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Big Data Customer Knowledge Management

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ABSTRACT

Knowledge management (KM) and customer relationship management (CRM) are dominant strategies for value creation for businesses in the new economy. Customer knowledge management (CKM) results in the merging of KM and CRM, where the knowledge management process is applied to customer knowledge, and customer knowledge is applied to customer relationship management operations. With the emergence of big data as the latest phase in the evolution of technology in business, CKM strategies need to be adjusted to meet the new challenges, changing from an internal organizational focus to new external channels such as social media and machine communications. This paper explores the concept of big data customer knowledge management. It presents an architecture that integrates CRM operations and KM processes with big data technologies that include NoSQL databases, Hadoop Distributed File System, MapReduce, and platforms for social media and machine-to-machine communications.

Keywords: big data, knowledge management, customer relationship management, customer knowledge management, social media, M2M.

INTRODUCTION

Customer relationship management (CRM) and knowledge management (KM) are value creation strategies that exploit the relationship and knowledge assets in order to maximize opportunities and achieve business goals. CRM helps companies to acquire new customers, retain existing customers, and increase profitability and market share. KM concerns with the creation, sharing, maintaining, and utilization of knowledge within an organization. It has evolved from the internal focus of product and operational excellence to an external focus of enhancing business processes across the extended enterprise. The merging of the two disciplines of KM and CRM has become an area of interest in business and academia. Gibbert, Leibold, and Probst (2002) described customer knowledge management (CKM) as the management of knowledge from customers, empowering customers as knowledge partners. Customer knowledge management also refers to KM models in which customer knowledge is applied to support CRM processes (Bueren, Schierholz, Kolbe, & Brenner, 2004; Gebert, Geib, Kolbe, & Riempp, 2002; Gebert, Geib, Kolbe, & Brenner, 2003). In this paper, the extension of the CKM model in the era of big data is explored.

Minelli Chambers, and Dhiraj (2013) described the emergence of the big data era as resulting from three dominant trends: the exponential growth of processing power, the accessibility of data with high volume, velocity and variety, and the convergence of traditional data management technologies, open-sourced technologies and commodity hardware. Big data are datasets whose

requirements for storage, processing and analytics are beyond the prevalent technology capacity of the time. Contributing to the characteristics of big data are high volume, high velocity and high variety. With the proliferation of the Internet, social media and mobile computing, the impact of big data is felt in many sectors and industries. The capability of business to exploit big data to gain actionable insights is becoming a critical strategy to create competitive advantages.

Customer knowledge management takes on new dimensions in the era of big data. Customer knowledge is acquired from sources beyond traditional CRM transactions to include big data sources such as call centers, Web logs, emails, surveys, social media and machine-to-machine communications. Knowledge creation, dissemination and sharing within an organization are extended to include other external communication media. New strategies in CRM emerge to leverage big data channels. They include listening and engaging through social media, interactions via machine-to-machine communications, in addition to high volume and high variety transactions through call centers and the Web. This paper combines the perspectives of knowledge management and customer relationship management in the era of big data. An architecture for big data customer knowledge management is presented.

BIG DATA CUSTOMER KNOWLEDGE

Classification of Customer Knowledge

There are three types of customer knowledge: knowledge from customers, knowledge about customers and knowledge for customers (Gebert et al., 2002). Knowledge from customers is knowledge created through the customers' experience with a firm and is residing in customers. Such experiences can be derived from customers' interactions with the firm in CRM operations of marketing, sales, and service, or from using a firm's products or services. Knowledge about customers may include characteristics in customer behavior, demographics and previous purchasing patterns. It can be knowledge accumulated from customer interactions captured through various touch points in CRM operations, and from external sources such as data mining firms, credit bureaus and public records. Knowledge about customer can also be generated via the knowledge creation processes in the KM cycle for knowledge from customers. Knowledge for customers is knowledge created to satisfy customer needs. It may include knowledge about a firm's products and services. It is created as a result of identifying knowledge deficits in the knowledge management cycle for knowledge from and about customers.

Big Data for Customer Knowledge

Manyika et al. (2011) describes big data as datasets, whose size is beyond the ability of typical database software tools to capture, store, manage, and analyze. The Gartner Group (2011) characterized big data by the three V's: volume, velocity and variety. Varying by industry, high volume data can be measured in terabytes (10^{12} bytes), petabytes (10^{15} bytes), or exabytes (10^{18} bytes). Sources that contribute to big data customer knowledge include traditional high volume CRM transactions, Web logs, call centers, emails, and surveys. Social media, machine-to-machine and spatial data are notable emerging big knowledge sources.

Social media contributes to big data. According to Terdiman (2012), over 500 million tweets are sent per day. This is compounded by millions of people reading billions of tweets every day (André, Bernstein, & Luther, 2012). Tam (2013) reported that Facebook passed one billion monthly active users in 2012. The proliferation of customer interactions via social networking services such as Facebook, Google+, LinkedIn, and Twitter, has created new sources of customer knowledge and new paradigms in CRM operations and analytics. Social CRM is an emerging CRM model that connects social media with CRM processes. Social media has become a new channel where the CRM operations of marketing, sales and service can be conducted via social campaigns and social engagement. It has become an important source of knowledge from customers where they express their experiences and opinions about a firm's products and services. It is also a source of knowledge about customers where social media profiles of customers may contain demographic, psychographic, behavioral, and personal information about customers. Collecting and analyzing real-time sentiments from social media can provide market perceptions of a firm's products and services. Knowledge about customers from social media can be used for market segmentation and target marketing. Knowledge for customers can be disseminated via social customer engagement such as social media support forums, Facebook pages and twitter streams.

Another source of customer big data is machine-to-machine (M2M) communication, which includes data generated from sensors, smart meters, and scanning equipment. IEE (2013) indicated that about 46 million smart meters have been installed in the US as of July 2013. According to Tweed (2013), more than one billion data points are being collected daily. A single jet engine can generate 10TB of data in 30 minutes and that the daily volume of this single data source runs into the Petabytes with more than 25,000 airline flights per day (Oracle, 2013). As 40 billion new devices are connected to the Internet in the next few years (Evans, 2012), the proliferation of machine-to-machine (M2M) applications is contributing to the explosion of big data set.

Cisco (2013) indicated that there will be nearly 19 billion connected devices by 2016 and that global mobile M2M traffic is on pace to grow to over 560 petabytes per month by 2017. Data in motion between devices has massive volume and is moving at tremendous velocity. M2M applications that contribute to high velocity data include real-time location tracking devices, built-in diagnostic devices for automobiles, real-time surveillance sensors, process monitoring and control in manufacturing, and telemedical devices for real-time monitoring of patients. Other popular sources for high velocity data include web logs, networking devices, smartphones, social media, online gaming, and SaaS Applications (ScaleDB, 2014).

M2M communication facilitates the collection of knowledge from and about customers and the dissemination of knowledge for customers. The integration of Axeda M2M data with SAP's CRM "allows information such as asset owner, location, product configuration, health status, usage, inventory levels and alerts to automatically populate in the SAP CRM Contact Center, where it can then trigger business process workflows such as service ticket/case creation, pay-per-use billing, warranty management, replenishment of consumables, product recalls, planned maintenance and more" (All, 2012, para. 2). It further indicated that M2M data increases the value of SAP CRM and ERP systems for many of their large enterprise customers.

Spatial data is data that describes geometric objects via coordinates and topologies that identifies geographical locations, boundaries and features on the surface of the earth. Spatial data from many devices, mobile or stationary, via wired and wireless networks, contributes to the high volume and velocity characteristics of big data. It is a growing area in big data analytics as a new channel for big customer knowledge. Alteryx indicates, “Analysts can rapidly prepare spatial data (with capabilities such as geocoding, cleansing, and blending) and then deliver critical spatial insight such as trade areas, drive times, and mapping” (2014, para. 2). Knowledge from and about customer associated with spatial data may include knowledge of customer travel location and time and associated activities. A customer standing in front of a shelf in a store may trigger a firm to promote certain products and provide comparative shopping in real-time. GPS trackers can be used to follow individuals, pets, or vehicles with smart phones. Knowledge for customers can be provided in real-time for location-based services and marketing. Associated Press (2013) indicated that utilizing in-store GPS, Apple could provide guides for shoppers based on their locations. Utilizing advanced robots, including unmanned aircraft systems and microsattellites for geospatial applications, may enable futuristic goals of air cargo companies moving freight across the globe in unmanned aircraft, and Jeff Bezos’ vision of Amazon delivering packages to customers’ doorsteps via unmanned aircraft system (Tully, 2013).

Customer Knowledge Management in the Era of Big Data

The customer knowledge management (CKM) process consists of knowledge acquisition, creation, dissemination and sharing, representation, storage and utilization of customer knowledge. Knowledge from and about customers are captured from customers through various touch points in CRM operations, third parties, and big data sources. Captured data are transformed into business intelligence and knowledge via analytics. Acquired knowledge goes through the SECI knowledge creation cycle of socialization, externalization, combination and internalization (Nonaka & Takeuchi, 1995). Knowledge for customers are developed based on the identified knowledge gaps, and communicated to customers. Traditional customer knowledge management takes an internal organization focus, whereas in the big data era it takes on an additional external focus of managing customer knowledge via platforms such as social media and M2M communications. They become new channels for the CKM processes of dissemination and sharing of knowledge, knowledge creation through socialization in the SECI cycle, and communication of knowledge for customers. The extension to external social channels promotes the emerging notions of listening, understanding, crowd sourcing, and customer engagement in knowledge management. Figure 1 illustrates the concept of customer knowledge management for big data.

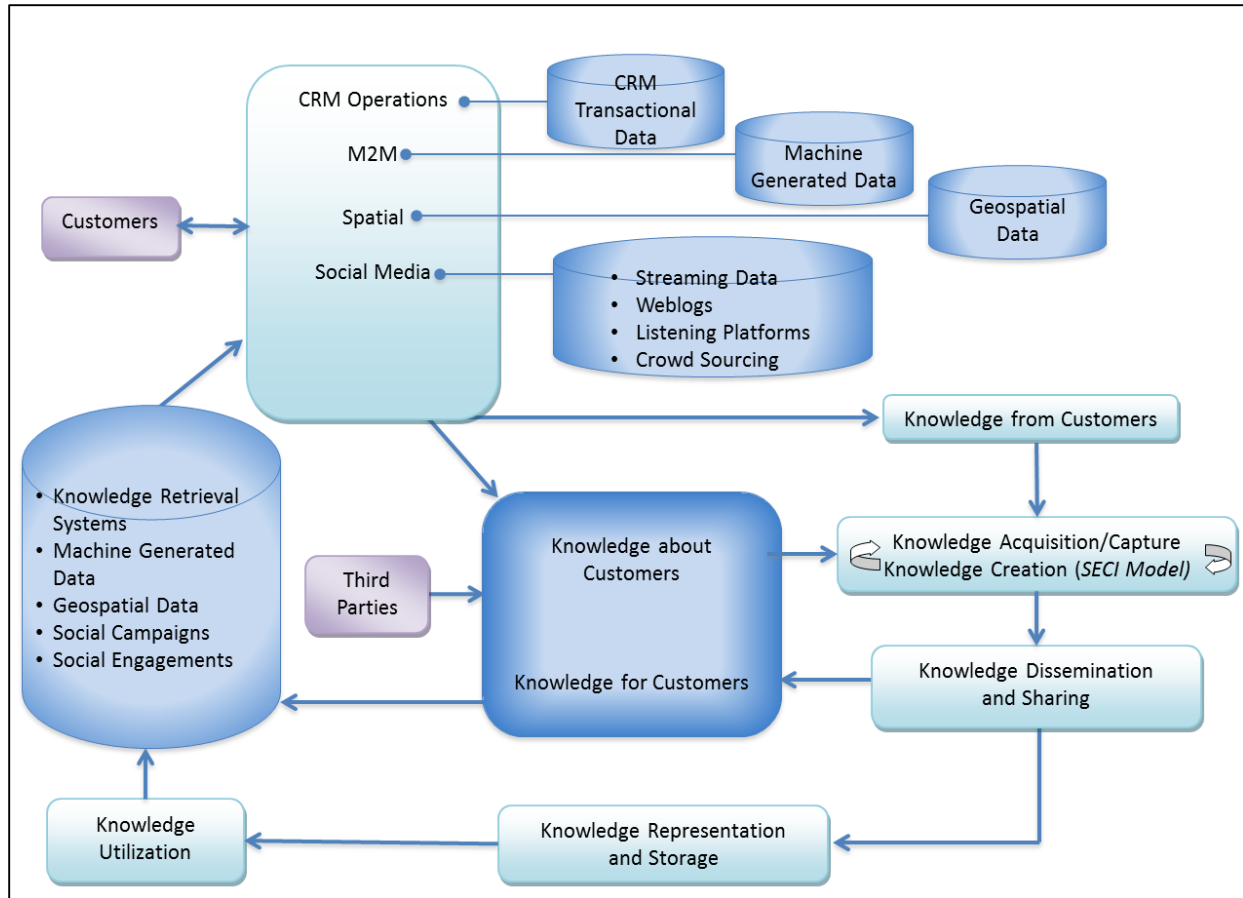


Figure 1: Big Data Customer Knowledge Management.

The Changing Face of CRM Operations in the Era of Big Data

Social media data inherently possess a combination of big data characteristics of volume, velocity and variety. The traditional CRM-CKM cycle includes the acquisition of customer knowledge from CRM operations of marketing, sales and service, and the utilization of knowledge created through the CKM process in CRM operations. New paradigms are emerging in CRM operations in the face of big data. Jones (2012) described that listening, engaging and capturing as some characteristics of social media strategy. Social media provides a platform for a firm to sense and respond. Listening through listening platforms allows a firm to capture and understand the interests of customers. A firm can respond to customer interests and pursue opportunities by engaging customers via social platforms. Social media becomes another channel for CKM where knowledge is captured, created, disseminated, shared and utilized.

New ways of marketing emerge leveraging “the wisdom of crowds,” which is knowledge created from the interaction of large group of people. A form of crowd knowledge acquisition is crowdsourcing, where a firm solicits and captures ideas from a large group of people, for example from online communities utilizing social media platforms, to solve business problems. In 2006, Netflix launched a crowdsourcing contest to award \$1M for at least 10% better predictions than the accuracy Cinematch can achieve on the same training data set; and the prize was awarded in

2009 (Netflix, 2009). Anheuser-Busch sought customer input to develop a brand more attuned to craft-beer tastes leveraging 25,000 consumer-collaborators (Jartese, 2013).

Firms are integrating marketing and sales efforts with social media in launching social campaigns, where knowledge about a brand is posted on social media pages. Marketers gain better understanding of the audience by monitoring the responses of the postings. A sales presentation is replaced by engaging prospects and customers via social networks. The sales team can follow leads generated through social campaigns. The integration of social media and marketing is an emerging trend. Koh (2014) reported the integration of Twitter and MoPub, the mobile ad exchange company, envisioning the application of Twitter data to targeting efforts on MoPub, which according Twitter, handles more than 130 billion ad requests every month that can reach more than one billion unique devices.

Customer service has evolved from the traditional customer support centers, to self-service FAQ, to social media support forums and other types of social media interactions via Facebook pages and twitter streams. There are a growing number of customers making complaints and service enquiries via social media. Seiter (2014) reported that customers spend 20% to 40% more with the company when companies engage and respond to service enquiries, and that over 70% of those who experience positive social care are likely to recommend that brand to others.

Geospatial data adds value CRM operations and analytics by knowing the location of customer assets. It helps organizations visualize and understand how customer, product and other business data are impacted by geography, enhancing the efficiency of CRM operations (IBM, 2014). Real-time location-based marketing and services can be provided to customers via real-time geospatial data from customers' smartphones and other devices.

AN ARCHITECTURE FOR BIG DATA CUSTOMER KNOWLEDGE MANAGEMENT

An architecture for big data customer knowledge management, which integrates big data, customer relationship management and knowledge management is illustrated in Figure 2. There are three dimensions to the architecture. One dimension shows the process of big data capture, storage and analytics. The second dimension shows the knowledge management cycle of knowledge acquisition, creation, dissemination and sharing, representation and storage, and utilization. The third dimension illustrates the CRM operations of marketing, sales, and service. Data analytics can go through two routes, the traditional business intelligence (BI) route through data warehousing, and the big data analytics route through the big data platforms utilizing technologies such as NoSQL databases and Hadoop. Knowledge derived from these analytical platforms provides the input to the knowledge management cycle.

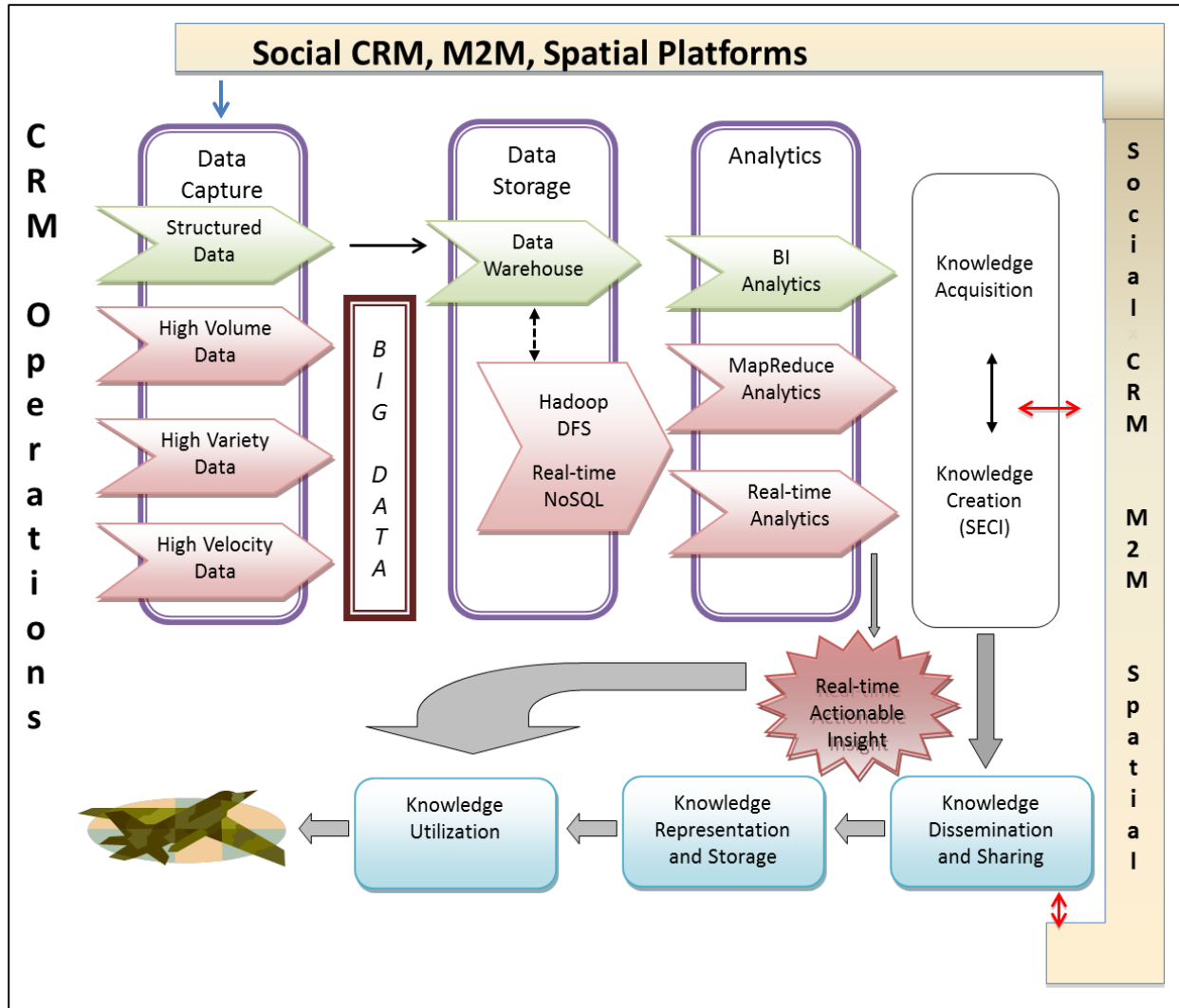


Figure 2: An Architecture for Big Data Customer Knowledge Management.

Big data from customers can be captured from various sources including high volume (terabytes, exabytes) transactional data, high velocity data such as data in motion, high variety (structured, unstructured, multimedia) data. CRM transactions in marketing, sales, and service are traditional data sources. Transactional data accumulated over time contributes to big data. Sathi (2012) described that a communications service provider would occupy five petabytes of data with 100 million customers if stored for 100 days. Unstructured data from documents, images, video and audio streams contribute to high variety data. High variety knowledge from and about customers can be collected via call center text and audio transcripts, customer Web contents, video feeds such as YouTube and images from photos published and shared by customers, and other sources. There are many contributors to high velocity customer data. They include log events from devices, websites and databases, smartphones, social media streams such as Twitter feeds and Facebook posts, and high velocity event data from SaaS applications (ScaleDB, 2014). Social CRM, M2M and geospatial platforms increasingly contribute to big data for customer knowledge.

Structured transactional data can go through the traditional data warehousing and business analytics platforms (such as OLAP and data mining) in the creation of business intelligence, which is fed into the knowledge management cycle in the creation of actionable customer knowledge to be utilized in CRM operations. The platforms that handle big data include Hadoop and real-time NoSQL databases. Hadoop is a distributed processing framework for large data sets across clusters of computers designed to scale up to thousands of machines, each offering local computation and storage (Apache, 2013a). Hadoop consists of two components, the Hadoop distributed file system (HDFS) that provides the data storage, and MapReduce that provides the distributed processing, over a large cluster of commodity servers. Analytical results from MapReduce provide an input to the knowledge management cycle for the creation of actionable customer knowledge. In spite of its high scalability and massively parallel processing capability for big data, Hadoop is a batch system that is not suitable for real-time processing. Real-time NoSQL databases such as Apache Hbase can be used in conjunction with Hadoop to provide real-time random access to big data (Apache, 2013b). Real-time analytics is deployed for big data captured in the NoSQL database in the creation of real-time actionable insight to be utilized in real-time operations and decisions. It also provides an input to the customer knowledge management cycle for the creation, dissemination, storage and reuse of customer knowledge. Real-time analytics can be combined with batched analytics to improve decision-making. There is a bidirectional relationship between data warehousing and Hadoop. Data warehousing can be a data source for complex Hadoop jobs, simultaneously leveraging the massively parallel capabilities of two systems (Awadallah & Graham, 2011), whereas, MapReduced data can be integrated with the data warehouse for further analytic processing.

The traditional knowledge management process is internally focused within an organization. A unique feature of this architecture for customer knowledge management is the addition of an external dimension. This external dimension allows the listening from customers, understanding of customer conversations, and engaging with customers in a conversation. In addition to traditional knowledge sources from CRM operations, the CKM process captures knowledge from customers using listening platforms in social CRM, and by logging into M2M and geospatial data from remote sensors. Knowledge creation via the SECI cycle, dissemination and sharing of knowledge can also take an external dimension via social media leveraging the wisdom of the crowds. Knowledge for customers can be disseminated via social customer engagements.

CONCLUSIONS

Customer relationship management (CRM) and knowledge management (KM) have been dominant value creation strategies for businesses to create competitive advantages. Customer knowledge management (CKM) concerns the application of knowledge management processes to customer knowledge, and the application of knowledge in customer relationship management operations. Big data is the latest stage in the evolution of technology in business. The ability to exploit big data to create actionable business insights is emerging as top priority in value creation. Big data sources for customer knowledge include high volume CRM transactions, Web logs, call centers, emails, and surveys, social media, machine-to-machine and spatial data. New paradigms have emerged in CRM and CKM utilizing the big data channels. CRM operations of marketing, sales and service have extended to social media campaigns and engagements, and M2M

interactions with customers. The CKM process has expanded to external social platforms for knowledge creation, dissemination, sharing, and utilization. The big data platform exploits technologies such as Hadoop distributed file system and MapReduce, that can afford distributed processing over a large cluster of commodity servers. Real-time NoSQL databases can be used in conjunction with Hadoop to provide real-time processing of big data. This paper provides a conceptual framework for the integration of CRM and CKM with big data channels and technology platforms. It illustrates the cycle of big data capture and the transformation into actionable business insight, which is fed into the CKM process of knowledge creation, dissemination and sharing, storage and utilization. Notable examples of new big data channels such as social media and machine-to-machine platforms are included for both CRM and CKM.

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