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SOCIAL NETWORK ANALYSIS AND INFORMATION SYSTEMS IN ORGANISATIONS: HIGHLIGHTING THE NEED TO UNDERSTAND HUMAN INFORMATION SHARING BEHAVIOUR

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Abstract
The purpose of this paper is to draw attention to the lack of importance given to understanding the users' behaviour and context when it comes to developing IS in organisations. To also point out the value of social network analysis (SNA) in the study of organisations and IS in general and give a critical review on SNA as a method.
The significance of SNA was demonstrated with a case study which shows in a little detail how it can help in understanding user behaviour and organisational context.
This is a paper that is based mainly on information systems (IS) in organisations, so it does not make any claims outside of this context, and while there are alternatives to SNA in understanding organisations, the paper focuses on SNA because of the insight it gives on the social environment of the organisation. The paper helps provide a general understanding of SNA as a tool in studying user behaviour in organisations with a view to IS development and evaluation, and also makes an effort to link and show the importance of the study of user behaviour to developing IS that is more suited to the user.

Keywords: Social network, Information system, Information behaviour, Organisational research

1.Introduction

This paper first explores research on information in organisations, the importance of understanding the members of the organisation, and what role it plays in IS development. Then social network analysis (SNA) as a method to help understand these behaviour is explained using a case study, and its use in evaluation of IS is also highlighted, along with its

limitation. Finally a discussion on its use in IS and the discourse on understanding users before the development of IS.

1.2. Organisations, information and systems

Organisations have been researched in many fields for the sole purpose of trying to understand its complexities and to help gain a competitive advantage in its ever changing environment and organisations have also been conceptualized as political systems, machines etc. for the same purpose (Morgan 2006). It is well researched that information plays a big role in an organisation's success and in a study carried out in many organisations, by Marchand et al (2001) they identified three information capabilities that organisations need to possess to increase productivity namely: Information management, information technology and information behaviour and values.

In the information age as it has come to be known, the importance of information in our everyday lives and organizations cannot be overemphasised. Perhaps a quote from Davenport (1997) would do a bit of justice to this view:

> The point is that the economic value from generating, using and selling information is growing significantly faster than value added by producing traditional goods and services"
>
> Stan Davis 20/20 vision

In fact there are organisations that exist just to share and or sell information. Organisations of this nature are viable, and most of them have become huge corporations; take social networking giant Facebook for instance.

Traditional organisations in other sectors have had to improve information flow within their organisation and from outside to try to maintain a competitive edge. So the need for organisations to manage information has increased, and this has been an issue of study, by both researchers and practitioners alike.

The importance of information cannot be overstated, and Hatala and George Lutta (2009) points out again that organisations that are able to share knowledge effectively among members will improve their competitive advantage, but this is seldom rooted into organisational principles and norms (Bock, Zmud et al. 2005). To this end an organisation's information sharing capability is fully dependent on the individual information sharing behaviour of its members and Baird and Henderson (2001) also point out that developing positive information sharing behaviour for employees would improve organisational productivity.

It is perhaps not a surprise that top management and information technology and systems are purported to be the facilitators of effective information sharing in organisations (Hatala and George Lutta 2009).

Another factor that information sharing is dependent on in an organisation is relationships and social interactions in the organisation. Social interactions can enhance information sharing in the form of social capital (Granovetter 1983), or tend to hinder information sharing, in a different view.

In effect information systems are in place to help employees to realise certain potentials (for example information sharing) in order to improve an organisation's productivity and increase competitive advantage. To understand how best to provide facilitation for employees, certain issues need to be understood like organisational structure and social relationships.

IS research has sometimes gone off on a tangent, trying to chase industry and going with whatever the new buzzword is and how the latest technologies can be applied without deeper understanding of these technologies and not being critical enough (Ramiller, Swanson et al. 2008).

The importance of understanding the nature of the organisation with respect to developing IS cannot be ignored, because the usefulness of IS in the tackling of organisational problems and providing improvements and efficiencies for organisations are dependent on the internal workings of the organisation. Understanding the information use is becoming increasingly important for developing IS because of the social economic and technological development (Hepworth 2007), and Johnstone and Tate (2004) write about the need to connect research about user behaviour to development of systems. Systems designers rarely take the research of users behaviour into consideration manly because of lack of appreciation of soft research and lack of relevance of human information behaviour (HIB) research results to IS design (Fidel and Mark 2004).

Fidel and Mark (2004) in their paper described a method known as cognitive work analysis that can be used to research users, with a view to designing systems. There have not been strong developments in this area due mostly to the amount of resources its takes to conduct such a study on HIB before implementing IS, it is however still worth looking at, perhaps for the future, maybe a more streamlined approach could be developed. The focus of this paper is to discuss the uses of SNA in pre and post development of IS not quite giving a systematic guideline that leads to the design of IS, but helps to understand the IB and context of the users, and also evaluate the system when implemented.

There are several research approaches for carrying out research in organisations and understanding its internal environments, mostly qualitative methods like case studies and observations (Pickard 2007), action research (McNiff and Whitehead 2002), and others like soft systems (Checkland 1999), but taking information sharing in organisations for example and its apparent dependence on social relations in the organisation, these methods and methodologies mentioned will not take into consideration nor shed enough light on these social relationships.

The method being proposed here to help understand social relations in organisation is social network analysis (SNA). The next section gives a detailed account of SNA and its guiding principles, but it is also important to point out that understanding social relations in organisations is not only necessary for information sharing, but also for understanding general working of most processes in the organisation. SNA is also useful in post IS development, in terms of evaluating its use in an organisational setting where collaboration between employees is very important.

2. About social network analysis (SNA)

Snow and Leach (2005) define networks as a system characterised by complex interconnectedness between its parts, and the study of which addresses the nature of relationships in the system, and not the nature of the actors in it. White (2008) quotes Wasserman and Faust (1999) in their description of a network as a "specific set of linkages among the identified sets of persons or institutions, with the additional property that the characteristics of these linkages as a whole, maybe used to interpret social action of the persons or institutions involved". Social network research studies the members of networks and their social relationships between them from the point of view of each member.

The study of social networks finds its origin in graph theory, and goes as far back as the 1950s, when anthropologists began showing interest in understanding the relational ties

between communities, and other social groups (Knox, Savage et al. 2006). It has been applied in a number of fields including sociology and politics (Wey, Blumstein et al. 2008). The study of networks has its theoretical aspects and methodological applications.

Social network theory (SNT) mostly suggests that the implications and patterns of relationships give rise to a specific behaviour. There are only a few prominent SNTs, and even at that they are not used by most social network studies (Schultz-Jones 2009). Below are brief explanations of two of the more prominent social network theories.

Strength of weak ties: This theory postulates' that those with whom an individual has weak ties (not directly linked to) within a network are likely to be more helpful in terms of obtaining useful resources and even more influential. Granovetter (1983) who founded the theory suggested that the strengths of a weak tie in networks are a function of three factors: frequency of contact, reciprocity and friendship.

Structural holes: This refers to the concept of identifying gaps in an organizational structure where missing linkages are and there are opportunities to help understand the behaviour of organizations (Burt 1992).

SNTs are few and far between, but the part of social network study that is widely used is the method of social network analysis to understand networks.

SNA is not a theory or a set of theories; it is more of a methodological approach to understanding network structures, through mathematical concepts, which connect nodes in the networks through ties (Knox, Savage and Harvey, 2006; Wey *et al.*, 2008). These network analysis methods have been used for years to understand several types of networks; institutional, animal, virtual, etc. The main focus in this paper is on social networks analysis, and how it can aid identifying relationships that have a shared behaviour which we desire to understand.

It will not be too far-fetched if it is assumed that all forms of groups are networks, because most things are connected in one way or another, and hence lend themselves very well to be studied as networks of some kind, once the boundaries and focus of the study are identified properly. SNA is used mostly to view and analyse structures and relations that are visible from the resulting network diagrams, but it can also help reveal other abstract factors like tension and influence (White, 2008). It is safe to allege that in every social group, there are inherent issues rooted inside the relationships between the members, and SNA provides graphical, mathematical, and explanatory ways of unearthing these issues. Networks are mostly represented graphically or by using matrices, the graphical depiction helps to view the network holistically, and give insight as to how the structure can have an effect on the actors. On the other hand when they are displayed in matrices, they are mostly to aid mathematical calculations and other statistical analysis of the network.

The study of social networks, can give insight into the relationships between actors in the network, and it can go further to explain possible causes for those relationships, and any resources being shared in that relationship. On the reverse side, advances in technology has helped to provide new ways to understand the networks, both in terms of analysis and in providing accurate data for more exploration of social networks (Harri and Kalle, et al., 2010).

There are three major factors that SNA sheds light on during analysis of the network, and they are; position, relationships, and structural patterns. Analysing them together can help to better understand occurrences in the network as a whole, or in the individual actors. Structure and position are similar in that they are physical properties of the network, but they are

dissimilar in their significance to the whole and the individual. The position is mostly concerned with the individual and the structure applies to the network as a whole.

Some of the terms that are used in social network analysis and their meanings in terms of how they help to understand the network:

2.1 Binary network
A basic network with only two values in the matrix (0 and 1), with 1 signifying a connection, and 0 signifying no connection.

2.2 Valued network
A network that has 0 signifying no connection, but instead of having 1 signifying a connection, any number above 0 signifies a connection, and could also mean the strength of the relationship or the category of the relationship

2.3 Symmetric network
This is a network that does not specify direction of a link, and every connection between two actors is reciprocated

2.4 Directed networks
This is a network that specifies the direction of a link, so while actor A might be connected to actor B, actors B might not be connected to A.

2.5 Degree centrality
The total number of relations an actor has in a network. The in degree is the total number of links that come into the actors from other actors in the network, and out degree is total number of links that goes out from an actor. In a valued graph it is the sum of the values given in any direction or in both of that is the case.

2.6 Ego network
An ego network is an actor's immediate connections to with its direct neighbours, and it could be inward connections or outward connections or both.

2.7 Weight
This is the values given to the a connection in a valued network

3. Uses of SNA in information and systems research

SNA has been applied in many fields, and it can be used to understand patterns in organisations, in terms of use of resources and also to help understand the behaviour of individuals in the organisation. With regards to IS, it can also be used to evaluate the use of systems.

Martínez, Dimitriadis et al. (2003) used SNA to evaluate the use of a collaborative system implemented for students, and was able to find out that the system helped improve the collaboration among students over the period of the course. However Martínez, Dimitriadis et al. (2003) did not employ the use of SNA alone, but included the use of qualitative methods which helped in having a deeper understanding of the context and users perspectives, while SNA helped to determine the level of collaboration between the users through drawing up

networks from the system logs, and analysing them to see the density and amount of collaboration going on.

Toral, Martínez-Torres et al. (2009) in another study used SNA to study the open source software online communities; the study showed that SNA was used to identify members that were most effective in the community, in terms of development of open source software.

Cheuk (2007) writes about the use of SNA in the knowledge transfer program developed by the British council, and how it helped to balance individual networking links within the organisation. Hassan (2009) research shows how SNA is used to evaluate the quality of IT enabled business process intervention, as a possible alternative to business process total quality management. Wang, Man et al. (2009) also demonstrated the use of SNA in intrusion detection systems, analysing the network layer and developing social matrices that are then used to detect suspicious activities in the nodes.

SNA could also help in established areas of IS, like IT diffusion (Harri and Kalle, et al., 2010), this is another areas that it could be implemented in, to help understand those factors that influence diffusion.

Going back to the other use of SNA in understanding the organisation and its members in lieu to developing systems to help improve existing processes or encourage a certain kind of behaviour, a study which the author has recently carried out is described below to see how SNA is used in this situation.

3.1 Case study

The study was about identifying social factors that affect individuals' information sharing behaviour in organisations, and SNA was used to see the existing network in terms of information sharing resources, and identify those that share information actively and those that don't. This would then be used for the qualitative phase of the study to understand the perspectives of those in the network. The study is ongoing and would be using two organisations; one a private medium sized manufacturing company and the other a public library in a medium size and densely populated city. By understanding what factors affect the information sharing behaviour of the individual, it could either lead to developing guidelines for management to help foster such behaviour or developing requirements for information systems that would help facilitate such behaviour in the organisation, and the latter is what is of more interest here. For the purpose of this paper only the SNA part of the research is described from the first organisation, which is the private organisation.

3.1.1. Methodology

The methodology for this study is essentially mixed, with both the use of SNA and semi structured interviews at a later stage. For the purpose of this paper which focuses on the SNA part of the study, the data gathering was through online questionnaires, and quantitative analysis of the generated network followed. The implication of using self assessment questionnaires to conduct SNA is discussed later in the paper as a potential limitation.

The questionnaire used for the data collection was split into two sections. The first part pertains to the individuals' demographics, how they perceive their information sharing abilities. The questions for measuring interval variables where measured on a five point scale. The second section is about the social network where each respondent is asked to select from the department, those that share information with them, and then answer questions about

frequency of sharing, communication channels, proactivity of the sharer, reliability and credibility of the sharer.

From these answers, the first section generated data about the attributes of the participants and second section was used to create relational networks of participants, based on each question. Some of the questions measured a similar kind of relation, so those questions that represented similar concepts had their networks merged by getting the average of the figures in the matrix.

The questionnaire was distributed to 13 volunteers in the department A, 9 completed the first part, and 7 completing both parts. In department B it was sent out to 9 respondents, they all completed the first part, but only 7 completed both incidentally. Table 1 shows the main questions that were asked in the questionnaire, some were measured in two parts, first as a self assessment, and the colleagues view.

Information sharing (self)	• I share information with colleagues at work when I come across useful information • I actively seek to distribute information to colleagues related to their daily work tasks
Information sharing (colleagues)	• These colleagues are actively looking to share information with me? (By active we mean; going out of their way to get you information you might need) • This colleague is always looking to distribute information to enable people work better • This colleague shares information with me

Table 1. Questions for generating network

	Department A	Department B
Density	0.738	0.69
Reciprocity	0.632	0.45
Total number of links	31	29
Cutset	A,G,E,F	A,B,D,F,G

Table 2. Network properties

Table 2 shows the number of links, the network density, diameter etc. The high density shows that the network, although small is very connected, and the links (which are directed) are a lot too for a small number of people. The maximum number of links in a directed network is $N^2 - N$, where N is the number of nodes, which in the case of both departments the network of 7 nodes is 42. In department A, the density of 0.738 shows that 73.8% of the total links available are connected in the network, which is 31 links in this network. There is also a high level of reciprocity between actors which is apparent also in the number of links and density. In department B the density is a little lower at 0.69 and we can deduce that it will have lower reciprocity from the first network since they have the same number of nodes.

A minimum cutset, which is a set of nodes that their removal would lead to a disjointed network and lead to having two or more unconnected components is shown in the table, and department A has 4 nodes while B has 5. This is not as important as it might appear because the number of actors in the network is few, but it is interesting to note the members of the

cutset because these are the central actors in the network that share or receive information the most, and in this study these actors are important.

Already a cutset that was shown in Table 2 of department A gives an indication of those that are central in this information sharing network. Of all those that are part of the cutset, actor B has a low out-degree, but was included because of its high in-degree in the network. In order to get those that share information the most in the network we take out actor A and we are left with three other actors (G, E, and F) that have been identified by their colleagues to exhibit proactive information sharing behaviour.

In the case of department B, using the cutset as a start point would be misleading as there are actors that have high out-degree and little or no in-degree in this network, meaning they share information, which is what we want, but people don't share with them. So actors like this will not be included in the cutset but obviously have the high information sharing tendencies that we are trying to identify.

So the active information sharers in department B have been identified solely using their out-degree and centrality in the network. Again there are three of them, with two being transmitters (i.e. not having any in links) and the other having both high in-degree and high out-degree, these actors are C,E,G. This discrepancy points out the need for the researcher's discretion while using SNA, which comes with experience of using it.
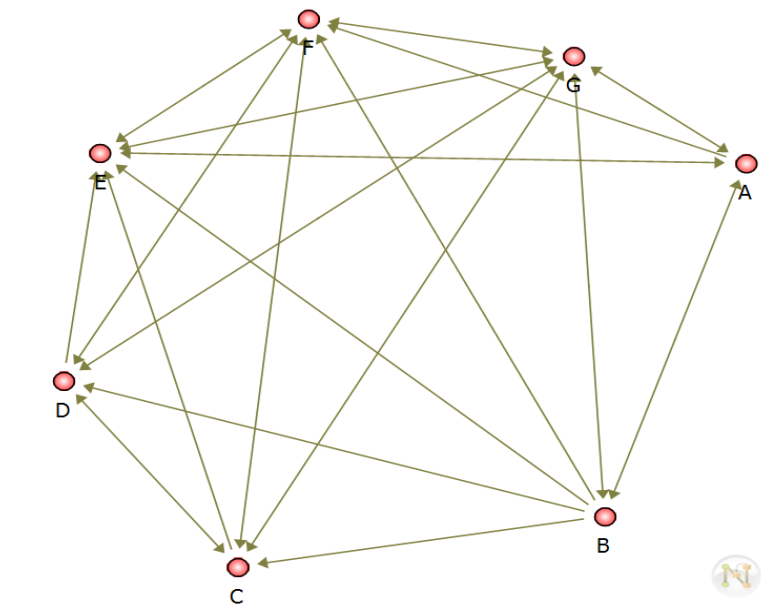

Figure 1. Network diagram for department A

These central actors can also be viewed graphically using the network diagrams, as depicted in Figure 1. For the study to be complete, there is the need for qualitative data collection to fully understand the network, but SNA provides a huge starting point for the qualitative analysis with regards to those who you might want to question, and what you might like to ask them about. For example using the reciprocity of links in the network, you might want to investigate further if individuals tend to share information with those that share with them in return. There are other indicators like this that SNA can give, but this is a limited view of the data, as the study is still ongoing.

This is a short example of how SNA can be used to understand the organisational environment and its members to help in designing of IS systems to help improve organisational processes, based on the phenomena of interest.

However as useful as SNA has come to prove both in the academic world and in industry, it has some limitations which is necessary to tackle in this paper for those who might wish to apply it in one way or another. The next section looks first at the general limitations of SNA and the limitations that are particular to the case study provided above.

4. Limitations of SNA

Below are some of the limitations that SNA is said to have based on research in different areas and some specific to the case study presented above.

4.1 Limited understanding

SNA is a very good tool to help understand patterns and get pointers with regards to the current situation, but Martínez, Dimitriadis et al. (2003) show in their study of evaluation of computer-supported collaborative learning (CSCL) systems, that there is only so much understanding you can get from implementing SNA alone, Martínez, Dimitriadis et al. (2003) further employed the use of qualitative methods just like in the case study presented here plans to do in future research. SNA will help to see the bigger picture and also help identify partly existing problems, but to understand the in-depth reasons behind these problems or attaching proper and relevant meaning to the big picture, there is the need to integrate a more interpretive method to gain further understanding. To support this, prominent researchers in SNA like Borgatti and Cross (2003) have also used qualitative methods alongside SNA to understand the phenomena under study better.

4.2 Reliability and Validity

Authors have often pointed to the issue of validity of data collected for SNA and the reliability of the collected data. Ferligoj and Hlebec (1999) and Galaskiewicz and Wasserman (1993) alluded to this in their papers about research using SNA and general overview of SNA respectively. The concern lies with how accurate the data is in terms of participant reliability in answering questions, from which the network is generated. The second being about painting the right picture, that is, if the resulting network actually portrays what the organisation is in terms of the phenomena under study.

With regards to the first concern, this would only occur in a situation where SNA is used to research current organisational setting and its members, which is the first type of research pointed out that SNA can be used for in organisations.

When it comes to evaluating systems like Martínez, Dimitriadis et al. (2003) did in their study, the use of system logs does not generate such a problem, so this means the evaluation of systems using SNA as a tool becomes more reliable.

On the issue of portraying the right picture, Penuel, Sussex et al. (2006) points out that missing data makes the network representation in SNA inaccurate. Indeed to see the whole and accurate picture, every detail needs to be clear. Again with regards to the use of SNA in systems evaluation, this might not be an issue, as all the users of the system would have records in the logs and hence no missing data.

4.3 Ethics

There are of course ethical issues with the use of any methodology and or methods in research, and SNA is no different, however there are heightened problems with regards to the data collection and also presentation. This is mostly due to the nature of the questions used to

generate the network and how recommendations are presented using networks to senior people in the organisation in some cases.

In Penuel, Sussex et al. (2006) research in schools about how teachers felt about sharing sensitive data like whom they trusted, and who they share information with, most participants felt the questions were a bit too prying, but some also state that wording the questions differently might make it less intrusive. In the same study they found that sharing the resulting network diagram was detrimental to certain individuals, because although names might be made anonymous, to make sense of the data sometimes departments might need to be included or other structural connotations, which might lead to unwarranted backlashes for those in that part of the organisation. This seems to be more of a problem with practitioners using SNA for organisational interventions, because for researchers, giving back recommendations is not always mandatory, but in some cases like the case study in this paper, organisations do expect recommendations, albeit not mandatory.

Below are limitations of SNA which the author has identified from the case study in this paper.

4.4 Contradictory data (Self and colleague attestation)

This is about data being collected about the same resource or phenomena in the organisation, from both the respondent and their colleagues. For example in the case study presented in this paper, the same question about information was asked each individual and then asked their colleagues, so in some instances when a participant felt that they shared information with a certain other, the colleague did not agree or feel the same way. This is not a generic limitation of SNA, because questions are usually asked in one way only, but the case study here tried to improve the validity of SNA data by asking colleagues too, and in the end the network was constructed using the colleagues' answers as opposed to the individuals' response about their activities. With the assumption that the testimony of two or more is more reliable than that of one participant, this has helped to improve the validity of the data. However it could only be used in certain studies like this, because the main aim of constructing the network was to identify central information sharers that could be identified by colleagues. In another situation where the objective of the research is different this technique might not be applicable.

4.5 Can be mechanistic in the study of behaviour

The study of human behaviour is always difficult and involves more than meets the eye. This is the case with using SNA to understand the individuals in the network. It appears too mechanical in its prescriptions and views of what, who and how individuals are influenced or affected by others in the network. For example proximity in the network could be said to be directly related to exerting influence on another (Wasserman and Faust 1999), which might not be the case with further inquiry. It is for this reason that as stated earlier, there is the advice to use some qualitative methods to further understand underlying reason behind patterns in the network. There are studies like Anderson's (2002) study of medical informatics that use SNA to describe prescriptive behaviour of practitioners, and he uses just the network and its mathematical deductions to try to explain behaviour.

4.6 Static picture

While this appears to be a general limitation of SNA, it is mostly worked around by researchers carrying out longitudinal studies (Martínez, Dimitriadis et al. 2003). The network diagram without a doubt gives a picture of the organisation at only one point in time which could give a picture that is only temporary, and may be due to certain factors at that point in time and not actual representations of the organisation as a whole in the longer term. In the case study described here, static data was used, mostly because of limitations in terms of access and time, but with further data collections with qualitative methods, it should reduce the overall effect the static data might have on the picture of the organisation.

This also brings up the topic of stability of network and what should be done to optimise the network. Researchers like Latour (1987) in his actor network theory tend to be of the idea that stability and consolidation helps improve networks, while Loon (2006) on the other hand suggests that networks should be open to change and in a sense be fluid, which makes the nature of the network transformative. Perhaps this is a debate more suited to SNA experts, but it is food for thought which is necessary for anyone planning on using SNA for any kind of organisational inquiry or intervention.

5. Discussion

Having looked at research in organisations and identified the need to understand user behaviour and context in developing IS, the paper has gone further to explain some methods that might be helpful in both identifying these behaviours that would help design better IS and evaluating IS. Using a case study SNA has been discussed in its use to understand the organisation and its members, and also briefly on how it has been used in evaluation of IS.

The use of SNA pre IS development, by no means leads straight to the design of IS, what it does is give a somewhat holistic picture of the user, their social environment and organisational context in general. This is then used to feed design of the system, not by actual activity of the user but by providing functions that will increase the user's experience and productivity by using the system.

In evaluating the finished system, if you take a snapshot, as it were, of the network of the existing process and take a snapshot again after the system is in place, you can measure the effectiveness of the system in simplifying or improving that particular business process. However, this is all dependent on the nature of the process and the organisation, which is why it imperative that, the earlier study of understanding the environment and the user is carried out as well.

Having said that, the author is aware that these studies do require a lot of resources and experience, and might not be feasible in many systems projects, due to resource limitation. An exception to this could be in large projects, where it will be well worth investing the time and resource into understanding the user and organisation in-depth before development takes place, in order to get a good outcome for the magnitude of the project. The reality that is beginning to emerge is that technology will help understand networks better, and networks would help understand users of technology in organisations better, and the possibilities are still evolving and wide ranging.

6. Conclusion

There seems to be a lot of research on the information user and their behaviour, but not much of that is passed on to the development of IS for these users. With IS researchers and practitioners not paying much attention to understanding the organisation and its members in more detail before embarking on developing systems. The need for this understanding has been highlighted in this paper, and SNA as a tool to aid this understanding has been discussed. The use of SNA post IS development was also stressed in terms of evaluating the system. Some limitations of SNA were discussed also to help and guide those who might be interested in applying this technique.

Hopefully this paper was able to highlight the importance of SNA, not just in organisational research as a whole, but in IS research and also shown ways in which it can be used. This is more about adding to the debate about the issue of studying the user behaviour well before embarking on developing IS and hopefully this paper has giving a little weight to this issue and demonstrated its importance to IS.

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