Knowledge Management as a Service
When Big Data Meets Knowledge Management

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Abstract: Purpose – Nowadays the world is getting more technological savvy. The collection of data is becoming a hype which is a phenomenon is called "big data". Companies seeking for these data collections and data analytics assuming valuable insights. As for now, these valuable insights are perishable to a high degree - perishable because the insights are only valuable if you can detect and act on them (The Forrester Wave, Q3 2014, p2). In our article, we propose to take advantage of big data analytics while introducing a service-oriented knowledge management discipline that will allow gaining the full value of big data. Herein, we focus on the benefit aspect of big data linked to the service approach of knowledge management, which may increase the value of big data.
Findings –In fact, big data analytics offer value and the use of big data has the potential to transform business in itself. However, there are greater opportunities beyond big data analytics once we turn data from information into a knowledge linked to business strategy, easy accessible and consume. With the introduction of knowledge management-as-a-service to the concept of big data, we provide justification for bringing proven knowledge management strategies and tools into the cloud sphere to bear on big data and business analytics. With the introduction of pre-defined service to knowledge management, we open the ability for increased competitiveness as a final consequence (Thuraisingham and Parikh, 2008) and the value of any company (Bertino et al., 2006).
Originality/Value – Our article outlines the previously underestimated strong link of big data and knowledge management and how the delivery of data-driven intelligence is supported with the appliance of a cloud-based service model. When big data and cloud-based knowledge management are combined are able to not only uncover a new revenue stream but also create a true competitive advantage.

1 INTRODUCTION

With the success of big data and the remarkably collection, storage, processing and analysis of data volumes never seen before (Bughin et al, 2010) an increasing volume, velocity, and variety at nearly exponential rates available goes alongside and are mined for useful information (Rajpathak and Narsingpurkat, 2013). The excitement of big data is has arguably been generated primarily from the technical possibilities in doing so but the question is if it is it appropriate to purely have a focus greater data volume, faster and ease to capture data? In our article, we would like to propose to take the next step and focus on the generation and management of knowledge that big data generates while using the paradigm of cloud-based services.

Knowledge Management in general emerged some decades ago (Drucker, 1969) and goes beyond a mere collection of data or information, including expertise based on some degree of reflection. It focuses on knowledge as a valuable intellectual capital that needs to be managed adequately (Erickson and Rothberg, 2011). As of today, nobody argues about the importance of managing knowledge for continuous business success. The success rely on non-value precursors like data and information that needs to be turned into valuable knowledge assets. In establishing the conceptual foundation of big data as an additional valuable knowledge asset (or at least a valuable asset closely related to knowledge due to big data analytics), we can begin to make a case for applying knowledge management services to data assets.

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This will help us to bring big data and big data analytics into the knowledge management field, creating a new and easy accessible "knowledge experience". Here, we can cite Yogesh Malhotra: "In knowledge management <…> the most limited resource is no longer information. It has become human attention – the ability to deal effectively with the growing volume and speed of information." In our opinion, the pure provisioning of data and information with the advantage of big data technologies is not enough. Therefore, we have to think of a new knowledge experience, to create a consistent and easy to handle experience. With the foundation of a cloud-based service approach in mind, a paradigm such as knowledge management-as-a-service can be discussed to increase the value of knowledge even further.

2 KNOWLEDGE MANAGEMENT

Before taking a deeper look into our proposed approach, we need to first understand the core elements of knowledge management and the distinction between data, information and knowledge.

2.1 Data, Information and Knowledge

- Data: is a set of discrete and objective facts about events. Information is a message, usually in the form of a document or audio-visual communication. As with any message, it has a sender and a receiver.
- Information: changes the way the receiver perceives something, and to affect their judgment and behaviour.
- Knowledge: is broader, deeper, and richer than data or information. Within managerial theories formulated by e.g. Schumpeter (1934), Drucker (1991) and Nelson and Winter (1982), knowledge has been defined as a source of competitive advantage in managerial theory. Knowledge can be categorized in the two types of knowledge:
  - Tacit knowledge is highly personal and subjective and focuses on learning and experiences (Beijerse, 2000).
  - Explicit knowledge which is formal, systematic and system-bound (Beijerse, 2000) and can be further divided into "know what", which is knowledge about facts and "know why" which refers to scientific knowledge of rules.

If we try to categorize knowledge based on the dimension of usage, we differentiate between.

- Organization knowledge deals with management in the organization such as policy, culture, personnel, career planning, internal processes, cut backs, alliances and teamwork.
- Marketing knowledge is about the external environment such as competition, suppliers, customers, markets, target groups, consumers, clients, users, interested parties, trade and distribution and relation management.
- Technological knowledge is knowledge of products, research and development, core competencies, technological development, information and communication technology and product development (Beijerse, 2000).

To sum up, data are a set of facts about events, information is a processed set of facts that are meaningful and knowledge is broader, deeper and richer as both data and information. (Hota et al, 2015). Having stated that, knowledge management can be considered as a process that comprises the creation, organization, sharing and usage of tactic and explicit knowledge (Wong and Aspinwall, 2004). In this regard, knowledge management systems are IT based systems developed to support the knowledge management processes (Alavi and Leidner, 2001) and based on the (big) data generated from big data (analytic) tools within a dynamic process from the perspective of business and technology (Khoshnevis and Rabeifar, 2012).

3 BIG DATA

For companies real-time business insights that big data technologies are offering becomes the main source of information on top of which companies decide and build their strategy. The value that companies aiming to get out of big data is tremendous, and becomes a necessary asset to survive in a highly competitive world. Real-time insights allow organizations, for example, to build better products, predict what future business outcomes might be, detect early data signals or better manage their inventory.

3.1 Key Characteristics of Big Data

All definitions towards big data make at least one of the following assertions (Ward and Barker, 2013):

- Size: the volume of the datasets is a critical factor.

- Complexity: the structure, behaviour and permutations of the datasets is a critical factor.
- Technologies: the tools and techniques which are used to process a sizable or complex dataset is a critical factor.

Manyika et al., (2011) considers that big data refers to datasets whose size goes beyond typical databases that can be created, stored, managed and analysed by existing tools; they also consider the need of the use of new technologies for managing big data. However, Fisher et al., (2012) considered that most often big data refer to the conception that the volume of data cannot be treated, processed and analysed in a simplified way, requiring much more robust technologies, techniques and people with new skills for managing these large data sets.

Overall, big data refers to the idea that a vast amount of data cannot be treated, processed and analysed in a simplified way. One of the most cited definitions is included in the Gartner report from 2001 they proposed a definition encompassing the "three Vs". Volume, Velocity, Variety. (This idea is supported the NIST definition which states that big data is data which: "exceed(s) the capacity or capability of current or conventional methods and systems", see Intel Peer Research, 2013)

- Volume: Refers to the amount of data, which is higher. Gartner first described it back in 2001: the Big Data volume definition will continue to remain a moving target and it is a matter of fact that Big Data sizes were ranging from a few dozen terabytes to many petabytes of data in a single dataset.
- Velocity: Refers to the speed of data collection. This means how frequently the data is generated. Typically, we can identify three main categories: occasional, frequent, and real-time (Zaslavsky et al., 2013) and often time-sensitive (Lévai, 2013).
- Variety: Refers to the range of data types, sources, and languages. In addition, difference sources will produce big data such as sensors, devices, social networks, the web, mobile phones, etc. For example, data could be web logs, RFID sensor readings, unstructured social networking data, streamed video and audio (Zaslavsky et al., 2013).

These 3Vs allow a perfect context-independent definition of the key characteristics of big data. What is missing here is the "V" that answers the question why to deal with big data. Reducing big data to the 3Vs we merely focus on no more than collection, simple analytics, and reporting for purposes of understanding and optimizing on process or decision and assessing the improvement of the existing effectiveness of one's company. So address even more value from these data we need to consider a "4th V – the value" as the context-sensitive dimension to overcome the "flashlight in the dark" where the companies are today. Therefore, we have to consider mainly three issues:

- High Complexity – getting data out of various platforms is different and the data we get is different – if they are available at all.
- Low Insight – because there is no apples to apples data comparison, measuring processes across the company or even beyond becomes virtually impossible.
- Low Business Support Value – essentially a result of the first two, means it is hard to measure the success of the company and with a lack of knowledge curve to improve even faster.

4 SENSING KNOWLEDGE MANAGEMENT AS A BIG DATA SUPPORTED SERVICE MODEL

Cloud computing consists of a wide array of new business models, the most prominent of which are Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). According to various documentations (e.g. TBR Cloud Program, 2013).

4.1 Cloud Services

- Infrastructure as a Service (IaaS): IaaS is the basis of the cloud architecture; and constitutes the dynamic provisioning of computing, storage, and network resources. IaaS users, in particular system administrators, IT architects, and developers (the latter for testing purposes), can access these infrastructure resources as required. IaaS provides linkage between different types of services which in turn leads to efficiency improvement and time reduction in business processes (Chang, 2013). With IaaS, the cloud offers platform virtualization to the customer. Instead of buying servers and other network equipment, users just rent these resources. In addition, whereas public cloud services are dominated by SaaS, "outsourced Private Cloud" services (managed/ hosted) are dominated by IaaS. For knowledge management it is necessary using a cloud infrastructure as a service for the

storage of aggregated data and knowledge to have the required computational capacity and the processing power.

- Platform as a Service (PaaS): PaaS is on top of the IaaS architecture and comprises the middleware and/or development platform, that enables PaaS users, in particular application developers and IT designs, to develop applications within the Cloud and/or operate them. PaaS is the offering of a computing platform as a service. Users are able to deploy their applications on such a platform. The platform offers auxiliary functionality such as a web server, databases, load balancing and more. For knowledge management this reflects to the ability to design own applications based on the provided infrastructure.
- Software as a Service (SaaS): SaaS contains the uppermost layer of the Cloud architecture, the actual business application: e.g. CRM, ERP, collaboration, etc. SaaS users are generally "traditional" end-users within business units. SaaS is the basic cloud service models are well known (Chandramouli and Mell, 2010). It is a model in which software is offered as a service to the user. The software is hosted on a server and users access the software by using a web browser. For knowledge management it is important to have the ability to gather knowledge from different – structured and non-structured sources.

Providing everything as a service is model that emerged with cloud computing. Garter defines cloud computing as a style of computing in which massively scalable IT-related capabilities are provided "as a service" using Internet technologies to multiple external customers (Patidar et al., 2012). Cloud computing realizes the idea of everything is a service (XaaS) (Riemann, 2015) and can be differentiated in three basic categories: Software-as-a-service (SaaS), Platform-as-a-Service (PaaS), Infrastructure-as-a-service (IaaS) (Villegas et al., 2012).

Overall, cloud services have the following key characteristics that are relevant for this article as there are self-service on demand and network access to cover the ability of accessing a broad range of data sources. Cloud services as a paradigm for convenient, on-demand access to a shared pool of configurable resources. As guidance toward the cloud market two dimensions shall be used to define the cloud service market segments (Forrester, 2010): "What resources are shared?" and "With whom resources are shared?" For this article, we will use the slightly simplifying assumption that clouds are commonly classified into Public Clouds, Private Clouds and Hybrid Clouds (Chang et al., 2014).

- Private Clouds: The cloud infrastructure is provisioned for exclusive use by a single organization comprising multiple consumers (e.g., business units). It may be owned, managed, and operated by the organization, a third party, or some combination of them, and it may exist on or off premises (Mell and Grance, 2011).
- Public Clouds: The cloud infrastructure is provisioned for open use by the general public. It may be owned, managed, and operated by a business, academic, or government organization, or some combination of them. It exists on the premises of the cloud provider (Mell and Grance, 2011).
- Hybrid Clouds: The cloud infrastructure is a composition of two or more distinct cloud infrastructures (private, community, or public) that remain unique entities, but are bound together by standardized or proprietary technology that enables data and application portability (e.g. cloud bursting for load balancing between clouds) (Mell and Grance, 2011).

5 KNOWLEDGE MANAGEMENT AS A SERVICE (KMaaS)

Considering the need of companies of having more valuable, data-driven insights and having already understood that knowledge management has to do with identifying and managing knowledge assets effectively in order to gain this competitive advantage and about effectively managing these assets, through combination, sharing, and other methods leading to their growth (Zack, 1999a; Grant, 1996) we propose to shift the available concept to the paradigm of cloud-based services to capture knowledge (Nonaka and Takeuchi, 1996; Polanyi, 1967), lower complexity, and stickiness (McEvily and Chakravarthy, 2002; Zander and Kogut, 1995; Kogut and Zander, 1992) and to employ a tool and to even better manage the knowledge (Choi and Lee, 2003; Schulz and Jobe, 2001; Boisot, 1995).

We believe in the two following main statements:

- With the use of big data and the benefit of cloud computing we have the ability to provide a major shift in how to create knowledge leading to a new reality of knowledge management
- With the shift from a centralized knowledge management information solution and asset to a

flexible and based on pre-defined services-based solution

If we emerge from the basic types of cloud service models, Knowledge Management-as-a-Service adds a context-sensitive layer to the service models available aiming to provide the most valuable knowledge, in the appropriate context and the easiest way possible. Therefore and according to our understanding Knowledge Management-as-a-Service is a layer on top of the basic service types that consumes the already available and aggregated data from the big data tools and its aggregation by big data analytics.

Knowledge management-as-a-service is a service model based on analytic data and consisting of aggregate data such as lessons learned, studies to leverage knowledge from anywhere, anything, and anyone in a distributed computing model. With the introduction of the cloud-based paradigm to knowledge management, any knowledge will be easier to access and even more important we can address on already mentioned issue – the will created a unique and easy-to-access knowledge experience. To embark the new service model we have to understand three main things:

- The technology fit to allow the data capturing
- The analytic fit to aggregate the data to information and the low the first step from data gathering to knowledge generation
- The fit of access of knowledge

With the concept of Knowledge Management-as-a-Service we will be able to move forward from purely data collection to knowledge generation that delivers the desired knowledge asset and competitive advantage. Knowledge Management-as-a-Service lets us access knowledge and experience structured in a way that we can find it, understand it and use it instantly.

Let us assume that Knowledge Management-as-a-Service is a productized and cloud-based service model offering a set of pre-defined knowledge assets that allows the execution data analytics, information aggregation and knowledge provisioning. Although such a service harbours an economic potential and proposes value towards data and information, questions that need to be answered are: can an individual and company-specific need for knowledge supported by a service? Additionally we need to understand how to manage the way from operational data, information towards valuable knowledge.

5.1 Big Data Impact towards Knowledge Management-as-a-Service

Big data and big data analytics can be seen as the first step in our journey of more meaningful analytics, from quantitative to substantial qualitative analysis. Gradually it is necessary to combine quantitative as well as qualitative analytical methods within the big data approach to enable more and more actionable insight-driven decisions. This will be one mail pillar to support. The identification of the right data and definition of right aggregation of data plays a fundamental role when thinking about a meaningful integrated experience for information leading to knowledge. To gain this competitive advantage we have to make sure that the workflow that distils low-value data, transforming them into high-value data reaches the level of knowledge to support the business adequately. The ability to generate knowledge from a large amount of data with different structures is part of what can determine big data management. It is a common understanding, that big data as a technology is a key enabler to success. Even though we have already seen the clear distinction between data, information and knowledge there is a strong relationship since the potential for data and information to turn into knowledge (Rothberg and Erickson, 2014). Once we look beyond big data and its enabling technology, Brynjolfsson and McAfee (2012) suggest that organizations have to consider on knowledge management, as the era of big data means not just more data.

It seems that big data has its main effect on explicit knowledge since the generation of any analysis is inherent in big data analytics but provides the ability to have a broader set of raw data for these analytics to increase the quality of explicit knowledge. However, the effect of big data on tacit knowledge shall not be underestimated: due to the ability to analyses masses of data and simulate scenarios the support on an individualized learning experience can be significant.

5.2 Cloud Services Impact towards Knowledge Management-as-a-Service

Since we have already proposed an answer how to provide a new knowledge experience with the benefit of cloud services. However, the question cannot be divorced from a thorough understanding of *the access* of data and information. For explicit knowledge private clouds has the most limited the access to any

knowledge as it ends at the companies' boundaries. This access to knowledge increases in other types of clouds and has its maximum in public clouds. On the contrary, for tacit knowledge, the type of cloud has only little effects or it is more likely to assume, that the private cloud has a positive influence towards tacit knowledge since it relies more on the users itself, their personal minds.

Therefore, access to tacit and explicit knowledge is neither as limited as in private clouds, nor is it as open as in public clouds, however, tacit knowledge is more accessible in private clouds compared to the explicit knowledge, because of the mentioned reason stated for public clouds.

Table 1: Benefit for knowledge types in different cloud deployment models.

	Explicit Knowledge	Tacit Knowledge
Private cloud	Low	High
Public cloud	High	Low
Hybrid cloud	High – medium	Medium – low

If we now add the context of usage, we will also find highly differentiated benefits due to the cloud deployment models. The organisational knowledge is driven by mainly company internal driven knowledge that is ti a certain degree focused on the tacit knowledge type since e.g. career planning and personnel data are certainly more focused on a personnel view , learning behaviour and subjective. Having this in mind the benefit of a private cloud is somewhat higher compared to marketing and technology drive knowledge aspects. Especially the marketing knowledge dimension relies on the benefit of a public accessible knowledge. While being mainly explicit driven the benefit of a broad knowledge base and network is very high – much higher compared to the technological dimension. Even though technology has a strong benefit from information and communication a lot of knowledge lies within the company and in personal experiences.

Table 2: Benefit for knowledge dimensions in different cloud deployment models.

	Organizational Knowl.	Marketing Knowl.	Technological Knowl.
Private cloud	High	Low	High-Medium
Public cloud	Low	High	Medium
Hybrid cloud	Low-Medium	High – Medium	Medium

6 CONCLUSION

Knowledge and knowledge management are largely connected to the idea of an IT-based infrastructure. For a successful knowledge management it is therefore essential to handle many aspects through and with technology: data gathering, data analytics that ultimately leads to a better enablement of decision-making.

While decision-making, reflects the need to maximize cross-functional cooperation between people who manage the data and the people who use them we have to consider knowledge as a fundamental object to improve competitive advantage and decision-making. In the information era, and more precisely in the era of digital information, this smart asset becomes increasingly necessary for business survival.

It is obvious that big data are much more than just a hype as this allows us to collect and crawl almost every data, which gives us more knowledge transfers opportunities. On the other side cloud services have the potential to transform the business and with the promise of a rapid scalability, the adoption cloud services will increase. Briefly, cloud services deliver the dynamic and flexible infrastructure that is needed for today's business requirements that are mainly driven by the factor of knowledge and the competitive advantage that is generated out of it. Therefore, knowledge management is in the focus of many companies. With big data, we have now a technology in place that is described by the 3 Vs and that provides opportunities for data generation and data analytics that mainly has a positive impact on explicit knowledge. Considering the 4th V – the value of big data it becomes obvious that it is important for companies not to stick solely in the big data technology nor in the big data analytics but invest time upfront to carefully identify what is the knowledge you would like to generate out of these data and make this accessible to the desired audience. Here the application of cloud services to knowledge management allows benefiting from a flexible infrastructure provided in different dimensions depending on the cloud service model. The degree of benefit often results from the type of cloud that is used. Therefore, it is necessary to analyse the knowledge types and dimensions prior to the alliance of big data in a dedicated cloud environment.

The key to success lays in the definition of knowledge management service. The idea is to define services.

That allow an easy adoption of (new) knowledge. Having the knowledge is unfortunately not enough.

Therefore, the service concept will allow the distribution of on-demand knowledge improving knowledge sharing and business connectivity.

Knowledge Management-as-a-service (KMaaS) is actually digital knowledge and experience packages accessible at any time, any place and any device. With the big data technology, it is of course much easier to get the right data – even in real time within a broad network of data sources that are accessible using digital sources of knowledge, independent of if the person that is providing the knowledge is available or not.

Knowledge Management-as-a-service depends on the type and dimension of knowledge. It is a context-sensitive layer in addition to the already existing service types. The emergence of KMaaS and the delivery of knowledge on demand will enable new knowledge generating and sharing models especially within explicit knowledge and in the dimension of marketing and technological knowledge. Organizations can more or less immediately benefit from reduced upfront costs and obtain increased reach based on a scalable and dynamic platform with the use of an agile big data technology.

These "knowledge-based-services" prioritize and guide of what data are needed and how these data need to be presented to be aggregated to information and experienced as valuable knowledge. Establishing knowledge services is therefore a continuous task. It helps reducing information overload within times of delivering big data at high volume, quality, and accuracy in a timely fashion is not possible without a streamlined approach towards managing the data to become information.

With the idea to introduce big data and big data analytics to the context of knowledge management. With the provisioning of a comprehensive set of already analysed data, enhanced these already available meaningful and comparable data with cloud-service-based knowledge management tools to we are able to "turn on the light" and let us address the pain points:

- Lower the complexity by having introduced big data analytics for getting data and doing the operational analytics
- Greater insight through consistent, comparable data, e.g.
  - Insight into customer buying behaviour can drive key improvements in the sales channel, as is already happening
  - Analysis quality issues within manufacturing across the entire supply chain may improve the entire production process
  - Closed loop transparency – being able to measure the success and drive greater efficiencies

Aligned with big data and with the cloud paradigm of a service oriented architecture might shift the knowledge management, but the impact big data has will affect knowledge management significantly in dedicated areas. With KMaaS based on big data technology and analytics, knowledge management will be shifted while providing a way to quickly address target group focused. At the same time, much of what we call knowledge today will be automated like physical labour and transactional tasks have been widely automated over the last three decades. Knowledge management is the cross discipline that will help to accomplish this task of an increased competitiveness by providing knowledge to strategy and clarity to content. Since KMaaS is context-sensitive we will have the ability that contextual connect the data sources versus just focusing on one thing at a time. It is about the ability to connect process, people and technology in a way that analysing a business problem, defining a solution and realizing success can happen seamlessly and in an integrated fashion. Knowledge Management is nothing overly complicated or esoteric. Companies are complex, human beings are as well, and sometimes even technology still is. As such knowledge management as a discipline aiming at connecting and integrating all of the above often failed to deliver what was promised in the first place. However, knowledge management is simply about finding simple, but nevertheless reliable and sustainable solutions for concrete business problems. For the same reason, knowledge management is never a goal in itself, if it is done right is always about enabling and bettering concrete business decisions

Of course only people create competitive advantages, not hard- or software alone. But in times of big data and cloud services it is not only impossible but not necessary to do it without carefully designed, integrated Knowledge Management that link corporate strategy to a structured yet people-focused approach to knowledge. We believe that the success of knowledge management depends on putting all the parts together: the right data, bid data and adequate analytics, and a flexible service-based platform to enable and valuing knowledge a culture to create a real "knowledge experience leading to a sustainable competitive advantage.

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