Knowledge in projects:
a collection of insights for improving project performance through knowledge,
across the temporary dimension of projects

Introduction

Projects are the realm of knowledge. Every project is a unique and temporary adventure where current knowledge is unleashed, applied and transferred, whereas new knowledge is uncovered, shared and documented.

Projects and knowledge are strongly related: on the one hand projects should exploit current knowledge available within the project environment, for improving project performance. on the other hand projects should develop new knowledge throughout the project life cycle, to be used for carrying out the current project and to be reused for future projects.

The key assumption is that projects are unquestionably a dramatic source of knowledge. Every project offers many learning opportunities to generate knowledge and increase both individual competencies and organizational assets. However knowledge is too often not yet formally considered and well-managed like other project management topics, such as scope, cost, risk, schedule. This lack of focus leaves knowledge unaddressed decreasing the project value in terms of conformance to requirements, professional development, business results.

The term "project" is to be considered in the broad sense of term: it may refer to a stand-alone project, to a project as a part of a larger program, to a program by itself.

This collection of insights is aimed at addressing knowledge topics with respect to the unique and temporary dimension of projects.

Insight 2 - Beyond the DIKW model" - V1.0

Tiziano Villa, PMP® PMI-ACP®
Founder "the Project Management Lab®"

1. The DIKW model

DIKW is an acronym that stands for *"Data - Information - Knowledge - Wisdom"*.

DIKW represents a hierarchical knowledge management model, widely recognized.

The first appearance of this hierarchy was in the poem "The rock" written by T.S. Eliot in 1934. The poem includes these lines: *"Where is the life we have lost in living?, Where is the wisdom we have lost in knowledge?, Where is the knowledge we have lost in information?".*

The model, referred as the "Knowledge Hierarchy" and the "Knowledge Pyramid", was developed in late 80s, as a common framework resulting from the views of Zeleny (DIKWE - Data, Information, Knowledge, Wisdom, Enlightenment), and Ackoff (DIKUW - Data, Information, Knowledge, Understanding, Wisdom).

Typically the model is represented by a pyramid (Figure 1).

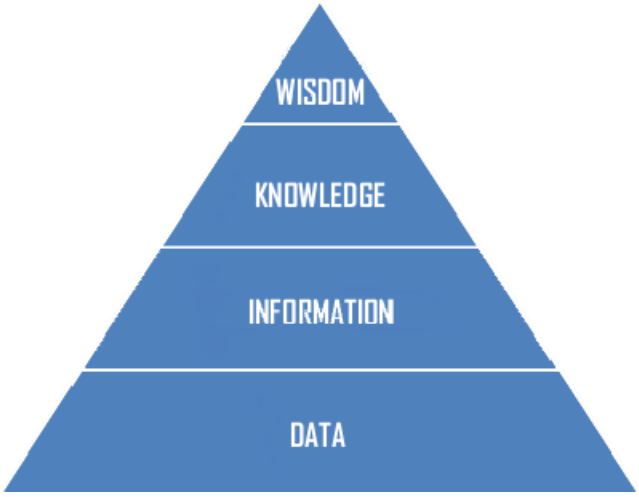

Figure 1 - DIKW model

Four are the hierarchical and incremental layers: each layer has a different meaning and is built on the one(s) below it.

Particularly: *"Each higher level is meant to subsume the lower one; that is, in order to act wisely, it is still necessary to have knowledge, information and data about the task"* (Zeleny, 1987); *"Wisdom is located at the top of a hierarchy of types. Descending from wisdom there are understanding, knowledge, information, and, at the bottom, data. Each of these includes the categories that fall below it, for example there can be no wisdom without understanding and no understanding without knowledge"* (Ackoff, 1989).

2. The layer "Data"

Generally accepted definitions for "Data" are the following:

- *"Data are symbols that represent properties of objects, events, and their environments. They are products of observations. Data are of no value until they are processed into a useable form."* (Ackoff, 1989);

- *"Data is a set of discrete, objective facts about events. In organizational context, data is almost usefully described as structured records of transactions. There is no inherent meaning in data. Data provides no judgment or interpretation and no sustainable basis of action. Data says nothing about its importance or irrelevance."* (Davenport - Pruzak, 1998);

- *"Data is the raw material of knowledge management."* (Pasher - Ronen, 2011);

- *"Data are true factual statements. Inaccurate or mistaken data is not going to be data at all."* (Frickè, 2007).

There is a sound alignment among these definitions, in that data are necessary but meaningless if not addressed. More data don't mean more value. Less data might be better than more. The availability a large amounts of data is an obstacle for identifying and making sense of data that matter.

3. The layer "Information"

This alignment diminishes passing from "Data" to "Information":

- *"The difference between data and information is functional, not structural, but data are usually reduced when they are transformed into information. Information is contained in descriptions, answers to questions that begin with such words as who, what, where, when, and how many." (Ackoff, 1989);*

- *"Information is relevant, or usable, or significant, or meaningful, or processed data."* (Rowley, 2007);

- *"Information is processed data."* (Pasher - Ronen, 2011);

- *"Information is data that makes a difference. Data becomes information when its creator adds meaning. Information is organized for some purpose. We transform data into information by adding value in various ways: contextualized, categorized, calculated, corrected, condensed."* (Davenport - Pruzak, 1998);

- *"Information is relevant data, together with, on occasions, the results of inferences from that relevant data. Information is thus a subset of the data, or a subset of the data augmented by additional items inferred or calculated or refined form that subset."* (Frickè, 2007);

- "*Information is data endowed with relevance and purpose. Converting data into information thus requires knowledge."* (Druker, 1988);

- *"While data and information can be generated without direct human interpretation, knowledge and wisdom cannot. They are human and context-dependent and cannot be contemplated without involving human comparison, decision making and judgment.* NB: for the author an example of information is the recipe for baking bread" (Zeleny, 1987);

- *"Explicit description is not knowledge, but information. The real difference between knowledge and information is between action and its description. Knowledge can exist only as action and information has no existence outside description of action. Information is a symbolic description of action. Information acquires value only if it leads to action, it is transformed into knowledge, As an input, information contributes to the product of knowledge and its added value can be measured via measuring the value of the product."* (Zeleny, 2013).

According to these definitions, the meaning of the term "Information" fluctuates inside and outside the "Information space" of the DIKW model, losing its steadiness. The lower limit of the range is represented by information as a simple selection of existing data (the boundary between the Data and the Information spaces of the DIKW model); the upper limit is represented by information as explicit artefacts such as formulas, if-then rules, schematas, descriptions, collections of 'know-thats', elements of propositional and declarative knowledge, a sort of "surface knowledge" (a part of the "Knowledge space" of the DIKW model).

4. The layer "Knowledge"

Passing from "Information" to "Knowledge", meaning becomes even more debatable. Anyway, authors agree that Knowledge is very complex, deep, rich and fluid concept, hard to define and to share:

- *"While data and information are piecemeal, partial and atomized by their very nature, knowledge and wisdom are holistic, related to and expressed through systemic network patterns, integrative by definition. Knowledge is contained in the overall organizational patterns of the network and not in any of its components, or their simple aggregates or collections. Knowledge is a self-producting and self-maintaining network of relations which are being continually re-created under perturbations. Knowledge is an autopoietic system. Knowledge cannot refers to a 'given and fixed' set of objects 'out there' which are to be simply 'captured', represented and modeled Knowledge is about human ability to make distinctions, choices and decisions." (Zeleny, 1987);*

- *"Knowledge is know-how, for example how a system works. It is what makes possible the transformation of information into instructions. Knowledge can be obtained in two ways; either by transmission from another who has it, by instruction, or by extracting it from experience." (Ackoff, 1989);*

- *"Experience and expertise which, when joined with the data and information, becomes knowledge. The existence or lack of knowledge is put to the test only through action."* (Pasher - Ronen, 2011);

- *"Knowledge derives from minds at work. Knowledge is a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the mind of knowers. In organization, it often become embedded not only in documents or repositories but also in organizational routines, processes, practices, and norms."* (Davenport - Pruzak, 1998);

- *"Knowledge has to be expressed through action. It is only through action that knowledge can be measured. Knowledge is a purposeful coordination of action. Achieving its purpose is also its sole proof of demonstration. Coordinating action is the test of possessing knowledge. Knowledge is not information: actions is and always will be different from its description."* (Zeleny, 2013).

The original sources of the DIKW model (Zeleny, 1987; Ackoff, 1989) clearly state that knowledge is essentially "know-how" (action), and not "know-that" (description). This meaning of knowledge has been recently confirmed by the same authors (Zeleny, 2013).

According to this perspective *"what is the PMBOK® Guide?"*. No doubt, the answer is "Information". For example the equation "SPI = EV/PV" (PMBOK®, page 219) is an explicit artefact that is applied for calculating the SPI for the current project at timenow, processing WPs performance data. The calculated SPI is itself an important information to be used by project manager and PMT - Project Management Team for evaluating the actual performance of the project, its forecasts and the need of corrective actions. Similarly for the Risk Impact Scales (PMBOK®, page 318) to provide information about the priority risks, and for the equations of triangular and beta distributions (PMBOK®, peg. 171) to provide information about activity duration estimates. This way the acronym "PMBOK" should be changed into "PMBOI - Project Management Body Of Information", if the willingness is to adopt properly and coherently the DIKW model to the project management discipline.

The definitions of knowledge of other authors aren't so clear-cut, in that they encompass in the term "knowledge" the coexistence of different types of elements, along a wide range from information to values.

All the definitions agree that knowledge is an holistic concept.

"In spite of the great advances which have been made in knowledge, some fundamental gaps still remain; matter, life and mind still remain utterly disparate phenomena. Yet the concepts of all three arise in 'experience, and in the human all three meet and apparently intermingle, so that real links must exist between them. Holism (from ὅλος = whole) is the term here coined for this fundamental feature of wholeness in the world. Natural wholes are always composed of parts; in fact the whole is not some entity additional to the parts, but is just the parts in their synthesis, which may be physico-chemical or organic or psychical or personal. As Holism is a process of creative synthesis, the resulting wholes are not static but dynamic, evolutionary, creative." (Smuts, 1926). "*Holism is tendency in nature to form wholes that are greater than the sum of the parts through creative evolution"* (Christakis, 2011).

Knowledge is holistic by nature in that it exists as a whole and not as a collection of parts. For example for developing a sound response strategy to the most priority risk of a large and innovative project, Project Manager, PMT members an SMEs strongly interact sharing information, models, experiences, insights, practices, procedures, organizational patterns, perceptions, beliefs, through a self-correcting and integrative way that can't be planned in detail before and rebuild precisely after. They progressively create a unique knowledge in response to a unique situation. Doing this, the system (individuals, group, organization) becomes more knowledgeable to cope with future similar situations.

Knowledge doesn't exist without a specific context, made of unique needs, options, decisions, actions. Elements that contribute to create a contextual knowledge may exist prior independently of knowledge as a whole, such as lessons learned database, project management standards, documentation of past projects, expertise of SMEs. Creating knowledge means combining preexisting elements and developing "live" new elements. But the key is the process for combining elements. Information, models, experiences, insights, practices, procedures, organizational patterns, perceptions, emotions don't mix up by themselves. How to guide the combination of knowledge elements is certainly one of the biggest challenge for new millennium projectized organizations.

As a result of this, it must be underlined that is quite unlikely to imagine an holistic approach driven by a hierarchical framework such as DIKW.

5. The layer "Wisdom"

The last and highest layer of the DIKW model is "Wisdom":

- *"Data and information are parts and pieces of different levels of aggregation, but knowledge refers to the intended whole. Wisdom then involves comparability of different wholes and the explicability of their choice or preferences. Wisdom goes beyond knowledge because it allows comparisons (judgments) with regard to know-why."* (Zeleny, 1987);

- *"Wisdom is the ability to increase effectiveness. Wisdom adds value, which requires the mental function that we call judgment. The ethical and aesthetic values that this implies are inherent to the actor and are unique and personal."* (Ackoff, 1989);

- *"Wisdom is high sensitivity in the organization to what is happening in the external environment. Wisdom describes an organization that renews its knowledge continuously."* (Pasher - Ronen, 2011);

- *"Wisdom refers to explicability: if I know why – and not just what and how – then I could also become wise, not just knowledgeable. Wisdom is about explicability and ethics of our doing. The newly produced knowledge is circulated and its purposes explicated into wisdom: knowing why to do or not to do something. Wisdom is derived from experiencing repeated action."* (Zeleny, 2013).

Despite its position at the top of the DIKW hierarchy, wisdom is only generally addressed. Probably for its very elusive nature, based more on abstraction, vision, foresight and less supported by information systems. Wisdom is on know-why, in that it allows to understand how to apply assimilated knowledge from one domain to new situations. Wisdom is the ability to decide how knowledge must be addressed and put to use. The challenge is to choose the most appropriate "whole" against a specific situation, with respect to the enterprise environmental factors (organizational, ethical, social). Wisdom is about *"why to invest on developing knowledge?, with which amount at stake?, through which framework?".*

Project Manager must be knowledgeable but wise too. He/she is asked to carry out projects in a more and more complex environment. Know-how is very expensive to find, mix and create contextually. Therefore *"which knowledge?, in which place?, at which time?, through which way?"* are vital questions. The answers comes from wisdom. Wisdom is more on context, whereas knowledge is more on content. Knowledge and wisdom are strongly linked in that simultaneously wisdom addresses knowledge and knowledge solidifies wisdom.

While knowledge is a mix of collective and individual elements, wisdom is only personal. A wise person is aware about the balance between the overall profile of the situation to cope with (real needs, goal, risks, resources, organizational background, culture, politics, constraints, group dynamics, people engagement) and the knowledge mix that is indispensable for managing the situation with a good probability of success. Then wisdom entails a sound understanding of the given circumstance, a personal willingness to apply one's own perception, judgment and personal knowledge, a polished ability to sparkle the process of knowledge creation.

An example of wisdom in project management is the definition of the knowledge management plan, during the initiation of the project. The plan should describe the high-level approach for managing the "knowledge" dimension of the project. In this case the wisdom of the project manager consists of depicting the project environment, imagining the knowledge-sensitive situations, evaluating the readiness of the organization to share accumulated knowledge and to create contextual knowledge, speculating a course of action, gaining commitment. This challenge becomes mission impossible if the project manager is "unknowledgeable about knowledge management".

6. Limits of the DIKW model against the project complexity

The DIKW model is essentially hierarchical, separated, sequential.

Hierarchical in that a layer can't exist if not based on the lower layer. Because of this a large amount of data is a *"conditio sine qua non"* for the availability of information, knowledge, wisdom. Separated in that each layer is specialized, well-positioned, recognizable, loosely connected to other layers. Sequential in that the relationships among layers are codifiable, linear, decomposable into an input-output chain, typically bottom-up.

These three features of the DIKW model are, at the same time, strengths and weaknesses. Strengths in that the DIKW model is easy to communicate, understand, memorize, walk through. It's a clear representation of a very complicated but not complex system. Weaknesses

in that the DIKW model can't represent the dynamics of a complex system, such as many projectized situations.

The DIKW model oversimplifies a complex situation, where elements are strongly interconnected and quite difficult to be managed separately. Knowledge permeates the project environment, revealing itself in many synchronized shapes.

Recently the DIKW model was abandoned by the same authors who proposed it in late 80s: *"The DIKWE chain is not really a chain (from inputs to outputs) and certainly not a hierarchy or pyramid, but a cycle. A new strategy is needed. a strategy of reintegration of what should have not been separated and pursued in a specialized way in the first place: namely Data (D), Information (I), Knowledge (K), Wisdom (W) and Enlightenment (E). These all are inputs and resources into a successful business action. All such inputs into a value-adding process must work in synergy, in an integrated fashion, to effectively bring to fruition their dependencies and potentials."* (Zeleny, 2013).

The ultimate goal of project knowledge management isn't to develop and stockpile knowledge but to produce options, decisions and actions for carrying out successfully the project, against complex situations throughout the project life cycle.

A large number of projects and a large number of situations within the single project solicit an holistic approach of knowledge management. For example during a project status meeting options must be developed and decisions must be taken for improving a poor project performance, Thus the equations CPI=EV/AC and SPI=EV/PV (explicit knowledge) are used to calculate the values of CPI and SPI at timenow (information), processing performance data (data). Then current CPI and SPI are discussed among PMT members (implicit knowledge) in order to analyze the underlying causes of current negative performance and trend (underestimates, gold plating, scope creep, lack of collaboration within the project team, inadequate scheduling, unclear responsibilities, adverse environmental factors). In a progressive and unschedulable way new data are processed, new information are produced, new insights are developed exploiting expert judgment (tacit knowledge) and organizational patterns (implicit knowledge). This happens through circular relationships and without the certainty that the right option will be found and the right decision will be taken. For a situation like this the DIKW framework can't modelize what truly happens.

In the project environment, boundaries among DIKW layers are vague and overlapped. The current CPI = 0.89 and the equation CPI = EV/AC are surely explicit artefacts but are they both information?; or one of them is information and the other one is knowledge? And again, personal insights by a SME about the impacts of priority risk are surely tacit assets, but are they knowledge or wisdom?

The only layer that almost doesn't melt into the others is Data. Data exist regardless the specific project situation to cope with. Time and cost performance data at different levels of the WBS (control accounts) are usually be available timely and accurately in a well planned and monitored project. Similarly for data of past projects and data on market conditions.

Many knowledge-sensitive situations of a complex project are effectively addressed through a knowledge mix where implicit and tacit elements are no doubt more crucial (vital few) than

explicit elements (trivial many). For example when a big issue must be solved quickly, an important make-or-buy decision must be taken, a cross-cultural team must be formed and managed, a sound project sponsorship must be gained, a schedule must be strongly compressed. In cases like these, data and information add a marginal value in developing options, taking decisions, implementing actions. Instead, individuals as knowledge workers and F2F interactions among them make the real difference, even if there is a limited availability of data and information. Therefore a key assumption of the DIKW model crumbles: hierarchy of layers.

Summing up, knowledge in complex projects should be managed through a model more systemic and less hierarchical, more integrated and less separated, more concurrent and less sequential, more organic and less mechanistic.

7. A proposal for a PKM - Project Knowledge Management model

The model the author proposes is based on the following definition: *"PK - Project Knowledge is a dynamic combination of explicit artefacts, implicit patterns and tacit expertise, applied for developing options, taking decisions and implementing actions throughout the project life cycle"* (Villa, 2015).

This definition underlines the "contextual mix" of different types of knowledge, to be used intentionally to achieve project objectives.

Four are the key features of an effective PK: contextual (tailored on project peculiarities), intentional (focused on project options, decisions and actions), dynamic (progressively elaborated and shared during the project life cycle), combined (based on different project cognitive elements).

Figure 2 depicts the framework of the PKM model.

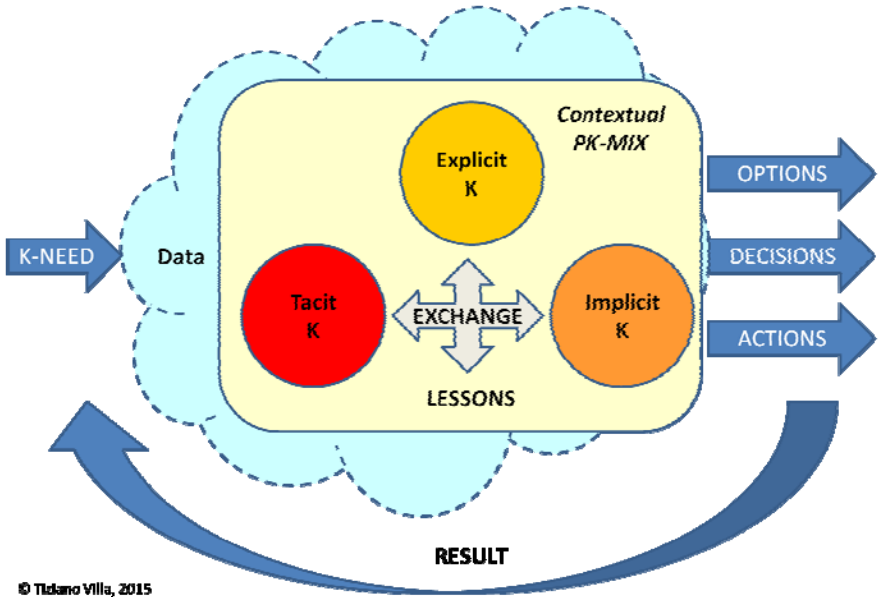

Figure 2 - PKM model

PK, as a whole, is a contextual mix. Explicit, Implicit and Tacit knowledge form the "contextual PK-MIX" (for the detailed descriptions of Explicit, Implicit and Tacit knowledge, refer to "Villa, 2015").

PK exists only against specific K-needs. During the project life cycle many and different knowledge-sensitive situations arise, each with its K-need. They are the *"KSN - Knowledge-Sensitive Nodes"* (Ibidem). KSNs are turning points where the output (options, decisions, actions) is strongly influenced by the PK-MIX.

For example, for the KSN "Create WBS" of a very innovative project, tacit knowledge of SMEs becomes more important than the availability of WBS from similar projects (explicit knowledge). Changing the project KSN, changing the PK-MIX.

The primary purpose of the PKM model is the development of options, decisions, actions for satisfying the K-need. The number of options, decisions, actions depends on the relevance of the KSN. Higher the relevance, higher the number.

An additional purpose of the PKM model is the creation of new knowledge ("lessons" in the broad sense of term), from lesson learned (explicit) to personal development (tacit), passing through shared organizational patterns (implicit). At the same time, a KSN consumes existing knowledge and create new knowledge.

This way PKM model can try to fill the gap between the k-need and the project result. Sometimes this happens, sometimes not.

PKM model integrates into an holistic view, the Information, Knowledge and Wisdom layers of the DIKW model. The Data layer remain outside, as an input (more or less relevant) of the integrated process that generates the contextual PK-MIX.

"A holistic approach requires us to describe things in terms that naturally lead to holistic thinking, while providing some form of categorization that leads to effective action." (Snowden, 2005).

PK can't be planned and monitored in detail, it can only be addressed as a whole, creating the right *"Ba". "Ba can be thought as shared space for emerging relationships"* (Nonaka - Konno, 1998).

Nowadays, the challenge for knowledgeable project managers consists in creating different types of *Ba* against different project KSNs.

8. References

Ackoff R. L. (1989) *From data to wisdom.* Journal of Applied Systems Analysis, 16 3-9.

Christakis N. A. (2011) *Shortland abstractions and cognitive toolkit.* www.edge.org.

Eliot T. S. (1934) *The rock: a pageant play.* Harcourt, Brace and Company.

Davenport T. H. Pruzak L. (1998) *Working Knowledge: how organizations manage what they know.* Harvard Business School Press.
Drucker P. F.(1988) *The coming of the new organization.* Harvard Business Review, 1-19.

Frickè M. (2007) *The knowledge pyramid: a critique of the DIKW hierarchy.* Journal of Information Science, XX 1-13.

Nonaka I. Konno N. (1998) *The concept of Ba: building a foundation for knowledge creation.* California Management Review, 40 40-54.

Pasher E. Ronen T. (2011) *The complete guide to knowledge management.* John Wiley & Sons.

Project Management Institute (2013) *A guide to the project management body of knowledge (PMBOK® Guide) Fifth Edition.* Project Management Institute.

Rowley J. (2007) *The wisdom hierarchy: representations of the DIKW hierarchy*. Journal of Information Science, 33 163-180.
Smuts J. C. (1926) *Holism and evolution*. Mac Millan & Co.

Snowden D. J. (2005) *The ASHEN model: an enabler of action.* www.cognitive-edge.com.

Zeleny M. (1987) *Management support systems: towards integrated knowledge management.* Human System Management, 7 59-70.

Zeleny M. (2013) *Integrated Knowledge Management.* International Journal of Information Systems and Social Change, 4 62-78.

Villa T. (2015) *Knowledge: definition, types, application in the project environment - V1.3.* PMLAB.

9. The collection "Knowledge in projects"

- Insight 1 - Knowledge: definition, types, application in the project environment;
- Insight 2 - Beyond the DIKW model.

10. Contact me

Comments, suggestions, disagreements are really appreciated. Please send them to tiziano.villa@pmlab.it or find me on Linkedin (tiziano.villa).