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Enhancing Cognitive Readiness of Construction Project Teams

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Abstract
Construction challenges require rapid decisions to be made by project teams. These decisions interact with the complex, dynamic and sometimes ambiguous project environment and affect the overall project outcome. Cognitive readiness in this context is the mental, emotional and interpersonal skills that relate to the way project teams perceive, remember, think, speak and solve problems encountered in project situations. Project teams, on top of technical and contextual competences, should possess the required cognitive readiness to address real-world problems and take rapidly the appropriate decisions. The investigation of cognitive enablers and barriers as well as their prioritization, adaptation and implementation in real-world situations is the subject of this paper. Methods assessing and procedures improving and monitoring individual and team cognitive readiness are also described. The main conclusion that can be derived from this work is that cognitive readiness of project teams relates mainly to the leadership style applied, to succinct and well defined team roles, to communication strategies and to procedures employed enabling lateral thinking, stimulation, assertiveness building, adaptability and automaticity of action.

Keywords
Project, Management, communication, competence, cognitive readiness

1. Introduction

In construction projects, the knowledge, skills, and attitudes of team members are often stretched beyond capacity in attempts to successfully implement increasingly complex projects. Team members are taxed with higher workload over an extended period. Other environmental stressors also affect team performance such as acceleration of schedule required by the client. Such situations may stretch the cognitive capacities of team members and negatively impact team performance.

Cognitive readiness can be defined as the possession of psychological (mental) and sociological (social) knowledge, skills, and attitudes that individuals and team members need to sustain competent professional performance and mental wellbeing in the dynamic, complex, and unpredictable environments (Strater *et al.* 2012) from the pre-project phase through to project completion (Archibald *et al.*, 2013).

In a highly dynamic environment where the consequences of poor team performance can be detrimental, it is critical to be able to quickly assess the overall readiness of both individuals and teams.

Authors found that overall project performance may be enhanced by applying the knowledge of human behaviour provided by the advances in cognitive psychology (Etter *et al.*, 2000; Morrison & Fletcher, 2001; Fletcher, 2004) to a real-world project, namely the construction of the campus of the Nazarbayev University in Astana, Kazakhstan with the budget of over One Billion Dollars. The specific methods, metrics and lessons-learned are summarized in the remainder of this paper.

2. Cognitive Readiness

Besides the definition of cognitive readiness presented previously, it must be noted that the concept also relates to the "capability to adapt to and quickly address with manageable stress new, unpredictable, unforeseen changes, acting dynamically and proactively with self-efficacy sensations" (Archibald *et al.,* 2013). As such, cognitive readiness is relevant both at the individual and the collective/team level (Fautua & Schatz, 2012; Fautua, et al, 2011). Such performance may be achieved for a project team after working together for a fairly long period of time. This research shows that this 'learning' period can be reduced due to a different applied mind-set so that team members enhance their competence development throughout their career implementing projects

Most existing project management standards (PMI, 2013; APM, 2012, ICB, 2006) emphasize the importance of effective teamwork on project success. In addition, ICB (2006) describes in detail the expected project management related competences and taxonomy.

Professional experience shows that project teams must be prepared to make decision at their respective levels instead of demonstrating an attitude of avoidance, leaving decision that could be taken at their level get unnecessarily escalated to higher ranks. This paper is aimed at defining cognitive readiness for project teams and then devises approaches for fostering, manning, and supporting such readiness.

The characteristics of a competent cognitive ready team *(*Archibald *et al.,* 2013*)*:
- Specific but complimentary roles coupled with the necessary skills and talents aligned with and committed to a common purpose.
- Team members are so devoted to their purpose that they will do all that is humanly possible to surmount any barrier hindering the achievement of project goals.
- Consistent and reliable performance demonstrating adaptive competence and accomplishing results.
- Interchangeable roles within realistic boundaries to better serve project goals. Leadership within the team is not dependent on a single individual but may be taken up by various team members, according to the current needs within realistic limits of scope and authority.
- Proactive in managing the tasks assigned
- Empathetic to the problems of other team members.
- Demonstration of positive attitude coupled with job satisfaction.
- Robust methods for resolving conflicts ensuring progression and achieving goals.
- Sense of focus and intense energy based on own consciousness and common norms and values.
- Accountability in relation to actions based on high levels of mutual trust.

Cognitive readiness is influenced by enablers and barriers which are two classes of cognitive behaviours generated by the way people's minds give meaning to the world around them based on their knowledge, perceptions, beliefs, how they elaborate the information emotionally, and how much they are aware about that using all the personal cognitive capability they have obtained through their life experiences within the cultures in which they have existed. Cognitive enablers and barriers depend on family, peer, religious,

spiritual, political, national, educational, vocational, recreational, and other factors. In this paper, however, we will confine ourselves to the study of those factors pertinent during project implementation.

The cognitive readiness model, which is adapted to the reality of the NU project, is based on project management concepts and how they relate to each other as described in ISO 21500. The target is to enhance personnel's naturalistic decision-making abilities. Essentially, this initiative seeks to enhance team leaders' cognitive readiness and their ability to foster such competences in their subordinates.

Developing cognitive readiness is generally time consuming, labour intensive, and expensive - requiring dedicated mentorship, years of study, and exposure to diverse experiences. At the NU project it has been recognized that personnel should be assisted in accelerating the acquisition of this expertise. To achieve this, cognitive readiness has been considered an enhancement to competence elements (technical, behavioural and contextual) as described in ISO 21500 (based on the ICB, 2006 model).

3. The NU Construction Project

The Nazarbayev University (www.nu.edu.kz) (NU) in Astana was established in 2010 as part of an initiative to create a world class University - a quantum leap of the educational system in Kazakhstan. A collaboration initiative with some of the leading top 100 universities from around the globe has also been initiated. The campus construction was implemented in an environment of ever changing stakeholders with new stakeholders coming to play during project implementation. To excel under such conditions, an innovation approach that enhanced the decision making process of project teams was implemented.

NU campus construction is implemented by the Private Entity – Facility Construction Directorate ("PE FCD"). Pre-project and post-project activities included activities such as business case development, conducting feasibility studies, design, construction, and transition to operations.

The internal stakeholders include the following teams:
- FIDIC engineer (Project manager company) – "PE FCD" (Project director, project committee, PMO, Project manager, Control Account Managers)
- General contractor – Sembol Construction company (Project director, Project manager, design team, construction team, subcontractor teams, and supplier teams).

The external project stakeholders include:
- NU - Project sponsor, Managing council, End user teams (Students Affairs, Graduate School of Business, Graduate School of Public Policy, School of Engineering, School of Science and Technology, NU Research Innovation Systems, Centre for Life Sciences, NU School of Medicine, etc.), Facility Management team ("PE University Service Management")
- Regulatory bodies and Special Interest Groups

Both internal and external project stakeholders (the "project environment") impact project performance and success. PE FCD had to consider factors both outside and inside the organizational boundary. Outside factors include socio-economic, geographical, political, regulatory, technological and ecological who impose constraints and introduce risks affecting the project. Inside factors include strategy, technology, project management maturity, resource availability, organizational culture and structure.

4. Cognitive Enablers and Barriers in project teams

Based on the experience gained at the NU construction project, cognitive influencers depend on *(*see also Archibald *et al.,* 2013*):*

- **Project delivery model.** The NU project delivery was Design Build and turnkey with open book re-measurable quantities, which was based on state approved unit price norm/regulation. This kept budget risk with the Client and enhanced a platform where functionality was a priority. This project delivery model encouraged improvisational responses to changing conditions by project personnel. Project owner and other influential external stakeholders addressed the formidable barrier to the adoption of Cognitive Readiness and enhanced communication at all levels between project teams.

- **Trust**. The Project manager team motivated the project personnel in a trustful, proactive and engaging manner. Trust was absolutely essential for the effectiveness of this proactive project management approach. Most construction projects suffer pathetic track record because contracts are immersed in distrust that poisons the operating environment with a resulting inherently distrusting attitude.

- **Quality and type of project information.** The project information control system, based on Earned Value Management approach, delivered monthly report incorporating scenario plans that take into consideration Chain Events that have a high probability of occurring. When such events occur, for instance, the need to incorporate changes necessary to enhance the functionality of the facility was met and dealt with proactively with the right attitude.   The Project Team reacted to changing future conditions without criticism or punishment, working "out of sequence" was common place. Apart from the bettered Project Information system, the Project Team was of a different mind-set to receive it. Cognitive Readiness went hand-in-hand with this Project Information System.

- **Stakeholders' value perceptions.** The project stakeholders both internal (the internal project owner, executive sponsor, project manager, other members of the project team) and external to the project (end user, facility management team, regulators, governmental agencies, people affected by the project and its results or product.) had their value perception. Many project team members are in direct contact with external project stakeholders. All team members' awareness of every project stakeholders' value perceptions was important. They assisted the project manager in managing these influences.
  All Key Performance Indicators related to important stakeholders were identified and considered during the pre-project (start phases). The stakeholders' project value perceptions were identified to determine if they could represent or be interpreted as either a cognitive enabler or barrier.

More specifically, within the context of the NU construction project the Table 1 summarizes the list of considered cognitive enablers and barriers.

Table 1: Cognitive enablers and cognitive barriers

Cognitive Enablers	Cognitive Barriers
Leadership	The Student Syndrome
Emotional Intelligence	Parkinson's Law
Metacognition Strategy	Burnout Syndrome
Lateral thinking	Internal conflicts that can lead to crises
Cognitive Appraisal	Drastic commitment reduction
Cognitive Adaptability	Overloading stress
Metacognition	Multi-tasking stress (Trying to do many tasks simultaneously
Resilience	Competence Borderline Syndrome or cognitive balance
Agency	The Skill Syndrome
Self-Efficacy	Cognitive lock

Automaticity of action or Heuristics in judgment and decision making	Haste (as in the well-known adage "Haste Makes Waste")
Communication strategy	Over commitment to bureaucratic goals
Arousal	Prisoner to heuristics, or the Prisoner's Dilemma
Assertiveness	Denial (of adverse developments or events)
	Fear of satisficing
	Perfection is the enemy of good.

5. Steps for achieving high team performance

Based on the experience of the NU construction project, the steps for achieving high team performance are listed below:

- **Define the cognitive readiness appraisal criteria:** From the listed cognitive enablers and barriers in Table 1 we selected and prioritized those items that are judged to be the most important for the situation at hand, namely the nature of the project and its environment. This list varies for different types and categories of projects in different regional, national, and global locations. For example, the key cognitive factors for a project team will not be exactly the same for the teams responsible for different types of programs and projects. The cultural, economic, technological, and political environments will have significant differences that will affect the selection of the cognitive factors for these teams.

- **Familiarize affected project managers and team members with the concepts of cognitive readiness:** Create the appropriate level of cognitive awareness through seminars and workshops led by persons who are appropriately expert in these cognitive psychology concepts and their practical application in a project setting. This function was implemented by senior management of PE FCD.

- **Conduct the cognitive appraisals of individual team members and of the team as a "whole':** These appraisals were conducted at the time the project team members were actually identified, and at the start of each phase in the team development (forming, storming, norming, performing). The appraisals focused on the cognitive capability judged to be important within the specific project category and organizational environment at hand. The assessment was conducted using self-report questionnaires.

- **Develop and Monitor the Project Team's Cognitive Readiness:** A cognitively ready project manager leading a cognitively ready team will be alert to any conflicts and interpersonal problems within the team and will periodically monitor what is happening within the team. As new team members are added, which is usual during project implementation, further indoctrination of the new members is conducted, and re-appraisal of the team's cognitive readiness is performed. When weaknesses are revealed, additional cognitive awareness training is conducted to continually improve the team's cognitive readiness. This is the ultimate goal of developing cognitively ready project managers.

- **Front-End Investment is required to assure that both the documented project and the project Team are "ready":** Project normally will be authorized to start when it is judged to be "ready", which usually means having an approved business case and project charter. This does not usually include any assurance that the proposed project team is "ready" in any sense other than the people are available to work on this project. In the design and construction of infrastructure facilities, project readiness is measured by a Project Definition Readiness Index (PDRI). In many projects a team is thrown together and expected to start work with little or no team preparation. A professional sports team will spend weeks/months, practicing as a team prior to its first competitive encounter on the field. Additional

investment of time and money is also required to prepare every project team to work together effectively and achieve team cognitive readiness. An important part of this front-end investment in the project team also involves team planning during the project start-up phase (Archibald 2003, pp. 280-300). Improvisational Management (in Cognitive Project Management), which includes early rehearsals, is a much more credible and effective antidote for the unwanted effects of Unknowns than the layering of contingencies that are promoted by classic Risk Management.

6. Cognitive readiness during project phases

It is worth focusing on the importance of reaching a first level of cognitive readiness accomplished during the Project Incubation Phase that enables the project manager to develop the team to be increasingly tuned to each other's ways of operating. If this is accomplished then the project will enter the Start Phase with a very high margin of safety. As the project proceeds through the Start and subsequent project phases we will be able to increase this cognitive readiness to its maximum level. There is no doubt that all the project team members have to work together on their project and respond to its changing requirements and conditions adaptively and coherently.

Such a team lets you accelerate the way you innovate. The project incubation and start phases represent a time when it is desirable to make evaluations in choosing and forming the high performing team and focusing on the stakeholders' value perceptions as well. After *Forming* the team, according to the Tuckman model (PMI 2013, p. 276), during the course of a project you can continue to benefit from and keep improving the team's cognitive readiness during the subsequent phases. The project close-down provides the opportunity to record both the individual and team cognitive abilities for reference when the project team is formed for the next project (Edison, 2008).

These cognitively ready individual team members and groups (teams) adaptively react and make decisions and possess the flexibility needed to effectively respond to failures, threats, scope creeps, change requests and unpredictable situations.   A team that is cognitively ready has the ability to address every new situation while performing at a high success level, regardless of the stress level involved.

7. Performance metrics

The project management team used emotional intelligence to reduce tension and increase cooperation by identifying, assessing, and controlling the sentiments of project team members, anticipating their actions, acknowledging their concerns, and following up on their issues.

The cognitive enablers or accelerators take the project ahead faster by repeated sprints. These sprints transformed the traditional project Earned Value (EV) from a predictive element to something dynamic, reactive and adaptive. And every project manager knew how important it was to have the possibility of high accelerations when a scheduled date is not achieved as expected and impacts the EV.

The transition from a cognitive constraint situation (barrier) to a cognitive enabler is always guided and catalysed by the emotional factor (Goleman D. cited in Archibald *et al.* 2013). It is the individual himself in collaboration with other team members who decides to "set again the priorities" following daily, weekly and monthly reports.

A direct and personal example of cognitive behaviour by the project manager was one of the most important methods of activating cognitive effectiveness. The emotional intelligence (EI) allowed the cognitively ready project manager to plan strategies and take suitable actions according to the team members that are involved. This brought team members' (and also stakeholders') knowledge into the

project with good intentions and results. Self-efficacy was enhanced by creating in team members feelings that their contribution is highly valuable. This approach took human behaviour to a higher self-perception than previously and increased their ability to deliver high performance. This study is focused on the performance metrics of project teams. Implementing the cognitive enhancement model elevated project delivery ability, as shown in Table 2.

Table 2: Budgeted Cost of Work Performed (BCWP) at the NU construction project
(In thousand USD)

BCWP	2010-2011	2012	2013	2014
1,000 $	11 463	29 860	109 850	135 964

8. Discussion and Conclusions

The models and methods developed depict a continuous integrated process of interaction with the project environment by the project team with the resulting cognitive accumulation of knowledge, competence and learning. Methods assessing and procedures improving and monitoring of individual and team cognitive readiness have also been described.

Human behaviour and attitude within and across internal and external stakeholders directly affect a project throughout its life cycle. Applying the knowledge of human behaviour provided by the advances in cognitive psychology enabled project managers and teams to build high-performance teams through perception, observation, appraisal, measurement, management, and improvement of project team members' and stakeholders' behaviour, leading to greater project success. The need for high-performance, cognitive-ready teams is great for innovative and transformative projects and programs such as the NU construction project.

This concept applied in the NU construction project enabled the achievement of:
• Improvements in the human collaborative interactions within project teams that lead to greater project success.
• Improved interactions between the project managers and other team members (internal project stakeholders) with their external project stakeholders that lead to greater project value, which includes both the direct business benefits of the project plus those intangible values such as stakeholder satisfaction, gratitude, and general good-will.

The Nazarbayev University project team experience in implementing the cognitive readiness enhancement model was greatly aided the buy-in by the senior management of PE FCD. This is partly because the management is made up mostly of professional project managers.

The major conclusions that can be derived from this work are:
• Project team members with a low level cognitive capability shy away from decision making in challenging project situations, which are perceived as threats. They show low aspirations and weak commitment to project goals. They demonstrate attitudes that are adverse to successful performance. They fall easy victim to stress and depression.
• A strong sense of cognitive capability enhances cognitive readiness in many ways. Team members with high cognitive capability approach difficult project situations as challenges to be mastered rather than threats to be avoided. Such cognitive readiness fosters interest and deep engrossment in activities. They set themselves challenging goals and maintain strong commitment to project goals. They are engaged in constant competence development demanded by the corresponding project situation. They quickly recover their sense of cognitive readiness after failures or setbacks. They approach threatening situations with assurance that they can exercise control over them. Such

cognitive outlook produces personal accomplishment, reduces stress, and enhances high performance.

- Cognitive readiness is the product of a complex process of cognitive capability enhancement in interaction with competence development. Once developed cognitive readiness leads to high performance of project teams.

- Cognitive readiness of project teams relates to the behavioural and leadership style applied, to succinct and well defined team roles, to communication strategies and to procedures employed enabling lateral thinking, stimulation, assertiveness building, trust building, adaptability and automaticity of action by the project manager and the project team with a view of the importance of all team members' awareness of every project stakeholders' value perceptions.

- Project teams work well together and enjoy doing so. They produce positive energy that is conveyed to stakeholders. They trust each other and produce superior results in the shortest possible time. The high-performance team is tight-knit, intensely focused on their goals and highly motivated. Within the high-performance team, people are highly skilled and they are aware of their roles in the team and are able to interchange them in helping each other (within practical limits). They easily communicate because they are "tuned" to each other's frequency. They are cohesively focused on a common goal, do not blame each other, are proactive and adaptive in a responsive manner, reliable as individuals and as a whole, share a sense of pride in the task they do, listen and help each other, spend time as friends celebrating achievements reached, and they are proud to belong to the team

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