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15P. Applying Organisational Learning to User Requirements Elicitation

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Abstract

The aim of the paper is to determine the best method to capture the functional and non-functional requirements of software and to ensure that the acquired software is deemed suitable by the users. The paper compares the organisational learning approach to the traditional method of software requirements elicitation and adoption. We analysed the two approaches in a case study of a Bahamian horizontal construction company. The focus of the study is on how the stakeholders capture tacit knowledge during the processes of both approaches. The findings show that the organisational learning model was more effective in eliciting software requirements, especially in helping incorporate the tacit knowledge of requirements in a broad range of company stakeholders. The study also demonstrates the significance of tacit knowledge among company stakeholders, in particular during the construction cost estimation phase. In order to produce a more accurate estimate and ensure the user acceptance for the software throughout the company, the cost estimation phase must be incorporated with the requirements and the users must be involved throughout the software requirements elicitation and adoption process.

Keywords

Organisational learning, user requirements elicitation

1. Introduction

The importance of information technology (IT) has grown within the past decade and IT is even seen as the main means to growth of organisations (Jain 2008). It had become increasingly important for personnel to learn and adapt IT within their organisations. The adoption process is not just a personal issue, but more likely, it is a matter of learning of the organisation as a whole. Many firms, such as Motorola and Fiat, already have formal and informal structures and processes to enable workers to share knowledge and skills with each other (Nevis 1995).

However, traditional software projects suffer from multiple problems: ambiguous, changing and incomplete requirements and inability to identify the problems existing in the commercial environment (Ovaska 2005, Kontonya and Sommerville 1989). Therefore they have also been shown to fail at an unacceptably high rate (Lyytinen and Robey 1999). The reason for the problems is widely linked to the lack of user involvement in these projects. The traditional model pursues an ideal of a complete and consistent (Kotonya and Sommerville 1998) requirements

elicitation, which could be refined, through proper techniques, from vague ideas to formal, written specifications (Kendell 1993). Still, a great deal of the knowledge of the people is in tacit form. People have experience, attitudes, beliefs and motivation, which cannot be specified in written form. Consequently, users find their own ways to “beat the system” by refusing accept changes without even trying them (Kendell 1993).

The organisational learning approach is a change focus to people-orientation along with a shift of attention paid to the capabilities and knowledge of people in the organisation. In this paper, we use a case company to apply organisational learning approach in general and especially the use of tacit knowledge in elicitation of software user requirements.

2. Research Approach

The paper is a descriptive single case study (Yin 1984). The case company employed both the traditional and organizational learning requirements elicitation processes with widely different results. The goal of the paper is to study how organizational learning could be applied for elicitation of software requirements and how the process could be enhanced. A model of organisational learning is provided along with a case study that demonstrates how organisational learning was used for requirements elicitation, along with its benefits, at a roadwork company. We compare the organisational learning approach to traditional method and give suggestions the requirement elicitation. We focus the organisational learning approach on the phases in which tacit knowledge is involved.

In order to implement our passive case study over its eight month time period, we employed a number of data collection methods such as semi-structured interviews, questionnaires, and participatory observation of developers and users. Open-ended interviews, along with participatory observation, were used with the 2-person software development team as they adapted initial requirements to a prototype, demonstrated it to the users, and then received feedback that refined the requirements and helped formulate user’s tacit knowledge into explicit knowledge. Participatory observation was used by the researchers with the foremen as they worked on their cost estimation; through observation, questions, and their off-hand commentary, it was possible to gain insight into their tacit knowledge and how they processed which factors to consider and take into account in their cost estimation calculations. This insight led to better understanding of the requirements that were obtained through the organisational learning approach. Because of the time-consuming nature of participatory observation and the diverse methods of cost estimation, analysts relied on interviews and prototyping to obtain this tacit knowledge instead. Open-ended interviews were used with managers, developers, and users in order to gauge the effectiveness of traditional software elicitation methods and to measure the degree of satisfaction with the software produced through the traditional relative to the organisational learning approach. Once a particular piece of software was implemented, participatory observations and interviews were used to record how users adapted the software into their existing business processes and how some of these processes changed in order to adapt to the new software. Questionnaires and interviews were used to determine the level of satisfaction as to quality and thoroughness of training. The group surveyed included two developers, five managers, eight foremen, and 18 users (professional staff who utilised the software along with the foremen).

The data consists of the progress of the company as it used different software elicitation techniques, encountered problems, and devised solutions to these problems while adopting the software within its organization. Each of the various groups included within these data collection methods had a different set of questions tailored to them (Yin 1984). One of the focuses of the study was the cost estimation model and a specific group of users, the foremen. Foremen were asked whether their cost estimation method was based on tacit experience or an explicit formula; if the former, how could this experience be formulated to be expressed as parameters within the cost estimation model. The managers were asked about the strategic role of the software; developers were asked about the elicitation methods employed and their success in eliciting complete requirements; and users were surveyed as to the degree of their input into the software process, the completeness of the requirements elicitation within the software, and how well the software modelled their work flows and if any business processes had to change as a result of software adoption. The results of the cost estimation produced by the foremen was utilised by other groups of users, such as accountants, who used the data for their proposals and reports.

After gathering all of this data, it had to be summarised and analysed. The degree of satisfaction among users with software obtained through traditional software requirements elicitation was compared with the satisfaction level of users with software obtained through the organisational learning approach. Satisfaction levels dealt with such factors as how well the software modelled their business processes, how well the software incorporated the tacit knowledge encompassed within the business processes which enabled them to do their job properly and accurately, and the thoroughness, availability, and reliability of training for users in the new system.

3. Organisational Approach to Requirements Elicitation

The organisational approach in requirements elicitation has both a political and social view. The political approaches regards the requirement elicitation as a socio-cognitive problem solving process (Orlikowski and Gash 1994; Davidson 2002) with conflicting interests and agendas, resource constraints, and political influences (Bergman 2002). The process can be characterised by differences and repeated shifts in assumptions and expectations of technology, which interfere with the project participants' understanding of requirements (Ovaska 2005, Orlikowski 1994). The users also tend to filter their information of their system through their own cognitive lenses, each with their own focus and values upon which they evaluate the system. Kurtyka (2003) identifies at least three views of culture towards the software systems: 1) the executives are concerned primarily with the company's financial value in terms of the return on investment, 2) the IT staff focuses on business processes and efficiency and finally, 3) the end-users focus on the work itself by putting values on teamwork and production. Due to the different values and focuses of the cultures, communication disconnections between the groups during the process are quite common (Kurtyka 2003).

The theory of organisational learning harnesses the different political and social views, as well as cognitive lenses, into an integrated idea about how the organisation can act as a knowledge creating entity (Nonaka 1994) in order to encourage innovation within the workplace (Landry 1992, Brown 1991). The theory of organisational learning divides knowledge into ontological and epistemological dimensions. From the ontological perspective, the knowledge can be both organisational and individual in nature. The organisational knowledge resides in organisational

structures, such as daily practises and business processes. The individual knowledge manifests itself in opinions, attitudes and beliefs. From the epistemological perspective, knowledge can be in a tacit or in an explicit form. The tacit form of knowledge is hidden and context-specific in nature, whereas the explicit knowledge is in codified, systematic form in which it is easily communicated (Nonaka & Takeuchi 1995). The knowledge which the users carry in their minds guides their behaviour in organisational situations, including basic assumptions about entities and business processes within the system. They use this knowledge to filter their experience and decide on how to respond and act.

Knowledge in the workplace, transformed through daily work, can be placed into a managed process where new knowledge is created and used in an organisation. In order to create new knowledge effectively Nonaka (1994) organises the flow of knowledge creation into four stages, in each of which, the knowledge is converted from one form into another. The process begins with a *socialisation* phase in which the team members share their tacit understanding and experiences. During the *externalisation* phase, these team members try to express their tacit knowledge into explicit form. In this phase, the tacit knowledge is formalised and categorised into requirements and it is incorporated into new processes. In so doing, the members become aware of the logic and motives of their current practices such as solving clients' needs, retaining market share, etc. The resulting explicit knowledge, in turn, is analysed and combined during the *combination* process into new explicit knowledge, for instance new or modified business processes. The *internalisation* phase occurs where the users adopt the new knowledge and learn to use it tacitly (Cooke & Brown 1999). During the socialisation process, the tacit knowledge is shared throughout the organisation (Cooke and Brown 1999). In this phase, the users learn to use and evaluate the software individually in their own business environment. Although the vendor/employer may provide formal training sessions, the most effective trainers are peer trainers (Markus & Benjamin 1996).

These processes are iterative, yet mutually enabling and overlapping (Cook and Brown 1999). Fischer (1996) claims that successful organisational learning requires a closed circle of knowledge (or experience); stimulation and externalisation; maintaining the interest of users; storing the surfaced information; and finally feeding it back when needed in a work context. In order to maintain user interest, each user needs to feel a personal benefit in participation which outweighs the effort expended.

However, the process of knowledge creation is not easy to manage. Especially the knowledge about the basic assumptions of people is rarely easily observable. Therefore, this tacit knowledge needs to be deciphered from their behaviour. This may also pose a problem with traditional business analysis, which tries to capture and analyse objects that have a real world entity, such as customers, but is not equipped to model the subtleties of the basic assumptions that are the core drivers of the organisation. These subtleties, or tacit knowledge, of the basic assumptions behind the modelled business processes cannot be easily extracted through traditional system analysis due to their "hidden" nature, but they must, instead, rely on the organisational learning approach for their elicitation. These subtleties, however, often form a critical factor in how decisions are made within organisations (Kurtyka 2003).

We also have to notice the different roles of people in knowledge creation process. The top managers provide strategic goals and standards while the middle managers handle the flow of ideas generated by their subordinates (Nonaka & Takeuchi 1995). Based on their experience, the subordinates provide information on business processes such as work routines, problems, constraints, et al. Using collaborative system analysis, the tacit knowledge within this work environment is brought to the surface, challenges to be solved are determined, and, through the use of prototypes, the tacit knowledge is made explicit (Sward, 2006).

4. The Model of Organisational Learning and the Software Acquisition Process

According to the review of Robey et al (2000) organisational learning concepts have been used widely in information systems research by stressing the importance of *organisational memory information systems* in artefact development. In these systems, the experiences of past projects are stored in order to be reused in forthcoming projects (e.g. Fischer et al 1996, Haudek & Schneider 1999). Our study follows the other stream of research which applies the organisational learning concepts to the process of implementing and using information technology in organizations. In this stream, the experience and learning from others play the central role. Instead of using earlier stored knowledge, these studies stress organisational learning as a dynamic process of creating new knowledge. This view enables a collaborative multiview approach (e.g. Tervonen et al 1997) and organized experiences exchange (Haudek 2006) as well as better use of firm-specific knowledge (Nambisan et al 1999).

The IT acquisition process can be seen as a process of organisational learning, as illustrated in Figure 1. When an organisation begins to acquire an IT system, it starts to externalise the user requirements. During this phase, the users test and evaluate the existing systems and practise by using their experience-based tacit knowledge. Users express their ideas and tacit understanding about the requirements in a transferrable explicit form. The combination process appears when the requirements are specified to find the “best fit” in the market. Internalisation process occurs where the users learn and test the system in a real business context. Finally, the socialisation process occurs when the new system use spreads throughout the organisation.

Our model is based on Rantapuska and Ihanainen’s (2008) model for ICT investments, which applies Agarwals (1997) idea of “organisational adoption and organisational diffusion”. The ICT investment involving a commercial-off-the-shelf (COTS) software selection has to be regarded as a case of organisational learning too. ICT investment is a typical change initiative in which the users are “prominently involved in the change” (Lynne 2004). Although COTS software shares common functionalities, it is used in wider range and in different contexts. The software also needs to be selected, customized, adopted and learned effectively in the target organisation.

5. Case Study

The Bahamian-owned company undertakes contracts in the areas of road construction, water and sewage works, and site clearance. The company is over 25 years old with over 130 employees, many of whom have worked for them for over 10 years. A small group of managers work with a small cadre of professional staff, such as engineers, surveyors, and material technicians, along

with a larger group of experienced workers to undertake various projects; it is crucial for the company’s survival that these projects meet the client’s specifications, deadlines, and budget. This company, as the subject of the case study, tried different approaches of requirements elicitation and software adoption with different degrees of success.

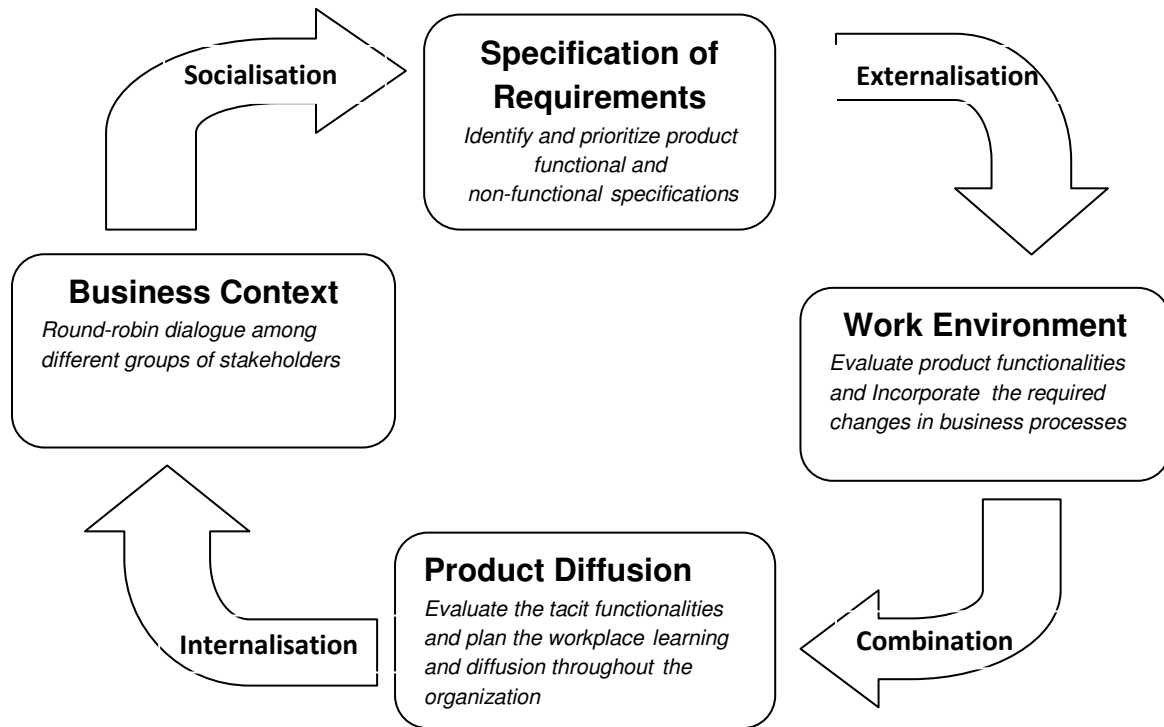


Figure1. Organisational Learning Approach to COTS/Custom Software Adoption

5.1 First Approach

The company first adopted a traditional, top-down approach in its adoption of software. Using a select group of stakeholder users (an accounting group), a small set of requirements were obtained through traditional software engineering methods where analysts gathered requirements through interviews. Given these requirements, a vendor was selected whose COTS software fit these requirements and the vendor was asked to demonstrate their software. The vendor demonstrated one module, accounting, which a few stakeholders were impressed with and upon their management’s approval, the product was purchased. No strategic visions of system integration were used by the company managers, nor were all stakeholder user groups consulted in terms of their requirements, their tacit knowledge, or their thoughts as to the suitability of the vendor. The company managers and a select group of stakeholder users selected a COTS module, accounting, which they felt met their needs and over-relied on the vendor and their promises in the selection of this particular software.

Because many user stakeholders were not consulted at all in the purchase of this software, there was tremendous user reluctance to use this software on a broad scale. Problems with this software, from the user standpoint, included little user consultation and the fact that the selected model failed to perform many of the functionalities within their business. These problems are

often inherent in the traditional requirements elicitation approach where management and sometimes a select group of stakeholders tried to force an organisation to adopt software because they feel that they are implementing good technology.

5.2 Second Approach

The second approach was an organisational learning approach. User stakeholders were consulted in round-robin fashion in order to determine what business processes were involved in their work, what problems they faced and wanted a solution for, what functionalities they looked for in software, and their constraints. After consultation, a rough set of requirements were arrived at. Analysts/developers further developed these requirements through their stakeholder interviews. One of the new set of functionalities that emerged was the incorporation of the construction cost estimation calculation module within the software. Once these requirements became explicit, the software was either selected for its desired set of functionalities (in the case of COTS modules) or designed and implemented (in the case of customised modules). In the case of customised modules, prototyping was used heavily with users/managers fully engaged in the process, providing feedback and change requests to ensure that their requirements were fully met. After all of the modules were implemented, these modules were tested by real users in the real work environment in order to determine how well these modules fit their requirements and how well they fit in with their associated business process. Training was a crucial part of their implementation process. Training first focused on a few key people within the business who, in turn, taught other staff how to use the software.

The requirement that cost estimation be included as a module within the software posed particular challenges. Cost estimation for roadwork includes the amount of material and work required for a given section of construction. This estimation, in turn, relies on the subject's knowledge and experience of their particular work context (substratum involved, particular equipment available, et al), a form of tacit knowledge, which cost estimation models cannot account for. This is particularly important in the Caribbean where material and equipment must be ordered at least 8 weeks in advance and which come in by ship. Any miscalculations in cost or material estimation can be very costly in terms of time delays and penalties.

Many of the functionalities that were obtained through stakeholder consultation were not explicit functionalities but they also included requirements that incorporated stakeholders' tacit knowledge and non-functional requirements that dealt with the design/functioning of the human-computer interface. In order to elicit the tacit knowledge of users in regards to interface design (externalisation), the development of the user interface often relied on prototyping with ensuing stakeholder feedback. Tacit knowledge of the user/stakeholder also became explicit through both stakeholder collaborative sessions and developer-stakeholder sessions (externalisation process).

The shift in focus from the vendor and their product to the solution to be implemented and high stakeholder involvement as part of the organisational learning approach achieved some benefits. Initially, when users were not part of the software procurement process and, in turn, received ill-structured software, these users were reluctant to use the software. However, when stakeholders, who included users, IT professionals, and managers, were involved from the beginning and as they worked with it and adapted the software to their business process (internalisation), their acceptance of this software increased and more and more people within the company became

interested in using it. In addition, part of the implementation process was a change and streamlining in their business processes in order to incorporate the software within their business environment. The new staff had taken a larger role in the IT procurement process. Rather than sitting passively while a vendor sells them software that does not meet their needs, the new staff has adopted a much more aggressive role – determining, through dialogue what their requirements for software would be and finding the best software that matched these requirements (socialisation). Peer training enabled other users to know how to utilise the software in order to conduct their business processes (combination process). However, despite finding the best-fit software in regards to their requirements, the software performed their business processes slightly differently so as part of their internalisation process, they slightly modified their business processes to fit their software (internalisation).

Kurtyka (2003) mentioned how there may be a communication disconnection between various groups in an organisation in terms of focus and values. An example existed in this study where management was concerned with accurate cost estimation in order to win contracts and be assured of a reasonable profit while users were more concerned with “getting the job done” - using teamwork to produce their set goals and overcome any problems that they may encounter along the way. Initially, neither side realised its importance to and dependence on the other. Accurate cost estimation relied heavily on subjective experience (tacit knowledge) of users such as how much effort and time would be required to clear a particular stretch of bush or cut a road through a particular type of rock. This experience is particularly valuable in the Bahamas because the topology and flora varies tremendously even in small spaces. However, this experience is the domain of the users who encounter these situations every day, rather than management. In order to arrive at accurate cost estimation functionality, the users’ tacit knowledge must be tapped and explicitly formed into rules, heuristics, parameters, and functionalities of the information technology system. Otherwise, management would obtain a system that provides inaccurate cost estimation which would cause financial loss, loss of potential contracts, loss of reliability, reputation, et al. Users require management for their strategic vision and to obtain a steady stream of work to remain employed. By getting users involved from the beginning and having them use their tacit knowledge to help elicit requirements or to evaluate products, a more accurate cost estimation sub-system was obtained. Users benefitted in at least two ways. One way was that by internalising the information system within their work routines and business processes. In so doing, these users benefitted from information technology in not having to rely on memory of past experiences for calculations and in being able to query the availability of and order equipment/supplies as needed. The second benefit was that they realised and internalised the value of accurate cost estimation, traditionally a goal of management, and consequently, they ensured any relevant data that they entered would be an aid toward this goal.

6. Determined Success Methods from our Study

Based on the experiences of the case study, we suggest some methods for the externalisation, socialisation and internalisation phases of the organizational learning process.

6.1 Externalisation and socialization phase

It is important to have user stakeholders share their experiences in regard to work routines, problems they encountered and how they resolved them, and the importance that they attached to a particular functionality as necessary to do their work. As an example, they might describe the effort and time they expended in constructing a particular stretch of road along with any problems they encountered, such as boulders, and their solution, such as use of specialized equipment to remove the boulders. These experiences, tacit knowledge, have a great impact in accurate cost estimation calculations and they are part of the key functionalities of the required software product, such as the ability to account for needed equipment. Middle management should try to direct discussion of these experiences such that the discussion does not become a disorganized discourse and such that the tacit knowledge within these experiences can be categorized and made explicit. The managers, by using the importance attached to each requirement by the user, are now able to prioritise these requirements. These sessions, and the requirements obtained from them, resulted in a clearer and more prioritised understanding of the requirements which the IT developer/analysts then obtained through their initial interviews of the stakeholders.

6.2 Externalisation phase

The use of prototyping has proven its worth in both having the design of the Human Computer Interface revised until it met the approval of stakeholders and in jogging the memory of stakeholders, who upon seeing the prototype in action, were able to identify previously-forgotten new functional and non-functional requirements of the product. The use of prototyping ensures that stakeholders play an important role both in requirements elicitation and in final product selection and, hence, they possess a stronger interest in and acceptance of the software that is finally obtained.

6.3 Socialisation phase

The best training is peer-based where a user, after being trained in the use of the product, trains their peers. Peer trainers are familiar with work context which the product embraces and can adapt their training to address the problems and situations within this work context. One early problem was the company hired “professional” trainers who did not know anything of the work processes of the company but their knowledge was limited to a few select modules of the new information system. Consequently, they could provide only limited training at a high price.

When implementing a new information system, it is important to implement it using a modular rather than the “big bang” approach. An organisation should introduce new modules one at a time and allow the associated stakeholders to be trained in their use, adapt their use to the

associated changed business process, and internalise this change within the organisation before introducing new modules.

6.4 Internalisation phase

Often, the adopted software will necessitate a slight reworking of business routines and processes. Training in the product's use becomes mandatory in order for users to adapt to this change in their routines and processes. This training must occur within the actual business environment in order for the user to fully comprehend how this product will affect their associated business routines.

Training demonstrations by product vendors often focus on only a subset of functionalities that cater to a particular group of stakeholders. Consequently, without the product being fully tested in the organisational-wide full business environment or ensuring that its functionalities meet the requirements of all of its users, the product will often fail to be adopted by users and leave functional gaps in the organisation's IT systems.

7. Conclusion and Discussion

The aim of this article was to find a method to capture the software requirements deemed suitable by the users. An approach, based on the organisational learning model, was adopted. After making some general remarks about the differences in approaching the requirement elicitation among stakeholders, we gave also recommendations to merge and exploit their different kind of tacit knowledge in the requirement elicitation process.

The case study revealed three cognitive lenses used by different stakeholder groups for the same event. 1) The developers were concerned with standardising business processes; 2) The managers were concerned about the cost, benefits of these changes and the impact that these changes would have on their business. Finally, 3) the expert users wanted to automate many of their business processes so that their routine tasks would be automated and that their expertise would be used more efficiently within the business.

There are some important things which we found to be worth of taking into account during the requirement elicitation process. We saw it very important to have the people to share their experiences during the whole process, especially in the externalisation and socialization phase. In our case this has a great impact for an accurate cost estimation. In the externalisation phase, the use of prototyping proved its worth in the design of the requirements of the product. In the socialisation phase, the peer-users in the real business environment showed to be the best trainers. When implementing the information system, it is important to implement it using a step-by-step approach because it enables reworking of business routines and processes.

Using the organisational learning approach, within this business, resulted in greater stakeholder user involvement and acceptance, an acknowledgement of the importance of tacit knowledge of its users and its incorporation within the requirements and ultimately within the software itself, and a higher quality and more accurate cost estimation module. Besides greater stakeholder

involvement and better requirements elicitation, the organizational learning approach goes further than traditional software elicitation methods in that it deals with stakeholder training and their adapting to organisational change brought about by IT adoption. Our case study demonstrates that this approach is best-suited for businesses with requirements that incorporate a high degree of tacit knowledge, require a high user buy-in to an IT system, and whose processes may undergo a high degree of change due to IT adoption.

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