Forming Design Teams to Develop Healthcare Information Systems

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Abstract. Healthcare information systems are assuming an increasingly critical role in providing quality patient care in an effective and efficient manner. However, the success of these systems in achieving these goals remains a lingering concern. Consequently, investigating and devising strategies to enhance the likelihood of success of a healthcare information system continues to draw research interest. One strategy recommended by both researchers and practitioners alike is the participation of the target users in the design and development of the information system. However, practical considerations mandate representative, rather than universal, participation of users. Unfortunately, the information systems literature offers few guidelines for selecting user representatives to serve on a design team. This lack of guidelines easily results in system designers talking with the wrong users or managers assigning the wrong users to the design team. On the basis of the theoretical paradigms underlying the user participation and design team concepts, the authors examined and derived user characteristics that are considered the most critical criteria for selecting user members of a design team. They then report on a field survey they conducted to validate the derived criteria in healthcare information systems context. The authors conclude that the system-related functional expertise should be the primary criterion employed to select healthcare personnel to participate in system design and development. Other criteria, such as users' communication skills, computing backgrounds, and personality traits, should be given secondary considerations. Ignoring these guidelines can render user participation superfluous, resulting in system failures.

Key words: forming design teams, healthcare information systems, hospital information systems, user participation, user representative selection

Healthcare information systems are increasingly becoming a strategic component of the healthcare industry. Although cutting-edge technologies continue to expand the range of potential applications, concerns about ineffective and inefficient information systems abound in the business (Tait and Vessey 1988; Barki and Hartwick 1989, 1994; Joshi 1990; Chellis 1991; Bloor 1992; Butler and Fitzgerald 1997; Lovelace 1997; Markus 2000; Howcroft and Wilson 2003; He 2004), as well as in the healthcare environment (Leape 1977; Kontongiannis and Embrey 1997; Sjoberg and Timpka 1998; Kowitt and Hollingsworth 2000; Laerum, Ellingsen, and Faxvaag 2001; Vimarlund and Timpka 2002; Ball 2003; Littlejohns, Wyatt, and Garvican 2003; Spyrou, Berler, and Bamidis 2003; Heeks 2005). Consequently, identifying strategies to enhance the system success has remained a major concern for both researchers and practitioners. One strategy almost universally prescribed as a key to the development and implementation of efficient and effective information systems is the participation by the target users in the design and development of the system. This participation is generally implemented through user membership in the design team. However, evaluation of this strategy has only produced equivocal results in the busi-

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ness (Ives and Olson 1984; Hirschheim 1985; Tait and Vessey 1988; Barki and Hartwick 1989, 1994; Klenke 1992; Koehler 1992; Amoako-Gyampah and White 1993; Lawerence and Low 1993; Hunton and Beeler 1997; Mckeen and Guimaraes 1997; Gallivan and Keil 2003; Gefen 2003; Guimaraes, Staples, and Mckeen 2003), as well as in the healthcare environment (Sjoberg and Timpka 1998; Laerum, Ellingsen, and Faxvaag 2001; Ball 2003; Ladner et al. 2003; Littlejohns, Wyatt, and Garvican 2003; Heeks 2005).

Various factors are believed to thwart the effectiveness of user participation, with the qualifications of participant users and their roles during system development process being prime suspects. For instance, system development directors express frustrations that managers are unwilling to assign qualified users to project development teams or that the qualified users refuse to participate in system development process (Wilder 1991; Payne 1993; Vimarlund and Timpka 2002). On the other hand, some practitioners and researchers maintain that systems fail because designers talk to the wrong users during system development (Kaiser and Bostrom 1982; White and Leifer 1986; Laudon and Laudon 1998; Ladner et al. 2003; Kujala and Kauppinen 2004; Heeks 2005). The question that logically follows is, "Who is the right, qualified user to consult or to serve on a design team?" The existing literature provides little insight on this issue.

The user characteristics deemed critical for effective user participation in system development process include: (*a*) personality traits (Kaiser and Bostrom 1982; Kujala and Kauppinen 2004), (*b*) computing skills (Ives and Olson 1984; White and Leifer 1986), (*c*) communication skills (Ives and Olson 1984; Pinto and Slevin 1987), and (*d*) system-related functional expertise (Boland 1978; Joshi 1990; Hunton and Beeler 1997; Mckeen and Guimaraes 1997; Livari 2004; He 2004). However, the empirical substantiation of the significance of these characteristics is lacking, and, as noted earlier, the user participation research provides inconclusive evidence of the merits of user participation. Consequently, validated guidelines for selecting users to serve on design teams remain equivocal at best. A two-staged research approach that could resolve this issue is to first infer the essential user characteristics from the theories underlying the user participation concept and then subject these characteristics to empirical testing. In accordance with these steps, we examined the theories underlying the "user participation" or "design team" approach and inferred the key criteria for selecting users to serve on a design team. Finally, we report the results of a field survey conducted to empirically validate the merits of the inferred criteria in the healthcare context.

User Participation Theories

In this section, we examine the theoretical paradigms underlying the concept of user participation and infer the primary criteria these paradigms prescribe to select users to serve on a system design team.

Two organizational paradigms usually advanced in the systems literature, as the theoretical basis for user participation include (*a*) participative decision-making and (*b*) planned organizational change (Ives and Olson 1984; Tait and Vessey 1988; Doll and Torkzadeh 1989; Saleem 1996). These paradigms assert that in many situations employees are likely to be more knowledgeable than their supervisors about the routine, detailed aspects of their jobs. Consequently, seeking and incorporating employee input in the applications and practical implications of their job-related decision making improves the quality of the decision. Furthermore, integration of employee expertise in decisions imparts in employees the sense of control, commitment, and decision ownership. In turn, these factors enhance the chances of decision acceptance. Thus, both paradigms maintain job-related functional knowledge or expertise as the fundamental reason for employee participation in decision making.

Information systems implementation in an organization is considered a special case of participative decision making or planned organizational change, wherein system users and designers substitute for subordinates and managers (Ives and Olson 1984). The argument generally advanced in support of user participation suggests that the development of an information system requires the blending of two types of expertise: (*a*) users' system-related functional expertise and (*b*) designers' technical expertise (Leape 1977; Boland 1978; Lucas 1978; Ives and Olson 1984; Kim and Lee 1986; Leonard-Barton and Sinha 1993; Regensburg and Van Dar Veen 1990). Therefore, eliciting and incorporating users' system-related functional expertise enhances the likelihood of developing a satisfactory system. User participation is believed to result in system success through intervening mechanisms, such as user understanding of the system content and objectives, sense of control, feelings of system ownership, better evaluation of the system, and an improved fit between user information needs and system capabilities.

The argument for user participation is further refined in terms of users' level of functional expertise and the appropriate degree or extent of their influence on system development. Therefore, a low degree of user influence is deemed adequate when designing standard application systems, such as a payroll system (Edstrom 1977; Ives and Olson 1984; Nicholas 1985; Butler and Fitzgerald 1997; Choe 1998; Fakum and Greenough 2004; He 2004). A high degree of user influence is recommended when designers lack the functional expertise required to develop the system, and the users possess such expertise (Edstrom 1977; Ives and Olson 1984; Nicholas 1985; Butler and Fitzgerald 1997; Choe 1998; Fakum and Greenough 2004; He 2004). These assertions imply congruence between the levels of a user's system-related functional expertise and influence on the system design—the greater the expertise, the higher the influence. The *status congruence theory* supports this correspondence between expertise and influence.

The effect of incongruence between expertise and influence on system quality is self-evident: Restricting the input of more knowledgeable users can only result in diminished system quality. Furthermore, this incongruence can create frustration and tension in the users and induce distrust and hostility within the design team (Adams 1953; Lenski 1956; Exline and Ziller 1959; Jackson 1962; Brandon 1965; Kasl and Cobb 1967; Kontongiannis and Embrey 1997). These factors, in turn, can precipitate negative attitudes toward the system. Notably, empirical evidence suggests group members expect congruence between their expertise and influence on the decision (Lenski 1956; Sampson 1963; Hunton and Beeler 1997).

A Field Survey of Design Teams

We conducted a field survey to empirically assess significance of users' functional expertise as a criterion to select and assign users to system design teams. The survey assessed participant users' levels of system-related functional expertise, evaluated the selected users' contributions during system design process, gauged users' satisfaction with their contributions to system design and measured users' satisfaction with the resultant systems. To accomplish this, system development activities in 36 hospitals in eight major cosmopolitan areas of the United States were surveyed. Initially, the information technology (IT) managers in these organizations identified systems that were (*a*) developed through user participation as members of design teams and (*b*) implemented during the past year. The recency of systems was expected to help users recall their perceptions and experiences during the system development process. The identified systems represented a cross-section of information systems applications within the healthcare environments.

The IT managers also identified the participant users. We requested that these users express their perceptions and experiences during system development and assured them of strict confidentiality of their responses. We interviewed users in person to confirm their participation in system development. Furthermore, we asked the users to rate (*a*) their computing skills levels as advanced, intermediate, or novice; (*b*) their personalities as extrovert, normal, or introvert; and (*c*) their communication skills as outstanding, good, or normal.

We note that the sample selection was not random. However, we adopted this strategy deliberately to survey the perceptions of the users who had actually served on application design teams. Therefore, we expected this approach to enhance the reliability and validity of the research findings. In total, 212 healthcare personnel participated in the study. These included nurses, physiotherapists, x-ray technologists, lab technologists, pharmacists, and case managers. The number of participants from different hospitals varied, ranging from a minimum of four to a maximum of seven participants.

Measurement of User Participation

We employed a user participation questionnaire (see Appendix A) to measure user perceptions of their system-related, functional expertise and their influence on system design (labeled *degree of participation* in user participation literature). User responses to questionnaires were used to place them within one of the four influence-expertise combinations. These combinations were based on two influence levels and two expertise levels. The first item of the questionnaire determined the level of user influence—high or low—and the next three questions determined the perceived user expertise—high or low.

High influence meant that a user perceived to have exerted a significant influence on system design, relative to other participants, and low influence indicated that a user perceived to have exerted insignificant influence, relative to other participants. Likewise, high expertise implied that a user perceived to possess greater system-related, functional expertise than other participants, and low expertise meant that a user perceived to possess less expertise than other participants.

Notably, the users with equal influence (item 1) were placed in the high influence category. This approach seemed logical because if users did not perceive their influence as small, then their input was viewed as significant, although others had the same amount of influence. (This option was placed in the questionnaire to help the users respond precisely to this item.) Equally expert users were placed in the high expertise category. The user responses resulted in the following four categories and group sizes: (*a*) high expertise, high influence = 64; (*b*) high expertise, low influence = 44; (*c*) low expertise, high influence = 51; and (*d*) low expertise, low influence = 53 (Table 1).

To convert these numbers into a balanced design, observations were randomly dropped to attain a balanced design with 44 observations in each category. The test results reported next are based on this set of observations. (It is important to note that statistical analysis with original, unequal category sizes provided similar results.)

System Success Measures

The indicators of system success typically employed in empirical studies include user satisfaction with system, user attitudes toward system, perceived system quality, and system usage (Ives and Olson 1984; Tait and Vessey 1988; Wilder 1991; Saleem 1996). With the exception of system usage (a behavioral measure), these indicators gauge users' perceptions concerning different aspects of systems.

TABLE 1. Expertise and Influence Categories and Number of Participants

System-related functional expertise	Influence on system design: High	Low
High	64	51
Low	44	53

System usage measures are typically used in case studies. This research focused on perceived measures of system success and used the user satisfaction questionnaire in Appendix B. The items in this questionnaire were based on the user satisfaction instrument developed and validated by Jenkins and Ricketts (1985) and Saleem (1996). In preference to creating another instrument to measure user satisfaction, we decided to use an instrument that had already been developed and validated.

The first six items of the user satisfaction questionnaire used in this study (see Appendix B) measured *user satisfaction with the system*. Item 7 measured a user's commitment to use the system, if an alternative were available (called *user commitment* hereafter). These variables indicated system success. Item 8 measured users' satisfaction with their roles and contributions during the system development process (called *role satisfaction* hereafter). Finally, item 9 measured users' attitudes towards the system designers with whom they had worked during system development process (called *attitudes towards designers* hereafter). The responses from the participants were pooled together, as is generally done in survey studies on participative decision making and planned organizational change. Furthermore, this approach seemed logical because the paradigms underlying the concept of user participation apply irrespective of the organization or industry.

Data Analysis

First, we analyzed user satisfaction questionnaire data to assess the questionnaire's reliability and validity. The Cronbach alpha measure of reliability for the questionnaire was 0.94 and suggested that the instrument was reliable in measuring user perceptions. The corrected item-total correlations measure of validity for various items ranged from 0.70 to 0.81, and all were significant at 0.0001 levels. Therefore we had confidence in the validity of the research findings.

To assist the reader in following the data analysis, Table 2 shows means of perceptions of system success, role satisfaction, and attitudes toward designers of the four influence-expertise user groups.

To analyze the data, we followed a two-step procedure suggested by Hummel and Sligo (1971). According to this procedure, researchers conduct a multivariate analysis of variance (MANOVA) with all the independent and dependent variables in the model, to identify the independent variables that

TABLE 2. Means of Users' Perceptions of System Success, Role Satisfaction, and Attitudes Toward Systems Designers

Group	User satisfaction	User commitment	Role satisfaction	Attitudes toward designers
HE,HI	30.73	5.42	5.34	5.56
HE,LI	26.98	4.47	4.61	4.32
LE,HI	30.63	5.23	5.17	5.23
LE,LI	30.01	5.42	5.15	5.21

Note. E = Expertise; I = Influence; H = High; L = Low.

have significant overall effect on the dependent variables. In the second step, they conduct univariate analyses of variance (ANOVA) involving significant independent variables and dependent variables. Table 3 shows the MANOVA results for each independent variable. Those MANOVA results suggest that the participants' personalities, communication skills, and computing skills do not significantly affect users' satisfaction with the system, commitment toward the system, role satisfaction, or attitudes toward the designers. Consequently, as suggested by Hummel and Sligo (1971), we did not include these variables in the ANOVA of individual dependent variables.

We found that independent variables (user influence and user expertise and their interaction) exerted significant overall effect on the variation in the dependent variables. Consequently, we analyzed their effect on individual dependent variables next.

First, we compared the two high influence groups with the two low influence groups. This analysis showed that the high influence users were more satisfied, $F(1, 172) = 23.47$, $p < .0001$, more committed, $F(1, 172) = 14.52$, $p < .0001$, more satisfied with their roles, $F(1, 172) = 18.93$, $p < .0001$, and happier with the system designers, $F(1, 172) = 28.57$, $p < .0001$, than the low influence users were. Results suggested that influential user participation enhanced the chances of system success and increased user satisfaction with their contribution and their appreciation of systems personnel.

The data also suggested an interaction effect between the user influence and expertise on system success and user attitudes: user satisfaction, $F(1, 172) = 25.63$, $p < .0001$; user commitment, $F(1, 172) = 20.87$, $p < .0001$; role satisfaction, $F(1, 172) = 25.01$, $p < .0001$; and attitudes towards designers, $F(1, 172) = 25.28$, $p < .0001$. This effect suggested that the amount of user influence required to achieve system success and induce positive attitudes depended upon the level of a user's system-related expertise. To clarify this interaction, we conducted a simple effects analysis. To be specific, we compared the two high expertise and the two low expertise groups separately to evaluate how the variation in influence affected the system success and user attitudes between the two groups at a given expertise level.

This analysis revealed that the two high expertise groups significantly differed in their perceptions: user satisfaction, $F(1, 86) = 8.47$, $p < .001$; user commitment, $F(1, 86) = 9.43$, $p < .001$; role satisfaction, $F(1, 86) = 8.76$, $p < .001$; and attitudes towards designers, $F(1, 86) = 7.87$, $p < .001$. This would imply that users with high expertise expect to make contribution to the system design and will be unsatisfied with the system and will develop negative attitudes toward designers if restricted to only nominal participation in the system design. The low expertise groups, on the other hand, exhibited little difference in their perceptions of system success or attitudes: user satisfaction, $F(1, 86) = 0.61$, $p = .60$; user commitment, $F(1, 86) = 0.57$, $p = .61$; role satisfaction, $F(1, 86) = 0.74$, $p = .50$; and attitudes towards designers, $F(1, 86) = 0.65$, $p = .55$. This would suggest that the low expertise users do not expect to make significant contributions to the system design and will be satisfied with the system even if they have little influence on its design as long as more knowledgeable participants exerted influence on system development.

To summarize the data analysis, users with influence on system design are generally more likely to accept the system than are the users without such influence. However, the effect of this lack of influence on user attitudes and perceptions depends on users' system-related, functional expertise. The expert users will accept a system only if they exert significant influence on its design; nonexpert users, on the other hand, will likely accept a system regardless of the extent of their influence on its design. Therefore, in a design team situation, it is imperative to elicit and incorporate expert users' inputs into system design to enhance the likelihood of system success among the user community. Thus, the data provides strong evidence of the contingent significance of users' system-related, functional expertise to select users to serve on system design team and to determine their role during the design process.

Conclusions

Assigning qualified healthcare personnel to system design teams or talking with qualified personnel during system design may determine the ultimate success or failure of the healthcare information system.

On the basis of an analysis of the conceptual paradigms underlying the user participation concept and the evidence gathered through a field survey, the results of our research suggest that users' system-related, functional expertise should be employed as the primary criterion for selecting users to serve as members of design teams. Other criteria, such as users' communication skills, computing backgrounds, and personality traits should be given only secondary considerations. This is logical because users are expected to contribute their functional expertise to the systems development process, and the systems personnel can assure input from all user participants, regardless of their personality, communication skills, or computing skills. Consequently, healthcare personnel with the best system-related expertise should be assigned to the design teams, and their input must be incorporated in determining system design and scope, and in resolving related conflicts.

Given that time, budgetary constraints, and users' job commitments affect the extent of user participation and system scope, our study highlights the situation where substantive user participation is critical for system success. The results suggest that for systems with well-defined or standardized requirements, user participation may be limited to review of the system scope, requirements, and design. However, when the system under consideration is unique, or its objectives, scope, and requirements are unclear, substantive user participation becomes critical to achieve a successful system.

The study results reveal an important benchmark for systems personnel to monitor and improve the quality of user–designer interaction. They suggest that system designers must attempt to maintain congruence between user expertise and user influence on system design.

The research findings also reveal a potential strategy to introduce a healthcare information system to the larger, or geographically dispersed, healthcare personnel after developing the system through participation by a few, representative users. Because nonparticipant users form their attitudes toward a system on the basis of their perceptions of the competence and contribution of participant users (Markus 2000), communicating the criteria employed in selecting participants and their contribution to system development will enhance the overall chances of system acceptance by nonparticipant healthcare personnel.

The results of this study are based on the perceptions of the users about systems they helped develop. To further evaluate and validate these results, researchers can directly investigate the perceptions of nonparticipant users in their future studies.

TABLE 3. Results of MANOVA

Variable	Wilks's λ	p
Personality	0.9634	.9587
Communication skills	0.9642	.9591
Computing skills	0.8917	.8831
Influence	0.5719	.0001
Expertise	0.5213	.0001
Influence × Expertise	0.5649	.0001

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Appendix A
USER PARTICIPATION QUESTIONNAIRE

Directions: Please react to the following statements about the system you participated in designing as a member of the design team. There is no right or wrong answer. We are interested in your perceptions about your and other team members' system-related knowledge and influence on the system design.

1. Compare with other members of the design team, how would you describe the extent of your influence on the system design?
   a. I was more influential.
   b. All of us had equal influence.
   c. I had little influence.

2. If you were more influential, how would you describe your system-related functional knowledge compared with other members of the design team?
   a. I was more knowledgeable.
   b. All were equally knowledgeable.
   c. I was less knowledgeable.

3. If you were equally influential on the system design, how would you describe your system-related functional knowledge compared with other members of the design team?
   a. I was more knowledgeable.
   b. All were equally knowledgeable.
   c. I was less knowledgeable.

4. If you had little influence, how would you describe your system-related functional knowledge compared with the members who had significant influence on system design?
   a. I was more knowledgeable.
   b. All were equally knowledgeable.
   c. I was less knowledgeable.

Appendix B
USER SATISFACTION QUESTIONNAIRE

Directions: Please react to the following statements about the system you participated in designing as a member of the design team. There is no right or wrong answer. We are interested in your opinions of how well this system supports your information needs.

1. How satisfied are you with the user interface of the system? (Circle one number.)
   Very Dissatisfied 1 2 3 4 5 6 7 Very Satisfied

2. How satisfied are you with the format of the system reports? (Circle one number.)
   Very Dissatisfied 1 2 3 4 5 6 7 Very Satisfied

3. How satisfied are you with the content of the system reports? (Circle one number.)
   Very Dissatisfied 1 2 3 4 5 6 7 Very Satisfied

4. How satisfied are you with the relevance of the system reports? (Circle one number.)
   Very Dissatisfied 1 2 3 4 5 6 7 Very Satisfied

5. How satisfied are you with the timeliness of the system? (Circle one number.)
   Very Dissatisfied 1 2 3 4 5 6 7 Very Satisfied

6. Do you think the system needs modifications and enhancements? (Circle one number.)
   Very Dissatisfied 1 2 3 4 5 6 7 Very Satisfied

7. If you had a viable alternative, how would you describe your likelihood to continue using the system under consideration? (Circle one number.)
   Very Dissatisfied 1 2 3 4 5 6 7 Very Satisfied

8. Are you satisfied with your contribution to the system design? (Circle one number.)
   Very Dissatisfied 1 2 3 4 5 6 7 Very Satisfied

9. If you were to participate in design of another system, would you prefer to work with the same system designer(s)? (Circle one number.)
   Very Dissatisfied 1 2 3 4 5 6 7 Very Satisfied