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A Model for Collaborative COTS Software Acquisition (COSA)

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***Abstract*—**Acquiring commercial off-the-shelf (COTS) software applications is becoming routine in organizations. However, eliciting user requirements, finding the candidate COTS products and making the decision is a complex task, especially for SMEs who do not have the time and knowledge needed to do the task properly. The existing models intended to help the decision makers are originally designed for professional use. SMEs are obligated to rely on the software vendor's ability to solve the problem with the systems provided.

In this paper, we develop a model for SMEs for the acquisition of Commercial Off-The-Shelf (COTS) software products. A leading idea of the model is that the ICT investment is basically a change initiative and therefore it should also be taken as a process of organizational learning. The model is designed bearing three objectives in mind: 1) business orientation, 2) agility, and 3) Learning and knowledge management orientation. The model can be applied to ICT investments in SMEs which have a professional team leader with basic business and IT knowledge.

***Keywords*—**COTS acquisition, ICT investment, organizational learning, ICT adoption.

I. Introduction

DEVELOPMENT of information technology is getting more and more people-oriented. Investing on ICT means focusing on organizational change and better business processes [1]-[3]. The success of those investments is based on personalized experiences with the product than the actual products itself [4]. The return of these investments will not realize before the people have learned to work effectively with the new system [5]-[6].

ICT applications are becoming a management issue in small and medium sized enterprises (SME) as well. Accordingly, the software vendors are focusing on smaller organizations [7]. Still, investing in ICT does not necessarily contribute to superior organizational performance [8]. There are barriers in the ICT adoption in SMEs: lack of finances, time [9], knowledge in IT planning [10] and appropriate skills [11].

Acquisition of new technology is very complex and may take too much time until the system is working properly [12]. Additionally, deployment of an ICT system includes a lot of context specific "how to" knowledge which cannot be transferred as such into another context [3], [13].

ICT acquisition is an organizational change process and a process of organizational learning. Collaboration with the users is widely accepted as a crucial part of ICT-projects [14], [15]. In order to ensure the usage of the system after implementation, the users must at least have a psychological feeling of being involved in that change [16], [17]. The nature of ICT adoption process is complex and context-specific, stressing the importance also of approaching it in its actual context and also as a process of organizational learning of the community of practice [18].

The existing COTS acquisition models are designed for IT-professionals and may contain a quite high number of rigorously defined tasks. For instance, the CMMI Acquisition Module [19], [20] divides the acquisition process into 99 separate practices. The models do not really welcome ordinary users to participate in the acquisition project [21], much less approach the acquisition as a process of organizational learning. In this paper we apply theories of organizational learning in COTS (Commercial off-the-shelf) software acquisition. Accordingly, we present a COSA (Collaborative Software Acquisition) model about how the stakeholders could be involved in new software acquisition process. From this perspective, the organization is a knowledge creating entity in continuous interaction with its environment [22]. The ICT acquisition is essentially an issue of knowledge creation requiring lots of organizational learning in interaction with its users until the intended change is real.

This is the second version of the original COSA model [23] in small and medium sized enterprises. The model is tested in two case studies: The first case, a small importing company purchased a customer relationship management (CRM) software package [24]. The selection team consisted mainly of sales and administrative personnel. The second case study [25] was conducted in a company specialized in industrial engineering. A team of mechanical engineers, IT support person and managers selected a product data management (PDM) system for managing their design and administrative documents.

The first version of COSA model proved to be too abstract for ordinary users. The user requirements and opportunities of the software should be demonstrated themselves in more concrete terms already at the early phase of the adoption process. The working process should also allow more interplay between the tacit and explicit knowledge. Accordingly, the working process should also allow repetition and return to earlier phases when necessary. The concept "collaboration" represents the nature of working in COSA where members do not just split the work with each other, but moreover, they are engaged in a common task, learn in group and are accountable to each other [26].

The paper is structured as follows: In Section II we present the ideas, theories and design principles behind the model.

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Section III presents the COSA model itself and finally, we discuss the limitations of the model Section IV.

II. Research Task

This paper aims at developing and describing a COTS model that makes the most of users' experiential and innovative capacity. The model applied the ideas of collaborative learning [26], user participation and organizational learning [22] in information system acquisition. We suggest that the users should be involved not only as sources of information or focus of the system, but moreover, act as developers and decision makers. The model also applied the idea of collaborative learning [26] in which learning merges through shared understandings of the learners involved [27].

Our model is focused on "technology driven change" [84] projects in which information technology is used as a driver, but the users are prominently involved in that change. We also limit the types of acquisition to the cases of "organizational adoption and organizational diffusion" [28]. These types of adoptions constitute cases in which the potential benefits of technology are recognized at the organizational level and there is also an organizational decision to diffuse the system to the target audience. This type of adoption requires strong commitment and innovation of the target audience.

The goals set for the model are:

1) *Business orientation*. The approach, concepts and tasks of the model should be adopted from the world of business. The use of the model should not require too much IT knowledge. In addition to technical and explicit knowledge, the model is sensitive enough to be linked to the real and tacit experience-based business context.
2) *Ease of use*. The adoption and use of the model does not require too much work because it is closely integrated into daily business processes. The number of tasks in the model should also be minimized.
3) *Learning and knowledge management orientation.* The model should foster organization as a learning entity in order to manage the IT-enabled organizational change process.

The research approach follows the structure of Design Science [29]-[31]. Following Hevner et al. [30], we present the *awareness of the problem*, the *suggestion,* the *knowledge base,* the *development* and finally, the *evaluation of the suggested solution*. As the awareness of the problem, we present a short literature review, theoretical background, and our arguments for the need of the presented model. As a suggestion for the solution of the problem, we present our model design in chapter four. The conceptual framework of the suggested model is based on the knowledge base created in organizational learning literature. We also rest many tasks on the previous IS (Information Systems) literature. The current development of the model is based on two aptitude tests in real life business cases. The development and evaluation of the model are done in peer reviews with selected IT consultants working in the problem area. We will also test our model in a real business context in the future.

III. Theoretical Background

A. User Participation and Collaboration

In collaborative design, the work starts in the practice field where the participants learn from each other, use familiar language and tools and also see how the emerging designs may affect the work [32]. Especially strong emphasis on user participation has been practiced in Scandinavian system development research projects [33] originally aimed at increasing working life democracy, but later on also at creating useful and high quality technological alternatives. Emphasis on democracy moved to emphasizing the computer as a tool totally controlled by the skilled worker. These systems should be designed in a cooperative design process and closely tied to a concrete work situation.

User participation and collaboration is beneficial to system success. It has been shown to strengthen the feeling of empowerment, ownership and independence, which in turn, leads to effective commitment and motivation [34], [35] and finally leads to better performance [36], [37]. User participation is especially important in software implementation. Soh et al. [38] found that it is very difficult to transfer knowledge between the different parties in ERP implementation. Knowledge is disparate and very sticky and tacit in nature. The only way to solve the problem is to give the end-users a much bigger role in the adoption than just a functional expert. They have to cooperate with the vendor and assimilate the functionality in some depth. The vendor has to familiarize the business area as well.

B. Organizational Learning

The theory of organizational learning [22], [39] provides an elaborated framework to manage the use and acquisition of knowledge in organization. According to the theory, working knowledge is generated in a continuous interaction in human activity (Fig. 1). The knowledge takes two different forms: tacit and explicit. Tacit knowledge is tied into action and is usually unconscious and automatic in nature, whereas explicit knowledge is rational and usually expressed in a transferable form. The organizational level in which the knowledge is constructed and used also varies from subjective and objective. The subjective knowledge refers to knowledge in individual minds whereas the objective knowledge refers to organized and shared knowledge repositories and routines between individuals.

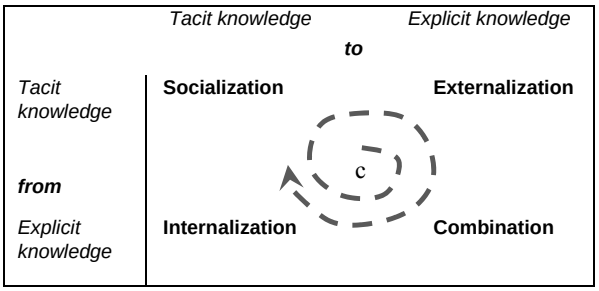

Fig. 1 Cycle of knowledge generation in organizational learning [22]

The interplay between these two forms of knowledge goes through four phases of knowledge conversation. 1) In the socialization process, the people share tacit knowledge by empathizing with each other in personal conversations. 2) In the externalization process, people try to articulate their tacit understanding in explicit form, such as numbers and documents. 3) Analysis and document evaluation is a typical work of combination process, in which explicit knowledge is connected to another explicit knowledge. Finally, 4) the explicit knowledge will be embodied in tacit knowledge in the internalization process when users, for instance, learn to use an information system. The process is not always sequential in nature. It may be iterative and the knowledge may also vary between the ontological and epistemological dimensions.

In the initiation phase, the organization prepares to ensure communication, motivation and commitment of the participating people (Fig. 1). The team must have knowledge officers as well as knowledge practitioners.

The idea is to ensure that communication and motivation are present within the body of participants. A common intention and feeling of autonomy [39] ensures motivational action-oriented stance towards the task in hand. A certain level of autonomy makes the team flexible and creative. To succeed in this knowledge creation and management project, the team should endorse practices that enable the participation of various people in the decision making. Those practices might be different from everyday routines where the entrepreneur/manager is often the only decision-maker [40]. Maintaining the "chaotic flow of ideas" combined with a common goal requires dynamic social interaction with a committed contribution of all stakeholders. To keep the knowledge creation process on a common goal, the physical or virtual place where the knowledge is created (known as "ba" by Nonaka et al. [41]), should keep people involved and stimulate them to share experiences and ideas.

The stakeholders have different roles and tasks in relation to how they take part in the knowledge generating process. The top-managers work as knowledge officers who give the sense of direction in terms of strategic goals, visions and standards. The actual team leader works as a knowledge engineer acting in two roles: Firstly, he facilitates the four models of knowledge conversion within the team: sharing experiences, making tacit knowledge explicit, combining new explicit knowledge and finally, helping people internalize the explicit knowledge. Secondly, the team leader also has to facilitate the flow of knowledge between the team and organization levels. The team members can be divided into two complementary groups of knowledge practitioners: The end-users, knowledge operators, accumulate and process context-specific tacit knowledge in the form of experience and working practices into explicit form. The other group, knowledge specialists, works as the key persons for mobilizing and combining the generated explicit into a form of requirements and system concepts. The knowledge specialists need context free and industry specific knowledge, as well as enough experience about the business and IT solutions.

In 1) *externalization* phase, the team members identify problems, share experiences and express the domain-specific tacit knowledge in explicit form. When doing so, the shared understanding about the goals, business tasks, needs and scope of the system will be specified. The goals are defined in terms of opportunities to be exploited and problems to be solved. The analysis of business tasks consists of listing the jobs and the tasks assigned in each job. When the team comes into a shared understanding about their goals and business tasks, they can elicit the needed characteristics of the software. When defining the scope of the system the team keeps the needs in a proper relation to the original goals set at the beginning of the phase.

In 2) *combination* phase the team defines the requirements, selection criteria and searches for promising candidates. The requirements are specified by selecting the needs which must be resolved with the software. In order to form the selection criteria, the requirements are weighed in relation to each other. The team conducts a market search and creates a short listing of candidates for further evaluation.

3) *Internalization* phase serves as the final usability test of the candidate solutions. The team makes a plan regarding the process for adoption.

4) *Socialization* phase is a diffusion process in which the skilled and active change agents [42] support the spread of software usage throughout the organization.

C. The Existing COTS Models

The existing COTS software selecting and evaluation models aim at providing a systematic and extensive approach to carry out the process from analyses of requirements to final selection of the candidate having the best fit [42] between the goals and ends ([43]-[45], [20]). The models have mostly a rational view of human behavior [46]. The models stress different issues of acquisition like requirement elicitation [45], rigor and standards [47], quality [48], [49], and also simplicity, rapidity and business issues [50]. The social issues are addressed in the Socio-technical Model (STACE) [50]. STACE suggests customer participation, participative management and collaboration. Optimum task grouping and multiple broad skills are addressed as part of the model as well.

Independent of approach, unavoidable tasks should be addressed. In accordance with Jadhav and Sonar [51] the process must include at least the following tasks in one way or another: 1) Requirements elicitation, 2) Alternatives identification, 3) Evaluation of features, 4) Selection 5), Final test 6), Contract negotiation and 7) Implementation.

Requirements elicitation plays an essential role [52] and is also a challenging task [53], [54]. The reasons for the difficulties in determining requirements may lie, among others, on two reasons: Firstly, the users derive the requirements mostly based on their existing work-related problems and not so much on the product features available [45]. Secondly, the selection is overly dominated by the vendor [55], which may limit the recognized opportunities and

comparison of candidates. Additionally, the criteria of evaluation used in selection should also be defined.

The next challenge is to identify the alternatives by conducting a market search meeting the criteria. The team has to prepare a short list by identifying the most promising candidates and eliminating the ones not having the required key features [44], [50]. The suggested strategies are progressive filtering, keystone identification and puzzle assembly [56].

Evaluation of features of the short listed alternatives is usually done based on written document information only. The candidates have to be evaluated and ranked. However, the formal methods are not used very often. The hands-on experiences about the candidates are also mostly limited to vendor demonstration [57]. Pilot studies and experimentation are used in a limited extend.

The final selection of the COTS product is regarded as a Multi-criteria decision making problem [52] in which the selection group chooses the "best-fit" between the software requirements and the features of the candidates. The final selection is always a trade-off and based on a combination of the technical, business, vendor and cost factors [58]. An evaluation method should be used to accommodate the evaluations of many users for multiple product features of the alternatives. The commonly proposed methods to calculate the best select are the Analytical Hierarchy Process (AHP) and Weighted Scoring Method (WSM). [59], [57]. When using WSM each criterion is weighted depending on its importance. For each candidate, the users evaluate the product features about how well they each of them meet the requirement. The weighted scores are calculated for the candidates. In AHP the evaluation is made pair-wise for each requirement. This method results in numerous pair wise comparisons and is unrealistic in many practical situations.

The final test, contract negotiation and implementation are not discussed very much in COTS literature. However, a pilot deployment should precede the final delivery of the system before the contract negotiation and final implementations [60].

IV. The COSA Model

Collaborative Software Acquisition (COSA) model applies organizational learning [22], [39] in COTS package acquisition and adoption. The model is designed to work as a user-friendly method for non-professionals in selecting their software packages. The idea of the model is that the users act in collaborative face-to-face meetings empowered with all decision rights and responsibilities for the decisions made. The COSA model interprets the four stages of organizational learning into phases of COTS package acquisitions (Fig. 2). The building of the team can be regarded as the fifth phase (Phase 0). Even if the phases are described as a sequential process, the team is suggested return to preceding phases whenever it looks reasonable. Repetition is actually embedded in the very nature of organizational learning in which knowledge shared and created in a "generative dance" [85] between individual-organizational and tacit-explicit dimensions.

The suggested principle of work organizing is the "middle-up-down", in which the middle managers have a central role; on the one hand, by acting as team leader to organize the "chaotic flow of ideas" towards a common goal and, on the other hand, trying to put the top managers' visions into daily work.

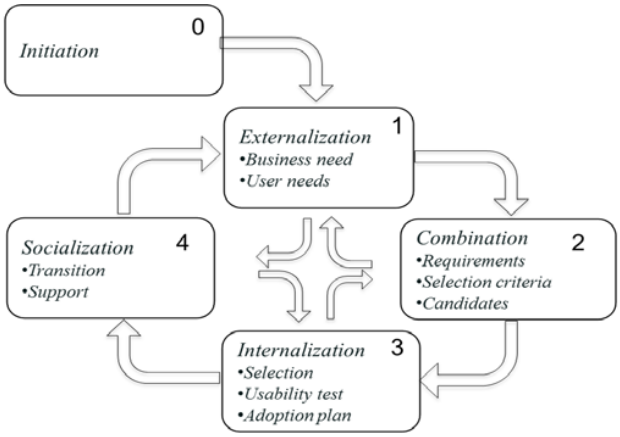

Fig. 2 COSA Model

A. Initiation

The users act in various roles in the "knowledge creating team": The top managers act as knowledge officers by providing resources and visionary ideas about the future systems. The middle manager act as knowledge engineer as team leader who facilitates the knowledge conversation processes and the flow of knowledge between the group and organizational levels. The team members make up of two groups of knowledge practitioners: The knowledge operators accumulate and transform context-specific tacit knowledge into explicit knowledge. The knowledge specialists combine the explicit knowledge into system concepts. The knowledge specialists need context free and industry specific knowledge, as well as enough experience about the business and IT solutions (Table I).

B. Externalization

In the externalization phase the team expresses domain-specific tacit knowledge in explicit form. The knowledge practitioners act as key players providing their work experience to build a shared understanding about the business context. Criticism, theorizing and evaluation of ideas should be limited as much as possible. The required changes have to be operationalized in terms of concrete organizational tasks. This leads us to investigate the working environment and define the required changes in job tasks due to the IT acquisition.

Extraction of tacit knowledge is basically a sequential process. The work-related issues such as routines, methods, tools, problems, impediments, can be listed in the order they come to mind. The notes and ideas can be registered without any pre-planned structure or hierarchy. A collaborative system analysis helps the team activate tacit knowledge and figure out the challenges of the new system. The use of archetypical

informal diagrams and prototypes helps make this knowledge explicit. As the result, the team becomes aware of what is important in the work in terms of business values, customer business needs, cost, etc.

All tacit knowledge that might affect the decision should be listed as well. These include, among others, personal experiences, attitudes, rumors and stories about the providers and products. For instance, some team members may have personal experience about a specific software package. This type of knowledge affects evaluation in relation to the products and should not influence the final selection too early. The company image may set some requirements for the software or provider as well.

Use Cases have a user oriented view by telling "a way to use the system" or describing the system in its environment "as it appears from the outside" [61, p. 168], [62]. Use case is a user-friendly way to link a user need of a task into a requirement of the system. The users are still free to use whatever method they know the best.

The first actual task is to specify the goals of the new application in terms of business need. The business need is expressed in form as a problem to be solved or as an opportunity to be exploited. The problem relates to the working context whereas the opportunity refers to software and business trends outside the company. It is recommended that the team members take some time to explore the market trends.

User needs refers to the expressed issues and functions which users want from the system. When the needs are specified as a requirement of the COTS system, they subsequentially become software requirements.

Elicitation of needs is social action in which different stakeholders try to share their viewpoints and awareness about the work content. The participants do not necessarily understand each other or share the same objectives. Strong personalities or power issues [63] may dominate the meeting even if they do not contribute much from a content viewpoint [64].

Still, the political issues should also be addressed in a positive sense. Some functionalities, especially those linked to core competences [65], critical success factors [66], or discriminating features [42] may be weighted by their relative importance. There are also features which cannot be linked to any specific task or job, but more likely to such issues as contract, compatibility, reliability, and portability of the product. The requirements for the vendor include features of the company like fame, size, location, etc. The results of the work are related to work contents and to user requirements.

C. Combination

Combination is a process of assembling new and existing explicit knowledge into a systemic form, such as specifications for a prototype of a new product [67]. In the case of COTS package selection, the selection team constructs a systematic view about the characteristics of the COTS software to purchase. The systematic view is a combination of the user-elicited needs and the features of existing COTS software offerings on the market. The process is actually not just a matching process between the features of the product candidates and the user requirements [68], but more likely, it complements the requirements-driven approach [69] with the market-driven [70] approach to help the user identify these requirements.

The primary goal of the phase is to specify the requirements, fix the selection criteria and find a "short list" of the candidate software products for further aptitude test. Eskelin [71] provides practical criteria for categorizing the requirements: 1) The Functional requirements refer to the functionalities of the software needed in the work. 2) The Non-functional requirements refer to general characteristics of the software like interoperability, portability, reusability, scalability, maintainability, performance, dependability, efficiency, reliability, robustness and usability. Finally, 3) the business issues refer to issues related to the contract (costs, licensing policy) vendor (capability, training, support, reputation) and market issues (marketplace changes, delivery period, market leaders, market trends, product reputation).

The selection criteria works as a filter to find the most promising COTS products on the market. Although the selection does not require a highly complex documented process, it should follow some kind of consistent process [11]. In order to diminish the work-load, special attention should be paid to the discriminating features of products and vendors. The knowledge specialists have to say whether the proposed solution really works and whether it suits with the existing standards, applications and infrastructure. In order to evaluate the products, a justification criterion for each requirement criteria has to be defined. The criterion may include explicitly expressed issues such as: business value metrics, functionalities, contract issues, etc. The criterion should also be measurable [42].

When all the requirements have been defined, a market search for the candidate vendors and software products can be selected for testing. Vendor demonstrations, third party evaluation reports, company visits and benchmarking can be used to obtain information. When preparing the test cases, the structure of the requirements can be organized as use cases. The stakeholders should also participate in the test session. The evaluation can be made measurable in numbers or other suitable scaling methods. The final scores can be calculated using a weighted scoring method. The process should end up with a short list of two or three candidates.

COSA process does not just find the "best" COTS product, but in addition, the participants create new organizational knowledge in form of new practices and information system. That process is a dynamic dialogue between tacit and explicit knowledge as well. A pure combination of explicit knowledge may cause superficial interpretation of the context. Anything may happen: unexpected discoveries, inadequacy of collected data [72], missing requirements, etc. Under these circumstances the team should keep the dialogue open between all four forms of knowledge and feel free to invent more requirements and selection criterion during the process when necessary.

D.Internalization

The internalization phase serves as the final aptitude test of the candidate solutions. In this phase, the users as well as various departments and stakeholders evaluate the concept, software product, as well as venders' capability. The team members learn to use the software at the individual level and gain concrete experience about how it works in real business contexts. The knowledge resources outside the firm might become more useful as they provide new information. However, the organization itself should 'own' the concept for the new system and validate the new information within the company [73]. The vendor may provide formal courses and demonstrations, but the actual tests should be implemented in-house and with real users and data. The stakeholders also see the application from different viewpoints and concentrate in different aspects. Keeping in mind the idea of organizational learning, the final decision has to be made in a collaborative judgment.

The evaluation process includes both tacit and explicit evaluation. Firstly, the users should get a hands-on experience about how the functionalities work in practice. This is a look-and-feel experience and fundamentally tacit in nature. The first hands-on experience takes usually place on the vendor demonstrations. The team should also test the software by them self. Secondly, the requirements should be rigorously evaluated against each evaluation criterion. The evaluator should avoid personal attitudes and use explicit, measureable and rational argumentation.

The team may pass the list of requirements to the vendor and ask them to demonstrate the software package in the light of the requirements. The team scores the candidate by each requirement. By using the average, the team selects the best candidate for the final test in real business environment and user data.

When the final decision is made, the team starts to prepare the plan for adoption. The adoption has two different types: evolutionary adoption is a diffusion process [74], in which the adopters of a technology learn about the innovation, are persuaded of its value, decide to adopt it, implement it and finally, reaffirm or reject the technology. The adopters are also divided based on their innovativeness, in other words how early they are ready to adopt the technology. The early adopters are the self-sufficient and technology oriented people who are also willing to take the risk to experiment with the technology, whereas the late adopters are risk averse by considering reasons and consequences for adopting the technology [28]. In that case the late adopters need much more convince and support them. Both groups should have a tailored adoption plan.

The adoption is revolutionary when it has to be instituted in its total and mature form in a 'big bang'. From the organizational learning point of view the evolutionally adoption is suggested. If the adoption is critical and no evolutional adoption possible the organization can may limit the time of incomplete adoption by implementing the application directly. In this case, the technology should be designed as an essential part of the regular work behavior and organization may take an active role in diffusing a technology to all individuals [75].

E. Socialization

The socialization phase is about supporting the software usage to spread throughout the organization. The benefits for the organization will finally actualize when the diffusion has proceeded widely enough. The adoption takes place as a diffusion process in which individual adopters perceive the technology's usefulness and ease of use [76]. The willingness to adopt depends not only on the individual adopter, but also on the organizational culture in general. Especially, this willingness is becoming important given the adoption of IS in applications, which support gross collaboration and require greater user participation [77]. When working in an interactive and collaborative environment the people also feel social presence and satisfaction [78], [79].

A successful diffusion requires organizational arrangements especially when the adoption requires deep learning [80]. The process can be promoted by using skilled and active staff members as the innovators or 'change agents' [81] who, by demonstrating an effective behavior, convince people for the change. The change agents should cover all departments and types of users in the target audience. Whatever the case is; a sense of voluntariness and user empowerment will help to create a good atmosphere for successful diffusion.

The effective use of information technology, as well as the acquisition process, is basically a learning process in which the adopters distribute and create tacit knowledge. In order to get full business value of that technology we should enhance its use and organizational renewal with environmental change. The created experience should be captured and shared. This can be made in a form of collecting experiences for further use into a group memory [82], [83] database, users' blogs, etc.

V. Conclusion and discussion

This paper describes the Collaborative Software Acquisition (COSA) model to help organizations in acquiring Commercial Off-The–Shelf Software package independently without ICT professional. The COSA model is expected to be easy to use and oriented to business terms. Additionally, a leading idea of COSA is that a COTS package acquisition is an on-going initiative of organizational learning and for this reason, the users and other stakeholders should be involved in this change process already from the start and not only as a source of information but as the principal drivers and decision makers. The success of the change initiative depends mainly on how intensively and motivated the participants are.

The contributions of the mode are as follows: Firstly, the model is to manage software acquisition as a dynamic process of knowledge creation in which the experience- and context-dependent tacit knowledge and the theoretical and universal explicit knowledge interact with each other. Secondly, the model empowers the users and other stakeholders to manage the change in their working environment from the subject of change to the agent to change, which will eventually increase commitment and working performance. Thirdly, the model

emphasis is less on technological knowledge but puts more focus on user-centered, business related knowledge, which should help an organization acquire proper software. Finally, empowering the users to acquire their software applications also strengthens the firms' competitive capability and provide independence from software vendors and ICT advisors outside the company.

COSA model focuses on requirements elicitation and commitment building among users. Some issues like risks and quality are not included in the model. This might be a problem. For instance the product features should be assessed also in relation to risks [72], especially when risks from failed products are high [75].

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