational networks measures the extent to which they actually contribute to the work of other organisational actors beyond the formal missions of their department. This is a network issue as IS staff must be well connected to the rest of the organisation in order to be called upon by their colleagues. If few linkages exist between IS staff and other actors, then there is no possibility for IS staff to contribute beyond the formal ways already described in the previous section. If IS staff are well connected in the network and if the nature of the linkages they have with other actors covers a broad range of types of interaction, it is likely to correspond to a pattern of exchanges between actors whereby IS staff do more than just keep systems running.

In the 4 organisations, interviewees described consistent patterns of interaction with IS staff. They provided anecdotes that illustrated the type of co-operation taking place between actors. This data was used to measure the level of integration of IS staff and to envisage how to improve their contribution to managerial processes. Alternative sources of IS expertise were considered in order to evaluate the importance of IS in general for the organisation. Such a study relied heavily on the investigation of the clusters of the organisations' networks that were concerned with sharing, requesting and distributing IS-related expertise.

- **Distribution Ltd**

In Distribution Ltd, the IS Department has been split between the different business units in order to bring it closer to its users. Overall, the degree of integration of IS staff in organisational affairs is high. It reflects the amount of work that has already been carried out in analysing the kind of business support IT can provide. This reflection has gone as far as creating new ways of trading through IT as evidenced by the evolution of the rich relationship between managers and the owners of the shops and supermarkets Distribution serves through its franchise. Thus, IS staff play a core role in maintaining a tight relationship with shop owners and shop managers on a daily basis, and IS is truly an enabler for the smooth and efficient circulation of information and communication within the *extended network*.

Two recent instances of decision making relating to the development and implementation of information systems can serve to show the efficiency of the contacts between IS staff and other organisational actors. These two decision making processes were fast (10 and 12 months including systems implementation) despite their degree of novelty and the size of the investments required. From a process point of view, IS staff were entrusted with the preparation of the IS side of the projects and were successful in securing the financial support of the Board of Directors. In one business unit, IS staff were put in charge of the project with users happy to merely follow up the progress achieved and satisfied with the finished product. Both projects were clearly of a decision support nature, which showed the solid business-oriented communication between IS staff and managers.

The network of IS expertise at Distribution Ltd is highly specialised (Figure 1). One part of the network has specialised in communicating with the franchised shops and administering the warehouses (business unit 2). Another part has specialised in providing support to managers in charge of the cash and carry stores (business unit 1) and another one had specialised on providing advice in IS matters and experimenting with new solutions (Group IT). One consequence of this specialisation is that the different IS clusters no longer communicate very intensely and are *weakly connected* (Granovetter, 1973; Burt, 1992). Overall, the network of IT expertise at Distribution Ltd has evolved in a way which serves well the needs of the organisation.

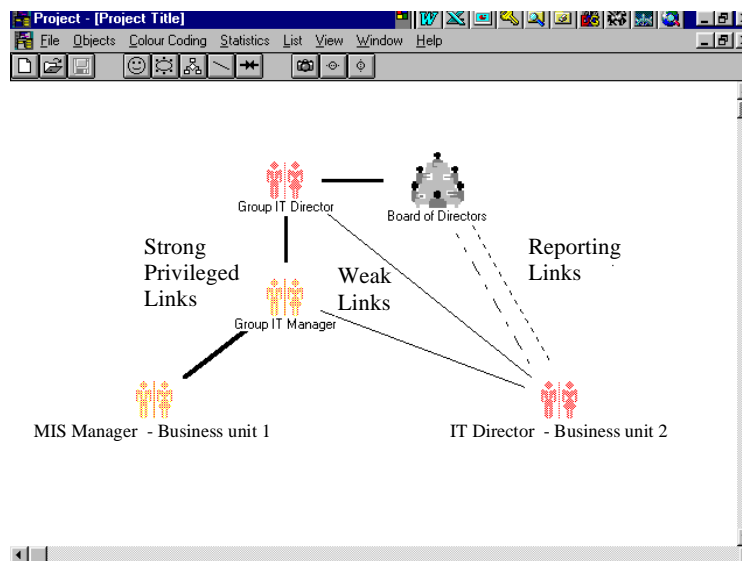


Figure 1: Relationships between actors in the IT network at Distribution.

- **Newspaper Ltd**

In Newspaper Ltd, the MIS manager explained that the small size of his department and the lack of a rigid structure were the keys to the flexibility of the service IS staff. They enabled IS staff to jump from one task to the next as they arise in the work of users. This was reflected in the pattern of work of IS staff. One of them said that he spent more than half of his time with users, developing small applications or fixing small operational problems. This required that he moved around quite a bit due to the decentralisation of systems in the hands of the users. Thus, there is much communication between users and IS staff.

In Newspaper, the informal communication network was very developed and many staff relied heavily on it in their work. However, this was matched by weak formal communication which left some categories of actors and some clusters in the dark. Thus, organisational actors who knew IS staff well felt well served and those who did not found it difficult to get their problems attended to. This highlights a fundamental dilemma in administering a service department: more formalisation of procedures slows down the service and wastes time, whereas informal patterns of relationship work very fast, but may not provide equal service to all users.

As a result, some managers complained that they were not getting enough information from IS. This may be due to a lack of familiarity with IS staff, whereby managers who have sought help before know how to get it while others are not certain whom to ask for support. For instance, for editorial matters, there was much confidence in and reliance on IS staff, especially in the wake of the implementation of the new system which had been the occasion to create many IS-user relationships. For the decision making of other areas, such as sales and marketing, the contribution of IS was far less evident.

Thus, Newspaper Ltd's IS-related network is very decentralised and expertise is widely distributed amongst the users of the systems. Local expertise is very developed as the formal IT department is small and users have acquired more expertise and more responsibility. Ultimately, the network of IS expertise at Newspaper Ltd was found to extend far beyond the formal IS structure.

- **Utility Ltd**

Utility Ltd provides a different but complementary picture of relationships between IS staff and other functional areas. Up to 1997, there was far more conflict than co-operation between IS and other areas. The chairman of the board initiated key changes in the IS Department as illustrated in Figures 2 and 3, including the hiring of a CIO. This evolution is significant because it meant that someone who was hired from outside Utility could spend time thinking about how IS can contribute to the business side. The CIO reports directly to the CEO instead of reporting to the Finance Director. He also re-structured the IS department by creating dedicated forums for the interaction and collaboration between IS staff and users. These joint committees are aimed at solving the problems of the past and getting rid of the unspoken organisational belief that "IS is bad". It aims at developing the co-operation that does not take place in the normal course of business, leading to greater awareness of IT and triggering more informal contacts between IS staff and users. As a catalyst for this metamorphosis, the CIO has asked functional area managers to select *key users* to be trained in IT matters and to facilitate dialogue between IS staff and staff in functional areas. As a result of these changes, an ambitious Enterprise Resource Planning (ERP) project has just been launched.

Utility Ltd has absorbed a number of local trading companies over the years and the IS Department was made up of local clusters loosely coupled and under the authority of one of the local IS Managers (see Figure 2). Thus, the user support manager was in fact the former IS manager for the East region and the Senior business analyst was the former IS manager for the South region. The titles had changed as the organisation grew, but the job descriptions and the sharing of responsibilities had not evolved in parallel. In the new structure, the division of labour in IS has finally been put in place. Thus, the network has become more centralised and IS staff have been re-allocated in a looser manner so as to increase the flexibility of the department in responding to users requests (see Figure 3).

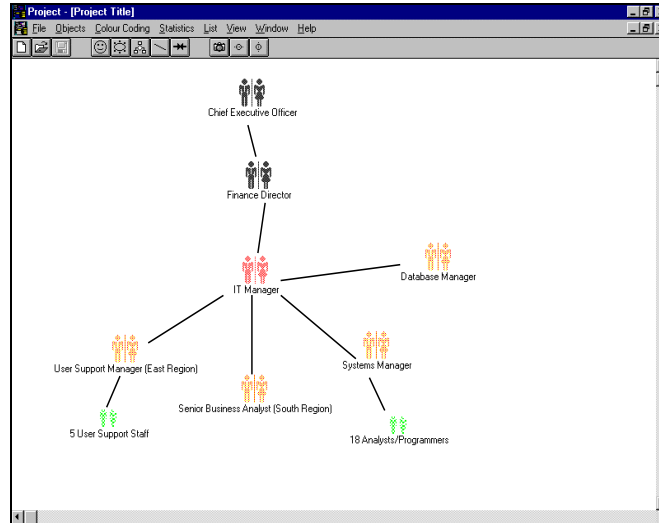


Figure 2: Previous structure of the IS department at Utility

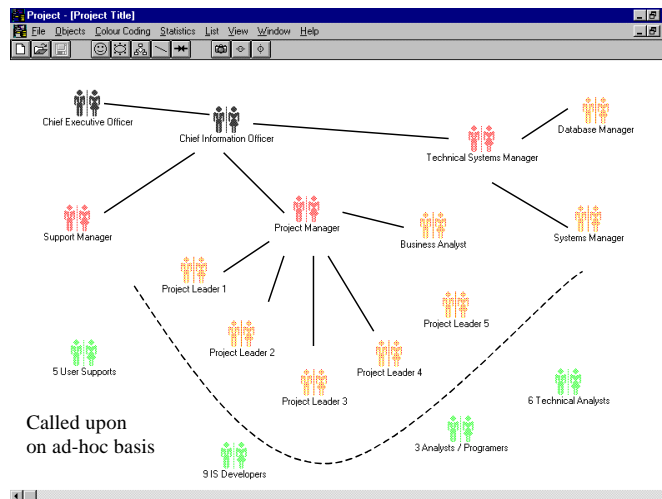


Figure 3: New structure of Utility's IS department.

▪ **University**

In University, the situation is similar to that of Utility Ltd prior to the changes described above. There is some collaboration between Computer Centre staff and other actors, but certainly not as much as there should be to allow the IT support to develop to its full potential. Collaboration is too often confined to the central administration, where the Computer Centre has most of its direct users. It provides the transaction processing systems University could not operate without but little else. In the academic departments, the level of collaboration ranges from irregular to none and some staff interviewed felt that getting in touch with Computer Centre staff was more part of the problem than part of the solution.

The low level of collaboration between Computer Centre staff and their colleagues cannot solely be blamed on the lack of responsiveness of IS staff, but also on the lack of interest of academic staff. At meetings where the role of IT is to be discussed, few staff ever turn up. It is difficult to analyse why there is such a low level of interest amongst teaching and research staff given the obvious contribution which computer support can make in academic activities, but it could be a reflection of the lack of confidence of higher level actors who

do not use IS for any purpose. The fact that a high profile Executive Information System (EIS) project for the college president received no support in the mid-90s is illustrative of this lack of interest.

Thus, in University, formal IS is highly centralised, and not well connected to the departments and research centres. The perception of the contribution of the Computer Centre is not good either and this results in a lack of enthusiasm in seeking greater collaboration. At the same time, observation reveals high levels of IS usage at departmental level and the high extent of IS expertise available in the university. Many scientific departments teach programming languages for the purpose of research and possess their own self-administered equipment. In other faculties, there are also some islands of IS expertise which contrast with the generally low level of expertise and use. Thus, IS expertise is decentralised, with dense, weakly-connected clusters of expertise and high levels of IS use. Organisational actors are well aware of these alternative sources of IS expertise and often seek advice from staff they know in the expert clusters instead of making formal requests to the computer centre. Thus, University staff's search for advice on IST matters is more determined by whom they played soccer with than by the internal structure of the organisation.

There are good and bad aspects to such a model. The positive aspect is that the level of expertise and use of IS in University is much higher than it seems and that IS expertise does not come from only one source. However, there is little control over what developments are taking place and no consistent access to IS support for users. As a result, monitoring the sharing of expertise in University is quite difficult. This situation encourages great disparities in development and makes integration of resources and sharing of information more difficult, which limits the potential contribution of IT in decision making processes. Furthermore, the lack of support from top managers may continue to slow further developments of the role of IS staff in University.

6. CONCLUSIONS

This research sought to analyse the organisational contribution of IS using a network perspective. It contrasted two approaches, one based on the analysis of the formal missions of the IS function and the other based on network analysis which sought to establish an alternative vision of the actual contribution of IS. The analysis carried out in four organisations revealed great differences between these four sites. Based on the analysis of the formal IS structure and the missions of their IS Departments, the four organisations studied were classified on a continuum of increasing operational IS support and greater contribution of IS to managerial decision making. This continuum shows different levels of reliance on IS for operational and managerial support matters. It shows the role of IS department in ensuring further development of IT through R&D. It also shows IS staff struggling to establish themselves as key actors.

But looking at the formal missions of the IS Department is not sufficient to assess the actual contribution of IS. The role of network nodes is determined by two core attributes: (1) their position in the network and (2) the nature of their relations with other nodes. The latter element is often neglected when analysing organisations. Researchers must interview organisational actors in order to establish the qualitative dimension of their contacts and their information flows. The onus is on researchers to gather the information that goes beyond the simple network picture drawn by who is connected to whom (Galaskiewicz *et al.*, 1994; Knoke, 1994; White, 1992). Thus, the investigation of the characteristics of the network aspects of IS expertise is also required. This analysis reveals that the perception of IS by other organisational actors – especially high level actors – and the extent of their communication with them are equally important indicators of the contribution of IS. Thus, the distribution of IS expertise in the organisational network is a more accurate measurement of the contribution of IS. For example, the kind of access which the IS manager has to high level nodes in other functional areas is important. When IS is present at Director or at Management Committee level, collaboration is driven from the highest level and will take place. When the IS Department is not represented in these forums, there is no formal method of communication between the Heads of functional areas and the head of the IS function and a reliable and consistent communication is unlikely to develop at the lower levels.

Based on these observations, the integration of IS actors of in the overall organisational network rests on (1) the number of independent contacts points between IS actors and other actors, (2) the hierarchical level and power of the most senior actor in that functional area and (3) the reputation of the IS area. These findings provide a blueprint for a greater contribution of IS to managerial decision making at all hierarchical levels.

This conclusion may lead to a re-orientation of some of the research in information systems development. Many problems and instances of failures have been reported in the literature on systems development (Fitzgerald, 1996), but any effort to provide a solution may be futile if the organisational context in which systems development takes place is not conducive to collaboration between IS staff and business staff. The fundamental difference in the integration and trust of IS staff in the organisations studied indicates that focusing on the methodological elements of systems development is not sufficient. A deeper reflection on the status and integration of IS staff might also be required.

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