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Parallels in knowledge cycles

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ABSTRACT

Knowledge management as an academic discipline is realizing phenomenal growth and international acceptance. However, there still exists no universally accepted framework or model. This paper reviews three of the most well known KM models from similar epistemological and ontological views. The three models reviewed are: Nonaka's SECI (Japan), March's Ex-Ex (USA) and Boisot's I-space (Europe). A number of recommendations for future research based on the similarities and differences among these models pertaining to knowledge management are presented.

1. Introduction

The academic discipline related to knowledge in organizations is still in its early stages of development, although a large and growing body of literature on organizational knowledge and its related disciplines (i.e., organizational learning, intellectual capital) is emerging (Gu, 2004; Nonaka & Peltokorpi, 2006). Over the past decade, the number of articles on knowledge management (KM) has been increasing at the average annual rate of 50% per annum (Serenko & Bontis, 2004). Given this trend, the total number is predicted to exceed 100 000 publications by the year 2010. Accompanying this growth is an equally impressive growth in the number of PhD dissertations which have been recently completed (Serenko, Bontis, and. Grant, 2009) as well as various rankings of academic journals (Bontis & Serenko, 2009a; Serenko and Bontis, 2009). The purpose of this research paper is to present a review of three knowledge management models from two perspectives: epistemological and ontological.

2. Literature Review

The field of knowledge management benefits from a healthy representation across various functional areas including international business (Schotter & Bontis, 2009), healthcare (Bontis & Serenko, 2009b), financial services (Bontis & Serenko, 2009c), and many more. These diverse contexts help to provide the momentum for growth in both theoretical (Serenko, Bontis & Hardie, 2007) and practical terms (Booker, Bontis & Serenko, 2008). These different philosophical streams influence the way individuals and organizations face practical problems related to knowledge creation and management (Choo & Bontis, 2002; Bontis, 2002; Zhao & Ordóñez de Pablos, 2010a, b). To shed more light into the issue of corporate epistemology, we can present three different theoretical perspectives of knowledge and knowledge creation as follows (based on Venzin, von Krogh, and Roos (1998) and adopted by Marr, Gray, and Neely (2003); Marr (2004): cognitivists, connectionists and autopietics.

Cognitivists consider the identification, collection and central dissemination of information as the main knowledge development activity. Organizations are considered as open entities that develop increasingly accurate pictures of their pre-defined worlds through the assimilation of new information. Knowledge is developed according to universal rules; hence the context of the incoming information is important.

Connectionists believe that knowledge resides in the connections and hence focus on self-organized information flow. There are many similarities here to the cognitivist viewpoint but the main difference is that there are no universal rules. Rules are team-based and vary locally; therefore, organizations are seen as groups of self-organized networks dependent on communication.

Autopietics considers the context of information. Information and knowledge cannot be easily transmitted since it requires internal interpretation within the system according to one's individual rules. Thus, knowledge is unique to individuals who develop it themselves.

These three different positions are the basis of how individuals and organizations view the practicalities of knowledge management. The positivistic scientific viewpoint of cognitivists allows that knowledge can be codified and represented separately from

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individuals. The connectionists combine private and public knowledge. The interpretive autopietics see knowledge as private and interlinked into the social context. Both subject and object are part of a situation and exist in a social and historical setting (Gherardi & Nicolini, 2003). Knowledge cannot be dissociated from the subject that processes it.

The ontological dimension of knowledge (i.e., the subject who knows) repeatedly appears in the literature at two levels: individual and group. Ontologically the organization is a cognitive entity (Cook & Yanow, 1995). However, the distinctions and dimensions are varied. For example, Spender, 1996b) and De Carolis (2002) present individual knowledge vs. social knowledge, the same way that it is presented within Nonaka and Takeuchi's 1995) knowledge spiral. Ichijo (2002) differentiates unique knowledge from public knowledge; Matusik (2002) differentiates private knowledge from public knowledge; and Fiol (2003) considers two knowledge levels: the individual and the organizational.

3. What is knowledge management?

Knowledge management (KM) is an organizational discipline bridging information demand and supply in support of learning processes within organizations that lead to improved performance (Curado & Bontis, 2006; Huizing & Bouman, 2002).

KM is the driver of intellectual capital growth which represents the most important intangible asset for firms (Bontis, 1996; Bontis, 1998, 1999; Bontis, Keow, & Richardson, 2000; Cleary, O'Regan, O'Donnell, Kennedy, & Bontis, 2007; O'Donnell et al., 2006; O'Regan et al., 2001; Seleim, Ashour, & Bontis, 2004; Wiig, 1997). However, when knowledge is viewed as a resource, a firm's decision to share it openly is seen to erode its competitive advantage (Andreou & Bontis, 2007; Bontis, 2001; Spencer, 2003). Thus, knowledge is a puzzling concept, which is difficult to measure, disclose and manage (Bontis, 1996; Bontis, 2003; Bontis, Dragonetti, Jacobsen, & Roos, 1999; Curado & Bontis, 2007; Spender, 2002).

Value is created for firms and nations when stocks of knowledge are harvested for strategic use (Bontis, 2004; Bontis & Fitz-enz, 2002; Cabrita & Bontis, 2008; Cabrita, Landeiro de Vaz, & Bontis, 2007). However, value may also be degraded when knowledge assets remain unused (Pike, Rylander, & Roos, 2002). Interestingly, knowledge assets are not consumed when they are applied to solving organizational problems. On the contrary, a knowledge asset's value is generally maintained and often enlarged by its application, while conventional assets must be depreciated or replaced (Bontis & Serenko, 2007; Spender, 2002). Thus, the strategic use of knowledge management as a process for intellectual capital wealth creation is critical to firms (Alvarez & Barney, 2001; Bontis & Nikitopoulos, 2001; Nonaka & Konno, 1998). Knowledge is transformed through the interaction of explicit and tacit forms (Polanyi, 1962). Therefore, firms need to redefine their strategies and functions within the context of harvesting the intangible value embedded within them (Blackler, 2002; Drucker, 1993; Guthrie, 2001; Mouritsen, Larsen, Bukh, & Johansen, 2001; Nonaka, 1991; Stovel & Bontis, 2002; Sveiby, 1996, 1997). After all, management capabilities, employee competencies, technical knowledge and tacit organizational routines, may turn out to be the main determinants of firm performance (Dess, Gupta, Hennart, & Hill, 1995; McEvily & Chakravarthy, 2002).

The knowledge-based view of the firm considers the organization as a recipient of individual and social capabilities, processing and transforming them into economically valuable products (Hoskisson, Hitt, Wan, & Yiu, 1999). This modern economic approach has become more relevant as recent research shows that firms basing their strategies on inimitable (through historic dependency, causal ambiguity or social complexity) as well as intangible resources outperform others that base their strategies exclusively on tangible assets (Barney, 2001b). Intangible resources present a higher probability than tangible ones to produce competitive advantage, especially firm specific resources like knowledge (Hitt, Bierman, Shimizu, & Kockhar, 2001a).

The following sections present three different approaches to knowledge management, by authors from Japan (Nonaka & Takeuchi, 1995), the USA (March, 1991) and Europe (Boisot, 1995).

4. Model 1: SECI (Nonaka & Takeuchi, 1995)

The SECI model focuses on knowledge flows which are often referred to as the spiral (Nonaka & Konno, 1998; Nonaka & Takeuchi, 1995; Nonaka, Toyama, & Konno, 2000a; Nonaka, Toyama, & Nagata, 2000b; Nonaka, Konno, & Toyama, 2001; Nonaka, 2002; Umemoto, 2002; Takeuci and Nonaka, 2003). According to Nonaka and his colleagues, knowledge flows in an endless circular movement from individual to collective to individual levels of analysis. At the same time, knowledge flows back and forth between its two epistemological forms, tacit and explicit. The spiral emerges when the interaction between tacit and explicit knowledge is pushed up from lower ontological levels to higher ones. This repeated movement perpetuates itself in individuals, in departments and in organizations, and back down again (Nonaka, Toyama, & Byosière, 2003). The four processes embedded within the model are: socialization; externalisation; combination; and internalisation (Fig. 1).

Socialization consists of face-to-face communications among organization members. It is the sharing of personal experiences and the reflection on other's experiences that provides the context for this information flow. The socialization process encourages organizational designers to provide adequate space and time for communication between individuals, apart from the formal agendas and meetings. The stimulus for such moments to occur might be located within the existence of comfortable rooms and social spaces which the Japanese refer to as ba (Nonaka et al., 2001).

Externalisation is a process that requires an individual to transform tacit knowledge into a permanent form that can be captured

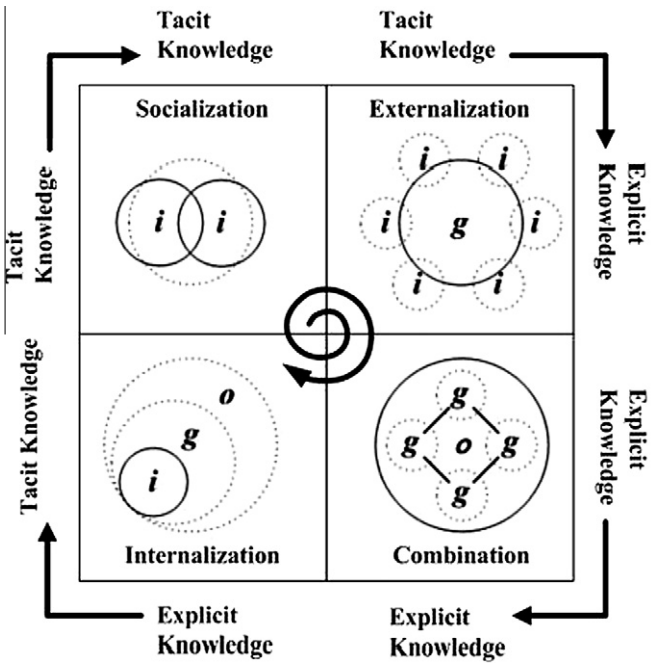

Fig. 1. SECI model (Nonaka & Takeuchi, 1995).

by others in the organization. This codification process occurs when tacit knowledge is articulated and converted into explicit knowledge, trough the use of images, words, concept definitions, figures, metaphors, and analogies. The individual's mental models are converted into common terms and concepts. This process occurs when individuals write down their thoughts on paper, or type out content within a document.

The combination process consists of the transformation of explicit knowledge into more complex forms. For example, when teams work together by integrating business plans and specific targets into an overall organizational strategy. At this level, collaboration is typically operationalized through virtual meetings where email and documents are shared (McKnight & Bontis, 2002).

The internalisation process takes the aforementioned explicit knowledge and converts it back into tacit form. In other words, when an organization has integrated and developed its strategic plan, an individual must then internalize what that plan means for his/her own employee behaviours. This is the phase where individuals transfer explicit organizational tasks into personal routines. Going through the four quadrants of the matrix, in a dynamic and continuous process of conversion, knowledge flows because of the interaction between tacit and explicit forms across individuals and collective levels of analysis. The factors that determine the speed with which the conversion rate occurs are organizational structure, the incentives to share, culture, leadership behaviours and the organizational routines (Nonaka et al., 2000b).

5. Model 2: Exploration – Exploitation (March, 1991)

March's model relies on the tension between the processes of exploration and exploitation. Exploration consists of the development of new routines that the organization establishes to support the creation of new products and services. In other words, the exploration of new knowledge is a result of organizational flexibility, research and development, risk management, experimentation, innovation and improvisation.

Exploitation, on the other hand, consists of leveraging current routines to refine products, processes and pre-existing knowledge. In other words, the behaviours in support of exploitation include pursuing efficiencies of current operations, and maximizing the effectiveness and execution of current processes.

The dynamic nature of this model is created through the tension between the organizational assimilation of new knowledge developed at the individual level (i.e., feed-forward learning), and the individual harvesting of pre-existing organizational knowledge (i.e., feed-back learning) (Bontis, Crossan, & Hulland, 2002). This tension occurs because organizational learning occurs when there is an alignment and emphasis on coordinating both processes across three levels of analysis: individual, group and organization (Crossan & Berdrow, 2003; Crossan & Hulland, 2002; Crossan, Lane, & White, 1999) (Fig. 2).

Feed-forward learning flows correspond to March's exploration process. This kind of learning involves individual acts of creation, experimentation and innovation, having in perspective the use of future knowledge. Conversely, feed-back learning flows correspond to March's exploitation process. This learning flow moves from the organizational level to the individual level by transforming institutionalized knowledge repositories back to individual behaviours through collaborative technologies (Bontis, Fearon, & Hishon, 2003; Chauhan & Bontis, 2004).

There are important implications in balancing the tension between exploration and exploitation. A firm that mismanages the alignment between the two may suffer from bottlenecks to learning thus hampering performance. The main problem of balancing exploration and exploitation is exhibited in distinctions made between the refinement of an existing technology and the invention of a new one (Winter, 1997; Levinthal & March, 1981; March 1991).

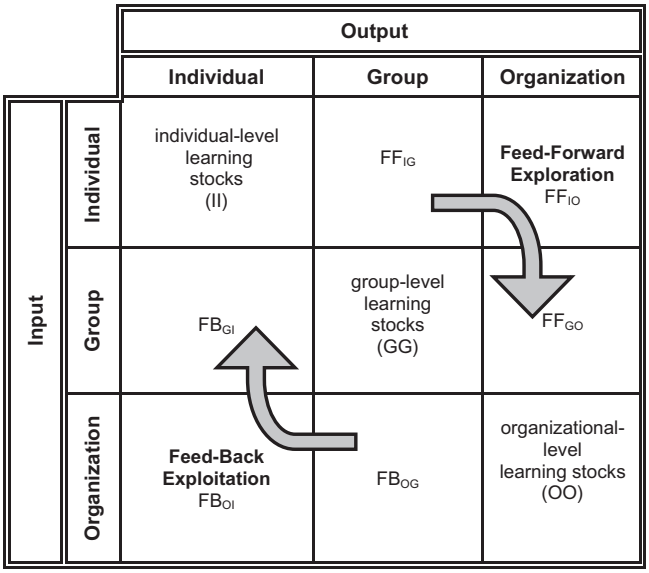

Fig. 2. Modified Ex-Ex Model (March, 1991 and modified by Bontis et al., 2002).

Organizations learn from experience how to divide resources between exploration and exploitation. Compared to returns from exploitation, returns from exploration are systematically less certain, more remote in time and organizationally more distant from the locus of action and adoption. Organizations, through adaptive processes, characteristically improve exploitation more rapidly than exploration. The advantages of exploitation cumulate. Each increase in competence at an activity increases the likelihood of rewards for engaging in that activity, thereby further increasing the competence and the likelihood of rewards (March, 1991).

Comparing both strategies as they relate to dimensions of efficiency and efficacy, it seams reasonable to suggest two propositions: efficacy shall be more closely tied to exploration (since efficacy benefits from creativity and innovation); whereas efficiency shall be more close tied to exploitation (since efficiency benefits from the continued refinement of processes). Tallman (2001) presents differences between both strategies regarding their respective return over time: exploitation generates present rents; while exploration originates the capability to generate future rents.

An organization that engages exclusively in exploration will suffer from the fact that it never gains returns from its accumulated knowledge base. An organization that engages exclusively in exploitation will also suffer in that it will eventually become obsolete. The basic problem confronting an organization is to engage in sufficient exploitation to ensure its current viability and, at the same time, to devote enough energy to exploration to ensure its future viability (Levinthal & March, 1993). This ambidextrous balance requires transformational leaders (Boehnke, Bontis, DiStefano, & DiStefano, 2003; Bontis, 2001; O'Donnell et al., 2004).

Knott (2002) gathered empirical evidence in support of the proposition that combining both strategies reinforces each one of them. There is a complementary effect between the two opposing strategies. According to the author, firm success in competitive environments involves exploitation of existing firm competencies, while surviving in dynamic environments involves the exploration of new competencies. Ichijo (2002) presents the dual option as the one involving the simultaneous use of both strategies in order to be able to manage different business scenarios. According to Ichijo

(2002), the two strategies are indispensable and secure the firm's competitive advantage when they are emphasized equally.

Maintaining an ambidextrous balance between exploitation and exploration is complicated. Organizations become trapped in one or more of several dynamics of learning that self-destructively lead to excessive exploitation or excessive exploration. Often, exploitation drives out exploration, because returns to exploitation are closer in time and space than are the returns in exploration (Levinthal & March, 1993).

6. Model 3: I – Space (Boisot, 1995)

According to Boisot the social learning curve takes place in the I-space (Boisot, 1995, 1998, 2002b). This process encompasses six steps: scanning, codification, abstraction, diffusion, absorption, impacting. The model is schematically represented by a cube where codification, abstraction and diffusion are the axes (Fig. 3).

Scanning is how we collect original raw data but our individual knowledge and experience allows us to interpret it in our own way. Scanning may be very rapid when data is well codified and ordered but very slow when data is random and context specific (Canals, Boisot, & MacMillan, 2005).

Codification is an individual's response to data that has been scanned. An initial pattern of raw information may be fuzzy but once an individual has gone through a process of classifying, interpreting and eliminating ambiguity, the knowledge can be codified.

Abstraction occurs when an individual generalizes the application of newly codified insights to a wider range of situations. This involves reducing information to its most essential features. Both codification and abstraction have a highly hypothetical structure given an individual's expertise and given reality. However, once knowledge has been codified and abstracted, diffusion can happen quite quickly.

Diffusion is a process that can occur rapidly only when knowledge is easily accessible. The diffusion of well-codified and abstract data to a larger population will be technically less problematic than that of data that is uncodified and context specific. Only by sharing context from sender to receiver can the speed of diffusion be increased.

Absorption takes place when an individual receives diffused knowledge and then modifies behaviour in a "learning by doing" pattern. As individuals absorb more knowledge, they build up a stock of practical experience. Applying new codified insights to different situations provides for more generalizable knowledge over time.

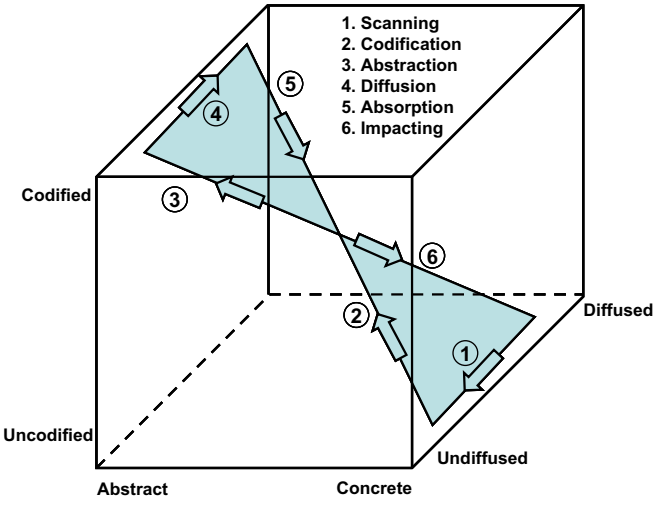

Fig. 3. I-space (Boisot, 1995).

Impacting occurs when newly absorbed knowledge is actually used and applied to concrete situations. When behaviours have been modified and new actions take place, then an individual can impact his/her environment with the new knowledge they have just acquired.

When it comes to levels of analysis, although not explicitly mentioned, the diffused –undiffused dimension would most accurately reflect what process is conducted individually versus collectively. Furthermore, although the terms tacit and explicit are not used, clearly the codified-uncodified dimension represents the same distinction.

7. Similarities and differences among models

Clearly, there are similarities and differences among the three aforementioned models from both an epistemological and ontological perspective. First, when considering the levels of analysis that each model examines, all three make reference to the transfer of knowledge from individuals to teams and up throughout organizations and then back down. However, only March's model as adapted by Bontis et al., (2002) explicitly isolates distinct levels of analysis. Both Nonaka and Boisot assume that certain processes take place at either individual or collective levels. For example, Nonaka's socialization process assumes that groups will engage with another to share tacit knowledge while Boisot's scanning process assumes it is initially conducted by individuals.

All three models consider the distinction of tacit versus explicit knowledge, even though only Nonaka articulates this directly. Tacit knowledge is assumed to be evident in March's individual level of analysis prior to exploration or feed-forward learning taking place. Furthermore, Boisot articulates the difference of tacit versus explicit knowledge through his codified versus uncodified dimension.

Please refer to Table 1 for a summary of epistemological and ontological similarities across all three models.

8. Discussion

Clearly, all three models share various dimensions and parameters as it relates to knowledge management. However, there are some interesting parallels when one examines the flow of processes across parameters as opposed to just isolating the elements themselves.

For example, when one examines the CAD (codification – abstraction – diffusion) sequence in Boisot's I-space, it is evident that he assumes this to be the natural path that leads one individual to share knowledge with others. Of course, this is akin to March's exploration (feed-forward learning) process and what Nonaka would consider as SE (socialization – externalization). These parallel processes taken together can be referred to as neoclassical learning since they pre-suppose that individuals interpret their environment, make judgements, and then share them with colleagues.

Conversely, Boisot's AIS sequence (absorption – impacting – scanning) represents the opposite knowledge flow. This is akin to the March's exploitation (feed-back learning) and Nonaka's CI (combination – internalization). This particular process builds on current stocks of intellectual capital at the organizational level of analysis and thus tries to support innovation through re-combinations of these stocks. As such, these parallel processes taken together can be labelled as Schumpeterian learning. Therefore, neoclassical learning strategies focus on preserving existing knowledge whereas Schumpeterian learning strategies focus on challenging or destroying it (Canals et al., 2005).

Table 1
Epistemological and Ontological parallels.

Model	Tacit to explicit			Tacit to explicit		
	Individual to collective			Collective to individual		
1. Nonaka	Socialization···externalization			Combination···internalization		
2. March	Exploration···feed-forward			Exploitation···feed-back		
3. Boisot	Scanning	Codification	Abstraction	Diffusion	Absorption	Impacting

Another benefit to these models is that managers can use them as diagnostic tools for their organizations. For example, they can use Nonaka's four quadrants to discover:

1. Do employees exhibit behaviours of one SECI process at the expense of the other?
2. What is the optimal distribution of time that an employee should participate in one SECI process versus another?
3. How long does it take for the full SECI spiral to be completed by various teams or work groups?

Similarly, using March's modified framework, managers can ask the following questions:

4. Is there an equal alignment between the resources that are devoted to exploration versus exploitation?
5. Do the stocks of knowledge at various levels of analysis grow with the same speed and investment?
6. What are the potential bottlenecks to completing the feed-forward and feed-back learning cycle by employees?

Finally, Boisot's model can also be used to ask a set of questions that provide unique insights for knowledge management processes as follows:

7. What happens to knowledge that contains the appropriate dimensions of codification, abstraction and diffusion, but does not adhere to the correct sequence of the prescribed six processes?
8. Can the processes in the I-space work backwards and not follow the prescribed sequence?
9. Can the throughput time of all six processes be measured and linked to organizational performance?

The questions above provide fruitful avenues for both practitioners and academics who want to pursue this line of thinking further.

9. Conclusions

A literature review succeeds when it helps other scholars make sense of the accumulated knowledge on a topic (Webster and Watson, 2002). The primary purpose of this particular review was to contrast three different knowledge management models and provide an evaluation of their similarities while also suggesting avenues for further pursuit. Some potential avenues moving forward might include the following.

The development of typologies as opposed to taxonomies. The developers of the three models have articulated taxonomies (or classifications) of important processes. Yet, there is no mention or empirical evidence as to what may be the optimal combination of these processes or the ideal types of structure or organizational design that would support long-term performance and learning (Bontis & Girardi, 2000; Bontis, Serenko, & Biktimirov, 2006). In this case, a typology of varying degrees of knowledge management and their expected performance outcomes would be quite beneficial.

A further exploration of grounded theory as it relates to the underlying development of each model. For example, whereas Nonaka's model is steeped in the discipline of organizational behaviour, March's framework is an outgrowth of the field of organizational learning. Finally, Boisot takes an organic growth position within the field of information management. In total, all three models come from various management disciplines. An integrated perspective may provide more conceptual clarity. Especially when an integrated framework considers transaction cost economics, information processing, and organizational culture as well.

The empirical testing of these models is much needed. Researchers can easily operationalize these processes into semi-structured interview questions for qualitative research and survey instrument items for quantitative research. It is recommended that both approaches are taken and that results are triangulated over several longitudinal periods.

Another compelling avenue of research would be the measurement of throughput time for the full cycle of knowledge flow to occur. This is a critical investigation for many businesses as they strive to compete in markets that transform themselves daily. Finally, what are the environment factors that impact these knowledge management processes. In other words, are individuals and organizations in full control of choosing to perform these processes or are there industry and competitive pressures that force one at the cost of another.

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