

Chapter 2

Technology Foundation and Talent Management for Digital Enterprise

This chapter reviews technology infrastructure for digital enterprise, enterprise systems supporting digital enterprise, and measures and tools for addressing security and privacy issues associated with digital enterprise, then discusses emerging technologies of Big Data and Data Analytics, Cloud Computing, and The Internet of Things, and concludes with talent management for digital enterprise.

2.1 Digital Enterprise Technology Infrastructure

The subject area of digital enterprise (like any other specialist area) is riddled with terminology. Much of the terminology relates to the underlying technologies. It is important to understand that digital enterprise applications are built on top of a number of technologies and required infrastructure. The underlying technologies provide a layered, integrated infrastructure which enables digital enterprise/applications to be deployed. The layered structure means that each layer depends on the layer below and cannot function without the lower layers. Table 2.1 shows the digital enterprise infrastructure.

2.2 Enterprise Systems Supporting Business Processes

Many companies have moved from mainframe legacy systems, which focus on traditional business functions or only supporting the internal business processes, to integrated cross-functional enterprise applications, which emphasize accomplishing fundamental business processes in concert with customers, suppliers, partners, and employees. Integrated systems, such as enterprise resource planning systems, knowledge management systems, supply chain management systems, and customer relationship management systems, allow the same data (especially from a central database) to be used for multiple applications; information output from one function can easily become data input to another function. Many organizations view cross-

Table 2.1 Digital enterprise technology infrastructure

Basic technologies	Functions	Application examples
Digital enterprise applications	Support business processes of organizations (e.g., B2B, B2C, and intra-organizational communication) and activities of individuals (e.g., communication, networking, community building, knowledge sharing, online shopping, online selling, and online information search) as well as the government's functions	Digital platforms, electronic marketplaces, E-procurement applications, sales force automation applications, digital retailing, digital banking, digital publishing, digital learning, digital auctions, search engines, social networks, virtual communities, and digital government
Interfacing, sharing, integration and aggregation applications	Tie different services together and integrate with business partners' applications	Service oriented architecture (SOA), Web services, virtualization, grid computing, cloud computing, utility computing, software-as-a-service, mobile computing, social computing, semantic web, web science, middleware, enterprise architecture, and enterprise application integration (EAI)
Common business services applications	Provide services required for digital transactions and functions	Digital security, digital authentication, IP addresses (IPv6), storage repositories, digital payment systems, and smart cards
Transportation services technologies	Publish and distribute information in different formats (i.e., in text, audio, fax, video) on the digital networks	Hyper-text transfer protocol (HTTP), transmission control protocol/Internet protocol (TCP/IP), electronic Data interchange (EDI), E-mail, world wide web (WWW), hypertext markup language (HTML), java, natural language, extensible markup language (XML), HTML5, virtual reality modelling language (VRML), and open source standards
Telecommunication networks and data storage facilities	Connect different devices together and enable digital communication	The internet (copper cable or fiber optics), TV Networks, telephone networks, mobile networks (3G or 4G), electricity grids, smart grids, wireless networks (including balloons, drones, satellites, laser, open space, underwater, and cloud-based wireless

(continued)

Table 2.1 (continued)

Basic technologies	Functions	Application examples
		networks as well as wireless personal area networks (WPANs)), mesh networks, intranets, extranets, virtual private networks (VPNs), local area networks (LANs), wide area networks (WANs), and data centers and data farms

Source Adapted from Xu and Quaddus (2009, p. 27); the author's own knowledge

functional enterprise systems as a strategic way to use information technology/information systems to share information resources and improve the efficiency and effectiveness of business processes, thus helping attain their strategic objectives. Table 2.2 presents key enterprise/cross-functional information systems that enterprises (especially large enterprises) can put in place. Such systems typically include enterprise resources planning (ERP) systems, customer relationship management (CRM) systems, supply chain management (SCM) systems, and knowledge management (KM) systems. A major trend of enterprise/cross-functional information systems is the move (partially or wholly) to the cloud. On top of such concerns of limited functionality, the potential loss of internal control, performance reliability, and security, organizations also need to look at such factors as implementation size, solution complexity, capital costs, operating costs, total costs, and implementation time when they are embarking on cloud services (Utzig et al. 2013).

Table 2.2 Key enterprise/cross-functional information systems in the organization

Key enterprise systems	Purposes and emphasis of the systems
ERP systems	Enterprise resource planning (ERP) systems focus on improving the efficiency of a company's internal business processes, such as production, logistics and distribution, human resources, accounting and financial processes
CRM systems	Customer relationship management (CRM) systems mostly deal with understanding, acquiring, enhancing relationships with customers, and retaining customers
SCM systems	Supply chain management (SCM) systems primarily provide the enterprise with the solutions in optimising the efficiency of its supply chain (especially its procurement and sourcing activities) and enhancing its relationship with its suppliers
KM systems	Knowledge management (KM) systems (also called organizational memory/organizational learning systems) aim at organising, storing, sharing and applying existing knowledge within and outside the organisation and creating new knowledge for the organization. Even though KM systems could assist in managing both tacit and explicit knowledge, the emphasis really is on managing the tacit dimension of knowledge

Source Developed from O'Brien and Marakas (2011, p. 275); the author's own knowledge

2.2.1 Integration

When organizations are embarking on exciting opportunities and capabilities offered by various technologies and leveraging advantages from multiple channels (e.g., call centers, stores/branches, online operations, mobile applications, videos, fax machines, agents and third parties), one critical factor is integration. They need to appropriately integrate various applications/systems with their information systems infrastructure or/and existing applications/systems and unify different channels to share information across the organization. Technologies such as service-oriented architecture, which can create a unified business-service layer for channels and front-end processes to share (customer) information, could be useful in this regard and help win or retain customers. For example, if a customer called before walking into a store, and this information is not managed and shared across the organization and the multiple channels, then the opportunity of winning the customer could be gone (Wang 2010). One particular relevant point at the moment is to integrate personal mobile devices (e.g., smart phones, tablets) into the IS/IT infrastructure so the owners of those mobile devices could securely and smoothly access the required information and make use of corporate applications (Kleiner 2012).

The next generation of Internet standards such as HTML5 will provide the access to all programs and applications via a web browser from any device anywhere anytime. HTML5 arguably is the most significant evolution yet in web standards, and it could locally store 1,000 times more data in browsers than they currently do (Korkmaz et al. 2011). It allows programs/applications to run through web browsers and communicate different multimedia content without requiring plug-in software and other workarounds.

2.3 Managing Security and Privacy Threats

To deal with various security challenges arising from the use of information technology and protect our information resources requires a variety of security tools and defensive measures and a coordinated security management program, including hardware, software, policies, and procedures. Some security measures and tools adopted by organizations include: Biometrics (e.g., Vein ID, finger prints, Iris Scan, face recognition, speech recognition), password, swipe card and other tools for physical access control, Malware and virus protection software/applications, Virtual private networks, Firewalls, Identity management and access control systems, Encryption (e.g., secure socket layer (SSL) protocol), Digital certificate, Digital signature, Tokenization and Key Management, Intrusion detection systems, Vulnerability scanning tools, Online access control, Security event correlation tool, Third-party Internet monitoring and analysis, Patch management tools, Network security protocols, Data backup, Data loss prevention systems (for monitoring data moving on the corporate network), Governance, risk and compliance (GRC) tools,

Information security plan, Regular security plan testing, Security plan compliance audit, Information systems control and audit, Risk Management and Cyber Risk Insurance, Security and Privacy risks committees, Mobile device management software, VoIP, Mobile, Social, and Cloud computing security policy, C-level positions (e.g., Chief Information Officer, Chief Security/Information Security Officer, Chief Privacy Officer, Chief Risk Officer, Chief Trust Officer), and locks/keys/physical security for computer hardware, (O'Brien and Marakas 2011, pp. 534, 538; Laudon and Laudon 2005, p. 542; Laseter and Johnson 2011; Westby 2012; Xu and Quaddus 2013, pp. 6–11; Oxford Economics 2013, pp. 18–22). Meanwhile, the larger the organization and the more sensitive of the information (i.e., information in certain government intelligence gathering agencies), the increased risk and costs of security breaches, the more comprehensive, systematic, integrated and sophisticated security (and privacy) measures need to be put into place. Westby (2012, p. 26) provides some recommendations for governing enterprise security management:

- Establishing a board Risk Committee for managing enterprise risks (including IT risks) and recruit directors with security, IT governance and cyber risk expertise.
- Ensuring privacy and security roles are separated and their responsibilities are appropriately assigned.
- Establishing a cross-organizational team and discuss privacy and security issues at least once every month.
- Creating a culture of security and respect for privacy and view security and privacy as a corporate social responsibility.
- Ensuring the quality of security program by regularly reviews and taking into consideration of best practices and industry standards.
- Ensuring the security and privacy requirements to third parties and vendors.
- Conducting annual audit of enterprise security program by relevant committees and act on identified gaps.
- Requiring regular security and privacy reports for board and senior executives.
- Assessing cyber risks and potential loss valuations and reviewing adequacy of cyber insurance coverage.
- Allocating sufficient resources for security and privacy programs.

Haag et al. (2008, pp. 330–339) suggest organizations can implement information security lines of defense through people first and technology second. They point out that most information security breaches result from people misusing an organization's information either advertently or inadvertently. Their views are supported by Laseter and Johnson (2011), who believe that many of the security breaches are done by insiders. The first line of defense an organization should follow is to create an information security plan detailing the various information security policies. Steps to creating an information security plan include (Haag et al. 2008, p. 333):

1. Developing the information security policies.
2. Communicating the information security policies.

3. Identifying critical information assets and risks.
4. Testing and re-evaluating risks.
5. Obtaining stakeholder support.

Information systems should be periodically examined, or audited, by a company's internal auditing staff or external auditors from professional accounting firms. Such audits should review and evaluate whether proper and adequate security measures and management policies have been developed and implemented (Laudon and Laudon 2005, p. 542).

According to a recent global survey of 12,052 senior executives by PWC (reported in Oxford Economics 2013, p. 30), some of the greatest obstacles to improving the overall strategic effectiveness of an organization's information security function include (in order): insufficient capital expenditure, lack of an actionable vision or understanding of future challenges, lack of an effective information security strategy, absence or shortage of in-house technical expertise, lack of leadership, insufficient operating expenditures, and poorly integrated or overly complex information and IT systems.

Good digital enterprise security management must take into consideration technology solutions, organizational policies and procedures, and laws and industry standards. Furthermore given the fact that a large number of security breaches are committed by insiders, education, and prevention programs should be heavily emphasized even though technological solutions and monitoring and controlling measures could be useful. It should be clearly spelt out that people are the first defense line, and technology is the second defense line. In addition, an effective cyber-security risk analysis and management process should be put in place and such process should include such steps as: (1) identifying risks, (2) prioritizing top risks, (3) conducting risk assessment, (4) selecting risk management options, (5) developing risk management strategy, (6) designing crisis management strategy (for unpredicted events), (7) implementing the developed strategies, and (8) monitoring progress and updating strategies (World Economic Forum 2014a, p. 42). Cyber-security risk management also needs to be an integral part of enterprise-wide risk management and governance processes and be an integral part of people's life in the organization (e.g., the biggest security vulnerabilities often exist in people's everyday uses of email and the Internet) (Bailey et al. 2014).

On a related note, the above-mentioned technologies and approaches for managing security are effective in dealing with privacy concerns as well.

2.4 Big Data and Data Analytics

Gathering and analyzing large (or very large)-scale data is quickly becoming popular among organizations for reasons such as large volume data from multiple channels and various sources, the need to better understand customers better, and the tangible benefits of gaining competitive advantages by doing this (e.g., the

success of the data initiatives of Amazon, Google) (Bughin et al. 2011). Big data can be defined as “data sets whose size is beyond the ability of typical database software tools to capture, store, manage and analyze” (Manyika et al. 2011, p. 1). Big data is different from the traditional concept of data in four perspectives (Dijcks 2012; Brown et al. 2011):

- **Bigger volume:** in 2010 enterprises and consumers stored 13 exabytes or 14 billion gigabytes) of new data on devices and the projected annual growth in global data generated is 40 % (just imaging the information produced by more than 4 billion mobile phones, by 30 million network sensor nodes, social networks. Do you know there are more than 30 billion piece of content (photos, notes, blogs, web links, and news stories) shared on Facebook every month and 2.9 billion hours of video are watched at Youtube every month?). It is estimated that there will be more than 50 billion connected devices in the world by 2020 (Dutta et al. 2012, p. 3). Have you imagined living in a yotta world (1,000 trillion gigabytes data in which your every move will be digitized and added to the data flow of the world)? (Siegele 2012). According to the latest EMC/IDC Digital Universe Report (reported in EMC Corporation 2014a), global digital data will reach 44 zettabytes (or 44 trillion gigabytes) in 2020 from 4.4 zettabytes in 2013. It is said more data were created between 2008 and 2011 than in all history before 2008 (Biggs et al. 2012, p. 48); and 90 % of the world’s data was created in the last 2 years, and digital universe (including all digital data created, replicated, or consumed) has been growing by a factor of 30 from 2005 to 2020, doubling every 2 years. In the past, data storage was expensive and a lot of data have been thrown away (Pepper and Garrity 2014, p. 35). However the price of storage is dropping significantly, and by 2020, storing a petabyte data will only cost US\$4 (Siegele 2012). According to Meeker (2014), global compute cost had been declining 33 % annually for the period of 1990–2013 and the cost of per 1 million transistors had decreased from US\$527 in 1990 to US\$0.05 in 2013; global storage cost had been declining 38 % annually for the period of 1990–2013 and the cost of per gigabytes had decreased from US\$569 in 1990 to US\$0.02 in 2013; global bandwidth cost had been declining 27 % annually for the period of 1990–2013 and the cost of per 1,000 Mbps had decreased from US\$1,245 in 1990 to US\$16 in 2013; and average global smart phone price had been declining 5 % annually for the period of 2008–2013 and the price had decreased from US\$430 in 2008 to US\$335 in 2013.
- **Higher velocity:** for example even at 140 characters per tweet, Twitter generated data volume is large than 8 terabytes per day as a result of high velocity or frequency. Do you know Youtube videos are uploaded 100 h/per min, Twitter delivers 500 million tweets per day, and Facebook has 150 billion friend connections (World Economic Forum 2014b, p. 9). And it is reported that 90 % of the world’s data are generated in the last 2 years (Conway 2012).
- **More data variety** (including traditional and non-traditional data and structured and unstructured data (i.e., social media data)): it is estimated that 95 % of the world data is unstructured data, which makes big data more meaningful and

challenging (Oracle 2012). In the future, 80 % of enterprise data (from both traditional and non-traditional sources) will be unstructured (SAP AG 2012).

- Higher economic value: huge financial gains can be realized via Big Data and more powerful and accurate decision-making and thus significantly improving business operations and organizational performance.

Big Data could exist in various formats (including video, image, audio, text/numbers), and include various types of data, including traditional enterprise data (e.g., customer, transaction, operation information), machine-generated/sensor data (e.g., call details records, weblogs, information from smart meters and smart devices, manufacturing sensors, network sensors, cameras and CCTVs, bar codes, embedded devices, equipment logs), and social data (e.g., information from blogs including micro-blogging sites such as Twitter, social networks). Start-up firms like Lexalytics and Klout have been established to understand social data (Dijcks 2012). We are in the Big Data era for reasons such as the cheaper and cheaper data devices (for example, for a few hundred dollars, you can buy a disk that can store all of the world's music (Brown et al. 2011)), the wide adoption of mobile phones and other mobile devices, and the great connectedness as a result of the availability of extensive networks across the globe.

Big Data could create value for organizations in several ways (Manyika et al. 2011, pp. 5–6): (1) creating transparency and improving efficiency via easier access to more data across the organization; (2) improving productivity and organizational performance through quicker, deeper and more accurate discovery, prediction and analysis; (3) better segmentation with more tailored customization actions; (4) better (automation) support in decision making; (5) enhancing existing products and services and creating new ones through better understanding customers' needs and stronger capabilities in identifying opportunities for new products and services; and (6) becoming a key basis of competition and growth through the use of Big Data for organizations as well as (7) better pricing strategies (for example, it has been suggested that on average, a 1 % price increase could translate into an 8.7 % increase in operating profits) (Baker 2014). Meanwhile, Professor Tom Davenport (reported in Baker 2014) has suggested that developing new products and services from Big Data is the most interesting and valuable initiative for organizations. Specifically Big Data could bring huge financial value to various sectors, for example (Brown et al. 2011; Manyika et al. 2011, p. 8; Plansky et al. 2013; Lund et al. 2013, p. 12):

- US\$300 billion value per year to US health care sector.
- More than 60 % increase in net margin to US retail sector.
- EUR250 billion value per year to Europe public sector administration.
- Up to 50 % decrease in product development and assembly costs to manufacturing sector.
- US\$100 billion and US\$700 billion value for service providers and end users in the sector of global personal location data.

- US\$175 billion revenue from commercializing data in 2013 and up to US\$300 billion in the next 3–5 years across financial areas of capital markets, commercial banking, consumer finance and banking, and insurance.
- Up to US\$325 billion annual GDP increase in retail and manufacturing sectors and up to US\$285 billion productivity gains in health care and government services by 2020 in the U.S.
- Huge benefits to sports industry?!: Have you watched the popular movie *Moneyball*? (Stafford 2012; Lohr 2012).

In 2012, the U.S. had one third of the world's data (followed by Western Europe (19 %), China (14 %), and India (4 %)), and it has been leading the development of Big Data (Lund et al. 2013, pp. 11–12). Some notable examples of using Big Data for competitive advantages include: Google, Amazon, Apple, Zipcar, and Netflix. Hagström and Gill (2012, p. 102) point out that the combination of hyper-connectivity, Big Data, and powerful analytics, has enhanced organizational ability to know, dialogue, and innovate.

Meanwhile some techniques for analyzing Big Data include: A/B testing, Association rule learning, Classification, Cluster analysis, Crowdsourcing, Data fusion and data integration, Data mining, Ensemble learning, Genetic algorithms, Machine learning, Natural language processing, Neural networks, Network analysis, Optimization, Pattern recognition, Predictive modelling, Regression, Sentiment analysis, Signal processing, Spatial analysis, Supervised learning and unsupervised learning, Simulation, Time series analysis, Visualization, and many others (Manyika et al. 2011, pp. 27–31). Some technologies and applications for Big Data are: Big table, Data warehouse, Cassandra, Cloud computing, Distribute system, Dynamo, Google file system, HBasem, Hadpoop, MapReduce, Metadata, Stream processing, Visualization, and many others (Manyika et al. 2011, pp. 31–33).

On top of the required techniques and technologies and talent to take advantage of the potential Big Data, organizations also need to (1) put in appropriate data policies in place (especially addressing data sourcing, accessing and disseminating issues and critical but complex (as a result of the size and the sources of data) data security and privacy issues); (2) make necessary organizational adjustments (including structural and cultural changes, end user education); and (3) ensure top management's skills and support for Big Data use in the organization. Meanwhile the data quality is one of the most critical factors (if not the most critical factor) for using Big Data for decision making; in order to avoid the problem of “Garbage in and Garbage out”, organizations need to work hard on the sources of the data (sources/data partners must be reliable) and on the acquisition/collection of data (e.g., right questions and research design; good understanding of data constraints; and ensuring real-time or timely data) (Chui and Fleming 2011). Meanwhile to maximize the value of Big Data, Organizations should let the business case guide the data analytics and minimize the cost of Big Data by targeting analyses generating tangible business results (Lund et al. 2013, p. 87). Another two critical areas associated with Big Data are having a culture that supports analytics and data-driven business making (including such things as (1) analytics are valued,

(2) creativity and innovation are valued, and (3) people are willing to work together and share in the organization) and putting data governance (especially focusing on privacy, security and compliance issues) into place (Halper 2014). Organizations also need to be effective in articulating Big Data and data analytics (e.g., having more effective measures, telling success stories better) (Vesset and Morris 2013). In addition, much of the data collected is unstructured in nature and is difficult to analyze, so the ability of effectively dealing with some unique dimensions of unstructured data have to be developed. For example, how can computers interpret our feelings, attitude and intentions in our messages? or how can computers deal with the tacit dimension of the knowledge sitting in our brain?); and the capabilities of continuous and high-speed decision making need to be developed as well as a result of the sheer speed of the flow of data (Baker 2014).

However while the huge potential and benefits are recognized, its role and influence should not be overstated. It should be remembered that human beings are decision-makers, and the machine or data is viewed as the basis upon which better decisions are made. Big Data could make our decision making process more scientific (Lohr 2012), but the role of our experience and intuition, which is impossible (or extremely hard) for the machine to emulate and acquire, should never be diminished. On a related note, we need to be aware that while we are talking about Big Data at the moment, we mostly refer to the data collected digitally via different channels and various devices (e.g., wired and wireless networks, mobile devices, desktop PCs, sensors, cameras, machines and equipment). However such digitally collected data could not provide all the required information to the organization (for example, some observational (or broadly speaking qualitative) research/data could not be collected and interpreted in a digital way); and Big Data approach may not be suitable or available to some organizations (for example, firms in some emerging markets where access to abundant information is very limited resulting from poor technology infrastructure and other factors; and similarly firms in some specified industries, firms working in relatively sparse data environments, firms with no resources for expensive data acquisition, hardware, and software or technology infrastructure, could have limited access to Big Data) (Meer 2014). With the right process and mind-set, firms with either Little Data or Big Data, could take advantage of available data (virtually all sources of information available to the organization) to make better decision, improve products, and enhance customer experience; meanwhile some areas they need to look at include: (1) demonstrating the commitment to become more fact-based in the decision-making, (2) having the willingness to learn by doing (i.e., doing some qualitative studies, using trials and errors, conducting pilot studies before larger scale data collection and data analytics), and (3) being creative (e.g., quick iPad-assisted customer surveys in the store by retailers, asking more target and specified questions in the online registration forms, leveraging the data collected in call centers, adopting user panels of savvy customers for ideas, and using sales representatives in the field to collect market intelligence) (Meer 2014). Another related question organizations need to ask is whether real-time data, which could be very expensive, is really necessary? For many organizations the answer could be not so, and for them aggregating,

organizing (i.e., giving structure to unstructured data), and analyzing data in a more leisurely approach via utilizing their existing infrastructure is a more practical way to go (Goodwin 2014b).

Furthermore, according to a recent research with some large Fortune companies by Wixom and Beath (2014), obstacles for firms to realize expected value from their data initiatives include: lack of common data platform and missing or broken business processes to support the common data platform, lack of user engagement, and lack of leadership or commitment for required change; and their suggestions for addressing these identified barriers are: having user-centric development (i.e., actively engaging users to develop tools and services), developing hybrids on staff (i.e., proactively nurturing business-savvy IT people and IT-savvy business people), and marketing internally (i.e., aggressively marketing and selling the value of data).

The Boston Consulting Group (reported in Argawal et al. 2014) proposes a framework for enabling Big Data in the organization, which looks at building up six capabilities:

- Identifying opportunities via creating a culture of innovation and experimentation (e.g., encouraging non-traditional ideas, fostering collaboration between data and business experts, adopting a test-and-learn approach).
- Building trust among consumers to enable broad use of their data (e.g., clearly communicating how data is used, providing choices and control, articulating the benefits of the data use).
- Developing technical platform and leveraging flexible, scalable, and efficient data systems (e.g., adopting a scalable and multipurpose data platform, utilizing/making most of the existing infrastructure, adjusting operational processes to leverage insights quickly).
- Shaping organization and developing capabilities to implement and take advantage of relevant data applications (e.g., establishing a Big Data Center of Excellence, gaining senior management's support/sponsorship, effectively managing data talent and skills).
- Participating in a Big Data ecosystem and identifying strategic partners that can help unlock new economic opportunities (e.g., understanding the opportunities for the organization in the ecosystem, identifying strategic partners, starting small but scaling quickly).
- Relationship building and having an open culture to support collaborating and sharing (e.g., having strong capabilities of managing partners, ensuring seamless integration, working on win-win arrangements and contracts).

2.4.1 Data-Led Transformation

Data-lead transformation involves monetizing data assets, integrating outside data with internal information, and developing data analytics to (Plansky et al. 2013):

- Leveraging enhanced data for core business (e.g., exploring new opportunities to enhance existing services through new data sources, developing new data platforms, delivering enhanced services).
- Generating new insights (e.g., having more and better understanding of customers, improving ROI of marketing efforts).
- Entering adjacent businesses (e.g., monetizing existing analytics capabilities, commercializing infrastructure to sell platforms as a service, partnering with adjacent players across the business value chain, identifying and monetizing new data sources).
- Developing new products and services (e.g., creating new sets of analytics and data products and services).

Some key design principles and required capacities for implementing data transformation strategy include (Plansky et al. 2013):

- Understanding your customers and investing in continuous improvement of addressing their needs.
- Having good understanding of your data and systematically organizing your data (e.g., cataloguing and mapping available data).
- Exploring the opportunities of the whole value chain of the organization and developing new opportunities from the data ecosystems and from the partnerships with relevant stakeholders.
- Sizing the value of opportunities of commercializing data and working on the scale, efficiency, and effectiveness of data initiatives.
- Enhancing the organization's IS/IT infrastructure and building a sophisticated, transparent, and flexible data infrastructure to unlock or maximize the value of its data.

El-Darwiche et al. (2014, pp. 46–48) present a Big Data Maturity model, which includes four stages:

- Stage 1 Performance management (e.g., looking at what can be read from the data by applying such tools as financial reporting, regulatory/compliance reporting, dashboards for management reporting, and performance measurement via key performance indicators/metrics).
- Stage 2 Functional area excellence (e.g., looking at what can be learned from the data to become better by applying such approaches and tools as smart pricing, targeted mailings, customer segmentation, customer value analysis, choice analysis, website clickstream analysis, loyalty schemes, customer satisfaction measures, supply chain balancing, facility optimization, fraud monitoring/prevention, traffic optimization, crime monitoring, patient treatment control, route optimization for fleet, and optimization of staff utilization).
- Stage 3 Value proposition enhancement (e.g., looking at how data can become a value driver of the business by applying such approaches and services as providing real-time targeted advertising and customized recommendations, providing personalized customer experience and services, providing online

telematics services, and using Big Data for preventative health monitoring and disease detection).

- Stage 4 Business model transformation (e.g., looking at how data can be used to fundamentally reinvent the business by applying such approaches as generating new revenue by selling data, having data-centric business models, quantitatively managing investment funds, and using crowdsourcing to augment internal data).

Meanwhile, in order to successfully execute the Big Data Maturity model, some key required internal capabilities are (El-Darwiche et al. 2014, pp. 49–50):

- Developing a clear Big Data strategy.
- Proving the value of data in pilot schemes.
- Identifying the owner for Big Data in the organization and appointed formal senior position (e.g., Chief Data Officer, Chief Data Scientist).
- Recruiting, training, and retaining data talent.
- Making Big Data an integral part of the operation of the organization.
- Establishing data-driven decision culture and proactively promoting such culture.

Governments have to take Big Data seriously. They need to work on a regulatory framework for data privacy (e.g., looking at such areas as the limitation of personal data collection, the specification of the purpose of the data collection, the protection of collected data, the prevention of data loss or unauthorized access, and the right of individuals to obtain information about collected data), deploy required ICT infrastructure, provide education/training, address public perception and awareness, and develop Big Data ecosystem (El-Darwiche et al. 2014, pp. 48–50).

2.5 Cloud Computing

Cloud computing basically is renting computing resources (including software, networks, servers, storage, processing, operation systems, applications, services) as per usage on the networks (especially the Internet), and it can deploy in the models of private cloud (solely for one firm and could be managed by the organization or a third party on its premise or off its premise), public cloud (is made to the general public or a large industry group and is owned by an organization selling cloud services), and hybrid cloud (the combination of private and public clouds) (Compuware Corporation 2010; Trend Micro 2010). By adopting cloud-computing, organizations could (1) better utilize there IS/IT investments; (2) have better flexibility, quicker responses to changes, enhanced ability for information systems to scale up, better ability of disaster recovery and business continuity; and (3) focus on their core business (especially for small and medium firms). One good example (reported in Roberts et al. 2010) is that by using Amazon's cloud computing facilities, The New York Times digitalized and catalogued more than 100 years of archived articles for its web in a 24-h period, avoiding the need to configure and run

a set of servers for a onetime effort. In line with the rapid progress and huge potential of Cloud computing, major ICT firms have committed significant resources to cloud computing developments.

Some typical technologies associated with cloud computing include virtualization and service-oriented architecture. It could be argued that the approach of clouding computing is not really new (i.e., thinking about the example of mainframe computer to individual users of it). The difference is between sharing computing resources on the networks [there are more than 50 million servers and most of them operates only at 15 % of capacity (Intel Corporation 2011; Harvard Business Review 2010)] and sharing the main-frame computer. Some characteristics of cloud computing consist of: (1) on-demand self-service (for example, required computing resources could be run automatically without human interaction once the parameter and instruction are set); (2) broad network access (for example, cloud services can be accessed by various devices such as mobile devices, personal computers, laptops); (3) resource pooling (the provider's computing resources are pooled to serve multiple clients simultaneously by using a multi-tenant model); (4) rapid elasticity (the ability of quickly scaling out and scaling in according to the changes in demand); and (5) measured service (adopting metering capability for transparency in monitoring, controlling and reporting) (Compuware Corporation 2010).

Cloud service models include (Trend Micro 2010; Intel Corporation 2011; Compuware Corporation 2010):

- Cloud Software as a Service (SaaS): providing the customer with the capability to use the provider's applications sitting on a cloud infrastructure. Examples of SaaS include Google's Gmail system and Microsoft's Office 365.
- Cloud Platform as a Service (PaaS): providing the customer with the capability to deploy applications on the cloud platform using programming languages and tools supported by the cloud provider, who has full control of the cloud infrastructure. Examples include Microsoft's Windows Azure and Google App engine.
- Cloud Infrastructure as a Service (IaaS): the customer has the ability to access processing, storage, networks and other fundamental computing resources and run arbitrary software such as operating systems and applications. But such computing resources controlled by the customer are typically for securing their own virtual machines and applications and data residing on them, the cloud provider still controls the underlying cloud infrastructure. Examples include Amazon EC2 and vCloud.

Meanwhile some major concerns of cloud computing are: security, privacy, availability and performance (Trend Micro 2010; Compuware Corporation 2010; Intel Corporation 2011). Security and privacy issues are very critical and typical for cloud computing since you have put your critical information/data in other people's properties and you have no good idea and have no effective control regarding what is going to happen to your data/information. Furthermore issues such as multi-tenancy (you are completely unaware of your neighbor's identity, security profile or intention), data access control and protection (the cloud provider could easily move

around your data for their purposes), data romance (there is no clear standard on how the cloud provider should recycle memory and disk space. So it is likely the next user of your ex-rented cloud computing resources could have your critical and confidential data), and data privacy issues (for example, data losses/leakage and breaches are top security concerns of cloud computing, especially for public cloud), further highlight the need for effective security management of information/data in the cloud.

Organizations need to put effective security management process and tools (e.g., encryption, control, and auditing) in place to protect the information in the cloud. Availability and performance issues are logical concerns when you are relying on other people's services. At the moment, even you host applications/systems in your organization, the availability is around 99 % since the networks are controlled by the telecoms who cannot guarantee 100 % availability, and while you put your applications/systems with the cloud service provider, the availability may become $99 \% \times 99 \% \times 99 \%$... since problems may come from each part of the cloud chain. One effective way to deal with such issues is to sign a service level agreement (SLA) with a cloud service provider. Another concern is the hidden costs in the cloud, and organizations need to pay close to attention to data transfer charges, which could increase dramatically once required cloud service and computing power grow to a certain level (Harvard Business Review 2010). Some other concerns include the need for adapting business processes to cloud applications, addressing the issues of integration and interoperability, establishing technology governance processes for cloud applications, and developing the required skills for managing cloud applications (Roberts and Sikes 2011).

2.6 The Internet of Things

The Internet of Things refer to objects embedded with sensors and actuators and linked with wired and wireless networks (Chui et al. 2010), and they can viewed as a part of the Big Data discussed previously in this chapter. They have the ability to sense the environment and deliver large volume of data through networks. According to Bisson et al. (2010), there are more than 35 billion Internet Things. And the number is growing very quickly. The Internet of Things could include cameras, sensors, routers, manufacturing equipment, traffic lights, rail cars, escalators, weather stations, vehicles, and others. Unlike end-user devices (e.g., desktop PCs, laptops, smart phones, tablets), connected devices are used for real-time monitoring, control, and integration (Sadauskas 2014).

The Internet of Things could assist organizations' efforts in various areas (Chui et al. 2010; EMC Corporation 2014b):

- Creating new business models and revenue streams: providing new value-added products and service to customers and addressing their heads in more efficient and innovative ways, identifying new business opportunities and revenue sources.

- Establishing better global visibility and therefore better global business: making it easier for enterprises to track effectiveness and efficiency of their global operations and supply chains and understanding their global customers.
- Tracking behavior: monitoring the behavior of persons, things, or data through space and time (e.g., targeted advertising based on the location of the users of smart phones; real-time information of movement of packages from the warehouse to end user).
- Having enhanced situational awareness and real-time information: realizing real-time and accurate information of physical environment (e.g., utilizing sensor networks that combine video, audio and vibration detectors to identify unauthorized individuals and crime suspects), and improving operational efficiency and enhancing customer loyalty by capturing and responding to real-time information.
- Supporting decision making via sensor-driven business analytics: supporting long-range and more complex planning and decision making (e.g., remote monitoring and controlling oil and gas operations; remote monitoring and controlling medical procedures).
- Optimizing resource consumption and management: monitoring and controlling resource consumption across network (e.g., managing consumption (and pricing) of water, electricity and energy via networked sensors and automatic feedback mechanism).
- Improving operations and processes: automation of processes by having much better information granularity (e.g., automation of chemical plants by utilizing sensors and actuators along the production lines), enabling organizations to capably make dynamic decisions on pricing, logistics, sales, and support deployment.
- Enhanced ability (especially in open environments with great uncertainty): rapid and real-time sensing and response systems (e.g., sensors in the two cars could detect and avoid potential collision between them).

The Internet of Things could contribute greatly to the economy. For example, the Internet of Things could contribute to Australia's GDP by US\$6.5 billion over 4 years (Sadauskas 2014). On a different note, while there are extremely large amounts of data being collected via The Internet of Things, it is reported that only one half of 1 % of the collected data gets analyzed in any way at all, and it is argued that knowing how to analyze and use the collected data (whether a small or large amount) to make better decision is the key skill required (Baker 2014).

2.7 Talent Management for Digital Enterprise

We are in the digital economy in which digitization is an essential part of the way we live, work and conduct the business. In line with the potential opportunities and the rapid development of digitization, many organizations have set up designated

positions for leading their digitization initiatives (even though their roles and responsibilities could vary based on the industry and the organization and even the location), such as Chief Digital Officer, Starbucks.; Digital Prophet, AOL; Head of Strategy & Programs for Digital Innovation, Philips; EVP, Digital Strategy & Emerging Business, Discovery Communications; VP, Digital Banking Strategy, Wells Fargo; EVP, Digital Media, BET Networks; VP, Digital Strategy, BAE Systems; VP, Digital Marketing & Media, GSN; Director, Digital Marketing & Communication, PBS; VP, Innovation, Deutsche Telekom; VP, Digital, Technology R & D, UFC; VP, Digital Strategy, Dell; CTO, Digital Operations, Education Week; VP, Audience Insights, TiVO; Director, Digital Strategy, Rodale Grow; Director, Online Strategy & Media, The Story Stuff Project; Global Head of Social Media, Bloomberg; among many others.

In association with the Big Data phenomenon, there is a shortage of people who have the required skills to deal with Big Data. For example, it is reported the U.S. alone faces a shortage of 140,000–190,000 people with deep analytical skills and 1.5 million data-savvy (being able to analyze Big Data and make decisions from Big Data) managers which are equivalent to 50–60 % gap in supply of required talent (Manyika et al. 2011, p. 3; Brown et al. 2011). It can be assumed in the future titles/positions such as “data strategist”, “data scientist”, “chief data officer”, “data expert”, “data specialist”, “data technology officer/expert/specialist”, “business intelligence specialist”, and similar titles, will become common terms for organizations. A more general term of “digital workforce” (Chui and Fleming 2011) has been suggested in recent years, and it includes people with different skills (from programming, computing modelling simulation, data analysis to analytical thinking and many others) for the current digital economy (also called knowledge economy). In addition, for knowledge workers (coined by Peter Drucker) such skills as organizing, accessing, processing, visualizing, understanding, analyzing and extracting the value from (large volume) information available in the organization are essential for doing their tasks effectively in the twenty first century (Manyika 2009). On a related note, according to a recent report by career website www.CareerCast.com (reported in Kensing 2014), a Mathematician is the best job of 2014 in the U.S. While mathematics is the important foundation for many disciplines, the phenomenon of Big Data has further enhanced its importance (at least to some extent). Meanwhile, the results of a 2014 McKinsey Global Survey of 850 C-level executives from various industries (reported in Josh and Willmott 2014) suggest that on top of the very much needed data and analytics talent, other digital expertise required by organizations include (in order): mobile or online development, project/program management, cloud and distributing computing, joint business and IT expertise, enterprise application architecture, cybersecurity, agile development, partner and vendor management, and data architecture.

Another critical dimension is recruiting, training and retaining good staff with digital expertise and skills. Agarwal et al. (2006) suggest that in order to retain good IS/IT staff, organizations need to work on such areas as: work environment, career development, community-building initiatives, money incentives and employment incentives. For many people, achievement (e.g., making bigger impact on more

people) is the most important motivator for them at work. The results of a recent survey by www.SmartCompany.com.au (reported in Ash 2014) prove this notion and indicate that the motivators for people at work include (in the order): achievement (70.8 % of the participants), money (64.7 %), creative output (41.2 %), great team (29.4 %), retirement (23.5 %), and status (11.8 %). One emerging trend is to hire and develop digital workforces, who have the skills to access, organize, understand, analyze, communication, and utilize the large volume of data for decision-making and for creation of new ideas (Chui and Fleming 2011; Manyika 2009). Having a digital talent management strategy in place is crucial for the success of the digital enterprise. One good example is comScore, a leading Internet analytics firm with a 1,200 global workforce possessing varying levels of skills and responsibilities of data analytics (reported in Wixom et al. 2013). comScore's strategy involves: investing significant time and resources in supporting and collaborating with universities (especially in the areas of business and IT where future talent can be sought), providing additional in-house data analytics training for new university hires, establishing groups across the company to foster a broad analytics savvy workforce, co-locating teams that need to communicate regularly, and adopting matrix organizational structures to bring together people with diverse skillsets. In addition to the traditional approach of recruiting university graduates, some organizations have taken a step further and started working on their digital talent pipeline from the school. For example, Deloitte now hires talent directly from schools and help students receive a university degree (reported in Goodwin 2014a). Organizations need to work on provide employees with multiple ways of acquiring skills (e.g., on the job training, company-wide formal training, observing others, attending own training outside of the work, information leaning such as reading articles and books, watching videos, and speaking with colleagues) and with different training strategies (e.g., mobile delivery of training, social media tools for training, massive open online courses (MOOCs), and gamification of training) (Accenture 2013).

Meanwhile, in line with the rapid development of computing technologies, the wide penetration of the Internet, and the large scale adoption of digitization by individuals, businesses, communities, governments, the demand for digital skills and talent will be no doubt increasing dramatically, and well as the need for more IS/IT skills and talent. The shortage of IS/IT skills and talent has not been commonly recognized, which could be a major hindering factor for future developments. The recent survey of 3,169 respondents from 105 countries by IDG Connect (2011) has highlighted this concern, and most of the participants of the survey indicated there is a lack of senior technical skills in the market. The survey also asked the respondents' opinions for IS/IT employment problems in their area. Some reasons identified from the survey include:

- Economy uncertainty: in bad times, hiring is always slow.
- Poor training: the results of the survey indicate IS/IT training issue is more of an issue for participants from developing countries in Asia, Middle East, Africa, and South America. In fact, many universities and colleges around the world

that used to offer information systems training programs downsized or even closed down their IS/IT faculties/departments after 2000.

- IS/IT talent brain-drain issues: the survey results indicate it is a major issue (more than 50 % participants believed) for Africans, South Americans and Asians. It has been an on-going issue for developing countries. Their best information systems talent prefer to go overseas for better pay and/or working conditions. But in recent years, to some extent, it has changed. For example, many information systems talents in China now would stay in China as a result of rapidly rising pay and many more opportunities in China.
- The challenge of updating skills constantly as a result of a very changing information systems industry: this issue is really making people in Asia think twice when they are planning to embark on IS/IT careers. In addition, the need for soft skills (e.g., interpersonal and communication skills, project management skills, language skills) was also pointed out by some respondents. This is so true. In addition, the challenge of updating skills constantly coupled with factors such as poor IS/IT training and IS/IT brain drain could lead to the identified shortage of senior technical skills.
- Generation Y work ethics: the majority of respondents across all regions agree that Generation Y IS/IT professionals (at the entry level) have different work ethics to older generations.

Another concern associated with IS/IT skills and talent management is the lack of soft skills among IS/IT people who highly (if not overly) enjoy their technical skills. But IS/IT people don't work alone in the organization, and they are there to work with the business side of the organization and are an integral part of the organization. Organizations should equip IS/IT people with such skills as effective working habits, better emotional intelligence and enhanced skills of persuading and influencing people to make them more communication-minded. In addition to the organization's capabilities of managing the required digital talents, the country differences also play an important role in attracting and retaining talents. Generally speaking, high-income countries are doing better than low-income countries. For example, according to INSEAD Global Talent Competitive Index (reported in Evans et al. 2013), the top 20 most talent competitive countries are (in order): Switzerland, Singapore, Denmark, Sweden, Luxembourg, Netherlands, United Kingdom, Finland, United States, Iceland, Canada, Norway, Belgium, Australia, Germany, New Zealand, Ireland, United Arabs Emirates, and France. Meanwhile according to a recent survey of talent challenges in emerging markets by Sylvia Ann Hewlett Associates and Booz and Company (reported in Divakaran et al. 2012), the lack of skilled employees along with rapidly rising salary expectations are constraining firms' ability to operate and expand in emerging markets (especially in BRIC countries of Brazil, Russia, India, and China). In responding to such challenges, Booz and Company (reported in Divakaran et al. 2012) provides some good suggestions:

- Being innovative in talent sourcing (e.g., building talent pipeline through university partnerships; partnering with outsourcing service providers; tapping non-traditional talent sources (such as crowdsourcing)).
- Cultivating a GLOCAL (global plus local) culture (e.g., investing in strong global brand; tailoring the employee value proposition for the local culture; and embracing local norms, behaviors, mind-sets, and commitments).
- Investing in global talent competencies (e.g., adopting a global career model, recruiting people who have the experience and willingness to work globally; implementing global training and development; developing a global knowledge management system).

Meanwhile in recent years, some firms have adopted the strategy of “acqui-hiring” (i.e., acquiring a firm mainly for its talents and skills rather than their products) (Brown et al. 2013).

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