Improving knowledge sharing in healthcare through social network analysis

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Abstract: Knowledge management systems (KMS) are critical to capture, retain, and communicate project results and knowledge of staff, prevent knowledge drain, and provide lessons learned type training. This research focuses on the development of a knowledge management system using social network analysis (SNA) to improve methods to organise and share knowledge for a large government healthcare organisation. A survey was employed to interview key players using the narrative interview protocol through focus groups formed from early adopters of process improvement methods to understand how stakeholders viewed and implemented changes to their work environment. Using these results, a Likert-style questionnaire was provided to all users. Social network mapping and analysis was performed relevant to basic network properties, characteristics of relations, and other relevant network features. The goal of this research is to identify key players, document how information is shared, recommend methods to sharing and retain knowledge, and measure the impact of the improvements.

Keywords: healthcare; knowledge management; KMS; knowledge management systems; SNA; social network analysis.

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1 Introduction

The transfer of knowledge and expertise between current and future employees is a key organisational concern. Knowledge management systems (KMS) improve the efficiency and effectiveness of knowledge transfer by enabling and supporting the use of existing knowledge as well as the creation of new knowledge streams. However, KMS design and the diffusion of knowledge through KMS is very complex. Various studies (Chen and Huang, 2007; Jung 2012; Li et al., 2011; O'Malley and Marsden, 2008; Ribino et al., 2011; Xu and Quaddus, 2012; Choi and Lee, 2003; Zhang et al., 2010) have been performed in order to analyse and improve the effectiveness of KMS. These studies initially considered approaches to manage information systems within an organisation and have increasingly focused on the preservation and dissemination of knowledge within the organisation. This research extends previous research through the use of social network analysis (SNA) to better model information diffusion best practices.

For this research, the current information sharing structure within a large national healthcare organisation is examined. The KMS used in the study focused on sharing methods and tools for continuous improvement across multiple hospitals and clinics across the USA. The identity of the healthcare organisation has been blinded for this study. Two identifiers will be used: 'A' representing a lower level stakeholder and 'B' representing a more empowered stakeholder. Two sources of information are used to create the initial social network view: the responses of a process improvement questionnaire provided to the research team by the organisation at the onset of the project and the information gathered from an early adopters questionnaire delivered to individuals within the organisation working in process improvement, hereafter identified as the first questionnaire.

2 Literature review

Numerous studies have been published on KMS in the last 20 years. Kaplan (2001) published a summary literature review to evaluate clinical decision support systems and consider whether best practices had been identified. The overall findings were that while there was a general consensus that these KMS would improve care, there was little adoption. There were considerable numbers of informatics applications that could benefit from a well planned and adopted KMS, however, no solutions were suggested that could identify factors or develop a framework for such a system.

One important contribution to modelling KMS came from the area of information systems through a model developed by DeLone and McLean (1992). This model has been widely accepted in the management information systems (MIS) community to determine the success of information systems. From a fairly comprehensive literature review of information systems modelling, the DeLone and McLean developed a model to assess the success of an information system. The research found six major factors leading to this success:

- system quality
- information quality
- use
- user satisfaction
- individual impact
- organisational impact.

They used these factors to describe a taxonomy of information systems success and validated the research through the use of several case studies to determine if the success of these factors leads to a successful information system. This work provided researchers a starting point in the development and assessment of information systems such as KMS. DeLone and McLean (2003) later modified this model to focus more on the net benefits of the system and how that influenced user satisfaction and intended use to allow for continuous improvement of information systems. This modification of the model improves the applicability to the type of system that is examined in this research project.

Extending the model proposed by DeLone and McLean, Van Der Meijden et al. (2003) modified the approach to make it applicable to inpatient clinical information systems. While most of the model fit well into this application, the biggest issue that needed to be addressed was that there was no method for adding failures of the system into any of the categories of the taxonomy. Previous research had not addressed what happens when information systems fail, possibly by author preference. The addition of the factors leading to the failures of any knowledge management system should be taken into account; for the DeLone and McLean model these would likely be addressed in the use and user satisfaction categories. It should be noted that Van Der Meijden et al. did not propose any solutions.

Wu and Wang (2006) later applied the DeLone and McLean model directly to a knowledge management system to propose a KMS success model. Their model was created in much the same way of the DeLone and McLean model, but with an emphasis on existing KMS. The major adjustment was a focus on the perceived benefits of the

KMS and how that related to the use of that system. This establishes the importance of the perceived value of the KMS being one of the primary requirements for a successful implementation. While a generalised model, this could provide an initial structure for the KMS currently being considered.

Several other authors have also worked to identify the leading factors to the successful implementation of a knowledge management system. Holsapple and Joshi (2000) proposed a framework for assessing KMS based on a Delphi study of 31 knowledge management researchers and practitioners. Their view of knowledge management revolved around three influences:

- environmental
- managerial
- resources.

From the description provided, these three influences would impact the use and user satisfaction in the DeLone and McLean model, as they would affect the general usability of the system. Choi (2000) also proposed several similar critical factors affecting the successful implementation of knowledge management are: information technology (IT) infrastructure, leadership/commitment and organisational constraints. Some parallels could be drawn between these works, as infrastructure is a resource, leadership would fall largely on management, and organisational constraints are part of the environment the system would need to work within.

Because KMS are used by businesses to maintain expertise and competitive advantage, there are several studies in this area that have information that would be beneficial to our efforts. Hansen (2002) made comparisons between different instances of knowledge sharing within a multiunit company, finding that the connectivity of the network was important for knowledge sharing and was beneficial to the users. However, not all sharing was useful, particularly for information that was codified; there was a negative impact on the other units trying to benefit from this information sharing because of the overhead associated with handling the information and trying to 'get it to work'.

Choi and Lee (2003) examined 54 businesses that implemented KMS and found four different categories, ranked as follows:

- dynamic
- system-oriented
- human-oriented
- passive.

These different approaches to KMS reflected how the community viewed and interacted with the system. Dynamic systems were the best performing category, which showed that KMS in which the participants were actively involved in sharing ideas and knowledge through meetings and/or seminar style events would be better suited to a successful knowledge management system. This would also support a community of practice approach to KMS, including an iterative feedback from the users to continuously improve the usability of the system.

Lee et al. (2005) also proposed a metric for measuring knowledge management. They used a survey format to gather information and proposed five components that contribute to successful KMS:

- knowledge creation
- knowledge accumulation
- knowledge sharing
- knowledge utilisation
- knowledge internalisation.

These metrics were determined from a business perspective that also included research and development efforts, but most of the concepts should still be applicable to a healthcare information system. Knowledge creation and accumulation would be merged into the information provided by the community populating the KMS, otherwise this model matches well with other research efforts.

Sedera and Gable (2010) performed a survey using the SAP Enterprise System Financial module to determine whether there is a correlation between knowledge management competence and enterprise system success. This was performed through a statistical analysis, and it was found that knowledge management competence accounts for about half of the variance in enterprise system success. This indicates that improvements in knowledge management throughout an enterprise will improve the overall performance of the enterprise. Important to this study is the finding that it was not a single improvement in knowledge management that improved enterprise success, but a combination of four:

- knowledge creation
- knowledge retention
- knowledge transfer
- knowledge application.

This also matches fairly well with the work from Lee et al. (2005) with minor modifications. These works as well as those previously mentioned give a basis for the factors leading to a successful KMS. Next there is a need to identify how to satisfy these factors to develop a successful system.

The relationship and correlation between IT and organisational knowledge needs to be understood in order to manage KMS effectively (Lee and Kim, 2000). To properly support knowledge management implementation, IT needs to be understood in terms of the necessary infrastructure to support that information system. IT infrastructure supports the flow and processing of information. It is essential that whatever form the KMS may take, the final product/system should be convenient and practical to use so that the adoption rate is maximised. The IT infrastructure should be designed to focus on the usability of the KMS. This assists in the measurement of learnability, understandability, and operability of the software and ensures satisfied, frequent users (Lee and Kim, 2000).

In an analysis of IT infrastructure and it's usability, Abran et al. (2003) detailed the ISO Consolidated Usability Model to measure knowledge and evaluate general usability of KMS. Results showed that 71.4% of participants agreed that the KMS is required in

order to learn and succeed in their tasks. Hashim and Bakar Md Sultan (2009) echoed this finding and suggested that KMS is linked to strong organisational security, but is rarely efficient or easy to use.

From a technical perspective, the purpose of KMS is also to offer uniform and user-friendly access to any significant information for a given task. As shown in models such as DeLone and McLean's revised model, the integration of personalisation and user satisfaction in KMS can be beneficial and efficient when it comes to delivering information for training purposes. The integration of a more human dimension is essential in systems redesign efforts. When system redesign emphasises the integration of technical with personal skills, there is a positive impact when it comes to the sharing of knowledge (Novac-Ududec and Mazilesci, 2011). These results indicated that in order to 'get the right information at the right people, at the right time' IT professionals need to know system users and their characteristics.

Moreover, organisational culture is often cited as a significant challenge in knowledge management practices and the creation of KMS. Organisational differences in terms of types of cultures, as well as organisational structure and roles in KMS design efforts can impact user willingness to use KMS. Alavi et al. (2005) is representative of a body of literature that highlights the influence of culture on the use of knowledge management technologies and the outcomes of such use. Recipients will adjust to changes in KMS according to their social connectivity within the organisation and inter-organisational trust. Thus, the success of a KMS can be linked to social networks (Reza-Montazemi et al., 2012). Further, there is a strong correlation between specific cultural attributes and the successful implementation of knowledge management and knowledge sharing (Park et al., 2004). Hence, the importance in looking at and analysing key concepts and common factors between organisational climate, organisational structure, and knowledge management is essential for KMS redesign (Chen and Huang, 2007).

Another factor to consider is the complexity of the organisation and the impact of the organisation's structure on knowledge sharing. Lin (2008) proposed that the more complex the organisational structure of a group, the more difficult it is to implement a successful knowledge management system. This was performed using a non-linear fuzzy neural network model that created layers of fuzzy systems connected through a network topology to determine the amount of knowledge shared. While this study was limited to five industries in Taiwan, it seems to confirm the hypothesis that the harder it is to communicate within an organisation, the more difficult it is to have an effective means of knowledge sharing.

Yusof et al. (2008) proposed an evaluation framework that would take into account the human, organisational, and technological fit of a health information system. They contend that the UK health systems they evaluated approached these different aspects separately and that a more holistic view would be beneficial. Their main findings were that user buy in, leadership, good communications, and an IT-friendly environment increase system adoption. This independent assessment concurs with other works presented here, showing that a holistic viewpoint that addresses the quality of the information, the ease of access/usability of the system, and a commitment from stakeholders are necessary for a successful KMS.

Only one study monitored an information system after it was implemented. Kim and Malhotra (2005) created a model to investigate how post-adoption behaviours affected the acceptance of an information system. They identified four factors that influence whether a web-based system remained in use:

- the underlying process of the system
- updating mechanisms
- feedback mechanisms
- repeated behavioural patterns.

This model assessed how people interacted with a web-based information system (in this case an academic portal) over time, but the results should be applicable to a web-based knowledge management system. This stressed the perceived usability of the system as well as the usability of the system. As users became more familiar with the system it is more likely that small inconveniences will drive them from using the system.

There are several other modelling efforts used in the assessment of KMS. O'Malley and Marsden (2008) introduced several statistical methods to analyse social networks, with a focus on how they could be used in the healthcare industry. Their work focused mainly on two models; an individual-outcome model in which the influences of other network elements on the individual are analysed and relational models where the network being analysed is a dependant variable describing how the individual is connected to and influences other aspects of the system. They described many graph theory and statistics based tools for capturing information about social networks, but the tie to healthcare concerns is only as an example problem in the work. One key contribution from O'Malley and Marsden's work was pointed out by Linkletter (2008), being that these models also showed how healthcare information can be spread from person to person in the network, similar to modelling an epidemic on a graph (Ashlock et al., 2011). This shows again the link between KMS and SNA.

The method used by Zhang et al. (2010) was a game theory approach to analyse KMS to determine how problems with these systems occur. Several Nash equilibriums were found in different situations, indicating that although there are many various methods for rewarding information sharing, they all lead to a set of four final states. The warning to be taken from this work is that rewarding knowledge sharing with no quality control over the information being shared will drive the system to a bloated state where useful information is difficult to find and the system eventually will fall into disuse. There needs to be a form of oversight and checks to ensure that non-useful information is not shared for the purpose of gaining some reward.

Other methods to investigate and/or improve KMS include work by Li et al. (2011), who proposed a fuzzy linguistics method to provide expert information in a knowledge management system. Expert profiles were created using the fuzzy linguistic methods to group sets of information together by degree of membership in those groups and classifying requests using another fuzzy assessor. This allows users to find 'expert' information in the system, and could be used in conjunction with semantic associations to provide guidance to an information request. Xu and Quaddus (2012) analysed knowledge management system adoption using a partial least squares approach to determine the factors leading to successful adoption. The case they investigated was businesses in Western Australia, but their findings corroborate the findings of other research given in this paper. While they found similar findings in the area of perceived usability, they expanded this into factors, which were individual factors, external inspiring, organisational factors, and task complexity. These findings further strengthen the focus

on the perceived usability of any knowledge management system that is to be implemented.

Ribino et al. (2011) proposed a knowledge management system that used a document based approach and an ontology model. They proposed pulling the semantic meaning from the data contained in the information resident in the system and using a semantic engine to connect the information. They also used a Bayesian network when dealing with uncertainty.

The use of computer semantics enabled by ontologies is one of the newest and most effective methods for accessing relational databases. Other projects involving ontologies include the work by Toledo et al. (2011), who developed an architecture based on an ontology related to their business to retrieve documents. While they state that their method does not require any linguistics analysis other than the domain ontology to develop semantic relationships, it does rely heavily on software packages and methods such as WordNet, OWL, and Protégé, making a fair amount of additional integration of resources necessary. An ontological approach focused on biomedical and healthcare was proposed by Novacek et al. (2008), which would be more suitable to the current KMS being considered. They demonstrated how their ontology could be used in some case studies, but did not apply it to a larger scale information system; only pulling data from some sample datasets. One of the drawbacks of using these semantic approaches is the need to deal with uncertainty in where some information fits into the ontology. One of the methods to address this is cognitive maps (Jung, 2012). The approach that Jung took was to generate look-up tables based on how the ontology was used and use these as a reference as to where to place a piece of information based on the user's interaction with the information system.

When assessed as a whole, the current literature in this area agrees on three major factors that affect the success of a KMS in both implementation and post-adoption. The quality of the information that is available in the system must be maintained; therefore, careful consideration of how that information is added and oversight is necessary. The usability of the system influences the adoption of the system and the post-adoption success of the system. The usability must evolve as the system is being used to ensure continued acceptance within the community. Finally, the ability of the system to make associations and accurately find the data is crucial to the overall utility of the KMS. The creation of a method to make associations between the large number of entries in the system is key to providing a system that provides maximum benefit to the users. All three of these factors are interrelated, which would be expected of a system that must combine technical, organisational, and human assets to accomplish its overall goal.

3 Research methods: survey design

The research design for this study followed a mixed methods approach (Creswell, 2003; Tashakkori and Teddlie, 2003) and builds on the similarities of quantitative and qualitative data analysis. For quantitative analysis, the research design used a formative analysis, i.e., perception based quantitative data. The qualitative analysis used an in vivo analysis (e.g., Morse and Richards, 2002) of the attitudes of stakeholders involved in the redesign effort. Data regarding stakeholder perceptions of the effectiveness of the system improvements were collected and analysed over a two month period through the use of a

continuous online survey. The survey used a combination of Likert-style questions along with open-ended questions inviting reflective comment.

A mixed-methods questionnaire design was used to collect data that would give further insight into the organisation's culture of knowledge sharing and to determine practices for improved communication that would be adoptable and sustainable within the process improvement focus area. As part of this step, a 20 question written questionnaire was developed and deployed to interview early adopters identified in the network analysis questionnaire. The questionnaire is provided in Appendix A. The questionnaire was sent to 770 individuals on the early adopters list. The questionnaire had 397 participants respond for a response rate of 51.6%. This section provides an analysis of the questionnaire responses.

In order to gain initial demographic information, the participants were asked for their primary position type. Administrative positions represented 48% of the respondents; however, the respondents adequately represented all position types. Also as part of the demographic information, the participants were asked for their length of service at the healthcare organisation. The respondents represented the spectrum of years of service. A majority (51%) of the respondents had 11 or more years of experience, and 69% of the respondents had more than six years of experience.

For further analysis of the participant demographics, the questionnaire requested information on their experience in system redesign/performance improvement. The respondents represented all levels of experience. However, the majority of participants considered themselves to have moderate to strong experience. In addition, 13% of the participants considered themselves to be an expert in system redesign/performance improvement.

4 Research assumptions

The social network topographies resulting from the previous early adopters study serves as the focal point for the evaluation. The research team has made some assumptions related to both the methods of sharing information and the goals of information sharing within the network as a basis for discussion and evaluation.

The first assumption is that small clusters of users have formed within the network related to particular projects. These clusters, or neighbourhoods, form as a result of co-location of the participants. Prior interactions at other work sites result in clusters to a lesser degree. Within these neighbourhoods information is shared readily, with a smaller amount of information being shared outside the neighbourhood.

Distributed systems have several locations (nodes) where throughput is processed and then sent out to the nodes connected to that hub. The nodes connected to these first hubs in turn act as hubs until the throughput is distributed throughout the network. Because of this, it is also likely that neighbourhoods in this social network are made up of smaller neighbourhoods, giving a similar hierarchical structure to the flow of information.

Further, we assume that there are levels of connectivity to the different projects within the healthcare organisation. Some projects are very specific to a location or a particular area, while other projects have the potential for broad and crosscutting impact across the organisation. Since every project will not have applicability to another cluster, the information generated may remain isolated to a small neighbourhood.

5 Network analysis

The first questionnaire administered by the organisation was used to determine who within the organisation was actively involved in process improvement. Results identified the key players in these areas and gave some initial insight into how information is shared within the organisation. The information found in the first questionnaire was delivered via Pajek files, a network analysis software tool, and allowed the research team to create graph structures to analyse the results. The key input for this information was, "Who are people within your group/division or at the national level (could include yourself) that have been actively involved in a process improvement effort or quality improvement exercise?" This enabled the research team to identify early adopters within the organisation. The persons identified in this survey were also the main contacts for the subsequent early adopters survey, making the connections within this body even more important. The combination of these two sets of information was used to gain insight into how information is shared within the organisation to develop best practices for implementing a KMS.

The results of this survey were used to represent a social network within the organisation where knowledge of process improvement and quality improvement was stored and shared. In addition, sharing this information with the participants acted as an introduction to those who identified other participants, increasing the visibility of individuals involved in the knowledge sharing, thereby expanding the social network. These results were viewed using a network analysis tool (Pajek) with the connectivity of the resulting graphs representing the flows of information. As the connectivity between individuals in the network represents the ability to share information, we can use the diameter and average degree of the graphs as an indicator of the rate at which information is shared.

Several nodes in the graph are only connected to one other node (70) or are not connected to any additional nodes (45). This indicates that about 25% of the individuals identified as working on process improvement are isolated from the majority and there is likely little, if any, information sharing.

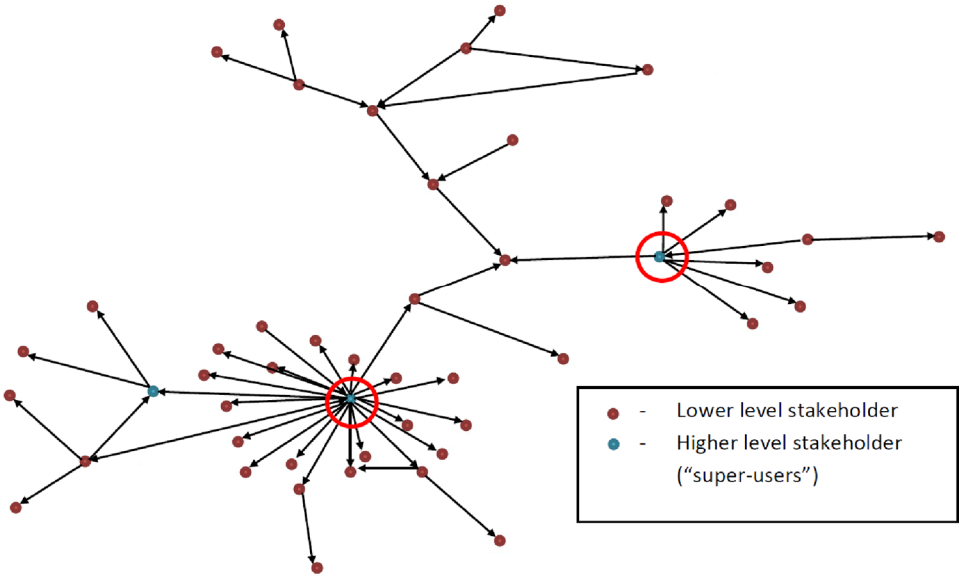
When the other graphs were examined, it was found that many of the other individuals identified were not strongly associated with other individuals. Overall, nearly 55% of the individuals were identified by a single participant as being involved in process improvement, but did not identify anyone themselves. Adding the number of participants who indicated only one other person or who were not connected to any individuals at all, over 75% of those taking part in the survey identified or were identified by only one individual or by no one else. Of the remaining participants, just over 11% identified multiple people involved in process improvement projects but were not identified by another. This leaves almost 14% of the participants who either identified other participants and were identified as being active in process improvement, or were identified by multiple participants as being involved in process improvement.

Reviewing the networks formed by the neighbourhoods, about 46% were involved in networks of size four or smaller, and 54% were in networks of nine or smaller. Of those larger neighbourhoods, about 3% of the total participants were in a network where a single individual identified 14 other people involved in process improvement. The remaining 43% of the participants in the larger neighbourhoods are involved in six networks. Even within these larger neighbourhoods most of the individuals do not appear to be aware of each other. There are 12 groups of three where each person has identified

the other two in the group as being involved in process improvement. The small number of sub-groups ('cliques' in graph theory) reinforces that knowledge is being spread out in a very limited manner, with few of the early adopters making contact with each other.

For example, Figure 1 shows the graph representing the largest neighbourhood from the study (the names of the individual involved are redacted for privacy concerns). As indicated by the arrows representing the edges of the graph, this network was not truly connected before the results of the survey were shared. After this information was given to the participants, the diameter of this non-regular graph is 8, with an average degree of 2.09. This graph configuration provides a slow rate of information sharing when compared the rate of information sharing in other graphs studied (Corns et al., 2005). In this most connected graph in the study, the removal of the two individuals circled in Figure 1 results in a near collapse of the connectivity within the neighbourhood. The number of members that would not connected to any other members is 22, and the graph would be partitioned into 4 sub-graphs, not counting the 22 isolated members. This shows that a lack of robustness in the network, as the removal of two individuals results in the isolation of nearly half of the members. In addition, the removal of these two members results in an average decrease of in the number of individuals the members are connected to from 46 to about 3.3, greatly reducing the potential of information sharing.

Figure 1 Social network graph of largest grouping within the organisation. The circled individuals represent points where the greatest loss of connectivity can occur (see online version for colours)



6 Discussion of survey results

The participants were asked how open they felt the organisation's staff is to change. The results show that 50% of the participants feel that the healthcare organisation is somewhat open to change. In addition, 38% indicated that they feel the healthcare organisation is somewhat negative or neutral to change. The questionnaire participants

were asked to respond on how successful are teams in maintaining improvements for six months or more. The purpose of this question is to determine if process improvements are sustained. Sixty three percent of the respondents indicated that teams are somewhat or very successful in maintaining improvements for six months or more.

The participants were also asked about the frequency that quality improvement tools are used by staff to improve performance. The purpose of this question is to determine if continuous improvement tools are commonly used throughout the healthcare organisation in system redesign/performance improvement projects and process improvement projects in general. The largest response rate (42%) indicated that quality improvement tools are used sometimes. 31% responded that quality improvement tools are used regularly or always.

To further understand the frequency of using continuous improvement tools, the participants were asked how often training in quality improvement tools is provided for staff. The goal of this question is to determine if training in continuous improvement tools is frequent and widely available. 55% of the respondents indicated that continuous improvement training for staff occurs never or sometimes. In contrast, only 23% indicated this training occurred regularly or always.

A plurality of comments reflected limited awareness of significant change in the reporting process (48%). Thirteen percent expressed dissatisfaction with reporting process. Other respondents (26%) provided comments regarding general organisational communication rather than directly responding to how the process had changed. Ten percent of respondents felt that change had occurred and viewed the changes positively. A small group (less than 4%) remarked on the usability of the reporting process as part of their responses. Underlying threads of dissatisfaction suggest that the respondents felt that changes were often labour intensive but lacking in improvement to work process.

A majority of respondents detailed organisational strategies for sharing information. A plurality of responses indicated that meetings were the most common mechanism. A sizable minority (21%) discussed limited awareness of such activities or dissatisfaction (13%) and reinforces the trend found in an earlier question that many respondents are not engaged in the organisational communication process or feel that it is ineffective. Fewer than 6% directly expressed satisfaction with the venues as offered.

A slight plurality of responses (32%) indicates that respondents do not use the organisation's documented performance improvement framework and continue to rely on previous methods. A few commented that their leadership team do not support the framework and insist that it not be used. Another 30% of respondents mention that they use the framework but most stated simply that it is used or that it is required so used. The final group (29%) expressed strong satisfaction with the framework. Most indicated that it provided greater ease of managing workflow.

A strong plurality of respondents (49%) mentioned that the ability to map the project was the most useful element of the framework. Other elements receiving notable responses include satisfaction with templates (8%) and the simplicity of the framework (12%). Approximately 16% expressed limited awareness of the framework indicating direction for future stakeholder engagement activities.

The plurality of respondents indicated that stakeholders are identified through team or group efforts (49%). Another 29% indicated that the leadership chooses stakeholders; a few (less than 3%) expressed concern that leadership commonly chooses the same individuals repeatedly or expressed concern for additions to workload. Passion for the

project was reported by 10% of the respondents as the key mechanism for stakeholder identification. Approximately 5% indicated that they did not know how individuals were selected.

Most respondents indicated that multiple methods are used as part of the feedback process. Responses generally favoured face-to-face as part of the method. Negative comments were expressed over the use of e-mail as a mechanism to provide feedback. Those who expressed lack of satisfaction felt that feedback was often buried in the flood of daily e-mails and overlooked. A few respondents expressed concern that feedback was ignored regardless of the mechanism. The plurality of responses indicated that face-to-face (16%); a combination of face-to-face, electronic, and written (11%); a combination of face-to-face and electronic (12%); a combination of face-to-face and written (16%) are the most common mechanisms. A small number of respondents (less than 3%) specifically mentioned SharePoint as the electronic option used.

The participants were asked to indicate how progress and results of their improvement projects are primarily recorded and reported. The goal of this question is to determine the preferred methods in order to design an appropriate system infrastructure for future projects. The main recording and reporting method indicated was committee meetings (57%). 14% of the participants are using SharePoint/intranet. The remaining groups are using display boards (9%), other methods not included (9%), dashboards (8%), and newsletters (2%). These responses indicate that the participants are not using methods to widely disseminate their improvement project information. Committee meetings may have minutes that capture some of the project documentation; however, this method does not promote the sharing of information across locations or disciplines.

In addition, the participants were asked to indicate if data is actively used to support quality improvement activities. The goal of this question is to determine if continuous improvement efforts are based mainly off of data or other methods such as gut feel or habits. The main recording and reporting method indicated was committee meetings (57%). 81% of the respondents indicated that data is used often or always to support quality improvement activities. These responses imply that the continuous improvement teams are actively gathering data and using this information to make data driven decisions.

The participants were also asked to indicate their preferred method to communicate project information. The goal of this question is to determine the preferred methods in order to design an appropriate system infrastructure for future projects that promotes communication across disciplines and locations. The largest response showed the preferred method is committee meeting reports (28%). Electronic reports on SharePoint (20%) and verbal reports (19%) were also ranked highly as preferred methods. Smaller percentages of the participants preferred other methods such as posters (or other hard copy) in public areas (10%), electronic reports on shared drives (9%), online databases (7%), and other methods not listed (7%). These results show a mixed preference between electronic (i.e., databases, shared drives) and soft (i.e., verbal reports, posters) methods.

7 Recommendations and conclusions

The key players involved in the knowledge management system described have been identified through two survey instruments. The network structures created from the results of the process improvement survey indicate the communication paths that

currently exist for information sharing. The early adopter questionnaire gave insights into how the users prefer to interact and the methods that they would adopt for information sharing. Based on the results of the both the process improvement and early adopter questionnaires and the previous observations, we recommend some corrective interventions. While these recommendations apply specifically to this healthcare organisation, these recommendations are applicable for improving knowledge sharing in any large organisation regardless of industry.

First, individuals identified by many others should form a network. For example, there were several individuals that identified people involved in process improvement. If these people were to form a network, it would rapidly increase the ability to disseminate information on projects. One identified cluster from the study points to a 'best practice' currently in place. This particular medical centre has a group of seven individuals who form a social network core. Three of these individuals indicate large numbers of other individuals in their own networks.

Second, develop a communication network between the early adopters identified in the surveys. If six individuals from this initial survey were in communication with each other it would be possible to disseminate information between nearly half of the individuals instead of the 10% currently represented by the largest neighbourhood.

Third, technical assistance should be provided to better facilitate the creation of connections for sharing information and networking opportunities. By providing ways to share information with these early adopters, it would also empower them to help others (train-the-trainer). This will give the early adopters the opportunity to be actively involved in the dissemination of process improvement information, which was on of the things many indicated they would like to be involved in. This gains additional buy in from the early adopters (who have already shown they are motivated) and also gives them the ability to help other individuals learn the system.

Finally, training these early adopters on the benefits and best practices of stakeholder engagement. If individuals are actively involved in process improvement, not just reading reports, this will help maintain interest in the program. Much like in education, a higher level of engagement and stimulation makes the system that much easier for the personnel involved to benefit from the information in the system. In looking at some of the process improvement initiatives, there are a few examples of units that are engaging in this vital activity. If this were merged into the documentation system, it would encourage use and possibly improve the quality of the information shared.

8 Future research

This research project is currently in progress. The next phase of the research involves the two remaining goals of implementing the recommendations and measuring their impact on knowledge sharing.

One of the implementations suggested was to create a network of the individuals identified as being active in the process improvement effort. If it were possible to bring in some of the other individuals associated in process improvement, a more resilient communications network could be put together. Where in the network would have the most impact would be critical to the improved communications.

Some of the individuals indicated location, and one of the networks found in the initial survey was formed of people who were all co-located. Finding additional

information pertaining to the geographical location could help to improve information dissemination. Using the internet as an example, a communication backbone between central individuals in this type of network could be formed as described in recommendation 2, but targeted to different facilities so that the number of new connections could be improved.

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Appendix A: Questionnaire

Narrative interview questions

General, demographic information

1 Describe your current position? How long have you worked in this area?

2 How long have you worked for this healthcare organisation?

3 What is your background?

Organisational work process

1 Describe the organisations current reporting system.

2 How often are the reporting systems revised?

3 How open is the staff to change? Are the changes effective? Why or why not?

Systems design

1 What is process improvement? Why is it unique?

2 What is your role with the continuous improvement projects?

3 Are you satisfied with continuous improvement state of development?

4 What impact does continuous improvement have on your daily workload? Your continuous improvement projects?

5 Is there value in developing an integrated system for your continuous improvement projects?

6 How usable is the current continuous improvement system for your projects?

7 How do you use the current continuous improvement system? How often?

8 How will the success of the continuous improvement process be measured?

Risk assessment

1 What risks are associated with your continuous improvement project?

2 How were stakeholders identified for your continuous improvement project?

3 What training will/should be provided to stakeholders on continuous improvement?

4 How were ideas communicated in relation to the continuous improvement project?

5 What input did stakeholders have on the continuous improvement project?

6 What is the feedback process for the continuous improvement project?

7 How are changes implemented due to the feedback?