

A three-stage model of requirements elicitation for Web-based information systems

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Abstract
Although requirement elicitation is generally acknowledged to be very important in traditional information systems development (ISD), it does not get enough attention in most Web-based information systems development (WISD). This paper highlighted the difference between ISD and WISD, and proposed a three-stage model of user requirements elicitation for Web-based information systems. This model divides the requirements definition into three stages: initial analysis, key user requirements elicitation and regular user responses. Most current WIS design methodologies consider only initial analysis, and neglect actual users' requirements. Key user input is emphasized in this model, and social network analysis is proposed as a tool for identifying key users. Requirements analysis for WISD is no longer considered a one-stop step, but is better regarded as a continuous evolving process. Finally, managerial implications are also provided in this paper.

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1. Introduction
Web-based information systems (WIS) are information systems (IS) that are based on Web technology and are likely to be integrated with conventional IS such as databases and transaction processing systems (Wang, 2001). Based on the scope of WIS applications, it could be classified into four kinds of systems:
1 intranets (supporting internal work);
2 Web presence sites (marketing tools designed to connect with consumers outside the firm);
3 electronic commerce systems (supporting consumer interactions, such as on-line shopping); and
4 a mix of internal and external systems (supporting business-to-business communication, commonly also called extranets) (Isakowitz *et al.*, 1998).

Perceiving the differences between WIS and conventional IS, many scholars have proposed new design methods for WIS, for example:
• a general model of Wang (2001);
• a portal design of Detlor (2000);
• an intranet design of Lee (1999);
• a hypermedia development process of Yu (2000);
• a user-based design process suggested by Abels *et al.* (1998);
• RMM proposed by Isakowitz *et al.* (1995); and
• the W life cycle model by Sherrell and Chen (2001).

Surprisingly, user requirements analysis for WIS development has not been paid enough attention by most design methods. The purpose of this paper is to address this issue and propose a model for WIS requirements elicitation.

2. Requirements analysis
Requirements analysis (RA) aims at identifying the necessary data and information in order to automate some organizational tasks and support knowledge workers in their decision making in order to achieve the objectives of the organizations (Taggart and Tharp, 1977). RA seems to be task-oriented since information systems are conventionally designed for organizational tasks (MIS, traditional management information systems, i.e. managerial reporting systems) or supporting decisions (decision support systems (DSS)). Nowadays, the definition of RA is broader because the scope of user requirements has been enlarged. For example, IEEE (1997) gives a precise definition of a requirement as:
1 A condition or capability needed by a user to solve a problem or achieve an objective.
2 A condition or capability that must be met or possessed by a system or system component to satisfy a contract, standard, specification, or other formally imposed document.
3 A document representation of a condition or capability as in 1 or 2.

The second criterion above extends user requirements a little because a system condition or capability may not have task-oriented implication. Broader definition of RA implies that it could be related not only with task-related functions (e.g. organizational objectives, decision making or problem solving), but also with non-task-related functions such as social, communicational, and even entertainment purposes. The distinction is distinctive for WIS development since the motivations for Web usage vary from simply information retrieval (Shneiderman, 1997), information dissemination (Artz, 1996) to more complex

transaction, interest, fantasy and relationship, etc. (Armstrong and Hagel, 1996). That is to say, not only task-related functions like those for intranets, extranets still hold, but also non-task-related functions like information/knowledge sharing and emotional support are important for users.

RA is an essential part of designing an IS. The incompleteness of user requirements is considered one of the top factors for IS failure (The Standish Group, 1995). It is reasonable to conjecture that one reason for many WIS failures in recent years might also be the incompleteness of user requirements. Liu *et al.* (2001) have identified four key dimensions (information and service quality, system use, playfulness, system design quality) that were found significantly related with perceived Web design quality. In an experiment, they also demonstrated that Web design quality is related to customer recall and recognition. However, it could not be concluded that their four dimensions of Web design reflect all user requirements.

Recently, more and more scholars have paid attention to the indispensable role of RA in ISD. However, the concerns were on modeling the team performance at the stage of requirements definition or requirements capture (Guinan *et al.*, 1998; Chatzoglou and Soteriou, 1999), on comparing the effectiveness of prompting techniques (Browne and Rogich, 2001), or on empirically validating a contingency model of information requirements determination (El Louadi *et al.*, 1998). Although RA is a requisite important step for any system development, how to elicit user requirements for WIS has still been rarely addressed in the literature.

The main purpose of this paper is to assert that RA could not be completed in one stage for WIS, and that further two stages are necessary to elicit key user requirements and regular user needs. Furthermore, social network analysis could be used as a tool for identifying either predefined or potential key users, and then the user requirements could be collected easily and correctly accordingly.

The next section will make contrast WIS with conventional IS, and then their difference in user requirements will be highlighted and explained. At last, a demand for WIS requirements elicitation new models will be discussed.

2.1 Difference between WIS and conventional IS

WIS, or Web applications, is conveniently described as a hybrid between a hypermedia and an information system. Because of the hybrid nature, WIS is distinguishable from

conventional IS. For example, from the perspective of data management, Fraternali (1999) claimed four WIS characteristics:

- 1 handling both structured and unstructured data;
- 2 supporting exploratory access through navigational interfaces;
- 3 customizing and possibly adapting to content structure, navigational primitives, and presentation styles; and
- 4 supporting proactive behavior, i.e. for recommendation and filtering.

From the perspective of requirements engineering, Overmyer (2000) noticed three differences:

- 1 different focus (WIS is more like a magazine and the responsibility of requirements definition lies with an editor rather than an engineer);
- 2 different disciplinary emphases (functionality, usability and graphic design are the three important requirements considerations); and
- 3 shorter life cycles.

WIS is better seen as an integrated platform, which not only support traditional MIS, DSS, executive information systems (EIS) (Basu *et al.*, 2000), but also document management, online publishing and communication. Thus, the comparisons can be made in terms of techniques, users, data storage and processing, and interface design.

Technically, WIS is based on Web technologies, which include HTTP, TCP/IP, etc. It is generally established for a huge number of users, who are even sometimes "all kinds of users" from the whole world village. On the other hand, even in a networked environment, a conventional IS is established for a certain type of user. For example, users of MIS could be all lines of managers and supporting staff.

From user viewpoints, WIS could be used for various purposes, e.g. supporting individual routine tasks, aiding information gathering, hunting for useful knowledge, sharing interests and feelings, or facilitating communications. In contrast, a conventional IS has more clear-cut purposes, e.g. supporting organizational tasks or decision making.

From a data storage perspective, WIS includes all kinds of data, all kinds of files, database management systems (DBMS). A number of data forms could be processed there: pictorial, voice, video, and texts. However, conventional IS deals with more simple data forms.

From the interface design perspective, interface problems seem to be more critical for WIS than conventional IS. An aesthetic

expert for interface design is generally recruited in the WIS team; however, not in a conventional IS.

2.2 Difficulties on WIS requirements elicitation

In comparison with conventional IS users, WIS users have several characteristics. They are more diverse, and are sometimes even unknown before the system development. Generally, users are expected to grow in the future. These would imply more difficulties in requirements elicitation:

- Users are generally diverse. Compared with users in conventional ISD, WIS users are more diverse in demographics, use habits, etc. Sometimes because WIS users are not known beforehand, stakeholders and developers assume them to be the "potential users" or "proxy users".
- Key users are hard to identify. WIS users are usually not only more in numbers, but also unknown to stakeholders. Even after the system has been in operation, it is still difficult for system managers to identify key users since not every WIS requires user ID and keeps monitoring its users' browsing activities.
- User requirements are volatile. Information searching and retrieval is considered one of the most important user requirements initially (Shneiderman, 1997). However, the social and communication needs are also increasingly important (Sass, 1997), especially in building virtual communities on the Web (Hagel and Armstrong, 1997).
- In WIS development, some conventional requirements elicitation methods (e.g. observation or interview) may become impractical, or sometimes need to be modified. Furthermore, researchers have not fully explored how to elicit user requirements for some new functions of WIS, e.g. forums, BBS, on-line meetings.
- Users are sometimes expected to grow in numbers for WIS, thus the user needs keep changing.

2.3 Three former approaches to WIS requirements elicitation

Since the rapid explosion of Web applications and usage, experts from at least three disciplines (computer science/information science; usability/human-computer interface (HCI); and requirement engineering) have tried to solve the WIS design problems. Each discipline has its own focus, but also has merits and limitations.

First, it is straightforward for computer scientists (especially experts in hypermedia

systems development) to propose new design methods and methodologies for WIS.

Object-oriented methodologies have been modified for WIS development, i.e. OOHDM (Schwabe and Rossi, 1995), WSDM (De Troyer and Leune, 1998) and a general model of Wang (2001). Entity-relationship methodologies variations have also been proposed, e.g. RMM (Isakowitz *et al.*, 1995). The focus of this discipline is to "solve" a system design problem with engineering approach, thus the user requirements problems are usually regarded as "user modeling" or "perspective modeling" problems.

The usability and HCI experts focus on the evaluative principles for a quality WIS. They have worked on developing universal design principles. For them, the WIS development is similar to standard usability engineering lifecycles emphasizing a user-centered, iterative approach, typically making little or no reference to forms of design representation or formal documentation (Nielson, 1993; Cunliffe, 2000). Usability testing is considered to be the central element in WIS development, and the general usability methods need to be simple, effective, participatory and reusable. However, few real users generally participate in "usability test" for WIS development and the test duration is not long.

Requirements engineering is a discipline addressing the customer need and new product development, and the WIS is naturally regarded as a software product. For example, Maiden and Rugg (1996) offered a general framework, ACRE, for requirements acquisition. Wieggers (1999) listed the "good practices" of requirements development and management. Saiedian and Dale (2000) investigated the key players and their roles with the existing methods and obstacles in requirements elicitation. For them, users are customers, and the relationship between WIS developers and customers is considered essential. However, the traditional requirements elicitation methods have not been appropriately modified in the WIS development.

One of the methods concerned users' requirements most for WIS development is a user-based design process proposed by Abels *et al.* (1997, 1998). Their design process incorporates users' information (seeking or usage) requirements analysis in four stages (information gathering, development, evaluation and implementation). Their design process, based on the waterfall model, is insightful and interesting. However, it only deals with information seeking

requirements, and there are no formal model or exact steps.

Based on the above review, a model addressing information requirements elicitation of WIS development is strongly needed.

3. Three-stage model of requirements elicitation

There are a number of WIS design strategies. For example, based on the relationship between Web site design and consumer retention intention, a classification model of E-commerce (EC) was proposed by McCarthy and Aronson (2001). The classifying dimensions are consumer response (purchase, choice and information) and the level of organization's dependence on EC. Four types of Web design are identified: introductory, informative, interactive, and intelligence. Considering the EC business models, Wen *et al.* (2001) suggested two general design strategies: informational/communicational and on-line/transactional. Focusing on the navigation and user interface design, Lee (1999) proposed IDM to design intranet applications. Wang (2002) integrated EC business model, information system model with object-oriented methodology, and proposed an EC information systems framework. It can be found that these differences originated from different application purposes or different focuses. This research does not intend to propose a new design methodology, just emphasize the requirements elicitation phase. In the following, different types of users and their corresponding needs will be first classified, and the model will be proposed later. Finally, the social network analysis, which is the tool this research proposes to identify key users, will be elucidated.

3.1 User classification

WIS users are diverse, heterogeneous, and sometimes are expected to grow at a certain rate. Therefore, it is essential to classify the users and their roles first before discussing their requirements. The WIS classifications are adopted from Isakowitz *et al.* (1998), and the user requirements dimensions are synthesized from several recent studies (Amstrong and Hagel, 1996; Shneiderman, 1997; Korgaonkar and Wolin, 1999; Wen *et al.*, 2001). Since Web usage is linked with a variety of user motivations, it is impossible to enumerate all user needs. As a starting point for discussion, this research just lists the user characteristics and their

accompanied requirements in different WIS applications.

As shown in Table I, a majority of users for intranets are employees in an organization; thus users could be identified before system development, and the user growth rate is dependent upon the organizational overall manpower growth rate, which is comparatively low. As for Web presence and electronic commerce, most users are customers, generally unknown beforehand and their identities are dependent upon their registration on their own. Customers and visitors are generally expected to grow at a high rate in a successful business. Extranets are mainly for business-to-business transactions; therefore, users are either inside or outside an organization. Most users within an organization could be identified in advance, and some of the business partner users could be reached before system development. But this user growth rate is not expected to be high because business partners are corporations, which are impossible to grow as quickly as customers.

One of the most important user requirements is information gathering and sharing; therefore, information content, the user's navigation processes and data filtering capabilities are prime system concerns. Convenient user interface is considered one of the most important factors to design a cyber store (Kim and Eom, 2002). All WIS subsystems need to address this type of user need. Some organizations are experimenting and facilitating knowledge management, and then the user requirements specially turn to knowledge externalization and systemization (Davenport, 1997; Hidding and Catterall, 1998).

Relationship or communication requirements are important not only in the workplace but also for personal purposes. Much computer-mediated communications (CMC) research has concentrated on how individual users interface with their computers, how persons interact on-line, or how a small group functions on-line (Garton *et al.*, 1999). Most WIS should take considerations of communications needs, but actually they now only provide simple communication functions, for example, e-mail or forum.

Transaction is the main function for e-commerce. However, the crucial customer requirements, such as privacy concerns, trust, and convenience, should be taken into consideration. In intranets or Web presence, because they are usually not for transaction, there is no need to include this dimension for analysis.

Playfulness or fantasy is seldom noticed except for some e-commerce sites or virtual communities (Armstrong and Hagel, 1996). A recent empirical study confirmed that playfulness is a key dimension of Web design quality (Liu *et al.*, 2001). Intranets and Extranets are mainly for intra-organization tasks or inter-organization transactions, and not suitable for users lingering on them for pleasure. But for Web presence and e-commerce, playfulness of Web sites could determine the likelihood of a user's repeat visit. Thus, it would be a key dimension during requirements analysis.

3.2 Three-stage model descriptions

As the discussion above, because users for Web presences and e-commerce are seldom known beforehand and are expected to grow at a high rate, it is unreasonable to take conventional system analysis approaches. As for intranets and extranets, users could be identified and comparatively quite stable, thus conventional system analysis approaches might be applied.

There are three WIS user problems:

- 1 Where are they?
- 2 Who are the more influential users?
- 3 How to elicit user's requirements effectively and efficiently?

This research proposes a model to solve these problems by the "divide-and-conquer" concept – dividing requirements elicitation into three stages, and each has its main tasks, participants, elicitation methods and deliverables. It is not reasonable to enumerate all elicitation methods here since the Web technologies are consistently changing rapidly and the corresponding elicitation techniques may be adapted. This research proposes a three-stage model as shown in Table II, which is described below.

Stage I (initial analysis)

The main task is to decide the system purposes. Every system has its objectives, for example, to facilitate work processes, to disseminate information, or to run a business. The strategic implications of the

system should be discussed and decided by stakeholders, which may include system owners and managers. The critical players in this stage are stakeholders and system developers since the objectives set in this stage determine the future project size, spent resources and the level of user involvement. Of course, if the developing system is small and its users could be explicitly defined, there seems no reason for further requirements explorations. However, if the system were medium or large scale, or the users could not be predefined, it seems better to proceed to the next one or two stages.

In this stage, generally the requirements are based from developers' past experiences, observing other competitive Web sites, or coming from imagination among participants. According to these inputs, a prototype might be built and put into pilot operation.

Stage II (key user requirements elicitation)

In order to retain customers or induce users to repeat visiting, even a EC Web site should not only provide content (information exchange), commerce (transaction), but also community (communication, entertainment or emotional support). Therefore, a Web site should encourage its users to apply for membership and interact with each other as frequently as possible. If no member system is adopted, a Web site should encourage visitors to leave messages through e-mail or message boards of this system. After a pilot run for a period time (i.e. two weeks or a month), some WIS members might register for this site. Promotion activities could be helpful in collecting membership data at this stage. The Web might also perform some data mining from the visitor's messages to hunt for key users.

The main purpose of this stage is to identify the key users and elicit their responses. This research proposes to adopt social network analysis (as explained in the next section) as a tool for identifying key users. Influential members of the developing communities for the Web site could be identified by means of social network analysis. The responses from key users are invaluable input for the second stage of

Table I

WIS user classification and requirements

	User characteristics			User requirements dimension			
	Main user role	Growth rate	Identity	Information	Communication/relationship	Transaction	Playfulness
Intranet	Employee	Low	Always	Yes	Yes	No	No
Web presence	Visitors, customers	Expected high	Seldom	Yes	No	No	Sometimes Yes
Electronic commerce	Customers	Expected high	Sometimes	Yes	Yes	Yes	Sometimes Yes
Extranet	Mixed	Low	Often	Yes	Yes	Yes	No

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development. For intranets and extranets development, since the user group is more explicit, it is suggested to combine stages 1 and 2, and also apply social network analysis to identify key users.

On-line questionnaires could be administered to those who have registered for membership. Gathering customer feedback via the Internet is possible (Sampson, 1998). The question is like the following (where (ID) represents the identifier or a nickname of a certain member):

Do you go to (ID) for help or advice on work-related matters on this Web site?

Whose (ID) articles do you think get most replies on this Web site?

Do you express your feelings to (ID) most often on this Web site?

Based on social network analysis, the central persons in regard to advice, information, and friendship could be identified. Those central persons are assumed to exert much more influence on this Web-enabled networked community. In the next step, it is easier to elicit "central" user requirements through e-mails, on-line questionnaires, BBS, or even on-line meetings. Although often neglected by most design methods or reliability tests, this step is crucial for spotting the key users of this Web site in terms of different requirement dimensions.

Stage III (regular user responses)

After acquiring feedback from key users in dimensions of information seeking, communication support or transaction, these claimed user requirements should be

analyzed. Some discrepancies among user requirements could happen, should be discussed, and resolved by stakeholders and developers. Finally, a formal system could be launched.

Not only are the user requirements volatile, but also it is possible that the WIS might be built on key user inputs that may not represent the regular user requirements. The established system constantly needs enhancing. Other frequent user's responses from e-mails, BBS messages or on-line questionnaires are a good source for user requirements. Web developers may design a systematic data-gathering scheme iteratively to enhance the evolutionary system towards user's needs. Measures of WIS satisfaction also help identify the key functions to be enhanced.

3.3 Identifying key users by social network analysis

Identifying key users is especially important for WIS requirements elicitation because users might be too many to be taken care of, too diverse to be analyzed, or too hard to be identified in the real world. Some previous studies proposed to put emphasis on user requirements by focus group (Abels *et al.*, 1997, 1998), or derived user requirements (Artz, 1996) or usability methods (Cunliffe, 2000) for Web applications. However, to our best knowledge, no study elaborates the methods for identifying the "key users". The authors propose to take advantage of social network analysis as a tool. The reasons are as follows.

Table II
Three-stage requirements elicitation model

Stage I Initial analysis	Stage II Key user requirements elicitation	Stage III Regular user responses
Objectives To elicit "imagined" user requirements from "proxy users" or typical target users	To elicit key user requirements by on-line questionnaires, e-mails or other feedback	To elicit regular user requirements by on-line questionnaires, e-mails or other feedback
Participants Stakeholders Developers	Stakeholders Developers Key users	Stakeholders Developers All regular users (especially frequent users)
Elicitation methods 1. Interview 2. Focus group 3. Questionnaire 4. Take other WIS as prototype for requirements elicitation	1. On-line questionnaire 2. E-mail 3. BBS or forum 4. Online meeting 5. Social network analysis	1. On-line questionnaire 2. E-mail 3. BBS 4. Forum discussions
Deliverables Statements for the system requirements were written and a prototype was built accordingly	Recommendations for the enhancement of the prototype A formal system was built	Recommendations for new version of WIS Satisfaction measurement

First, most requirements elicitation methods only focus on information seeking or general navigation analysis. By applying social network analysis, other dimensions such as communicational, social, emotional support needs could be also identified. Identifying the key social leaders could help elicit their comments, which may enhance the system design on the social/communicational functions, interface or other design qualities.

Second, sometimes the users for a WIS are fairly divergent. It is not easy to conduct a requirement analysis with "too many users", not to mention that many might be "potential users". Only a limited number of users are valuable for reliability tests (Nielsen, 1993), the same rule holds for requirements analysis.

Third, the users themselves are the invaluable resources for a WIS not only for their contributions to the site's content but also for their potential purchasing power. Web users are valuable for their comments and responses that could be systematically and effectively used in system analysis.

Social network analysis (SNA) is a social science method. It is now popularly used in the CMC studies, which is used to draw and measure relationships and flows between people, groups, or organizations. The nodes in the network are the people and groups while the links show relationships or flows between the nodes. SNA provides both a visual and a mathematical analysis of complex human systems (Garton *et al.*, 1999; Wasserman and Faust, 1994).

SNA can be used to evaluate the location of actors in a network. Online users could be depicted as nodes in a network. The rationale of SNA is that the respective position an actor occupies determines to what extent he (she) can access other resources or information in the network. The prominence of an actor could be determined structurally in a group. There are several indexes in SNA for describing the structural properties of actors and groups. The most important index is "centrality", which is used to measure the importance or prominence of a node in a network. A so-called "kite network" in Figure 1, devised by Krackhardt (1990), gives an excellent example to explain the most popular centrality measures: degrees, betweenness, and closeness.

- Degree is the number of direct connections a node has. Social network researchers measure network activity for a node by the concept of degrees. In Figure 1, Diane has the most direct connections in the network, making hers

the most active node in the network.

Diane has the degree of six in this case.

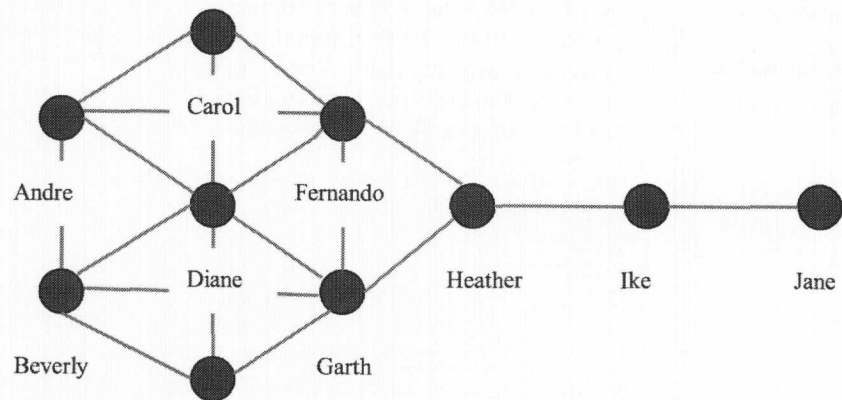
- Betweenness is usually the measure of the extent to which a node is between two constituencies in a network. For example, in Figure 1, while Diane has many direct ties, Heather has few direct connections (three direct connections). Actually, she has one of the best locations in the network – she is a boundary spanner and plays the role of "broker". She is between two important constituencies. Without her, Ike and Jane would be cut off from the information and knowledge in Diane's cluster. A node with high betweenness has great influence over what flows in the network.
- Closeness is the geodesic distance of a given node to all other nodes. In Figure 1, Fernando and Garth (each has degrees of five) have fewer connections than Diane, yet the pattern of their direct and indirect ties allow them to access all the nodes in the network more quickly than anyone else. They have the shortest paths to all others – they are close to everyone else. Indeed, they are in an excellent position to monitor the information flow in the network.

The social relations or ties could be determined by practitioner or researcher's observation or questionnaire. A pictorial view of actors' relationships, called a sociogram, is also helpful. Several packages, for example UCINET, PAJEK and KRACKPLOT, etc. (Scott, 2000) are available for sociogram drawing and data analysis.

SNA identifies who is communicating with whom both inside and outside the organization. Network analysis is useful in identifying information-related roles such as gatekeepers, opinion leaders and boundary spanners in an organization, as shown in Figure 2 (Loughman *et al.*, 2000). These terms are described more fully and explained their relationship to WIS as follows.

- *Gatekeepers*. These control the flow of information. They can decide what information will be forwarded to other network members, when it will be forwarded, and the degree of filtering. A gatekeeper can speed up, slow down, or even terminate the flow of information. For intranet development, gatekeepers are important since they may provide valuable system functionality insight for analysts. To an Internet development, gatekeepers assume the information monitoring roles and could inform developers of their requirements in terms of information monitors. Closeness is a good indicator for

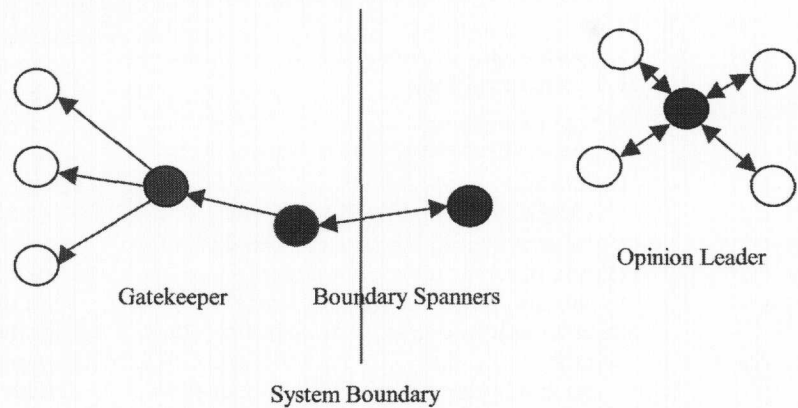
Figure 1
Demonstration of three centrality measures



Source: Krackhardt (1990)

- gatekeepers. Thus, it can be postulated that the higher a user's score on closeness, the more he or she can provide the information monitoring requirements to developers.
- *Opinion leaders (stars)*. These are the communication focus within the organization, and they have many relationships with other members. They are called opinion leaders because they are at the center of network communication activities and could have much influence upon other members. They tend to be powerful, respected, and followed without necessarily having a formal leadership role. Opinion leaders may not be so evident in WIS. However, through social network analysis, other users could easily identify opinion leaders. Then, they could provide a good source of user requirements. Degree is an excellent indicator for opinion leaders. It is reasonable to make the hypothesis that the higher degree a person possess on a WIS site, the more influence this person has on other users, thus providing richer or more typical requirements.
 - *Boundary spanners*. These span a network or organizational boundary to bring in new information and ideas or carry them outside the boundary. Boundary spanners perform critical functions of helping overcome problems associated with group decision making such as groupthink, and of avoiding system entropy by bringing in information. Because the communication among organizations could be ameliorated through these boundary spanners, they are also very helpful for intranet or extranet development. To an Internet development, the term "boundary spanner" may not be appropriate since the boundary between organizations is blurred or even not existent. In that case,

Figure 2
Common network roles



the "broker" role may be important for his or her function in information or knowledge dissemination. Betweenness is a measure of the extent of being a "broker". It can be postulated that the higher betweenness score of a user, the more this person can provide broker-related requirements for developers.

Many social relations could be analyzed and demonstrated by SNA pictorially and mathematically. For example, in Figure 1, the nodes indicated their centrality indexes. Diane has the highest degree; Fernando and Garth the highest closeness; Heather the betweenness. In another word, Diane takes the role of "opinion leader"; Fernando and Garth of "gate keepers", and Heather of "boundary spanner". Several SNA tools are available for analyzing the network data by sociograms and different indexes.

In the recent years, social network analyses have been used extensively to understand online users' behavior and their interaction processes. Sociologists have researched the behavior on computer networks as on social networks (Wellman, 2001). It has been empirically demonstrated that many important concepts such as centrality and density of egocentric networks are related with perceived individual and team performance. For example, in a field study on the social networks of MBA students, centrality in advice, communication, and adversarial networks have been found to affect both students' attitudes and grades (Baldwin *et al.*, 1997). It is hypothesized in this paper that through social network analysis, the "central" persons in advice, communication, or friendship networks of a Web-enabled community could be found. Then, through interacting with the key persons, system analysts could more effectively and efficiently identify the different dimensions of user requirements.

4. Discussions

4.1 Assumptions

There are five underlying assumptions in our model that should be noticed. In the following, this paper will list these assumptions and discuss what could happen if the above assumptions failed.

The first two assumptions actually also exist in other elicitation approaches. They are:

- 1 method is necessary and sufficient for information systems development success; and

- 2 systems developers will use a suitable method if they have it at their disposal.

These two assumptions are philosophical questions in essence. Methods or methodologies usually offer developers guidelines for WISD no matter whether they obey the methods strictly or not. Actually, Whitley (1998) demonstrated that in three award-winning Web sites, their development might not need methods or methodologies. Fitzgerald (1997) also found that developers omitted certain aspects of methodologies not from a position of ignorance, but from the more pragmatic basis because certain aspects were not relevant to the development environment they faced. Some software vendors or consulting firms have also provided Web application development tools and methods, for example, visual editors, hypermedia tools or model-driven generators (Fraternali, 1999). However, this research asserted that IS development should not be deemed as arbitrary artistic activities rather than science or engineering. Some methodologies are necessary to achieve IS success. Even though there is no consensus on a general model of the lifecycle of a Web application, there are practical methods or rules for guiding its development. On the other hand, as DeLone and McLean (1992) claimed, IS success is an elusive variable containing many dimensions: system quality, information quality, use, user satisfaction, individual impacts and organizational impacts. It might be hard to infer the organizational impacts from any adopted IS development method. WIS design methodologies have just come into existence, and need further empirical evidence for their validity. However, as a minimum, user satisfaction could be expected from a well-done IS project. That is related to the third assumption,

The third assumption is that good understanding of user requirements is a prerequisite for WISD success. WIS users are generally in great numbers. The proposed model provides a method for identifying the key user requirements in different dimensions, which are major concerns for WISD success, at least user satisfaction. Key users are important for requirements elicitation since they provide inexpensive and valuable information. Certainly, further empirical evidence has to be collected on the effect of the adoption of this model to elicit user requirements, and the effect of clear user requirements on WIS success. Even though no positive relationship between clear user requirements and WISD success can be proved to exist at this time, the

proposed model is still valuable since key users of different perspectives offer system developers and stakeholders many good ideas that may not be noticed by themselves.

The fourth assumption in our model is that interactivity is a crucial part of WIS design, and the interactions between on-line users or between users and developers would become the foundation of requirements analysis. Of course, not all WIS regard user interactions as essential part; however, the interactivity is increasingly important. In fact, the most popular usage of the Internet has been claimed to be a communication channel (Deville, 1995). If the interactions were weak, Web sites could strengthen interactive functions, adopt some promotion activities to induce interactions of customers. In the case that the interactions among users might not be important for the target Web site, i.e. a static homepage, then it would be sufficient to gather frequent users' responses (Stage III) directly, and ignore Stage II.

The fifth assumption is that user requirements could be explicitly and clearly stated, and that their claimed requirements correspond consistently with their actual browsing usage behavior. Some may claim that user requirements could only be obtained by observing directly their "actual browsing behavior", through access pattern analysis or log analysis. For example, Perkowitz and Etzioni (2000) proposed the concept of "adaptive Web sites" that semi-automatically improve their organization and presentation by learning from visitor access patterns. Learning from visitor access patterns is inevitably a good source of meeting user requirements. However, it can be argued that these access patterns are not enough to capture user requirements. For example, new functions required by users could not be acquired through access pattern analysis. Data from log analysis or pattern analysis should be used as a complementing, rather than replacing, user requirements materials. If user requirements could not be clearly stated, a prototype is built for gathering "not so obvious" requirements. The requirements gathering process is actually iterative. In addition, users can state their requirements conveniently by "hyperlink" to their reference Web sites, which is less possible for traditional ISD.

4.2 Managerial implications

While applying our model, there are also some major concerns that managers should take care of.

To begin with, WIS objective is paramount. Different Web sites have different purposes.

A distance-learning site is mainly for teaching and learning. In that kind of site, task-oriented information requirements from both teachers and students should be especially paid attention. It would be different from a game fan site that is for fun. Therefore, information requirements of different roles might be given different weights while designing the systems.

Second, user population and heterogeneity should be an important concern. If the user population is large and diverse, then searching for key users and analyzing their requirements will be valuable. However, if the intended user population is small, or the user homogeneity is quite high, then it would be of less value to identify the key users.

Third, interactivity is an integral part in this model. Admittedly, not all WIS regard interactions between users as important. However, no one will deny the significance of user interaction in the WIS use. If interactivity is not high, promotion activities or hot issues may increase users' interaction. Thus, online users have a better chance of developing their relationships, and influential users could be found. If no interactivity is intended for a Web site, then frequent users' feedback (Stage III) is still valuable for revising the WIS.

Fourth, key users may change during the WIS lifecycle. Thus, key user management may become a managerial issue. The role a key user keeps may also be an important issue. For example, what kind of roles, opinion leader, gatekeeper or boundary spanner, are the most important for the development of WIS? Or, could these roles change during the evolution of a WIS? Managers need to make decisions and keep eyes open on user roles while adopting this model for requirements elicitation.

Lastly, managers should be free to modify the proposed model slightly while actually applying it. Sometimes, even before designing Web sites (e.g. for alumni liaison), the user population could be known explicitly in advance, and there have already been some interactions between these future users. In such situations, it is suggested that social network analysis be applied to both stages 1 and 2. Then, it could be found out or might even stimulate the potential key user requirements in stage 1. In stage 2, from the listing of active users, it might be easy to obtain the actual key user requirements. By applying SNA in stage 1, system development would benefit from capturing the exact user requirements early and stimulating potential later usages.

4.3 Future studies

The contribution of this paper is to address an important question regarding WISD and propose a three-stage model to solve it. However, there are still several questions to be worked out in the future. Is role analysis offered by SNA applicable in all WIS? If so, what kind of roles are essential for system development? What kind of indexes of SNA should be used, and how many "key" users are suitable for WISD? Further work should focus on some WIS and analyze the flow of communications in WIS – both synchronously and asynchronously (chat, e-mail, discussion forums, BBS, etc.) Is there a hierarchy, or structure to the flow, do any of the different "roles" that users take change based on the organizational hierarchy, etc? And how does the use of a WIS ultimately impact on organization – does it help the organization achieve its goals, and if so, can the connection between the use of a WIS be clearly linked to this achievement?

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