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Information System Knowledge Transfer Needs Assessment Instrument

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ABSTRACT

Many companies rely on information systems (IS) that are critical to their business operations. Some of these IS utilize obsolete technology, and often include embedded business rules that are imprecisely documented. There is a risk that crucial knowledge related to maintenance of these IS could leave organizations as a result of the surge in retirement of experienced information technology (IT) professionals. This paper presents design science research, in which a survey and method of analysis was developed to assess and prioritize knowledge transfer needs related to IS. The instrument builds on industry leading practices in knowledge retention and incorporates social network analysis in order to produce a tool that is more comprehensive and efficient than previous tools built for this purpose. The analysis produces a prioritized list of knowledge and skill areas as well as a prioritized list of employees to focus knowledge transfer efforts within a firm.

Keywords

knowledge management, knowledge retention, knowledge transfer, survey, social network analysis, legacy information systems

INTRODUCTION

Many companies rely on IS that are critical to their business operations. Some of these IS utilize obsolete technology, and often include embedded business rules that are imprecisely documented (Wu, Sahraoui, & Valtchev, 2005). There is a risk that crucial knowledge related to maintenance of these IS could leave organizations as a result of the surge in retirement of experienced IT professionals (DeLong, 2004).

The probability for knowledge loss related to IS increases when organizations do not have plans in place to facilitate transfer of this knowledge from experienced IT workers to newer employees. Unfortunately, many companies underestimate the importance of a structured cyclical succession planning process (Xavier, 2009). Many firms do not have a systematic way of identifying what knowledge is most critical and which people contain the most valuable knowledge. According to a study by Deloitte and Touché (2005), only half the firms surveyed had identified a list of critical skills, and more than one-quarter viewed defining critical skills as unimportant. Without knowing which IT workers contain the most important knowledge, companies cannot retain as much critical knowledge as they could with focused knowledge transfer efforts.

This research uses a design-science approach to create an instrument that can be used by practitioners to assess IS knowledge transfer needs to focus knowledge retention efforts. According to Hevner et al. (2004, p. 75), the "design-science paradigm seeks to extend the boundaries of human and organizational capabilities by creating new and innovative artifacts." This is in contrast to the natural science or behavioral paradigm, which "is concerned with explaining how and why things are" (March & Smith, 1995, p. 253). A significant amount of behavioral science research exists across a variety of academic disciplines and business environments that describes how and why knowledge management is a necessary challenge for firms to address. Some existing instruments are used by organizations for knowledge transfer needs assessment, but they do not take into account both the expertise related to specific knowledge/skills as well as the importance of individuals within social networks. Existing instruments are time consuming for both data collection and analysis. The goal of this research is to produce and evaluate an instrument that addresses these concerns.

A utility company in the Midwest was selected as the case company to evaluate the instrument. The utilities industry is characterized by low turnover, an aging workforce, and aging legacy IS. The case company shares these qualities and has a diverse portfolio of IS making it appropriate for our research. All of the 155 employees within the IT division were invited to participate. The employees at the case company were familiar with the IS across the company.

The contribution of this research is the development of an instrument that synthesizes best practices in knowledge transfer needs assessment with social network analysis. The instrument uses a survey format to efficiently collect data on knowledge/skill areas and owners of knowledge/skills. Social network analysis can then be performed on this data to produce rankings for actionable assessments to focus knowledge transfer efforts within the firm.

INSTRUMENT

Surveys used by the Tennessee Valley Authority (TVA) provided a starting point for this research (Paladino 2007; Trinkle 2005). TVA's efforts to identify knowledge at risk for being lost were not restricted to a particular area of the company and their instrument was qualitative with free form entries for much of their survey. In contrast, our instrument is targeted specifically towards IS and utilizes a more structured framework based on the different knowledge and skills used within the firm, which allows for a more targeted analysis of data. Existing social network analysis research also served as a reference to establish the portion of the survey that examines the network of relationships for different types of knowledge within the firm (Cross and Parker 2004; Parise et al. 2006).

Our instrument consists of a login page, a section for input of co-worker related information, and a section to rate knowledge/skill areas. The potential participants are identified by a unique username. Background information including the projected retirement date, department, and supervisor for each employee is collected from management prior to the survey so that each survey respondent only has to input information that is not already known.

In order to create a survey that was concise, intuitive, and comprehensive, a custom form and corresponding database was developed for this purpose. After collecting the survey data in an online database, the data was then transformed into a structure suitable for analysis.

Survey Part 1: Co-workers

The first part of the survey asks each respondent to reference co-workers. The respondent will see a different page depending on whether or not they have other employees that report directly to them. If they do not have any employees that report to them, the respondent sees a table where they can identify the frequency of communication with up to 10 co-workers that they go to most often for three reasons: knowledge, troubleshooting, and innovation.

The knowledge social network rates how frequently a particular person is referenced for information necessary for others to complete their work. The goal is to identify individuals that are known to have relevant knowledge. Identifying who is knowledgeable is important when dealing with IS since a conversation with a person knowledgeable about software, hardware, etc. can often provide beneficial information much quicker than searching through documentation, which may be difficult to find, difficult to interpret, may not provide sufficient detail, and may not even exist.

The troubleshooting network rates how frequently a particular person is referenced for thinking through a new or challenging problem. Certain people may be particularly effective at working through problems. Troubleshooting IS is an important skill since it often involves dealing with many interrelated concepts and varying levels of abstraction.

The innovation network rates how frequently a particular person is referenced for discussing a new idea. Particular people may be most effective at developing new ideas and bringing them to fruition. This is important for IS since it is a rapidly developing field and some people may have a skill set that is more geared towards the generation and promotion of new ideas.

Survey Part 2: Knowledge / Skills

Part two of the survey serves the same function as TVA's second phase in identifying knowledge retention: to prioritize the relative importance of particular knowledge and skills, the imminence of the loss of that knowledge, the feasibility of recovering the knowledge if lost, and the difficulty of transfer of this knowledge (Paladino, 2007). At TVA, this information is gathered in a survey using open ended questions. Rather than using free form questions, the survey in the present research utilized a standard set of 15 knowledge/skill areas. Using standard values allowed for the aggregation of data in the analysis. Without standard values, there would likely be a wide range of granularity in those knowledge/skill areas listed, and there could be numerous different descriptions for the same knowledge/skill area. In order to gather information on any potentially

important knowledge or skills that are not included in the standard list, the participant has the option to manually enter additional knowledge or skill areas. The IT management at the case company developed the list of 15 standard knowledge/skill areas and breakdown of details beneath each knowledge/skill area based on the activities involved in the IT division.

The survey section for each knowledge/skill area includes three types of ratings: impact of losing the knowledge/skill, the difficulty of transferring the knowledge/skill, and the feasibility of recovering the knowledge if it has been lost. These three criteria for prioritizing knowledge retention efforts are taken from the knowledge retention process in place at the TVA (Paladino, 2007). In addition, respondents can specify up to three primary owners of each knowledge/skill area.

ANALYSIS OF RESULTS

The analysis presents two prioritized lists of primary importance: a list of knowledge/skills, and a list of employees ranked so that the records at the top are those that should receive the most focus in knowledge transfer efforts. To calculate the transfer focus rating for knowledge/skills, the importance of each knowledge/skill as rated by employees (referred to as "retention significance") is multiplied by the risk of losing that knowledge skill (referred to as "attrition risk") based its distribution among employees close to expected retirement. The results are aggregated and ranked from highest to lowest. The results from the pilot survey are shown below in figure 1.

The transfer focus ranking may show that particular knowledge or skills present great risk relative to the other knowledge and skills. In the data show in figure 2, network did not score the highest in terms of retention significance, but the knowledge and skills related to networking were highly concentrated among several employees that were expected to retire in the near future. The high attrition risk contributed to the top ranking of network for the transfer focus rating.

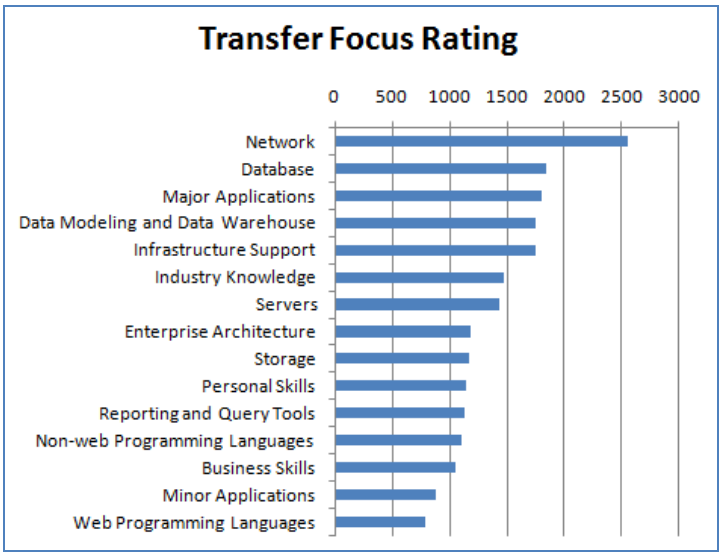

Figure 1. Knowledge / Skills Transfer Focus Ranking

The survey also produces a list of employees prioritized by transfer focus. The transfer focus rating for each employee takes into account the likelihood of retirement for that employee, the number of times that they were listed as an owner of a particular knowledge/skill, and the number of times that co-workers referenced them as a resource for knowledge, troubleshooting, or innovation. In this ranking table, the manager's rating of the position risk factor is also shown for comparison.

In Table 1 below, several excerpts from the pilot survey results are shown to illustrate the types of useful analysis provided by this tool. The fields in Table 1 are defined as:

- Retirement Factor – calculated based on expected retirement date, with 5 indicating expected retirement within a year, and 1 indicating that expected retirement is more than 4 years in the future.

- Knowledge Skill Owner Reference Count – number of times that this employee was listed as an owner of a particular knowledge/skill area.
- Knowledge Skill Owner Reference Ranking Percentile – an indication of the ranking scaled to a percentage between 0-100%, with 100% representing the top percentile and 0% representing the bottom percentile. Each employee is ranked based on the number of times they were referenced as an owner. If two employees are referenced the same number of times, then they receive the same ranking. The percentile is calculated by taking the rank of each employee, dividing by the total number of rankings, and subtracting that value from 1. For example, there may only be 90 rankings across 100 employees due to matching values across certain rows. If an employee receives a rank of 10 in this scenario, then the percentile would be 1 - 10/90 = 89%.
- In-Degree Centrality Ranking Percentile– ranking percentile based on a measure of how many other employees reference this employee as a resource for knowledge, innovation, and troubleshooting.
- Employee Transfer Focus Ranking Percentile – ranking percentile based on knowledge transfer focus rating which is calculated by multiplying the retirement factor by the knowledge skill owner reference ranking percentile and the centrality ranking percentile. This measure takes into account the imminence of retirement, the number of people that have referenced this employee as an owner of particular skills, and the references of co-workers in the social network analysis portion of the survey.

Person ID	Retirement Factor	Knowledge Skill Owner Reference Count	Knowledge Skill Owner Reference Ranking Percentile	Position Risk Factor	In-Degree Centrality Ranking Percentile	Employee Transfer Focus Ranking Percentile
Excerpt #1: Top Ranked Employees						
428565	5	20	61%	5	83%	99%
711856	4	27	74%	null	75%	98%
Excerpt #2: Central Generalists						
846585	1	2	3%	3	60%	19%
212635	1	2	3%	3	49%	17%
Excerpt #3: Central Employees with Low Position Risk Factor						
499840	1	2	3%	2	86%	24%
890477	1	null	null	2	51%	0%
Excerpt #4: Non-central Experts						
502916	1	13	39%	null	18%	38%
887455	1	15	45%	4	15%	37%
Excerpt #5: Central Experts						
900379	1	69	97%	null	91%	92%
365685	1	35	87%	null	98%	91%

Table 1. Employee Transfer Focus Ranking

The first excerpt shows the top two employees for knowledge transfer focus based on their imminence of retirement, their recognition as an owner of specific knowledge/skills, and the frequency that other employees referenced these employees as a resource for knowledge, innovation, and troubleshooting. Top ranked employees should receive the most attention in knowledge transfer efforts.

The second excerpt shows two employees that are central to the informal social networks for knowledge, troubleshooting, and innovation, but are not recognized often as primary owners of specific knowledge/skills areas. These employees could be facilitating vital communication and may act as the liaisons between those seeking knowledge and the experts that possess that knowledge.

The third excerpt shows two employees that are central to the informal social networks for knowledge, troubleshooting, and innovation, but were rated with a low position risk factor by their manager. These results illustrate differences between a manager's assessment of an employee's knowledge and skills, and the perception of the rest of the co-workers. These

employees serve a vital role to the communication networks within the organization, even though their importance may not be recognized by their manager.

The fourth excerpt shows employees that were not referenced as a resource for knowledge, troubleshooting, and innovation frequently, but were designated as primary owners of specific knowledge/skills frequently. It may be that these employees require more independence to perform their job. These employees may need more assistance in communicating with co-workers.

The fifth excerpt shows two employees that were listed very frequently as owners of specific knowledge/skills and were also listed frequently as a resource for knowledge, troubleshooting, and innovation. It is possible that these employees could become bottlenecks for knowledge and communication. An organization may be able to benefit by determining the reasons that these particular employees became so vital in terms of expertise and communication, so that other employees can be trained in order to achieve similar success.

The analysis also provides a detailed ranking of the top employees for each knowledge/skill, and a detailed ranking of knowledge/skills for each employee. Social network analysis software was used to produce a social network map to help visualize the knowledge, troubleshooting, and innovation communication networks in the organization.

FUTURE CONSIDERATIONS

The response rate for the instrument evaluation was only 32%, lower than IT management at the case company expected. The null values resulting from the partial response rate affected the employee rankings. Since many of the position risk factor values were not populated by managers for their employees, the position risk factor was excluded from the ranking calculations even though this would be an appropriate value to include in the employee transfer focus rating. If there was a higher response rate by managers, the position risk factor could be included as part of the calculation for the employee transfer focus rating.

This instrument was targeted to the IT division of a utility company. Both the list of standard knowledge/skill areas and the three dimensions that were used for social network analysis reflect this focus. These can serve as example content for other organizations of varying sizes across other industries that wish to utilize this instrument for analyzing IS knowledge retention needs. The structure of the instrument could be utilized for areas other than IS across many industries as well. If this survey structure and analysis is implemented with a focus other than IS, then it would be necessary to develop a standard set of knowledge/skill areas and identify the type of social networks to be analyzed to provide input that is relevant to the area of focus.

This research was limited to prioritizing the needs for knowledge transfer based on the existing distribution of knowledge and relationships within a particular part of an organization. Further research opportunities are available to determine how best to proceed with knowledge transfer efforts at an organization once the needs have been identified. This instrument did not explain why certain people are ranked higher than others as owners of particular knowledge/skills, or within informal social networks. Further research is necessary to confirm the ultimate causes for the ranking of these employees as knowledge/skill experts that are central to the social networks in the IS division.

The future research opportunities stated above could provide valuable insight that would allow organizations to tailor day-to-day training and knowledge transfer processes. This would allow organizations to more effectively distribute knowledge and reduce overall risk of knowledge loss.

CONCLUSION

Transferring knowledge related to IS is important to the successful operations of organizations. Much of the knowledge used to maintain critical IS is held by employees that will be retiring in the near future. Since it is not possible to transfer all the knowledge at risk for leaving, it is important to focus knowledge transfer efforts on the most important knowledge/skills and the most relevant employees. This instrument provides an efficient method to collect information regarding importance of knowledge/skills, the recognition of who owns particular knowledge/skills, and who people go to as a resource for knowledge, troubleshooting, and innovation. The analysis provides rankings of knowledge/skills and employees that can be used by management as a guide when designing knowledge transfer efforts.

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