The Cognitive Knowledge Dimension in the Successful Implementation of Information Technologies

Ornit Raz

MIT

Albert I. Goldberg

Faculty of Industrial Engineering and Management

Technion – Israel Institute of Technology

ABSTRACT

An important element in an organizational culture involves cognitive knowledge identities (CKI) that provide understandings about the operation of knowledge management systems. A first dimension, **signification**, establishes "properties of a worker" and the "nature of knowledge". A second dimension, **interpretation**, defines the linkages of the worker to others: colleagues, managers, organization, and external environment. This paper introduces a set of measurements for cognitive knowledge identities (CKI). In a study of 580 employees at 18 organizations, we explore the distribution of cognitive identities and establish the importance of a match between CKI and information technologies on performance. This inquiry provides findings that could help organizations better deal with knowledge needs in this era of institutional complexity.

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Knowledge management aims at the rationalization of knowledge utilization in organizations. This objective should lead to a choice of methods most appropriate for meeting requirements of specific tasks to be performed (Perrow, 1967). Where routine work occurs, the best techniques can be sought in the sphere of scientific management: first, a study of the optimal approach to carry out a task, and then, the training of workers to follow the preferred work procedures without deviation (Taylor, 1911). Where more complex work is undertaken, workers need a basic understanding of the nature of the tasks, and then given discretion to establish the best work methodology for a specific task.

Unfortunately, many organizations fail to use a completely rational approach for attaining best possible performance. A cognitive aspect influences the selection of methods for the management of knowledge. The cognitions are part of the organizational culture of each organization, as employees share assumptions and beliefs as part of their organizational identity (Albert & Whetten, 1985; Dutton & Dukeich, 1991: 39-40). The organizational culture may have little relationship to actual tasks being performed by workers and instead be influenced by a national stratification system requiring significant social distance between managers and

workers (Piore and Sabel, 1984), or by institutional isomorphism forcing the mimicking of work methods used in other organizations (DiMaggio and Powell, 1983).

Organizational cultures also influence the successful implementation of information technologies (Allen and Hauptman, 1990; Orlikowski, 2000; Huang, et. al., 2003). Embedded in every information technology is an underlying structure delineating its social nature. Some information technologies may be primarily directed at increasing management control over task execution, while other information technologies facilitate the work of professionals by providing essential information, or encourage greater cooperation among specialists. As a consequence, a failure to successfully introduce various information technologies can be explained by a mismatch between an organizational culture and the underlying structure of a new information technology (Newell, Scarbrough, and Swan, 2001).

The Cognitive Aspect of Knowledge Management

Theories of organizational cognition clarify how organizations shape symbolic representations of knowledge schemas (Walsh, 1995). There is high agreement among various theories that social groups and organizations are the primary source for schemas shaping individual cognitions: a view shared by theorists using institutional analysis (Douglas, 1986), organizational culture perspectives (Schein, 1985), and organizational identity theory (Albert & Whetten, 1985).

Cognitions are held by organizational employees on the way that knowledge is used in the workplace (Fiske &Taylor, 1991). This cognitive process influences organizational decision-making as it operates on different organizational levels: individual worker, work group, organization, and even industrial sector (Casey, 1997; Phililps, 1994; Swan and Newell, 1994).

In an extension of these theories, we consider the question: in what way does an organization understand or perceive knowledge? Perceptions regarding how knowledge should be best applied are built around two dimensions (Giddens, 1979, 1984): 1) **Signification** delineating the organization's perception of the "properties of the worker," and 2) **Interpretation** defining presumed linkages between workers and the organization, managers, colleagues, and external environment.

Signification entails understandings on the abilities of workers to use knowledge – workers' ability to learn, ability to create, and the holding by workers of different work motivations.

Interpretation involves understandings about the linkages between a worker and relevant others in his or her organization. The linkages involve:

a. Worker-firm**:** how a firm links workers to the use of organizational knowledge. To what extent do workers hold crucial knowledge, can be easily replaced, or show creativity and inspiration?

b. Worker-manager: linkages about the role of management in employee use of knowledge. Are managers expected to supervise/ control the use of

knowledge by workers, act as mentors to competent workers, or become champions of worker creativity?

c. Worker-colleagues: collegial linkages differ among the cognitive identities. Do workers pass explicit data/information to colleagues, consult with colleagues, or expected to "brain storm" with colleagues in the search for new knowledge?

d. Worker – external Environment: The linkage between workers and their external environment differs for each cognitive identity. Are workers looking for **data** from the external environment, seeking **knowledge** from the external environment, or trying to obtain **feedback on new ideas** from the external environment.

The combination of cognitive dimensions produces three unique cognitive knowledge identities (CKI). First, **Tayloristic** identities are based on an externalization of knowledge where workers follow rules without understanding the rationale for these procedures. Second, **Expert** identities are built on worker competencies. Finally, **Innovation** identities call for the creative act of conceiving new knowledge. Each identity calls for different motivational bases and reward systems, relevant management responsibilities, and proper use of information technologies.

1) Tayloristic. This approach has become central to the work of many organizational practitioners. An effort is made to make knowledge explicit by coding it into work procedures or embedding it in technologies. In this knowledge system, workers are not expected to understand what they are doing as long as they follow rules and regulations under the strict supervision of direct managers. Workers are motivated to fulfill a contract with their employer in which they receive agreed upon remuneration in return for disciplined work.

2) Expertise. In contrast to the Tayloristic system, the expertise knowledge system requires workers to make decisions regarding the use of knowledge. Knowledge is personalized as workers make use of their own "tacit knowledge" that includes know-how and skills relevant to the work (Hansen, Nohria, and Tierney, 1999). Workers are expected to be self-motivated to meet the objective of completing their tasks successfully.

3) Innovation. This knowledge system involves workers in a development of new knowledge. Workers are motivated by a work challenge and make use of their intuition and insight in the question for creative ideas and results. Enabling conditions are given that allow them to exercise freedom in the exploration of new ideas with colleagues both in their organization and in an external scientific community.

Since the three cognitive knowledge systems represent ideal types, there is an imperfect relationship to actual work experience. In practice, management and workers do not clearly define the interdependent elements of the three different systems. Thus, management may expect workers to follow instructions, to make changes when there is a need to modify systems, and to come up with new ways of

doing the work. This is an impossible situation. Workers cannot both follow instructions strictly and also be expected to make changes.

Some organizations found a solution to the incompatibility of different cognitive knowledge systems by having workers operate in more than one system simultaneously. In such cases, for one task, workers can be considered experts and have their own "decision space," and for another task, workers are expected to follow organizational rules and regulations.

Give the possible dominance of one particular cognitive knowledge identity in an organization requires consideration of a contingency approach to the introduction of information technologies (Newell, et. al., 2002). Successful adoption of a information technology in an organization with a Tayloristic identity calls for an embedded structure that gives greater control by management over work. Where possible, such technologies are also directed at replacing human beings. An expert identity calls for information technologies that provide essential information and allow for increased knowledge exchange with colleagues. An innovation identity should develop information technologies that provide access to knowledge and opportunities for testing new concepts within the scientific/societal communities.

This paper introduces a set of measurements for cognitive knowledge identities (CKI). The measures are used to explore the distribution of cognitive identities within firms varying from high-tech to service organizations and to test the degree to which a match between a CKI and information technologies can lead to improved performance. Lessons are learned from this inquiry that provides a better understanding of how organizations can better deal with knowledge needs in this era of institutional complexity.

METHOD

a. Construction of Research Instruments

A review was made of the research literature on cognitions related to workers and the use of knowledge at work. Interviews were conducted with managers and workers. On the basis of these findings, a questionnaire was constructed, pre-tested in two organizations with 136 workers and mangers, and then substantially improved in order to increase the reliability and validity of questions to be used in the field stage of the research.

b. Sample

Data were collected from 580 employees at 18 organizations. Firms varied from high-tech industrial enterprises with extensive R&D operations to service organizations such as banks and hotels.

c. Measurement of Variables

1. Cognitive Knowledge Identities

Items for the cognitive knowledge identities (CKI) included references to both the "signification aspect" (i.e., the nature of the worker) and to "interpretation aspects" (linkages between employee-firm, employee-manager, employee -colleagues and employee -external environment).

Workers were asked to express their agreement or disagreement with 32 different cognitive evaluations of their organizations. The items were scaled along a Likert Scale with five categories, from 1="strongly agree" to 5="strongly disagree".

2. Information Technologies

Information technologies (IT) can include computer systems–both hardware and software. The application of IT often involves networking and telecommunications, in the context of a business or other enterprise, plus services, and supporting infrastructure to manage and deliver information using voice, data, and video.

Workers were given relevant examples of information technologies from their work in order to clarify its meaning. In the cases where employees worked with more than one IT, they were asked to refer to the system with which they primarily worked.

Workers were asked to describe the impact of information technologies on their work using 12 different items scaled in four categories from 1="great extent" to 4="not at all." Factor analysis revealed three independent dimensions with each factor reflecting a different IT design (structure): IT that controls workers–we call this a "rigid system"; IT that supports workers' expertise–we call this an "elastic system"; and IT that supports workers' innovative ideas–we call this a "dynamic system."

3. Performance based on the use of information technologies

Workers were asked to describe the impact on their work from changes in information technologies over the three previous years. Fifteen 15 different items were used based on a "semantic differential" scale. Items referred to two main themes: work performance and communication.

For work performance we examined reductions in the time needed for doing a task, reductions in the cost of the task, improvements in the quality, increases in the number of different tasks performed, allowing employees to work with a greater variety of materials/people, reduction in the need for expertise to do job, and increasing the quantity of similar tasks completed by a worker.

4. Communication

For communication we examined the transfer of meaning and understanding among workers through verbal and non-verbal means. Such communications could be held between colleagues at work or with people outside the organization.

FINDINGS

A factor analysis was performed with 32 different cognitions included in the questionnaire to measure knowledge cognitions. The results of the factor analysis are shown in Table 1.

Table 1: Employee Cognitive Interpretations of their Organization
(N=580)

Tayloristic Identity	**Factor Weight**	**% Agree**
Workers are doing a god job just when follow strictly the rules and regulations	.65	67
Managers are expected to strictly control the work of their employees	.50	52
Workers are seen as easily replaced by a new worker	.43	30
Worker are seen as working for a salary without any interest in the work itself	.66	20
Mangers are expected to immediately reprimand workers who make a mistake	.58	12
Expert Identity		
Workers are seen as able to "understand" how to do their work and not just to follow instructions	.44	83
Workers are expected to try to use their personal knowledge/experience to solve a work problem and not wait for new instructions from management	.41	79
Worker are seen as motivated to seek new knowledge wherever they can find it	.68	72
Workers are seen as motivated to seek a way to reach work objectives when regular methods don't work	.46	67
Management are expected to encourage workers to try out their ideas even if they don't work	.32	67
Innovation Identity		
Workers are expected to work with colleagues on new product/ideas	.68	63
Workers are expected to collect information from outside the organization that can be used to perform a job	.52	54
Workers are expected to seek and to obtain data (facts, figures) about a task or client needed to complete a job	.63	51
Workers are expected to test new ideas by communicate to relevant others outside the organization	.50	48

The factor analysis revealed three key factors as independent dimensions for cognitive knowledge identities. In Table 1, 14 of the items are shown that scored high in a factor analysis. The items were used in the construction of indices to measure the three cognitive identities: the “Tayloristic identity” (Standardized Alpha =.71), “Expert identity” (Standardized Alpha =.68) and “Innovation identity” (Standardized Alpha =.73).

Workers were separated into three main characteristics defining their employment: 1) production/service, 2) professional/managerial, and 3) R&D. Each job responsibility was presumed a have a different relationship with the use of knowledge --

production/service workers expected to follow procedures, professional and managers required to have basic understandings of the nature of their work, and R&D workers called upon to have special abilities necessary for the creation of new knowledge. Findings are given in Table 2.

Table 2: The distribution of Cognitive Knowledge Identities for three types of workers

	Type of worker		
CKI Index	Production and Service	Professional/Managerial	R&D
Tayloristic	24%	14%	18%
Expert	36	53	20
Innovation	18	15	29
Tayloristic + Expert	8	4	1
Tayloristic+ Innovation	1	0	0
Expert+ Innovation	12	13	30
Tayloristic + Expert+ Innovation	1	1	1
	(182)	(303)	(71)

Table 2 reveals a substantial degree of apparent inconsistency between the nature of the employment and cognitive knowledge identities. Production and service workers should be expected to work according to Tayloristic principles, but only 24% perceived their organizations as supporting this form of identity, with another 10% combining Tayloristic and other cognitive identities. A fairly high one/third of these workers claimed that their organizations expected some degree of innovation from them.

There was a better match for professionals and managers since 53% saw themselves as in an organizational framework that encouraged expertise and another 18% combined expertise with other identities. Only 14% of these professionals and managers claimed that they were working under exclusively Tayloristic cognitive identities.

R&D workers were likely to see their organization as encouraging a knowledge identity tied to their innovative activities: 29% saw the CKI as innovation and another 31% found the organization encouraging innovation combined with another form of cognitive identity. But in an unexpected finding, 18% of these R&D workers reported themselves working under the cognitive identity of Taylorism that would not seem ot make possible actual innovation given the requirement for a strict following of rules and procedures.

In the next step of this analysis, relationships were explored between the type of worker and the design of the information technologies they experienced. Information technologies were considered appropriate for work organized under Tayloristic principles when designed to increase managerial control through the provision of information on worker activities. An information technology optimal for expertise supported worker competencies by providing information needed to make decisions

on how best to do a job. An innovation related information technology should support worker creativity in the development of a new product/service.

The design of an information technology was cross-tabulated with the type of worker and the results shown in table 3.

Table 3: The design of IT for different worker groups
N=580

	X^2	Type of worker -% agree		
		Production/ service (185)	**Professional /managerial (314)**	**R&D (76)**
IT control workers				
Helps my manager know exactly what I am doing	P<.01	48	29	18
Provides instructions on exactly how to do my job	P<.01	41	25	15
Provides feedback about the final results from your work – after I complete my part	P<.01	39	28	27
Corrects my work when I make mistakes	P<.01	25	12	6
Informs me about mistakes in my work that I am making	P<.01	25	12	7
IT supports workers' expertise				
Provides information that I need in order to make the decision on how best to do a job	n.s	34	43	41
Helps me to communicate with other workers to convey or exchange information	P<.01	53	56	70
Helps me to communicate with other departments/units in the organization	P<.01	47	53	68
Helps me to contact fellow workers directly for help in finding a solution to a work problem without requiring me to go through regular procedures	P<.01	27	30	45
IT support workers' innovative ideas				
Provides a capability for developing a new product/service	P<.01	10	16	41
Helps me to exchange ideas and opinions with other workers	P<.01	26	30	46

The results show that information technologies designed for control purposes are more likely to be reported by production/service workers rather than other types of workers. Nevertheless, a serious proportion of about a fifth of professional/managerial workers as well as R&D workers also experience controlling information technologies.

Information technologies designed to support worker expertise were found to be experienced by all three types of workers – though particularly high for R&D workers. This may reflect the need for all three types of workers to obtain data and to be in communication with other workers. There also may be a difficulty in differentiating between communications directed at providing simple information and more sophisticated systems that communicate more complex concepts.

Information technologies providing support for innovation ideas were reported by almost half of those in R&D. While this may be seen as quite positive, it also means that more than half of these workers are not assisted by vital information technologies. Again, a small but interesting proportion of other workers are also provided with means that do not seem relevant to their type of work.

These findings reflect a degree of ambiguity but still support our thesis that type of work should be matched to the use of specific information technologies. Divergences from this hypothesis could indicate a mismatch between the type of work and the use of information technologies, or in a more positive manner, point to the possibility that some workers are involved with more than one type of task, each requiring a cognitive knowledge system.

The main hypothesis of the paper is evaluated in table 4. The date used to text the degree to which performance of information technologies relate to an appropriate match between a CKI and information technologies.

A fit was calculated between a CKI and the design of different information technologies. In other words, a fit existed if a Tayloristic CKI matched a Tayloristic information technology, an expertise CKI matched an expertise information technology, and an innovation CKI matched an innovation information technology. These matches were related to the performance of information technologies and controlled by the type of worker. Results of this analysis are shown in Table 4.

Table 4: The Impact on the Fit between CKI and Information Technology (IT) design on performance for different worker groups

% agree

	Type of workers								
	Production / Service			Professional/ Managerial			R&D		
	FIT between CKI and IT design								
	low (90)	high (85)	χ^2	low (176)	high (120)	χ^2	low (44)	high (27)	χ^2
Work performance									
Meet higher standard of quality	24	44	p<.01	26	42	p<.01	38	44	n.s
Decrease cost for task	5	26	p<.01	7	16	p<.01	13	15	n.s.
Increase the number of different tasks that I do	10	24	p<.01	7	19	p<.01	4	19	p<.05
Allows working with a greater variety of materials/people	16	25	p<.05	17	27	p<.01	20	33	p<.05
Reduce time needed for doing the task	30	13	p<.05	23	12	p<.05	22	15	n.s
Increase quantity of similar tasks that I complete	19	9	p<.01	21	7	p<.05	15	13	n.s

The analysis reveals that a proper fit between cognitive knowledge identity and the nature of information technologies improved work performance for production/

service and professional/managerial workers. The fit improved the standard of quality, reduced costs for tasks, increased the number of tasks completed, and allowed a greater variety of materials/people. Also relevant was the improvements of performance regarding the time needed to do a task, and the quantity of similar tasks completed.

The fit, however, had less meaning for R&D workers, though there was still some significance of a fit on increasing the number of tasks and allowing work with a greater variety of materials and people.

CONCLUSIONS

This research established the measurability of such CKIs. Indices were developed for the measurement of Tayloristic, Expert, and Innovation CKIs. Cognitive Knowledge Identities define the way organizations understand or perceive knowledge. CKIs are important for the organization of work as they determine understandings regarding workers' abilities to deal with knowledge and set the framework for transactions between employees and their organizations

In general, our hypotheses regarding the CKIs are supported by the results. Clearly, each knowledge system calls for a different organizational dimension mix. However, it was obvious from the results that many workers are mismatched between the nature of their tasks and the cognitive identification of their environment.

More complicated outcomes are derived from the existence of situations where workers are expected to perform tasks that call for the concurrent implementation of different CKI's. We believe that this is probably due to the complexity of particular jobs–workers are expected to follow instructions strictly for one task and to be more independent to work as experts on other tasks, or even to be creative and innovative, for other tasks.

Of special interest, was the fairly low proportion (24%) of production/service workers who felt they were working within a cognitive knowledge culture that encouraged Tayloristic work. Indeed, a third saw their organizations also expecting them to innovate. This may reflect a national culture in Israel where workers are expected to be more involved with their work, or may reflect the smaller size of organizations and more complex task requirements. It would be interesting to see the distribution in these cognitive knowledge identities in larger industrial societies.

This study extended understandings about the reasons for failure in the introduction of new information technologies. A value aspect sets the way organizations understand knowledge. Our models showed performance improved when work conditions match the chosen CKI. In other words, IT design appropriate to a CKI improved performance of work from information technologies being utilized.

Managers introducing IT systems into an organization should examine the forms of CKIs found in their organization. Then, a determination should be made on whether or not the CKI is appropriate for the form of work. Where the organizational culture is so strong as to make change impossible, then it may be necessary to modify the structure of the tasks. After this, they must evaluate the social structure designed into

proposed IT systems – what it is intended to enable and what are the system constraints. Finally, managers should make sure that the IT system matches each CKI. For example, if a manager determines that the knowledge is codified and is perceived as set of rules (Tayloristic identity), then the IT system should control workers' actions and strengthen supervision over workers. Otherwise, the IT system will not lead to better performance.

In contrast to those considering the extent to which information technologies are changing organizational structures, this research takes a more conservative approach to change. Organizational cognitions regarding knowledge have a dominating role in the effective introduction of new technologies. The technologies must be consistent with existing value structures in order to be successful. The introduction of an information technology not in agreement with the basic organizational cognitions will probably lead to its eventual rejection. On the other hand, organizational tasks may not be consistent with existing organizational cognitions and one or the other may need to be changed for highest organizational performance.

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