Knowledge Sharing and Application in Complex Software and Systems Development in Globally Distributed High-Tech Organizations Using Suitable IT Tools

Nataliia Samoilenko, Nazmun Nahar
Dept. of Computer Science and Information Systems, University of Jyväskylä, Finland

Abstract–**Although the quality of complex software and systems development greatly depends on the effectiveness of knowledge sharing and application, there is a dearth of research on effective knowledge sharing and application in globally distributed complex software and systems development of high-tech organizations by using suitable IT tools. Knowledge sharing and application in globally distributed complex software and systems development often fails due to inappropriate tools, processes, strategies and culture. Hence, the research is conducted to fill in this gap by examining how knowledge sharing and application can be facilitated, reviewing applicable theories (i.e. absorptive capacity theory) and identifying the most appropriate IT tools, methods and strategies that can significantly enhance knowledge sharing and application in developing complex software and systems in globally distributed high-tech organizations. An IT-supported framework has been developed based on an extensive review of past literature, expert views and personal experience in the field. The framework presents the most relevant IT tools, methods and strategies that have the capacities to facilitate knowledge sharing and application in globally distributed teams of high-tech organizations to a greater extent. The framework can be applied in both research and practice. The implications and future research directions are discussed as well.**

I. INTRODUCTION

Early Islamic philosopher Abu Bakr said*, "Without knowledge action is useless and knowledge without action is futile"*. Without knowledge application there is no use of knowledge existence. While discussing knowledge application it is important to take into account the following aspects [40]:

- ***what types of knowledge are used,***
- ***who use it**,*
    - *when to use it,*
    - *in which context,*
    - *under which conditions/circumstances,*
    - *how often,*
        - *the degree of knowledge complexity,*
        - *the importance of knowledge,*
        - *safety of knowledge, etc.*

Knowledge management consists of four major phases that are knowledge creation, knowledge storage, knowledge transfer/sharing and knowledge application/utilization. Knowledge application is the most important and critical phase, because if knowledge is not applied it is useless to implement the previous three phases of knowledge management cycle. Knowledge application can be defined as the actual use of knowledge for the benefit of an organization, team or individual [31]. Knowledge application involves various activities which are performed to facilitate effective usage of knowledge for achieving organization's goals, improving decision-making, developing complex software and systems, solving human and other problems [20]. In this study, the terms *knowledge application* and *knowledge utilization* are used interchangeably.

Knowledge utilization involves three major activities: retrieving, processing and applying knowledge [33]. When utilizing knowledge organizations deal with creating/producing, analyzing, transforming, comparing, evaluating and disseminating knowledge. High-tech organizations not only simply transfer knowledge to their employees, partners, clients, end-users, etc., but also investigate what types of knowledge are *critical/essential*, and particularly for complex software and systems development as well as how to enhance its effective use, easy acquisition and sharing among globally distributed teams.

The success of knowledge sharing and application in achieving organization's goals depends on 1) the **quality of knowledge** that should be applied or shared/disseminated, and 2) the **ability of an organization** to provide, manage and disseminate not only the general knowledge but also the *critical knowledge*. Therefore, high-tech organizations focus on identifying, managing and enabling some of the critical knowledge (i.e. best practices) to be accessible by other team members.

Knowledge application aims to a) enhance understanding, b) improve problem solving, c) decrease uncertainty in decision-making, d) increase critical knowledge application, e) nurture various skills and capabilities (i.e. technical), f) expand level of intelligence, g) support innovativeness, h) speed up productivity, i) enlarge know-how, j) encourage not only being reactive but also proactive organization [40,61] in general as well as k) facilitate the development of complex software and systems, communication and knowledge sharing in globally distributed teams of high-tech organizations in particular.

For efficient knowledge sharing and application organizations can encourage their development teams to be not only reactive, but also proactive. In turn, by deploying *proactive* approach, high-tech organizations can better serve their customers, implement customer requirements, satisfy end-users needs, assure safety of corporate knowledge use, increase competitiveness, etc. By leveraging *reactive* mode high-tech organizations can avoid "reinventing the wheel", evade mistakes and erroneous solutions, comply with standards, be able to compete on the market, etc.

Complex software and systems development is seen as knowledge intensive process where different types of knowledge (i.e. technical, business, design, processes, product-specific, domain-specific and other types of knowledge) are applied by globally distributed teams. High-tech organizations face challenges in communicating and applying different types of *critical* knowledge across geographical distances. IT tools become essential means for accessing, retrieving, collecting, processing/analyzing, disseminating and enabling knowledge. This study deals with knowledge sharing and application as well as the relevant IT tools, methods, strategies, etc. that can be used in these phases.

In particular, with the help of various suitable IT tools high-tech organizations can significantly facilitate sharing and application of knowledge in globally distributed teams needed for the development of *high quality* complex software and systems. However, organizations significantly face problems in selecting the most suitable IT tools from a huge amount of currently available and emerging tools that are needed particularly for knowledge sharing and application purposes. Furthermore, after the selection of suitable tools high-tech organizations may come across with the challenges of integrating the selected tools with internal corporate IT infrastructure/systems.

The previous studies [6,8,27,68] have only dealt with a few IT tools for knowledge application and sharing (i.e. expert systems, artificial intelligence, social media, simulation and other software). With respect to the selection and utilization of appropriate IT tools for knowledge sharing and application has not been widely investigated by the academia. Thus, there is a research gap that requires further investigation. The particular research problem addressed in this study is *how high-tech organizations can facilitate effective knowledge sharing and application/utilization for complex software and systems development in globally distributed teams?*

To answer the research question, an extensive literature review is carried out, where we a) extensively investigate the existing and emerging IT tools, methods and strategies that can support knowledge sharing and application in globally distributed teams in general and for complex software and systems development in particular, b) analyze each individual tool-specific features with respect to knowledge sharing and application, c) identify the most appropriate ones and provide organizations with supportive guidelines in selecting the suitable IT tools, methods and strategies for gaining maximum advantages from using them, and d) analyze and apply absorptive capacity theory. Finally, we develop a framework which consists of a wide variety of the most important IT tools that have the capacities in sharing and applying/utilizing knowledge. We then explain the application of these selected tools in detail.

The reminder of this paper proceeds as follows. The research methodology applied in this study is described in Section II. The literature review is conducted in Section III. The background theory (absorptive-capacity theory) applied in this study is discussed in Section IV. Section V develops a framework that consists of the appropriate IT tools that can help in effective knowledge sharing and application and discusses the implications of these tools. Finally, conclusions and implications are discussed in Section VI.

II. RESEARCH METHODOLOGY

We extensively reviewed previous literature that dealt with knowledge sharing and application where IT tools, methods and strategies were described to some extent. For this we explored various kinds of sources, such as digital libraries, printed materials and online sites/social media (i.e. contributed by experts, software developers and other practitioners in IS field). We examined various important databases (i.e. ACM, Nelli, Emerald, Elsevier, JSTOR, Linda and EBSCO), journals (i.e. IEEE, ACM and other IS magazines), conference proceeding and the relevant books. Moreover, we evaluated the importance of non-published information regarding the subject matter. We analyzed and summarized information systematically based on the selection of most relevant material related to the main research problem and objectives of this paper by following the procedure discussed below.

We followed the two-phase process consisted of: 1) literature review and 2) framework development. In addition, we analyzed and applied absorptive capacity theory which deals with organization’s capacities to identify and absorb external knowledge for achieving organization’s goals. *In the first phase,* we collected published material relevant to our main research problem and objectives through *keywords search*. Then, abstract and conclusions of the selected articles were read quickly for identifying the important information as well as contribution and importance of the authors’ findings on this subject matter. Based on the appropriateness of individual title and abstract, the irrelevant articles were eliminated and most applicable ones were read thoroughly. In particular, we rejected articles following these criteria that: a) did not deal specifically with knowledge sharing and application, or methods and strategies for knowledge sharing and application and b) discussed particularly the technical aspects of the technology or IT tools development and utilization. *In the second phase,* we developed a framework based on the analysis of various tools from the selected papers (information sources) that can help in knowledge sharing and application as well as summarizing the results.

III. BACKGROUND LITERATURE REVIEW

In this section, knowledge acquisition, knowledge sharing, knowledge application, complex software and systems development, and knowledge application in complex software and systems development are discussed.

A. Knowledge acquisition

Knowledge application is associated with acquiring knowledge. Knowledge acquisition can be defined as absorption and storage of new information in memory [58]. Knowledge acquisition refers to eliciting knowledge from external resources, understanding this newly obtained knowledge and transforming it into a form or representation (where knowledge representation aims at delivering knowledge in a structured way) that can be interpreted by people (teams, organizations) or processed by computers [2,36]. Knowledge acquisition may involve a) systematically collecting and structuring knowledge, b) intelligently representing it with the purpose to be retrieved by others, c) learning for obtaining missing skills (overcoming skills gap) needed for understanding recently acquired knowledge [2].

Before knowledge can be applied/utilized it should be understood by receiver/user for making decisions, solving problems or actually using it [43]. Ribes and Bowker [49] identified the following basic phases involved in knowledge representation, acquisition and application: 1) *understanding the problematic of interoperability;* 2) *learning the practice of knowledge acquisition;* and 3) *engaging the broader community*.

Organizations can facilitate knowledge acquisition through: a) sophisticated searching, b) intentional capturing of experts' knowledge, c) involving communities: identify valuable knowledge and expand its use inside communities/teams, supporting communication inside and among communities/teams, etc. [49]. From 1) knowledge retrieval systems where the focus can be on a) automatic knowledge retrieval, e.g. automatic knowledge retrieval from the Web [56] and automatic knowledge retrieval from conceptual models [4] as well as b) organizing knowledge in a structured way for alleviating its retrieval), 2) information retrieval systems (i.e. web search engines) and 3) data retrieval systems (i.e. database management system) organizations can acquire knowledge [66]. Various IT tools can be deployed for accessing knowledge, supporting knowledge acquisition or retrieval as well as managing and applying increasing amount of knowledge; for example the solutions provided by company *Acquired Intelligence* (http://aiinc.ca/) delivers customized applications for increasing usability and efficiency.

B. Knowledge sharing

Through knowledge sharing information, ideas, skills or expertise are exchanged among people, teams, an organization or a community.

Knowledge sharing activities are usually supported by knowledge management systems. However, technology is only one of the many factors that affect the sharing of knowledge in organizations. Some of these factors are organizational culture, trust, and incentives [13]. Some employees are likely to resist sharing their knowledge with the rest of the organization [16].

To enhance knowledge sharing and eliminate knowledge sharing obstacles, the organizational culture should encourage discovery and innovation. This may in turn result in the creation of a flexible organizational culture [16].

Knowledge sharing plays essential role for knowledge application procedures. Without exchanging of ideas, thoughts, information and knowledge, intensive communication and a trustful environment, globally distributed teams encounter problems in applying knowledge. Organizations located in various countries with different cultures, geographical distance, customs, traditions, political situations, government rules and regulations, different languages, etc. can add additional obstacles to knowledge sharing and application. Therefore, creating a collaborative working environment with the help of various IT tools can eliminate many of these obstacles. For example, social media, cloud computing, etc. can be widely used for knowledge sharing among people located around the world.

C. Knowledge application

"An important aspect of the knowledge-based theory of the firm is that the source of competitive advantage resides in the application of the knowledge rather than in the knowledge itself" [1,p.122]. Therefore, organizations value and strive to exploit effective and intensive application of knowledge rather than knowledge itself.

Jović and Draskovic [31] defined knowledge application as the actual use of knowledge for the benefit of an organization, team or individual. Knowledge application means placing knowledge into action.

Knowledge application involves three major activities: retrieving, processing and applying knowledge [33]. "Knowledge application phase describes integrating knowledge into organizational practices by using technology to guarantee effectual use of knowledge. Moreover, knowledge application translates information into practical tools and applying the knowledge into real world" [32].

In this study ***knowledge application*** refers to the process of acquiring, retrieving, analyzing or processing, evaluating, comparing and using knowledge for achieving organizations' goals in general and complex software and systems development goals in particular, - with the help of appropriate IT tools, methods and strategies which are needed for supporting communication, executing development tasks, solving complex problems and working together in globally distributed teams of high-tech organizations.

Knowledge application is about *absorbing* knowledge. Knowledge application involves various activities, such as learning, conducting research, training, testing, actual usage of knowledge, etc. While applying knowledge organizations need to focus on: decreasing uncertainty in problem-solving, facilitating *complex* decision-making, enhancing quality of new knowledge creation, improving dissemination and communication in general and among globally distributed teams in particular.

Knowledge is applied by people who can be located in geographically dispersed countries with different cultures, educational backgrounds, working practices, norms, laws, etc. Globally distributed teams who develop jointly complex software and systems encounter difficulties in communication, coordination of development tasks, collaboration and mutual work as well as they need to deal with misunderstandings, miscommunication, frustration and other problems due to differences in cultures, working norms, routines, traditions, regulations, etc. Therefore, laws established by government where the organization is located, culture of that particular country or organization, norms and goals of a project or a team, etc. should be taken into account when dealing with various globally distributed teams for achieving complex software and systems development goals.

D. Complex software and systems development

Complex software and systems development is a sophisticated process which involves teams of specialists (software engineers, software architects, systems developers, testing managers, IT managers, systems integrators) from different industries with different backgrounds, who create millions of lines of codes software or system. The software or the system is then integrated with hardware and peripherals. Such software or system is complex as it must interact with the physical world and take into account possible changes in settings, external environment and physical devices itself (or peripherals) throughout the execution process. It is not just "the realization of mathematical functions as procedures" [34,p.1]. It is much more laborious process due to the development of heterogeneous systems (consists of software, hardware and physical devices) with rigorous requirements analysis, high demands for accurate performance, strict time limits given for execution, need for reliable backup support and may include a huge amount of different types of resources. The *quality* of complex software and systems plays crucial role, as in some cases, human's life depends on its functioning [34].

The ability of development teams to facilitate effective communication, exchange skills, ideas and experiences, conduct mutual collaboration and support a friendly working environment are important issues for complex and large scale software development projects. Selecting appropriate technology and methodologies are essential for coordinating and managing teams of software engineers by assigning specific roles, giving instructions, providing training, etc. All these require intensive interactions and exchanging of knowledge among globally distributed teams.

E. Knowledge application in complex software and systems development

In this study, we define ***knowledge application in complex software and systems development*** as the actual use of lessons learned, personal experiences and skills, best practices of an organization, etc. for developing complex software and systems by a) utilizing appropriate IT tools, methods and strategies for communication, coordination and collaboration, b) working on the same project and c) sharing and exchanging ideas, knowledge, experiences, files, etc. in globally distributed teams. It can involve accessing, retrieving and capturing knowledge of individual, expert, corporate, etc. It also deals with codifying and integrating new knowledge that is obtained through learning. Merging the newly obtained knowledge with personal knowledge and modifying knowledge when applying to specific software development purposes, etc.

Software developers obtain new knowledge from individual project. This can be obtaining corporate knowledge concerning the new product development, sharing experiences among the team members, exchanging ideas between the team members, giving advices to novice, etc. In some cases, the effectiveness of knowledge application relies also on the software developers' capabilities to absorb and apply critical knowledge efficiently. Thus, we analyze and apply the absorptive capacity theory in this research (see Section IV).

Organizations can gain significant advantages from **reusing** corporate knowledge and relevant external knowledge from other institutions, partners, clients, competitors, end-users, etc. Thus, supporting reuse of valuable external knowledge and *extensive reuse of corporate internal knowledge* (i.e. best practices, lessons learned, important archives, etc.) of an organization - can facilitate complex software and systems development to a greater extent.

IV. ABSORPTIVE CAPACITY THEORY

Rapid evolving of technologies, shortening of technology and product life cycles, frequent changes in customer requirements, fast progress in software industry, competitive business environment, increase volume of knowledge, etc. (or we call it, *dynamic context*) require high-tech organizations to be able to react to all these challenges quickly. Consequently, in such a dynamic context, it also entails for organizations to realize, process, absorb and apply external knowledge.

Cohen and Levinthal [15] defined ***absorptive capacity*** as "the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends". Absorptive capacity also called "learning" process [15].

Absorptive capacity theory explores an organization's ability to identify new knowledge from external resources, integrate it with internal resources and use it for achieving organization's goals [15]. According to the theory, an organization with higher capacity in absorbing "external and new knowledge" has the higher ability to succeed in achieving organizational goals in comparison to organizations which have poor absorptive capacity. Moreover, organizations with higher absorptive capacity will proactively search for new knowledge and actively absorb it. In contrast, organizations with lower absorptive capacity will avoid some important changes by not implementing them as well as will also elude new knowledge search and acquisition. Different types of tacit and explicit knowledge are required by the development teams for developing *innovative* and *high-quality* complex software and systems. Thus, high-tech organizations should extensively support and enhance absorptive capacity in globally distributed teams. Hence, absorptive capacity theory is the most appropriate candidate for this research.

Absorptive capacity in globally distributed teams of high-tech organizations. The ability of software development teams to absorb internal and external knowledge is essential in complex software and systems development. However, coordinating the absorption related activities among globally distributed teams becomes more difficult. IT tools are inevitable for supporting communication among globally distributed teams, storing and transferring knowledge, working on the same projects where implementing joint tasks, simultaneously making new changes and adding new documents, updating various versions of the same programs, etc. In turn, by using appropriate IT tools globally distributed teams can enhance their absorptive capacity.

Absorptive capacity of an organization depends on *prior knowledge*, and in particular: 1) prior corporate's knowledge and 2) relevant background of each individual of a team [15,25]. Globally distributed software development teams are consisted of individuals with different but relevant backgrounds and who possess knowledge, experience and skills in different industries. Therefore, absorptive capacity of these teams can be enhanced by a) efficiently storing related prior knowledge and applying this knowledge whenever necessary and b) providing simple access and easy retrieval of corporate knowledge. Creating and maintaining a corporate knowledge base is needed for supporting efficient knowledge storage, maintenance and retrieval. In addition, organizations can provide training and learning programs of software development teams with the purpose of educating and encouraging each individual to apply personal knowledge and capability along with externally obtained knowledge. As a result, by using such engrained knowledge of each individual as well as by efficiently storing and disseminating it among individuals, organizations can enhance and develop absorptive capacity of a team significantly.

Absorptive capacity of an organization consists of two major elements: 1) external knowledge acquisition and 2) internal knowledge dissemination [28,37]. Knowing and being aware of some innovations, advancements, updates, etc., that occur externally outside the boundaries of an organization is not enough, software development teams should be able to respond to those changes actively [37].

Zahra and George [67,p.186] reconsider absorptive capacity as *dynamic capabilities* which can be *potential capacities* (associated with knowledge acquisition/retrieval and assimilation) and *realized capacitates* (associated with knowledge transformation and application/exploitation). In most of the cases, the primary focus is more on analyzing and reporting realized capacities. Yet, organizations show a lack of attention to potential capacities, which can contribute to innovative complex software and systems product development. However, potential capacities not necessarily mean actual knowledge application or exploitation [15,67].

Teece et al. [59] defined "dynamic capabilities as the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments. Dynamic capabilities thus reflect an organization's ability to achieve new and innovative forms of competitive advantage given path dependencies and market positions". They stated that the essence of organization's dynamic capabilities consists of three major elements: **processes, positions, and paths** and described as "organizational processes, shaped by the firm's asset positions and molded by its evolutionary and co-evolutionary paths, explain the essence of the firm's dynamic capabilities and its competitive advantage".

Sáez et al. [52] identified two core constituents of dynamic capabilities: 1) *absorptive capacity* with the focus on identifying new external resources, transforming them for learning, understanding, assimilation, adaptation and capitalizing by an organization and 2) *innovative capacity* which means *proper* ability to use internal knowledge base and resources for responding to external changes *effectively*. Only focusing on absorptive capacity without *effective utilization* of newly absorbed knowledge for developing distinctively higher quality and innovative complex software and systems can increase cost significantly and create low quality or unsuccessful product. Yet, only devoting into the innovative capacity may not provide *sufficient* knowledge related to product concept creation process needed for developing sophisticated software and systems. Thus, by fostering and sustaining dynamic capabilities with the focus on both absorptive capacity and innovative capacity organizations can develop higher quality products in comparison to the outcomes that can be obtained by nurturing only absorptive capacity which can be risky or only innovative capacity which can bring scarce information needed for developing complex software and systems.

However, high-tech organizations develop complex software and systems in a dynamic context with rapid changes in technologies, client requirements, end-users preferences and market demand; increasing volume of knowledge; frequent updates, etc. which urge them to develop also *adaptive capabilities*. Adaptive capabilities mean "ability to identify and capitalize on emerging market opportunities" [5,10,29,64]. Tuominen et al. [62] and Biedenbach and Müller [5] identified that ability to adapt to technological, external market and internal organizational changes in time/early enough can constitute high level of adaptive capacity. Biedenbach and Müller [5] and Wang and Ahmed [64] expanded the term dynamic capabilities to three elements: absorptive, innovative and adaptive capabilities. High-tech organizations can gain competitive advantage by nourishing 1) absorptive capabilities for identifying and processing the newest information related to complex software and systems development; 2) innovative capabilities for developing innovative software and systems or updating and enhancing current products; and 3) adaptive capabilities for investigating evolving market prospects, identifying potential product niche and forecasting future trends [5].

Teece [60] asserted the necessity of developing dynamic capabilities of teams to gain organization's competitive advantage: "(1) to sense and shape opportunities and threats, (2) to seize opportunities, and (3) to maintain competitiveness through enhancing, combining, protecting, and, when necessary, reconfiguring the business enterprise's intangible and tangible assets."

While discussing dynamic capabilities it is important to consider *learning* process. Dynamic capabilities and learning process are closely related components which can enable organizations to achieve higher level performance, agility and business goals. Through provision of **adequate training** the organizational capabilities and learning skills can be improved significantly. Training *type* (i.e. learning by doing, learning by using, etc.), *level* (i.e. single-loop learning, double-loop learning, etc.) and *context* (i.e. teams, organizations, communities, etc.) should be considered when arranging training program [3]. Different types of training to address particular complex software and systems development goals can be organized at different level of complexity ranging from more simple programs for novice to more advanced level knowledge interpretation and acquisition for software engineer experts. For example, deutero learning, adaptive learning, emulation, imitation, cognitive learning, collective learning, education and other ways can be arranged for teams or individuals [3,p.2]. Through computer-based support or e-learning (e.g. various online learning programs: http://www.cbtplanet.com/), simulation tools, classroom learning, self-study, etc. globally distributed teams can obtain or develop necessary knowledge, skills and capabilities needed for complex software and systems development.

For example, Zollo and Winter [70] differentiated three types of learning: 1) *experience accumulation*, 2) *knowledge articulation*, and 3) *knowledge codification*. In general, there are two major categories: *individual learning* and *organizational (social or collective) learning* [3].

Cultivating and maintaining dynamic capabilities are needed in order to be able to respond and adjust to different kind of changes in customer requirements, market situations, product related regulations, etc. By restructuring corporate knowledge repositories and/or reconfiguring corporate systems, reintegrating earlier deployed IT tools or replacing it with newer IT tools, reviewing existing enterprise architecture, updating available resources, etc. organizations can provide their globally distributed teams with multiple resources, enhance knowledge renewal and circulation and as a result, improve dynamic capabilities. However, it can be costly and hard to incorporate modern IT tools or reconstruct existing corporate system and modify enterprise architecture. The other challenges can be in selecting the appropriate IT tools for knowledge maintenance, dealing with advancements in technologies and rapidly increasing volume of knowledge. Therefore, in this study we identify the most appropriate IT tools, methods and strategies that can significantly support dynamic capabilities needed for effective knowledge sharing and application in globally distributed teams while developing complex software and systems.

The greater challenges are associated with reacting accordingly and effectively to various changes that can occur in dynamic environment. Utilizing suitable IT tools, methods and strategies and adjusting to frequent technological changes can significantly accelerate the development process of complex software and systems in globally distributed teams. However, high-tech organizations still need assistance in selecting the most suitable ones from diverse IT tools and understanding each individual tool-specific functionalities with respect to knowledge sharing and application. Thus, we summarized the benefits that can be gained and the problems that should be taken into account while utilizing each specific tool (see Table 1 in Section V).

V. A FRAMEWORK OF IT TOOLS FOR KNOWLEDGE SHARING AND APPLICATION: THE EXPECTED BENEFITS AND PROBLEMS

Through an in-depth literature review, we identify a broad range of currently existing and emerging IT tools. We select and analyze the most relevant IT tools that can support knowledge sharing and application in globally distributed complex software and systems development as described below (see Section A & Table 1). The selection process was based on analyzing and evaluating different features of the identified IT tools. We examine the effectiveness, such as positive and negative impacts of utilizing each particular tool for knowledge sharing and application. We explain the benefits that organizations can gain and the problems they encounter that may need to solve in knowledge sharing and application when utilizing these tools. In Table 2, the knowledge sharing and application aspects of each individual IT tool with respect to absorptive, innovative and adaptive capabilities of the absorptive capacity theory are presented.

A. IT tools for knowledge sharing and application/utilization and their implications

Artificial intelligence (AI) software. By developing robots/agents and applying intelligently knowledge of humans into these robots/agents with the help of computer systems, experts strive to improve decision making, ease problem solving, help in dealing with complex tasks and simulate human behavior. In particular, building autonomous agents for dealing with consciousness (e.g. Consciousness and Emotion Reasoning Architecture) was developed by Moreno and de Miguel [42] [8]. Artificial intelligence (AI) facilitates knowledge application through codification of knowledge and storing it in knowledge repositories in such form so that it can be extracted and used by many users. AI supports processing of information with the help of various algorithms and methodologies. For instance, with the help of *neural networks* experts can apply stored knowledge to solve practical problems, e.g. which loan applicants are too risky can be predicted and they will not be given loan.

Through intelligent search, discovery, retrieval and filtering of information experts can obtain valuable information and gain new insights. AI refers to the utilization of intelligent agents, expert systems, natural language processing, speech recognition, image recognition, neural networks, fuzzy logic, etc. [8,18]. AI is used for managing a huge amount of information, such as for capturing and representing knowledge of many experts. With the help of AI experts strive to automate workflow [18]. However, it can be problematic to automate more sophisticated processes. Other difficulties arise when developing AI systems which require knowledge and expertise from diverse industries, a long period of time and high financial resources. In some cases, lack of filtering of information, inability to adapt to changing environment and lack of creative thinking can result in poor solutions. In addition, AI cannot explain reasoning behind giving solutions in some cases.

With the help of AI some specific tasks can be performed much faster than human can do. AI can repeatedly process a huge amount of data where human is incapable. It can tolerate various conditions and recover from system failures [18]. In addition, through the application of Semantic Web methods, processing of the content on the Web pages can be improved and accelerated.

Expert systems (ES)/knowledge-based systems (KBS). Expert systems (ES) support knowledge application by capturing, integrating, organizing, and representing knowledge of many experts. It improves decision making and problem solving by collecting best practices from different industries (e.g. related to software engineering), simulating human expert way of thinking (e.g. reasoning such as logical way of human thinking, etc.), defining and analyzing problems as well as giving ready solutions or new decisions that experts may not be aware of [68]. However, in some cases ES is not capable of finding mistakes that human eyes can spot immediately. In some cases, it may be difficult for a human to interpret the reasoning and logic behind the solutions provided by ES [68].

ES includes *knowledge database* which contains knowledge of many experts and *inference engine* which imply searching and sorting of information, applying certain algorithms, rules and logic associated with problems in order to give solutions. Through analysis of problems or information with the help of ES, experts can derive better quality solutions. However, ES requires frequent updates of knowledge databases and it cannot adapt to changes (e.g. in working environment and conditions when human react automatically) [30]. There are neural networks, genetic algorithms, fuzzy logic, rule-based, frame-based, mixed and other types of expert systems [68] with different degree of problem solving capability.

ES is important for managing domain specific knowledge. ES is built on knowledge acquired from multiple sources (knowledge from work and materials of different experts) which are specific to a certain domain. ES delivers richer knowledge which can support more qualitative decision making and domain specific solutions can easily and quickly be found. It can be used in situations when precise rules should be applied to obtain quick solutions (e.g. by using IF-THEN statement: “IF the animal is warm blooded and purrs THEN the animal is cat” [38]), forecasting based on past data, etc. ES contains both explicit and tacit knowledge. One of the advantages is that ES allows transformation of explicit and tacit knowledge into a format that can be retrieved by others. ES simulates human way of applying knowledge, analyzing it and deriving solutions. The benefit of ES is that it can perform the same work by applying the same knowledge and logic repeatedly where human would feel exhausted or when human is retired and can no longer apply his knowledge and perform the job. Another positive feature is that through application of previous knowledge and certain logic ES can derive new solutions. At the same time users should possess required degree of knowledge in order to use ES correctly and make use of the content of the knowledge that ES provides.

Simulation software. With the help of simulation software users can be placed in different environments where they can see and follow step by step processing of knowledge application, explore problems/tasks and activities, receive fast feedback, etc. Through observing how experts or computer systems utilize embedded knowledge in context-specific environments, users with different backgrounds can learn and obtain new knowledge/insight. Users with different level of background knowledge can search for suitable programs and choose needed level of complexity for learning and applying own skills [24]. However, often there is need for predefined or some basic level of knowledge for being able to perform assigned tasks and/or to analyze outcomes of simulation programs [27].

Simulation software facilitates knowledge utilization by providing experts with tool which can contain specific information, themes and features (such as terminology; practical exercises imitating real environment and conditions where users can practice, see mistakes, analyze results, etc. related to certain domain) for advancing learning and absorbing of new information and knowledge. By displaying information, providing fast feedback, allowing dialogue with computer programs and generating “what-if” scenarios, experts can use their knowledge through different modes for accelerating problem solving and improving decision making. Through application of certain algorithms, rules, logic, etc., simulation software can deliver results on certain input information. However, it can be difficult for experts to understand and explain the results of simulation derived from input information.

Decision support systems (DSS). Decision support systems (DSS) aims at improving the quality of decisions through data analysis, usage of knowledge-based systems/experts systems, comparing various existing solutions and applying different options for evaluating potential results [23,55,69]. In particular, intelligent decision support system (IDSS) consists of DSS and artificial intelligence (AI). IDSS can be categorized into group decision support system (GDSS); distributed decision support system (DDSS); intelligent, interactive and integrated decision support system (3IDSS); intelligent decision support system based on knowledge discovery (IDSSKD) [69]. For example, GDSS can be effective tool for supporting collaboration and knowledge sharing in groups during decision making process.

DSS is based on knowledge of many experts and intelligent computer programs. Moreover, DSS allows management and integration of experts' knowledge with other experts' knowledge in an efficient way. Through collecting, combining and analyzing knowledge from different sources, DSS supports more effective management of knowledge and improves decision making [23,55,69]. However, the quality of collected knowledge relies on inputs and existing sources. DSS offers options for processing of information, applying certain methods, exploring and evaluating results, etc. However, experts are responsible for inputting information into the system and choosing a right option for analysis of information. Experts should have certain knowledge for putting correct inputs into the right places in the systems in order to receive correct outputs. DSS can provide experts only with certain processed information, but it is not capable of making decisions itself. Therefore, knowledge and expertise of experts are required for making use of results received from DSS and decide upon final decisions.

Social media. Through social media users are encouraged to share not only explicit, but also tacit knowledge and personal experiences.

Social media can help to improve the quality of software development by facilitating communication among employees, exchanging experiences, supporting decision making, receiving feedback, etc. [6].

Wiki systems. Wiki systems can be used for knowledge sharing and application. Employees are encouraged to share their knowledge and experiences for achieving organizations goals collaboratively [25,65].

Anyone can access, add and modify the content of the wiki which may cause difficulties in structuring or reorganizing wiki websites. Contributors may want to add new category (or page), expand a category with subtopics, reorganize the existing structures, etc. [63].

Users may come across with problems of finding needed pages or information and connections among multiple pages. It can be difficult to keep various versions of the created and modified content across multiple pages [17].

Company blogs. By deploying *company blogs* organizations can facilitate knowledge sharing, communication and collaboration among employees [44]. Blogging enhance the quality of software by aiding during the development process. For example, "blogging by developers is used to discuss fixes to shared problems" [6,p.10].

However, this endeavor requires sufficient resources from organizations to provide a group of people who can devote their time and efforts for contributing and maintaining a company blog. In addition, there are risks of knowledge leakage outside the boundaries of an organization, knowledge misuse, misinterpretation and misunderstanding.

Cloud computing. "Cloud Computing provides a collaboration platform for knowledge sharing" [11,p.670]. It facilitates knowledge sharing with the help of Web 2.0 solutions [35]. It improves problem solving by supplying various resources and technologies.

However, there are a number of risks associated with cloud computing on-demand service delivery: the provision of service depends on the work of service providers, data can be lost in case of computer systems failures, etc. [9].

Grid computing. "Grids provide a robust and highly scalable infrastructure for multi-purpose problem solving tasks" [39,p.54]. "Grid computing is coordinated resource sharing and problem solving in dynamic, multi-institutional virtual organization" [22].

"The essences of grid physical network are to continuously speed information flow through improved processing, storage, discovery, retrieval, acquisition, and sharing within expansive colossal social networks" [41,p.366].

Grid computing improves knowledge application and sharing by offering users high capacity IT tools performance. It supports decision making processes by developing advanced solutions with the help of other technologies [39]. It can speed up problem solving and risk management by combining various systems and sharing computer resources while minimizing cost and time consumption [41,51]. For example, grid computing enhances execution of tasks by balancing load performance and tolerating faults with the help of utilizing immense storage capacities located in distributed places around the world [44].

However, there are some disadvantages, such as it is not clear how grid computing can be connected with knowledge management principles. For example, "how Grid Computing can amalgamate collaborative machine semantics with human cognitive activities" [44,p.366]. There is inefficient understanding between computing power performance and human interactions. Particularly, the challenges arise in dealing with tacit knowledge application and communication and especially, in globally distributed environment.

Moreover, it requires extensive knowledge from users to be able to understand grid computing environment (e.g. what tasks/functions are performed on which host) [7].

Storage virtualization. Storage virtualization facilities can be used for efficiently storing and managing knowledge with the purpose to be further retrieved, applied and shared among users. It allows sharing of information resources over the geographical distance which facilitates knowledge application as well [46].

Storage virtualization improves knowledge application and sharing by providing “transparent data migration, data replication, thin provisioning, and space- and time-efficient backups” [50,p.40]. However, there are “the limitations of the underlying technology and the complex administrative handshake required to leverage the features of the virtualization” [50,p.40].

Server virtualization. “Server virtualization (or virtual server consolidation) enables multiple virtual operating systems to run on a single physical machine, yet remain logically distinct with consistent hardware profiles. The “host” operating system creates an illusion of partitioned hardware by executing multiple “guest” operating systems” [12,p.44]. Server virtualization increases storage capacities (e.g. managing larger volume of data)

Server virtualization allows simultaneous execution of multiple tasks while efficiently utilizing computer resources. It can improve quality of service provision while reducing costs. Yet, there are risks associated with server breakdown (or “single point of failure”), lack of vendor support and control over operations as well as demand for machines with high processing power capacity [12,47].

TABLE 1. A FRAMEWORK OF IT TOOLS FOR KNOWLEDGE SHARING AND APPLICATION/UTILIZATION

Knowledge sharing and application/utilization phase			
Phase specific utilization of IT tools	**Benefits obtained**	**Problems/Difficulties encountered**	**References**
Artificial intelligence software (e.g. Watson, BLIASoft Knowledge Discovery, KnowledgeX, etc.)	• Development and use of intelligent agents/robots. • Includes a wide spectrum of fields: experts systems, robotics, natural language processing, speech recognition, etc. • Performs knowledge codification, processing and application. • Intelligent management of knowledge. • Simulates human expert thinking process. • Improves decision making, problem solving, optimization and forecasting. • Automation of work (e.g. autonomic configuration, recovery and optimization computing). • Uses Semantic Web methods for machines to better analyze and process content on the Web. • Uses intelligent agents for knowledge application (e.g. learning agents learn from users' behavior and obtaining new knowledge for giving better solutions). • Provides content analysis and summarization of text. • Does some tasks much faster than human.	• Lack of creative thinking. • Unable to automate sophisticated processes. • Cannot adapt. • Cannot explain reasoning for giving solutions. • Lack of filtering of information. • May give wrong/biased solutions.	[8,18]
Expert systems/knowledge-based systems (e.g. Exsys, Vanguard, XpertRule, etc.)	• Help in decision making and problem solving. • Are based on knowledge of many experts. • Allow capturing, organizing and representing knowledge of many experts. • Consist of *knowledge database* and *inference engine*. • Perform human work and thinking simulation (e.g. reasoning, carrying out, giving advises, etc.). • Define problems and causes of these problems, suggest solutions and give recommendations. • Provide analysis and interpretation of problems and questions. • Support forecasting based on the past data. • Suggest solutions that experts may not be aware of. • Transform tacit and explicit knowledge into a form that can be presented to, accessed and used by others. • Are utilized across many industries.	• Require frequent updates. • Cannot adapt. • Users are required to have a certain level of knowledge in order to use systems correctly. • May lead to wrong decisions. • Lack of creativity. • It can be problematic to explain the reasoning and logic for some solutions.	[30,38,68]
Simulation software (e.g. MATLAB and Simulink, Stella, iThink, AnyLogic, NetLogo, etc.)	• Alleviates decision making and problem solving. • Available for users from different industries with different backgrounds. • Learning, seeing, improving understanding (e.g. how certain systems work) and obtaining missing/new skills and knowledge. • Analyzes and displays knowledge. • Analysis with “what-if” scenarios.	• Can be difficult to explain the results of simulation. • Requires a certain level of knowledge for being able to analyze outcomes.	[24,27]
Decision support systems (e.g. Vanguard, Analytica, Decision Lab, Decision Manager, etc.)	• Provide tool and augmented knowledge. • Improve quality of decisions. • Improve information management and evaluation. • Provide user friendly interface for integrating and making analysis of information.	• Do not make decisions itself. • Rely on input knowledge (e.g. incorrect inputs deliver incorrect outputs). • Require expert knowledge to make	[23,55,69]

	• Support efficient information processing. • Help in automating tasks (e.g. through mathematical calculations, sorting, etc.). • Performs some specific tasks similar to experts (e.g. by applying certain rules, algorithms, methods, etc.). • Support management and integration of experts' knowledge with other experts' knowledge and computer systems. • Apply simulation approaches for supporting decision making and problem solving rapidly. • Support "what-if" analysis of problems or tasks.	final decision. • Challenges in designing human-computer dialog.	
Social media (e.g. LinkedIn, Facebook, Twitter, Skyrock, Bebo, MySpace, Orkut, Trig, Digg, etc.)	• Enhance software development quality. • Facilitate knowledge diffusion and sharing.	• Misuse of knowledge. • Security issues. • Quick spread of information (e.g. build or damage brand image).	[6,19,48,54]
Wiki systems (e.g. Tiddly-Wiki, Media-Wiki, Phpwiki, Usemod, Pmwiki, Tikiwiki, Moinmoin, Oddmuse, etc.)	• Expedite knowledge sharing. • Improve knowledge use. • Make and manage links among topics easily. • Editing the content by multiple users. • Convenient tool for collaboration across geographical distances. • Support knowledge revision and update. • Help to build and use knowledge in "target field".	• Difficulties in structuring wiki websites. • Evolving nature of wiki pages. • Lack of connections among pages. • Difficulties in maintaining the content of a wiki across multiple pages.	[17,26,63,65]
Company blogs (e.g. Blogger.com, WordPress.com, etc.)	• Facilitate knowledge sharing and discussions among people located in globally distributed organizations. • Content management and integration with other media and content. • Targeted communication formed by virtual community with common interests and goals. • Receiving instant feedback, comments, replies to questions. • Regular reviews and updates of the content. • Enhance software development quality.	• Require sufficient recourses. • Lack of knowledge safety. • Depends on the knowledge and efforts contributed by users.	[6,44]
Cloud computing (e.g. Dropbox, Amazon EC2, Amazon S3, etc.)	• Platform for collaborative knowledge sharing. • "Support complex applications" [35,p.174]. • "Provide channels, tools and chances for users to transform knowledge for use" [35,p.174]. • Accessing highly scalable resources and services from anywhere at any time via internet. • Provide dynamic, intelligent, autonomous and large-scale environment for knowledge sharing and application.	• Security risks. • Dependency on third party/service provider. • Risks of data loss.	[9,11,35,39]
Grid computing (GC) (e.g. Globus Toolkit, UNICORE, gLite, CNGrid GOS, etc.)	• Supports knowledge discovery and sharing. • Improves knowledge application and processing. • Parallel execution of tasks. • Has immense storage capacities utilization. • Balances load performance. • Has fault tolerant capacity. • Speeds up decision making. • Solves large-scale computational problems [45,p.239]. • Provides access to grid resources. • Accessible from everywhere and sharable by everyone.	• Complicated grid computing environment. • Unclear link between GC mechanisms and knowledge management principles. • Complexity of tacit knowledge utilization. • Increased complexity of GC infrastructure and decreasing users with technical knowledge.	[7,21,39,41, 45,51]
Storage virtualization (e.g. NetApp Data ONTAP, EMC Invista, IBM SAN Volume Controller, etc.)	• Data can be accessed, shared and relocated over the geographical distance. • Ease data management. • Dynamic reconfiguration of the shared storage resource. • Speed up application recovery. • Integrated data management.	• Increased infrastructure complexity[53]. • Risks associated with backup support. • Reliance on service provider.	[46,50,53]
Server virtualization (e.g. VMware, Xen, etc.)	• Facilitates knowledge application and sharing. • Improves problem solving and decision making. • Quickens disaster recovery. • Dynamic resource scheduling. • Optimized server capacity utilization. • Heterogeneous workloads execution.	• Relies on server performance. • Dependence on vendor quality service. • Limited tasks/processes controllability. • Requires powerful machines.	[12,47,57]

In this section, we first summarized the most appropriate IT tools for knowledge sharing and application. It discussed the positive and negative impacts of using each individual tool for sharing and applying knowledge. The framework can support high-tech organizations in sharing and applying knowledge for developing complex software and systems in the globally distributed context with the help of appropriate IT tools. In particular, the selected IT tools can be used for a) tacit and explicit knowledge capturing, codification, analysis and application, b) automatic processing of information, c) simulation of human thinking, d) decision making, etc. The framework can assist in understanding the benefits that can be gained and the problems that can be encountered while using each individual tool for sharing and applying knowledge to achieve the organization's goals.

The success and quality of complex software and systems development relies on the effectiveness of knowledge sharing and application by globally distributed teams. If the existing knowledge is not applied to its fullest potential or shared with other members of software development teams, there is no use of its creation, storage and sharing/transferring. Accepting or rejecting and further absorbing the obtained or retrieved knowledge are essential for applying knowledge in general and in complex software and systems development in particular. Hence, for effective knowledge application high-tech organizations should: a) continuously maintain higher absorptive capacity of globally distributed teams, b) encourage knowledge sharing and exchanging of ideas, experiences, etc., c) provide appropriate IT tools, methods and strategies for communication, coordination, sharing and application of knowledge, d) arrange training and learning for globally distributed development teams in order to overcome critical skills/knowledge gap, obtain needed knowledge, etc.

Moreover, due to rapidly increasing volume of knowledge, replacement of existing knowledge with new knowledge, adding new knowledge or information to existing knowledge, frequent changes in various important items (i.e. customer requirements, market demands, innovations, etc.) for efficient knowledge sharing and application, it is necessary to continuously monitor, update and maintain and assure: a) the accuracy of tacit and explicit knowledge codification, b) the selection and effective utilization of appropriate IT tools, methods and strategies, c) the reliability and security of knowledge storage systems, d) the appropriateness of knowledge transfer to members of globally distributed teams, specifically who need it in time, d) the correctness of knowledge integration of many experts, e) providing instructions and guidelines if and when necessary, etc.

B. Impact of absorptive capacity theory on knowledge sharing and application for complex software and systems development in globally distributed organizations

Organization's ability to identify and absorb knowledge from external resources (i.e. social media, international conferences and forums, webinars, private blogs, etc.) can also influence knowledge sharing and application for the development of complex software and systems. Higher capacity to absorb knowledge would greatly help organizations to develop higher quality complex software and systems. For enhancing absorptive capacity of employees organizations need to utilize relevant IT tools. On the other hand, utilizing IT tools with limited ability to absorb knowledge would not be an effective strategy for developing complex software and systems. Therefore, the ability to identify and absorb new knowledge goes along with the ability to select and utilize appropriate IT tools - for effective knowledge sharing and application among globally distributed organizations.

Absorptive capacity theory is a well suited method for improving knowledge sharing and application in complex software and systems development. Prior knowledge of an organizations and diversity of software developers' backgrounds affect the development process. Moreover, in globally distributed settings, such aspects as different cultures, languages, communication strategies, business environment, political stability, government rules and regulations, etc. can restrict or negatively influence the way and openness of an individual a) to share knowledge easily, equally or act as a contained person and b) to apply significantly personal efforts, energy, amount of time and intelligence in knowledge sharing and utilization.

Absorptive capacity theory embraces *knowledge cumulativeness* which is associated with the ability to assimilate prior and new knowledge with the purpose to retrieve and apply it further [14]. Knowledge application depends on prior knowledge, learning and communication. Therefore, absorptive capacity theory can explain organization's behavior and readiness for knowledge sharing and application to some extent. Particularly, absorptive capacity theory can help understand reasons and grounds of motives for knowledge sharing/not sharing and intensive knowledge application or avoiding big changes and adhering to weak knowledge exchange among employees.

Table 2 depicts the knowledge sharing and application aspects of each specific IT tool with respect to absorptive, innovative and adaptive capabilities of the absorptive capacity theory.

TABLE 2. IT-SUPPORT FOR DEVELOPING ABSORPTIVE, INNOVATIVE AND ADAPTIVE CAPACITIES

IT tools	**Absorptive capacity:** *Identify external resources, assimilate them and apply for achieving organization's goals*	**Innovative capacity:** *Use internal resources for responding to external changes*	**Adaptive capacity:** *Investigate evolving market, identify product niche and forecasting future trends*
Artificial intelligence (AI): Aims at developing robots, agents and machines for simulating human behavior; includes a vast amount of algorithms, methods, strategies, etc.		Using AI techniques and mechanisms for applying internal resources efficiently.	
Expert systems (ES): Get knowledge from experts before making a decision; use AI methods, algorithms, models, machines, etc. to reason and make decisions; provide with a decision without further improvements.	Help novice to get access to experts' knowledge.		
Simulation software (SS): Is used for forecasting, experimenting and examining real situations.			Forecasting (i.e. potential product usage, demands, user behavior, etc.)
Decision support systems (DSS): Users make final decision based on offered outcomes; aim at improving provided decisions.		Examining outputs provided by DSS for making the final improved decision.	
Wiki systems: Platform for collaboration that can facilitate knowledge application in the target field.	Accessing and obtaining advantage from using external resources.	Using own wiki for reacting to external changes.	
Company blogs: Targeted communication among people with common interests.	Get fresh ideas.		Getting access to recent information.
Social media: Connect people around the world; facilitate communication.	Can be enhanced through social interactions.		Investigating market and product related issues (i.e. user opinions).
Cloud computing (CC), Grid computing (GC), Storage virtualization (SV), Server virtualization (SV): Provision of various high-capacity mechanisms for knowledge management.	Exploiting various high-capacity mechanisms for identifying external resources.	Exploiting various high-capacity mechanisms for applying internal resources.	

VI. CONCLUSIONS AND IMPLICATIONS

Although knowledge management discipline as well as software and systems development field have been widely investigated there is still a dearth of research on knowledge sharing and application in globally distributed complex software and systems development by using suitable IT tools, methods and strategies. This study provides a comprehensive overview on the various appropriate IT tools, methods and strategies that can significantly improve communication, support knowledge usage and exploitation, and speed up knowledge sharing in the globally distributed context to a greater extent. This is one of the major study in the field that has dealt with IT-supported knowledge sharing and application in globally distributed complex software and systems development of high-tech organizations. From the framework described in *Table 1* we can see that the usage of IT tools is inevitable for effective knowledge sharing and application needed for developing complex software and systems in globally distributed teams.

However, only provision of IT tools is not enough for successful knowledge sharing and application in complex software and systems development, high-tech organizations should improve and sustain dynamic capabilities (which constitute absorptive, innovative and adaptive capabilities) of globally distributed teams. Thus, we apply absorptive capacity theory for enhancing absorptive capacity of globally distributed teams. We also investigate and search for not only reactive, but also proactive ways of how other components of dynamic capabilities can be improved. The taxonomy of IT resources presented in this study connects well with the absorptive, innovative and adaptive capabilities of absorptive capacity background information (see Table 2). It can help readers to see the main findings related to the application of each specific tool for supporting absorptive, innovative and adoptive capacities.

We suggest that for efficient knowledge sharing and application high-tech organizations should proactively encourage their globally distributed teams to use the most appropriate IT tools, methods and strategies to support communication and friendly working environment, gain advantage from *adequately* arranged training and practicing programs, take into account differences in cultures and collaborative norms, increase exchanging/sharing of ideas and personal experiences.

Theoretically, the study contributes to the existing body of knowledge through the application of absorptive capacity theory and the utilization of appropriate IT tools, methods and strategies for knowledge sharing and application in general and in complex software and systems development in particular, in globally distributed teams of high-tech organizations that can be used for further research in this field.

Practically, this study provides organizations with a better understanding of the most appropriate IT tools, methods and strategies as well as each individual tool specific benefits and problems while using them for knowledge sharing and application purposes, that can facilitate: a) efficient knowledge sharing and application in globally distributed high-tech organizations, b) effective tacit and explicit knowledge capturing and analysis, c) more accurate tacit and explicit knowledge codification, d) automatic information processing, as well as enable e) simulation of expert thinking, f) alleviating and enhancing decision making, and g) development of innovative software and systems particularly.

This study suggests that not only reactively, but more important proactively high-tech organizations should improve absorptive capacity and other components of dynamic capabilities (innovative and adaptive capacitates) of globally distributed teams and also at the same time provide and encourage utilization of the most appropriate IT tools, methods and strategies for successful knowledge sharing and application. As a result, this can help high-tech organizations to obtain their goals, increase competitive advantage and in particular, enhance the quality of complex software and systems. By using the research results, organizations can enhance communication, coordination and collaboration as well as significantly can speed up knowledge sharing and application among globally distributed teams. However, further research is needed to validate the developed framework. We will validate this framework by conducting a multiple case studies in our next study.

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