Re-Visiting the Knowledge Pyramid

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Abstract

The knowledge pyramid has been used for several years to illustrate the hierarchical relationships between data, information, knowledge, and wisdom. This paper posits that the knowledge pyramid is too basic and fails to represent reality and presents a revised knowledge pyramid. One key difference is that the revised knowledge pyramid includes knowledge management as an extraction of reality with a focus on organizational learning. The model also posits that newer initiatives such as business and/or customer intelligence are the result of confusion in understanding the traditional knowledge pyramid that is resolved in the revised knowledge pyramid.

1. Introduction

Much has been written on the knowledge pyramid or data, information, knowledge, wisdom, DIKW, hierarchy and its use in knowledge management, KM. This paper continues this discussion but takes a different tack. It is posited that the knowledge pyramid is an artifact of KM processes and not an artifact of reality. This is a different tack in that several authors (Ackoff, Sharma, Bates, Fricke) consider the pyramid as a natural expression of the relationships between DIKW and the logical progression for the generation of IKW [1] [2] [17] [20]. This paper posits that the natural relationship between DIKW is actually an inverted pyramid and that the knowledge pyramid is an artificially constructed artifact representing the relationship between DIKW in an organizational KM context.

This is a conceptual paper that hopes to promote discussion and insight by researchers into the nature of KM and its relationship to the overall processes of learning. It is expected that new insight into KM processes such as filtering and selection processes can be gained by this discussion. Another goal of this paper is to create a model that integrates KM and Business Intelligence, BI, and/or the other “intelligences” such as Customer Intelligence, CI. It is also expected that this discussion will generate a better understanding of KM processes so that better KM systems, KMS, can be designed. Finally, this paper will state definitions of terms important to KM, including definitions of data, information, knowledge, and intelligence. It is hoped that these can be accepted as working, consensus definitions but it is recognized that these terms are philosophical in nature and can be debated as long as we want. This debate is embraced but not encouraged as I agree with Keen and Tan [15] who believe that while it is important to understand KM terms, it is unproductive for researchers to get focused on trying to precisely define these terms at the expense of furthering KM research. As a discipline we need to allow the debate but we also need to unite into a consensus set of working definitions. It is hoped this paper will spur this consensus.

2. Methodology

This is a conceptual paper, however, the arguments made and conclusions presented are based on action research. The inspiration for this paper comes from a project the author is currently working with a United States based defense contractor. Specifics of the project and the company cannot be presented due to nondisclosure agreements. What can be said is that the company is attempting to take technologies and experience developed/gained working with United States Department of Defense and other national intelligence agencies and generate a commercial knowledge management offering. The role of the author in this project is as a KM academic expert responsible for providing KM focus and direction. It is action research as the author has a vested interest in the success of the project and in generating a commercial KM offering.

Specific data for this paper came from the company’s initial presentation of what was considered to be a knowledge pyramid. This pyramid cannot be presented due to nondisclosure agreement. However, the presented pyramid can be described as a fusion of the traditional knowledge pyramid with KM processes.
and intelligence concepts. It was analysis of this pyramid and discussions with the project team that is the basis for this paper.

3. The Traditional Knowledge Pyramid

References to a knowledge hierarchy can be found in the popular literature but generally Ackoff is given credit for the first academic publication. Figure 1 illustrates the traditional knowledge pyramid as originally proposed by Ackoff [1]. The inference from the figure is that data begets information begets knowledge begets wisdom. An additional inference is that there is more data than information, more information than knowledge, and more knowledge than wisdom. This model has been used in countless HICSS presentations as well as other KM presentations and it is stated as a given truth that it is a generally accepted model showing the DIKW hierarchy [7] [8] [20]. The model does not philosophically define data, information, knowledge, or wisdom and it is not the purpose of this paper to do this, there are many sources already available that make arguments supporting various definitions. However, it is the purpose of this paper to propose consensus, KM focused working definitions. The traditional knowledge pyramid uses the following summarized basic definitions:

Data – basic, discrete, objective facts such as who, what, when, where, about something.
Information – data that is related to each other through a context such that it provides a useful story, as an example, the linking of who, what, when, where data to describe a specific person at a specific time.
Knowledge – information that has been culturally understood such that it explains the how and the why about something or provides insight and understanding into something
Wisdom – placing knowledge into a framework or nomological net that allows the knowledge to be applied to different and not necessarily intuitive situations

These definitions imply that there is a relationship between data, information, knowledge, and wisdom and it is the knowledge pyramid that provides a graphical representation of these relationships as a roll up hierarchy of data leading to information leading to knowledge and finally leading to wisdom (henceforth this will be referred to as the DIKW creation flow).

Houston and Harmon describe this in the use of summations: \( I = \Sigma(D) \), \( K = \Sigma(I) = \Sigma \Sigma(D) \), and \( W = \Sigma(K) = \Sigma \Sigma(I) = \Sigma \Sigma \Sigma(D) \) [9].

The use of the pyramid is typically in instruction of database and KM concepts to reflect that “data,” “information,” “knowledge,” and “wisdom” are different concepts and are in increasingly higher levels of abstraction. This paper argues that the DIKW pyramid is a misleading representation of the relationships among these concepts for information systems research purposes. Maintaining the fuzziness of these concepts in the information systems discipline leads to confusion. We need to better define these constructs to begin to eliminate some of the ambiguities in our research.

4. The Revised Knowledge Pyramid

A counter point to the traditional knowledge pyramid is provided by Tuomi [21]. Tuomi [21] states that data is not the building block for information, knowledge, and wisdom as data is not observed, collected, or recorded in a vacuum. Rather, our understanding of the world through our wisdom and knowledge drives us to collect specific information and data to support our use of our knowledge and wisdom. In this view, the hierarchy flows down the pyramid rather than up the pyramid and data does not exist as a collection of unrelated facts as all collected facts are related to our basic knowledge and wisdom. While this is an improvement to the knowledge pyramid it still leads to confusion.

4. The Revised Knowledge Pyramid

The revised knowledge pyramid attempts to place the knowledge hierarchy within the context of the natural or real world. Figure 2 illustrates the revised pyramid. What it shows is that data, information, knowledge, and wisdom exists in a global context, i.e. humans are constantly gathering and processing data into information, knowledge, and wisdom. However, the data gathered and processed is not all that is available and is limited by the abilities of the sensors to detect, interpret, and capture data. Sensors can be our human senses, other’s human senses, or mechanical sensors...
where mechanical sensors are anything that is not a human sense such as a light detector, radio wave detector, pressure meter, a typed in transaction record, etc. They reflect that as sensors improve our ability to capture more data improves. A human example of improving sensors is using lasiks to improve eyesight allowing a person to “see” much more, enriching the vision that is captured. The dotted arrows reflect the processing into information, knowledge, and wisdom using the processes of insight, analysis, and sense making. These lines are bi-directional indicating that the generation of information, knowledge, and/or wisdom may progress up the hierarchy or feedback down the hierarchy as the user understands more of what they are learning (this recognizes Tuomi’s [21] counter view). The lines between layers reflect the social networks used to transfer to different users. Social networks are being used loosely in this context and refer to any formal or informal, direct or indirect methods used to transfer data, information, knowledge and wisdom between users. Examples include classroom settings, word of mouth, published articles, conference presentations, email, etc. Ultimately, this is a representation of the knowledge hierarchy and the general learning process for people and societies that results in multiple large bodies of knowledge being generated and used. The endpoints lead to learning. Why learning? Learning has a multitude of definitions but for this model learning is defined as the acquisition of DIWK that leads to a change in behavior or expectation within the individual or group that is doing the learning.

Why is the knowledge pyramid inverted, i.e. why is there more information than data, more knowledge than information, and more wisdom than knowledge? One reason is simply mathematical, if information is the structuring of data into meaningful combinations, then the number of possible combinations for a quantity x of data is minimally x! implying there is possibly a greater amount of information than the original amount of data. Considering that data users may have differing frames of reference for processing data in different disciplines of thought (for example accountants versus marketers or engineers versus biologists) it is very conceivable that the amount of information generated is greater than the original amount of data. This same argument can be used for the generation of knowledge and wisdom, especially when it is also considered that users may have different ethical, religious, or cultural belief systems that could cause them to interpret information and then knowledge differently (for example Christians may generate different wisdom from the same knowledge than a Buddhist would or free societies different than totalitarian societies). This is consistent with Nonaka,[18] Jennex, [12] and others that argue that all knowledge is context specific. An example of this is technology transfer that takes DIKW from one discipline and attempts to apply it to another, for example, taking the knowledge used to create sound canceling headphones and applying it to identifying radioactive substances (both use learning algorithms to identify patterns).

Figure 2. Revised Knowledge Pyramid
The solid vertical arrows represent application of knowledge management to the revised knowledge pyramid. Jennex [11, p. iv] has defined knowledge management as “the practice of selectively applying knowledge from previous experiences of decision making to current and future decision making activities with the express purpose of improving the organization’s effectiveness.” This implies that knowledge management is not trying to capture all knowledge or wisdom. Rather, knowledge management targets specific knowledge and wisdom needed by an organization to perform specific tasks.

The implication is that the KM knowledge pyramid is a subset of the revised knowledge pyramid as shown in figure 2. There are other differences. KM tends not to use wisdom but is beginning to apply intelligence concepts and differentiate between knowledge needed to make a decision and specific actionable knowledge needed to make a specific decision in a specific context. For example marketing knowledge is needed to create marketing campaigns but specific customer knowledge is needed to make decisions as to how to market specific customers. For some users this is confusing as it seems to imply there are differing types of knowledge needed for KM. However, this tends to be consistent in intent to Tuomi’s [21] concept of wisdom.

This confusion may be a driver for those who practice Business Intelligence, BI, or Customer Intelligence, CI, etc. as they see a need for differentiating between general information and knowledge and specific decision information and knowledge (BI is defined as the collection, analysis, and presentation of business information for decision making [22] while CI is the same only for customer information [23]). Figure 2 captures this by using the term intelligence rather than wisdom where intelligence refers to very specific actionable knowledge. The term intelligence is taken from the intelligence realm, that area that seeks to generate actionable knowledge to be used in the formulation of strategies and tactics to accomplish a specific goal, such as beating an opponent during wartime or to determine what actions should be planned. This term is not chosen lightly as it does fit into the DIKW hierarchy meaning that it is the interpretation of data, information, and knowledge to create courses of action or make specific decisions. Also, the KM arrows are shown to be double headed as the hierarchy may travel in either direction. In fact, it is expected that while the learning process will tend to generally be a bottom up process, meaning that it starts with the interpretation of data, organizational learning and KM will generally be a top down process where it is first determined what actions or decisions need to take place or be made and from that identify what intelligence, then knowledge, then information, then data is needed to support taking the specific actions or making the specific decisions.

That the KM knowledge pyramid terminates with organizational learning rather than learning is because KM tends to be organization focused (it is recognized that there is personal KM but in many cases personal KM is also driven by organizational needs). Organizational Learning is defined as a quantifiable improvement in activities, increased available knowledge for decision-making, or sustainable competitive advantage [3] [5] [6] [17]. Huber, Davenport, and King [10] believe an organization learns if, through its processing of DIKW, its potential behaviors are changed. This is consistent with the termination of the revised knowledge pyramid only in the organizational context.

The other major difference is in the application of filters. While the general learning process seeks to push data, information, knowledge, and wisdom out to all who wish to use it, KM does not. As stated earlier, KM seeks to support specific decision making and thus needs specific data, information, knowledge, and intelligence. Additionally, KM seeks to share this with the right people at the right time [14]. This implies that KM filters data, information, and knowledge to generate specific, actionable intelligence that is shared with specific, limited users. Filters are placed on the social networks to limit access and to separate and capture that which is needed from that which is not. This is a fairly new term for KM as the KM literature tends to use the term KM strategy. It is the position of this paper that KM filters are the implementation of KM strategy. That filters are important is evidenced by Jennex and Olfman [13] who found KM strategy to be a key critical success factor.

A final difference between the traditional knowledge pyramid and the revised knowledge pyramid is the removal of apex’s. This was done to remove confusion as an apex tends to imply that there is an ultimate point, such as the ultimate key wisdom for the traditional knowledge pyramid or a single key datum for the revised knowledge pyramid. While it is somewhat satisfying to refer to ultimate points, this paper does not support the idea of a “big bang” theory for data or an ultimate, supreme wisdom. Rather, the paper does support that there is some initial level of data and some ultimate amount of wisdom or intelligence. To support this position again consider the contextual nature of knowledge and wisdom/intelligence and the multiple frames of reference and contexts that users bring to the generation of knowledge and wisdom. Also consider
that most organizations do not ultimately need one key piece of intelligence as there is rarely a single decision that needs to be made. Hence the revised knowledge pyramid is pyramidal in form as that provides a visual impact as to the relative amounts of data, information, knowledge, and wisdom/intelligence but are flat topped, much like the Aztec and Mayan pyramids and not like the Egyptian pyramids (note that this is being used to illustrate the point and not to imply that there is more merit to one style pyramid over another).

5. Discussion

The revised knowledge pyramid recognizes Ackoff [1] and Tuomi [21] and finds both wanting. Ackoff [1] assumes data generates information which generates knowledge which generates wisdom. Tuomi [21] believes all data and information is collected based on influence from existing knowledge and wisdom. Ackoff’s pyramid flows up, Tuomi’s pyramid flows down and reality as observed and implemented in the revised knowledge pyramid recognizes that flow is in both directions. Tuomi [21] is wrong in thinking that flow is only down the pyramid. Basic research often times involves collecting data about something that we do not have knowledge or wisdom. An example is physics research in the late 1800s. Scientists did not understand nor did they have knowledge about atomic structure, subatomic particles, and radiation. Data was collected an observed by scientists noting that photographic film was fogged when near certain materials. This data was gathered and then put into context as information that said specific materials caused fogging. Consideration of this information led to the formation of theories to explain why this happened, generating potential knowledge. Analysis of this knowledge led to experiments designed to prove the correctness of this potential knowledge. This example shows that both Ackoff [1] and Tuomi [21] are right and both are wrong. Flow of creation is in both directions of the pyramid.

Another example bolstering this argument is the use of data mining to create information by discovering patterns in data. Commonly called knowledge discovery, it is the analysis of these new found patterns, or information, and the application of context, culture, and other knowledge that creates knowledge; and the positioning of this knowledge into existing problem or competitive advantage contexts that creates actionable knowledge or intelligence. In this example the predominant direction of creation flow is up the pyramid but it can also be argued that previous knowledge of business needs, processes, and behavior influenced the interpretation of discovered patterns into knowledge and intelligence so that creation flow is actually in both directions.

A final example is from engineering. It is common for engineers to instrument everything they can when conducting testing, even if they are not sure of a purpose for the data. A high pressure vessel destructive test from my past illustrates this. The test called for burst testing a 2500 psi vessel pressure using water. Standard instrumentation for measuring pressure and temperature were used plus video monitoring was added. There was no real need for collecting video data other than it was thought it would be interesting to watch. Since water, a non-compressible liquid, was being used as the pressuring medium it wasn’t expected to be a violent failure (violence in this case is represented by a very large, very fast release of energy) as it was expected that the vessel would crack and the water spill out or perhaps spray out. The test team was very surprised when the test resulted in a spectacular release of energy. The video data was what provided the story and it was interesting to see the test setup disintegrate during the first test and then to see that the test setup was surrounded by sand bags and other retaining walls for the second test. The point of this example is that there are many situations in which we collect data for no real reason other than we can and it is later analysis of this data that results in the generation of unexpected information, knowledge, and intelligence.

6. Conclusions

The revised knowledge pyramid is visually more complex and thus less satisfying as a visual model then the traditional knowledge pyramid but is more satisfying conceptually as it fits our perception of reality to a better degree than the traditional knowledge pyramid. Is this the final model? Probably not but it is a step in the right direction and a starting point for more detailed discussion on the knowledge pyramid. Should we quit using the traditional knowledge pyramid? Probably not, it has its use as a tool for introducing the concepts of data, information, knowledge, and wisdom to beginning students. However, it is recommended that the traditional knowledge pyramid be quickly followed by the revised knowledge pyramid as this is a better model for explaining what KM is and does and for how DIKW are created.

The revised knowledge pyramid also shows that BI, CI, etc. are really not new applications but are manifestations of confusion caused by the traditional knowledge pyramid. While it is expected that BI, CI, etc. practitioners may not embrace that they are within
KM, the model does support the fusion of these initiatives into the KM discipline and KM researchers are encouraged to include these approaches in researching and applying KM.

Finally, this paper proposed to provide a set of what are hoped to be consensus working definitions of KM terms from the revised knowledge pyramid. These terms are summarized below:

- **Data** – basic, discrete, objective facts such as who, what, when, where, about something.
- **Information** – data that is related to each other through a context such that it provides a useful story, as an example, the linking of who, what, when, where data to describe a specific person at a specific time.
- **Knowledge** – information that has been culturally understood such that it explains the how and the why about something or provides insight and understanding into something.
- **Wisdom** – placing knowledge into a framework or nomological net that allows the knowledge to be applied to different and not necessarily intuitive situations.
- **Intelligence** – specific actionable knowledge needed to make a specific decision in a specific context.
- **Learning** – the acquisition of DIWK that leads to a change in behavior or expectation within the individual or group that is doing the learning.
- **Organizational Learning** – a quantifiable improvement in activities, increased available knowledge for decision-making, or sustainable competitive advantage. An organization learns if, through its processing of DIKW, its potential behaviors are changed [3] [5] [6] [10] [17].
- **Social networks** – any formal or informal, direct or indirect methods used to transfer data, information, knowledge and wisdom between users.
- **Filters** – KM processes that limit access and separate and capture that DIKW/I which is needed from that which is not.

The implications of this paper are many. KMS designers have a better understanding of how KM fits in the general DIKW world. KMS can focus on strategy and strategy implementation through the design and implementation of KM filters. This leads to the possibility of creating audit mechanisms that can validate that KM strategy has been properly implemented that is similar in nature to auditing security policy implementations in firewalls. Another implication is a clearer understanding of the role of social networks in the creation and transfer of DIKW/I. KMS designers will also be focused on providing technological support for these social networks and it clarifies that KMS is more than just knowledge storage and retrieval technologies, they also incorporate communication and collaboration technologies. Another implication is a new focus on identifying specific actionable knowledge for focused decision making, or, as stated in the paper, generating intelligence. A final implication is that KM should now be recognized as an integrated part of regular DIKW/I processing. KMS designers should be focusing on integrating KM processes into regular work processes.

7. References


