Assessment 1: The DIKW Hierarchy

CP5806 - Data and Information: Management, Security, Privacy and Ethics

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Task One

The data-information-knowledge-wisdom (DIKW) hierarchy is a construct that has been widely used in the information and knowledge literature (Rowley, 2007). Whilst the idea of a sequential progression from data to wisdom appears to be reasonable, deeper consideration reveals it to be a flawed view of reality. Therefore, the author disagrees with the implicit assumption that there can be no wisdom without knowledge, no knowledge without information, and no information without data.

There have been a number of critiques of this aspect of the hierarchy. Frické (2018) argued that acceptance of universal statements such as "all rattlesnakes are dangerous" as valid pieces of information when they cannot possibly be inferred from data invalidates the presumption that data must come before information.

Furthermore, the idea that data is the foundation for all other levels is suspect from a methodological perspective as it implies that data is collected mindlessly before somehow being transformed in order to derive insight and answer questions. Instead, the collection and subsequent transformation of data is usually preceded by knowledge or wisdom in the form of a theory or question and therefore implies the existence of knowledge without information (Frické, 2018; Ted Institute, 2014).

There have also been proposals to invert the pyramid on the very basis that knowledge can come before information and information before data. For example, Tuomi (1999) argued since information is structured and verbalised knowledge, and data is the result of adding value to information, knowledge should be the base of the hierarchy rather than data.

Finally, wisdom has proven to be an even more problematic concept than knowledge, and as a result is largely absent from the DIKW literature, with one interpretation being that many authors do not view wisdom as being a function of knowledge, and perhaps a completely different concept altogether (Frické, 2018; Rowley, 2007).

Task Two

In 1989, Ackoff stated that each level of his DIKW hierarchy “includes the categories that fall below it” and estimated that “on average about forty percent of the human mind consists of data, thirty percent information, twenty percent knowledge, ten percent understanding, and virtually no wisdom” (as cited in Bernstein, 2009, p. 68). The author disagrees with Ackoff’s statement on the basis that the storage mechanisms in the human brain are somewhat more complex than those of a computer. The author also concludes that it would be possible for the brain to contain more knowledge than information.

The human brain perceived almost everything about its immediate surroundings, but in order for stimuli to pass into short-term or working memory (STM), they must have either been part of an automated process or paid attention to, and therefore undergone some sort of processing prior to entry (Lutz & Huitt, 2018) Therefore, using Ackoff’s definitions, nothing in the human brain is stored as pure data.

The other type of storage is long-term memory (LTM), which is essentially limitless but also an unconscious storage location. Content must be retrieved back into STM before it can be used or acted upon. Whilst there is no general consensus regarding how this actually occurs (Greshko, 2019), Cognitive Load Theory indicates that as expertise in a domain grows, what is retrieved also changes. This is why expert chess players, for example, are able to play multiple games of chess simultaneously. They still have the same STM capacity as a novice player, but entire games are single chunks of information (Charness, Tuffiash, Krampe, Reingold, & Vasyukova, 2005).

Given the permanent fluidity of the contents of LTM and its limitless size, it would be impossible to calculate even approximately how much of the human mind contains wisdom, knowledge and/or information, and therefore certainly possible for it to contain more knowledge than information.

Task Three

The DIKW hierarchy is a “taken-for-granted” notion in data and information science (Rowley, 2007). Nevertheless, the hierarchy is not without its criticisms, which include the representation of the hierarchy as a bottom-up process, the ambiguity in the definitions of the levels and the placement of wisdom at the pinnacle.

One criticism is that the hierarchy is an incomplete representation of knowledge-creation. For example, some argued that the process should actually go the other way based on the idea that all data must contain an element of theory and therefore information or knowledge. As a consequence, the hierarchy should be reversed and start with wisdom and end with data (Frické, 2018). Alternatively, Jennex (2009) posited that the process was actually bi-directional to reflect that individual learning is generally a bottom-up process but organisational learning and knowledge management tends to be top-down.

A second criticism of the hierarchy is the lack of definitive definitions for each of the levels irrespective of those proposed by Ackoff when first introducing the construct. The variety of definitions for data, information, knowledge and wisdom has also proved problematic as it has highlighted the ambiguity in the relationships between them (Robertson, 2013; Rowley, 2007). For example, Weinburger (2010, para. 11) argued that knowledge is far more than transformed information and results from a complex process that is “social, goal-driven, and contextual and culturally-bound”.

The final criticism of the hierarchy discussed here relates to the placement of wisdom at the top of the hierarchy. Frické (2018) argued that since wisdom was a completely different concept to the other three, it did not belong at the top of the hierarchy, and this had been implicitly acknowledged by many - from Plato through to Ackoff himself. Rowley (2007) found there was very little discussion regarding wisdom in the reviewed textbooks and concluded one possible explanation for this was that, consistent with Frické’s view, wisdom could not be obtained from information and knowledge.

Task Four

Transaction processing systems (TPSs), management information systems (MISs), data warehouses, decision support systems (DSSs) and expert systems (ESs) are all examples of data or information systems and each can be mapped to a level of the DIKW hierarchy.

TPSs record routine transactions of an organisation and store it in the databases and data warehouses necessary for higher-level information systems (Zwass, 2017). Therefore, they are most appropriately mapped to the data level.

MISs rely on the data collected by TPSs to generate detailed, routine reports required by lower-level management of an organisation and are usually focused on historical or current activities (Zwass, 2017). Given the usual data source and type of output, a MIS are most appropriately mapped to the information level.

As data warehouses collate the data from TPSs and other databases to enable later data mining for insights regarding business processes and products (Zwass, 2017), they are similar to a MIS and therefore also most appropriately mapped to the information level. However, in some cases, larger and more complex data warehouses could be a type of DSS (for example Ohlinger, 2006) and therefore also mapped to the knowledge level.

DSSs are sometimes known as business analytics applications due to their purpose of extracting insights from data warehouses and other lower-level information systems via modelling or data mining. Due to the more complex data interrogation approach and output of such systems, DSSs are most appropriately mapped to the knowledge level.

ESs are a type of advanced DSS that uses machine learning to derive insights and make decisions within a domain normally requiring human expertise. However, despite their ability to solve complex problems, they are currently unable to apply the adaptive judgement expected of a wisdom-generating system (Ackoff, 1999; Zwass, 2016) and therefore are also most appropriately mapped to the knowledge level.

<u>Task Five</u>

In a 1989 paper, Ackoff stated that “From all this I infer that although we are able to develop computerized information-, knowledge-, and understanding-generating systems, we will never be able to generate wisdom by such systems” (Ackoff, 1999, p. 172). Despite the lack of substantial progress in developing systems able to duplicate human thought processes, the author disagrees with Ackoff’s statement on the basis that “never” is a very strong claim.

All successes so far in the field of artificial intelligence have been restricted to the applied type. One such example are expert systems, which combine a knowledge base and an inference engine to produce human expert-like decisions and behaviour (Copeland, 2020). However, despite the use of fuzzy logic to more-closely approximate the uncertainty in the decision rules employed by human experts, no current expert system would be considered a wisdom-generator by Ackoff.

Expert systems have only achieved so-called routine expertise, which means the ability to apply pattern recognition to solve familiar problem types and a limited set of new scenarios (Gube & Lajoie, 2020). They have no concept of the limits of their expertise; nor can they use their expertise to solve completely novel scenarios in an innovative manner (Airbus’ ‘What book?’ events (Fitzherbert, 2012)) and in doing so create new knowledge. This is a defining characteristic of human adaptive expertise and indicates the level of metacognitive skills Ackoff’s wisdom-generating systems would have to display (Gube & Lajoie, 2020).

All that being said, Ackoff could hardly have foreseen the technological advances made since he made the statement regarding computerised systems. At the time, the internet was still in its infancy and today there are self-driving cars and programs that can teach themselves to play chess ("The Guardian view on the future of AI", 2019). If this current rate of advancement continues, then it might just be possible in the future to develop true artificial intelligence and prove Ackoff wrong.

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