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Josip Sertic and Ivica Zaverski

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Amy Javernick-Will, University of Colorado and Ashwin Mahalingam, IIT-Madras

EXPLORING PROJECT-SPECIFIC KNOWLEDGE – REVALUATION AND IMPLICATIONS FOR ENGINEERING ORGANIZATION

Josip Sertic[1] and Ivica Zavrski[2]

ABSTRACT

Engineering projects are mass generators of information and knowledge such as facts, truths, beliefs, perspectives, concepts, judgments, expectations, methodologies and know-how. Summarizing all the above, projects are dealing with knowledge relevant for unobstructed work continuance and reaching project objectives. While most project information and knowledge is simple in nature and easy to understand, its volume imposes a challenge for everyone who tries to catch up with the project dynamics for effective downstream operation. This phenomenon becomes visible and thus important in situations of frequent change of personnel or reorganization activities due to often long duration of organizational engagement on the project. In this paper, authors use knowledge-based-view to investigate operational underachievement in construction projects. Literature review shows that some aspects of the problems shares similarity with the concept of Project-specific-knowledge (PSK). This paper aims to unveil PSK presence in project construction phase, develop new understanding of this type of knowledge and point some critical issues that can affect project governance policy. Empirical findings are based on dual research strategy i.e. exploratory research and questionnaire among practitioners. Exploratory research is performed during construction/erection phase of a large infrastructure project in which authors describe the phenomenon in its occurrence. Second part of the research is a questionnaire involving dozen projects. This part of the research, investigates experiences of PSK absence, occurring difficulties, action solutions which at the end confirms PSK industry wide importance. Based on the research results, PSK concept is positioned within knowledge management literature enriched with elaboration of its occurrence and importance. At the end, authors enclose selection of guidelines for future research.

KEYWORDS: project knowledge, project organization, operational performance, built environment

INTRODUCTION

Engineering projects in the built environment utilize resources for reaching project goals. Availability and optimal use of those resources builds overall competitiveness of an organization. Knowledge, as a resource, stands out due to a cohesive roll it plays in construction production process. Ambition of this research is to identify causes of operational underachievement or failure in the engineering projects. Sometimes, project teams experience poor performance without direct and visible cause. And sometimes those causes can be avoided

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[1] Researcher, University of Zagreb, Faculty of Civil Engineering, Zagreb, Croatia, jsertic@grad.hr
[2] Professor, University of Zagreb, Faculty of Civil Engineering, Zagreb, Croatia, zavrski@grad.hr

with awareness of their existence. Active knowledge inside projects is usually managed intuitively by project managers or through corporate process standard. As the project dynamics roll, so does the information and knowledge creation, sharing and utilization. Some projects are operated in conditions of permanent project team, meaning that personnel stay on the project throughout the whole phase. On the other hand, most projects experience constant change in operating personnel. Due to industry fragmented nature, reorganization and services outsourcing are frequently used project management methods that affect knowledge in the project. Distant construction sites and long project lifecycle add to the frequency of such practice. Therefore, this issue is definitely one of critical concerns for firms that export their engineering services world-wide or commit in large projects.

Motivation for this research comes with initial recognition of knowledge related problems through authors' enrollment into an ongoing project. Authors use exploratory research for recognizing scenarios of operational failure/underachievement and their causes. Additionally, authors devote desk research for rationalization of the phenomenon within the existing theoretical concepts i.e. Project-specific-knowledge (PSK). This specific aspect of knowledge proved relevant for day-to-day operation, team integration as well as independent operation of other project parties. Second part of the research explores how professionals deal with change of personnel, examines their experience and questions if they find PSK concept appropriate. The reality of project specific knowledge as factor of project management success is described with its potential in future research that can help project teams avoid underachievement and failure.

LITERATURE REVIEW

So far, knowledge research concerning construction industry has produced a plethora of findings. Before bringing subject of research in focus, literature review aims to describe various theoretical discourses of knowledge in construction and choice of theoretical background authors' use in the research. The first is that information and knowledge are two different concepts where information presents a well stated and codified proposition about states of the world, properties of nature, identities of agents and explicit algorithms on how to do things. Knowledge, on the other hand, includes cognitive categories, codes of interpretation of the information itself, tacit skills and search and problem solving heuristics irreductable to well-defined heuristics (co-opted from Prencipe and Tell, 2001). Phenomenon of knowledge in

construction has been investigated widely due to its critical role in various discourses. To name few, competitiveness discourse (Sertic and Zavrski, 2011, 2010a&b, Anumba et al., 2008; Prahaled and Hamel, 1990,), project management (Christensen and Bang, 2003, Damm and Schindler, 2002) and resource based view (Meso and Smith, 2000) nominate optimal knowledge management as the most challenging task managers have to deal with. There are numerous definitions of knowledge as there is a lack of consensus for unanimous definition. From Plato's *justified true belief* to Grey's *description of knowledge as a encompassing use of information and data, corresponding human virtues, competences, ideas, intuition and motivation* (co-opted from Boskovic, 2010). Nonaka (1994) defines knowledge/learning as a dynamic human process of synchronization of individual beliefs with general truths. On the other hand, separate research path deals with knowledge codification. It concentrates on transfer of tacit knowledge into explicit form and its utilization throughout the organization (Disterer, 2002; Scherer i Reul, 2000). Organizational studies investigate how project oriented firms deliberately acquire, manage and utilize knowledge (Schindler and Eppler, 2003; Kotnour, 2000; Leseure and Brooks, 2004). All these efforts are focused on the knowledge base that surpasses single project scale and deals with accumulation and codification for generic use on other projects.

For knowledge management discourse, the most commonly cited contributors of knowledge taxonomy are Nonaka et al. (2000). They introduce SECI model that explains the link between explicit and tacit knowledge. SECI model is based upon four processes, in which knowledge changes epistemological character i.e. explicitness and tacitness. These processes are called socialization, externalization, combination and internalization. To elaborate further, Socialization is a process of sharing individual knowledge among individuals in direct vicinity while Externalization represents tacit knowledge articulation to become explicit. Combination is a process of explicit knowledge transfer that allows knowledge transfer among groups across organizations. Internalization is the process of understanding and absorbing explicit knowledge into tacit knowledge.

All processes above are related to a team, project, organization or other level of abstraction. When dealing with tacit knowledge within project boundaries Howard (1989) introduces a concept of PSK. Howard concentrates of a design phase of the project and puts *that Project-specific knowledge (PSK) should be captured so that it can be used in downstream activities, such as verification of design standard conformance, redesign and facility*

management, and in future design activities using case-based reasoning. And while Howard explains aspects of PSK that are focused on design process and product quality, authors identify that no investigation of PSK influence on project delivery i.e. construction/erection phase has been done so far.

RESEARCH METHOD

In this paper, PSK is investigated as an operational factor in following two steps. First step is an exploratory research with some elements of the grounded theory. This step was conducted while authors engaged themselves in an ongoing project. Exploratory research is chosen as it allows investigation of a knowledge phenomenon within its real-life context as the boundaries between phenomenon and context are not clearly evident. Further on exploratory research allowed authors to familiarize themselves with the problem (Stebbins, 2001). In this part of the research, authors use informal coding for focusing on decision making processes. During the process, lack of knowledge about this specific project is recognized in numerous scenarios including action strategies for solving respective problems. These scenarios are elaborated in the findings section. A literature dissection is done determining if the literature describes the issues identified. That led in PSK concept identification that has so far been exclusively related to design process, so authors take a logical step forward and investigate PSK in light of construction management processes as well. Identification of similar research bring author in position of criticism and chance for theory upgrade.

Second step of this research is conducted as a questionnaire with goal of exploring construction professionals' experience when assigned to a new project. Questionnaire was designed as a Likert scale questionnaire with 30 questions divided in following two parts: First section asked if respondents have experienced difficulties due to personnel change, reorganization, task reassignment, communication difficulties, frequency of occurrence etc. Respondents were asked about various scenarios that have caused PSK loss. Second section asked respondents to consider organizational, technical and institutional nature of issues they came across in *new* tasks and how did they deal with them in the downstream process, what were the requirements and solutions for problems occurred. Goal of the second section is to check if PSK is as a rational epistemological construct experienced widely in industry and to examine respondents' reaction in scenario of PSK loss.

Questionnaire was distributed to four respondents. Respondents were asked to go back and remember three projects they participated therefore cumulatively twelve project scenarios are considered. Respondent profile is a follows: project manager or department heads with substantial experience in more than one market. Respondents were contacted directly and questionnaire was distributed via e-mail. Three respondents asked for discussion via telephone regarding filling in the questionnaire. Questionnaire was structured upon finding of the exploratory research i.e. experiences of PSK absence, occurring difficulties and action solutions with outcomes. In the questionnaire, authors have tried to investigate if responses could be explained by the PSK construct.

EXPLORATORY RESEARCH

Authors have engaged themselves into an infrastructure project for a period of three months in which they have acted as assistance in process of site reporting, project planning and claim management. In that position authors were required to communicate with all team members as well as direct counterpart planners within Engineer and Project owner organization.

Project Description

The nature and the scope of the project was erection of a four level highway interchange with substantial amount of energy cables and water supply and drainage infrastructure. Specialist works included micro-tunneling and 60ft deep shafts that are to secure proper storm drainage. Project was planned in four milestones and authors have engaged themselves at the end of the second milestone. Project difficulties at the time included severely missed budget and schedule, bringing the Contractor and the whole project on the brink of sustainability.

The project was distant geographically and institutionally to contractor's traditional market causing personnel to work short periods, i.e. from three month up to a year. Further on, a significant outsourcing practice was present. All the above proved to challenge daily operating routine. Authors' roll in the project was to help in the project planning process. Further on, authors assisted project manager and project planner in information gathering and reporting as well as drafting new operational plans. Due to severe delay, authors were helping commercial and claim consultants as well as forensic planner in building up a claim package for the Contractor, which proved to be an additional motive for this work. Presence of outsourced

specialists for commercial issues, forensic planning and claim management offered authors to analyze their modus operandi and results at the end.

FINDINGS AND DISCUSSION

Due to project size and already finished second milestone (out of four) authors' initial difficulty was to cope with numerous issues and their details that proved to be expected. Reportedly, all new members required at least two weeks to reach independent operating ability. As per work assigned, authors have communicated with personnel, e.g. shaft construction, road base and asphalt manager, concrete production, subcontractor managers (specialist works like micro-tunneling, special concrete coating, electrical works were subcontracted). All personnel appeared ready to cooperate on current issues. In case, an issue surfaced that has occurred before he/she arrived on the project their readiness to deal with it lapsed. Therefore, authors felt comfortably working with personnel that were present on the project for a long time. Their assumptions proved correct most of the times, advice useful, issue handling proved efficient and their relationship with counter parting personnel from Engineer or Project owner proved to be invaluable. On the other hand *new comers* proved to be ambitious yet their assessments proved to be more/less unreliable, their reporting insufficient and lastly communication with unfamiliar counterparts made them nervous. Project manager has intuitively shown understanding to such practice. And while all the above puts certain burden to whole organization, it isn't as dangerous as following: some *newcomers*, due to project unfamiliarity, indulgently relied upon information and instruction provided by the Engineer. This practice questioned decision making independence of the Contractor and potentially putting the Contractor in submissive position towards the Engineer.

While assisting claim package build-up, certain commercial and technical issues of staggering importance have been enigmatic and incomprehensible. This was most emphasized while doing forensic planning to decipher cause of delay events. Also, an activity that proved to be most time consuming was documentation browsing in search for important information. Aside time consuming, that activity proved quite expensive due to hiring consultants for that job. After substantial number of work hours, consultants started asking elaboration from personnel about past issues. Few of the team members were able to elaborate and these issues proved to be strong points of the whole case while *newcomers* were reluctant to communicate with claim manager.

Further on, claim managers tried to get answers from the Engineer team. While, few of the Contractor personnel were able to recall the real story behind the issue, Engineer counterparts gave their explanation at once. It is important to note that Engineer personnel haven't changed much during whole project.

As per ongoing work, fresh personnel were unable to make quick decisions when comparing offers from supplier or subcontractors as well as lacked negotiating confidence. As per influence of the environment, *new comers* lacked closeness with their counterparts and spent some time in calibrating relations. That proved to be an important cultural-cognitive aspect of day-to-day operations. Authors conclude that operative capacity and work precision depended upon the fact when individual was engaged in the project. Initially, taking pace with project dynamics prove to be immense learning effort yet expectable and inevitable process that was recognized by the project manager and colleagues.

Exploratory research provided following conclusions: 1. Assessment ability of newly arrived personnel proved questionable; 2. For knowledge related to project history, an interpretation was asked from project stakeholders lowering the degree of independence of the organizational decision-making; 3. Capacity for solving day-to-day issues was lower in the beginning, requiring their colleagues to handle part of their job i.e. advising *newcomers* on expectations and providing and insight on previous events.

Relatively comparative issues are recognized in works of Howard (1989) and Chapman (1998). Both authors concentrate on design phase of the project lifecycle. While, it is not argued if their findings are useful in design phase, authors find lack of solutions for construction/erection phase of the project. And while, Howard and Chapman do not question the possibility of capturing PSK into explicit repository of organization, authors contrast the phenomenon with the Ba concept of knowledge, (Nonaka and Konno, 1998) and domain knowledge (El-Diraby et al., 2005).

The Ba, within the existentialist framework, is a multidimensional space, namely, physical, virtual or mental space. A space where knowledge emerges and is kept stored. Separated from Ba, knowledge becomes information or data. Ba is an encompassing term for knowledge creation by a group, team or organization therefore the boundaries are blurred as well as its properties. Project specific knowledge concept can be recognized as a result of Ba or its respectable part. Ba encompasses growth of knowledge and does not specify whether this

knowledge is tied to a specific project. On the other hand domain knowledge is part of domain knowledge which professionals use and develop on their own for individual operating capacity. As properties of both concepts suit the PSK character, authors localize it as showed on Figure 1.
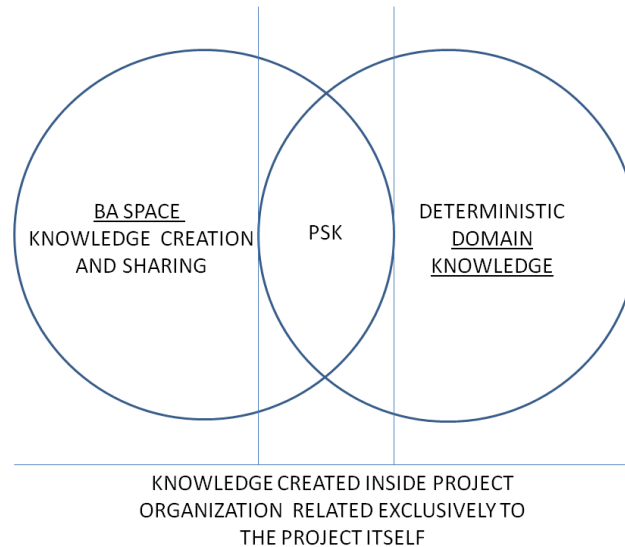

Figure 1. Visual conceptualization of PSK in relation to existing knowledge concepts.

As per findings of the exploratory research, authors find that loss of the PSK leads to loss of decision making capacity. Such issues for the design phase are addressed by Chapman (1998) who *examines how system dynamics may be employed to assist in comprehension of how risk event of change of key project personnel impacts on design production and ultimately the design duration.* In line with Howard and Chapman, Nazem (1969) recognizes productivity loss due to frequent change of *technical and managerial staff. This loss of productivity is explained as arising from the complex nature of planning, co-ordination, control and communication…A knowledge vacuum is created when a member of staff departs* (co-opted from Chapman, 1998). This proved to be the earliest recognition of the phenomenon that lacks proper articulation within current knowledge base. Therefore, authors conclude that PSK should be recognized as a much broader phenomenon hidden in all project phases. With its obscure nature, PSK can be depicted through a proverb: W*e do not care of what we have, but we cry when it is lost*. This means that PSK is best perceived and valued in situations when deficit occurs, when there is lack of information and knowledge about certain project events.

QUESTIONNAIRE AMONG PRACTITIONERS

Authors conduct a questionnaire in which respondents were asked to identify most frequent issues regarding personnel leave, reorganization and PSK loss. Further on, respondents were asked to consider organizational, technical and institutional nature of issues they came across doing the *new tasks* and how did they deal with them in the downstream process, what were the requirements and solutions for problems occurred. Goal of the second section is to check if the response authors recognize PSK as *appropriate concept for description of real situation.*

Respondents were asked if they have been assigned new tasks due to personnel change in project organization and how did they deal with it. In most cases, respondents have found new tasks demanding. According to questionnaire results, all tasks were allocated to a competent administrator. Communicating with unknown counterparts is seen as most difficult and stressful part of the job as most of these dialogues relied on previous events and understandings that are not easily verified. Before their active engagement, in most cases respondents were given an update of recent events. First few questions of the questionnaire are not exclusively related to PSK yet are focused on overall burden of the newcomer. For instance, preparations conditional for successful administration of new tasks like learning specific skills i.e. technical software (16%); Regulation/ Norm (58%); National language (0.0%) and Communication Channel (33%) (e.g. Skype, Business software) while in 16% of cases none of the above was required (Please note that multiple answers were allowed therefore the sum of shares is not 100%). In 60% of the cases, further requirements were put in front of the respondents i.e. adjustment of working practice (e.g. new location, working hours and cultural aspects). When considering the need for an update of historic events that occurred in the project or simply search for an opinion, in 16% of cases consulting the ex-task-administrator (ETA) was crucial for success while in other cases a moderate support was required. No respondent ETA departure from the project and in 90% of cases communication was actively kept after the ETA departure. Further on, scenarios of personnel change and their frequency are investigated in the questionnaire. In regards of the ETA departure and if organizational change was planned, presumable or sudden, respondent have shown that all three scenarios are equally frequent. In case of a sudden departure, respondents were given an indefinite period for administering tasks and responsibility for delay was not

exercised. In case of planned or presumed departure respondents were given a time limited/temporary engagement in the new/additional tasks.

Regarding performance of the newly assigned tasks, respondents felt that they have performed moderately successful of even better than expected. In 67% of cases coping with technical aspect of the new task was demanding while in 33% of cases easy. The commercial aspect proved to be demanding more frequently (80% of cases) while the institutional aspect of the tasks has proven to be relatively demanding (50%) and in two cases impossible to administer. In case of unexpected costs occurrence, due to faults in administering new tasks, general response was that responsibility was waived away from respondents.

Among difficulties that were mentioned, one that stands out is inability to gather enough information for decision making with confidence. Lack of confidence corresponds to authors' findings in exploratory research. For understanding the background of the task respondents have used primarily project log, e-mail history and dialogue to colleagues (100%) and occasionally various project reports (75%) and other sources (50%). Respondents have rarely called for help from co-workers.

Respondents have recognized the phenomenon of knowledge related to specific project and that it is acquired while active on the project. Most respondents recognize and confirm the importance of awareness of existence of this phenomenon for the project downstream. Again, equally respondent recognize three categories of such knowledge i.e. technical, commercial and institutional. This type of knowledge is indirectly recognized through the informal seniority of the one who shares it positioning those individuals as valuable employees.

CONCLUSION

Knowledge issues in engineering project are gaining more and more recognition for the role they play in organizational competitiveness, efficient business process as well as successful overall project management. As per day-to-day changes in project operations and inseparability of knowledge from project personnel, keeping the knowledge inside organization becomes a challenge for project management. Deepening the understanding of the knowledge emergence, sharing and utilization becomes an imperative for managing knowledge based processes in the built environment. For sensing problems that project personnel faces on daily basis, authors engaged themselves in exploratory research that has resulted in identification of causes of

operational underachievement in circumstances of intensive personnel turnover inside project organization. In general, recognized causes of operational underachievement can categorized in following four categories:

1. Limited absorptive capacity of individuals (newcomer) for learning project history

2. Third party dependence for interpretation of past project events

3. Low level of synergy with inter-organizational counter parting personnel

4. Lack of self confidence in decision making process

A relating literature was reviewed resulting with re-conceptualization of PSK concept and determining that PSK plays an important role in day-to-day operations. Authors recognize PSK as both, property of the individual and the group. Further on, PSK tends to be a base for domain knowledge buildup. A questionnaire was conducted that shows influence of PSK on daily business and in situations of PSK absence, what solutions professional use to overcome difficulty. Professionals mostly rely on generic project datasets such as project log, e-mails, reports while maintaining distant contact with ETA for sake of clarification and further elaboration. At last, PSK concept is unconsciously recognized by project manager which is obvious in responsibility waiver for issues from the past. Therefore, authors conclude that PSK concept is applicable for describing the "on field" situation and there is place for further investigation in management practice of this type of knowledge. Authors indicate that PSK issue can be investigated on level of business process in terms of codification and sharing as well as application of IT solutions.

ACKNOWLEDGMENTS

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