Chapter 1
The Big Data Value Opportunity

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1.1 Introduction

The volume of data is growing exponentially, and it is expected that by 2020 there will be more than 16 zettabytes (16 Trillion GB) of useful data (Turner et al. 2014). We are on the verge of an era where every device is online, where sensors are ubiquitous in our world generating continuous streams of data, where the sheer volume of data offered and consumed on the Internet will increase by orders of magnitude, where the Internet of Things will produce a digital fingerprint of our world.

Big data is the emerging field where innovative technology offers new ways of extracting value from the tsunami of new information. The ability to effectively manage information and extract knowledge is now seen as a key competitive advantage. Many organizations are building their core business on their ability to collect and analyse information to extract business knowledge and insight. Big data technology adoption within industrial sectors is not a luxury but an imperative need for most organizations to survive and gain competitive advantage.

This chapter explores the value potential of big data with a particular focus on the European context and identifies the positive transformational potential of big

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data within a number of key sectors. It discusses the need for a clear strategy to increase the competitiveness of European industries in order to drive innovation and competitiveness. Finally the chapter describes the key dimensions, including skills, legal, business, and social, that need to be addressed in a European Big Data Ecosystem.

1.2 Harnessing Big Data

The impacts of big data go beyond the commercial world; within the scientific community, the explosion of available data is producing what is called Data Science (Hey et al. 2009), a new data-intensive approach to scientific discovery. The capability of telescopes or particle accelerators to generate several petabytes of data per day is producing different problems in terms of storage and processing. Scientists do not have off-the-shelf solutions ready to analyse and properly compare disperse and huge datasets. Enabling this vision will require innovative big data technologies for data management, processing, analytics, discovery, and usage (Hey et al. 2009).

Data has become a new factor of production, in the same way as hard assets and human capital. Having the right technological basis and organizational structure to exploit data is essential. Europe must exploit the potential of big data to create value for society, citizens, and businesses. However, from an industry adoption point of view, Europe is lagging behind the USA in big data technologies and is not taking advantage of the potential benefits of big data across its industrial sectors. A clear strategy is needed to increase the competitiveness of European industries through big data. While US-based companies are widely recognized for their works in big data, very few European organizations are known for their works in the field. This currently makes Europe dependent on technologies coming from outside and may prevent European stakeholders from taking full advantage of big data technology. Being competitive in big data technologies and solutions will give Europe a new source of competitiveness and the potential to foster a new data-related industry that will generate new jobs.

Addressing the current problems requires a holistic approach, where technical activities work jointly with business, policy, and society aspects. Europe needs to define actions that support faster deployment and adoption of the technology in real cases. Support is needed not only to “build” the technology but also to “grow” the ecosystem that makes innovation possible. There are many technical challenges that will require further research, but this work has to be accompanied by a continuous understanding of how big data technologies support both business and societal challenges. How can data-driven innovation be integrated into an organization’s processes, cultural values, and business strategy? Europe has a track record in joint research efforts, as well as strength in converging policies or eliminating adoption barriers. There is an opportunity to build upon these and other European

strengths in order to enable a vision where big data contributes to making Europe the most competitive economy in the world in 2020.

1.3 A Vision for Big Data in 2020

The Information and Communications Technology (ICT) sector is directly responsible for 5 % of European GDP, with a market value of 660 billion euros annually; it also contributes significantly to overall productivity growth (20 % directly from the ICT sector and 30 % from ICT investments). Big data solutions can contribute to increase European competitiveness by delivering value adding tools, applications, and services. One estimate for 2020 puts the potential of big and open data to improve the European GDP by 1.9 %, an equivalent of one full year of economic growth in the EU (Buchholtz et al. 2014). International Data Corporation (IDC) forecasts that the big data technology and services market will grow at a 27 % compound annual growth rate (CAGR) to $32.4 billion through 2017 (Vesset et al. 2013).

The European Commission launched in March 2010 the Europe 2020 Strategy (European Commission 2010) to exit the crisis and prepare the EU economy for the next challenges in terms of productivity, economy, and social cohesion. The Digital Agenda for Europe is one of the seven flagship initiatives of the Europe 2020 Strategy; it defines the key enabling role that the use of ICT will have to play if Europe wants to succeed in its ambitions for 2020. The paramount importance of big data was recognized by including a specific topic in the Digital Agenda to get maximum benefit from existing data and specifically the need to open up public data resources for re-use. As then EU Commissioner Kroes stated, "Big Data is the new Oil" that can be managed, manipulated, and used like never before thanks to high-performance digital tools, making big data the fuel for innovation.

1.3.1 Transformation of Industry Sectors

The potential for big data is expected to impact all sectors, from healthcare to media, from energy to retail (Manyika et al. 2011). The positive transformational potential has already been identified in a number of key sectors.

- **Healthcare:** In the early twenty-first century, Europe is an ageing society that places significant demands on its healthcare infrastructure. There is an urgent need for improvement in efficiency of the current healthcare system to make it more sustainable. The application of big data has significant potential in the sector with estimated savings in expenditure at 90 billion euros from national healthcare budgets in the EU (Manyika et al. 2011). Clinical applications of big data range from comparative effectiveness research where the clinical and financial effectiveness of interventions is compared to the next generation of

clinical decision support systems that make use of comprehensive heterogeneous health datasets as well as advanced analytics of clinical operations. Healthcare R&D applications include predictive modelling, statistical tools, and algorithms to improve clinical trial design, personalized medicine, and analysing disease patterns.

- **Public Sector:** Europe's public sector accounts for almost half of GDP and can benefit significantly from big data to gain efficiency in administrative processes. Big data could reduce the costs of administrative activities by 15–20 %, creating the equivalent of 150 billion euros to 300 billion euros in new value (OECD 2013). Potential benefits in the public sector include improved transparency via open government and open data, improved public procurement, enhanced allocation of funding into programmes, higher quality services, increased public sector accountability, and a better-informed citizen. Crucial to the future is the definition of policies to share data across government agencies and to inform citizens about the trade-offs between the privacy and security risks of sharing data and the benefits they can gain. Big data will also change the relationship between citizens and government by empowering citizens to understand political and social issues in new transparent ways, enabling them to engage with local, regional, national, and global issues through participation.
- **Finance and Insurance:** There are a number of ways for financial service companies to achieve business advantages by mining and analysing data. These include enhanced retail customer service, detection of fraud, and improvement of operational efficiencies. Big data can be used to identify exposure in real time across a range of sophisticated financial instruments like derivatives. Predictive analysis of both internal and external data results in better, proactive management of a wide range of issues from credit and operational risk (e.g. fraud and reputational risk) to customer loyalty and profitability. A challenge for the financial sector is how to use the breadth and depth of data available to satisfy more demanding regulators while also providing personalized services for their customers.
- **Telecom, Media, and Entertainment:** Big data analysis and visualization techniques can enable the effective discovery and delivery of media content enabling users to dynamically interact with new media and content across multiple platforms. The domain of personal location data offers the potential for new value creation with applications, including location-based content delivery for individuals, smart personalized content routing, automotive telematics, mobile location-based services, and geo-targeted advertising.
- **Retail:** Significant opportunities for using big data technologies reside in the interactions between retailers and consumers. Data is playing an increasing role as consumers search, research, compare, buy, and obtain support online and the products sold by retailers increasingly generate their own data footprints. Big data can increase productivity and efficiency resulting in a potential 60 % increase in retailers' operating margins (Manyika et al. 2011). Big data can impact retail in areas such as marketing: cross-selling, location-based marketing, in-store behaviour analysis, customer micro-segmentation, customer sentiment

analysis, enhancement of multi-channel consumer experience; merchandizing: assortment optimization, pricing optimization, placement and design optimization; operations: performance transparency, labour inputs optimization; supply chain: inventory management, distribution and logistics optimization, informing supplier negotiations; new business models: price comparison services, web-based markets.

- **Manufacturing:** The manufacturing sector was an early adopter of IT to design, build, and distribute products. The next-generation of smart factories with intelligent and networked machinery (i.e. Internet of Things, Industry 4.0) will see further efficiency improvement in design, production, and product quality. Big data will enable fulfilment of customer needs through precisely targeted products and effective distribution. In addition to efficiency gains and predictive maintenance, big data will enable entirely new business models in the area of mass production of individualized products.
- **Energy and Transport:** Big data will open up new opportunities for innovative ways to monitor and control transportation and logistics networks using a variety of data sources and the Internet of Things. The potential for big data in the transport sector is estimated at USD 500 billion worldwide in the form of time and fuel savings, with the avoidance of 380 megatonnes of CO_2 emissions (OECD 2013). The digitization of energy systems enables the acquisition of real-time, high-resolution data via smart metres that can be leveraged within advanced analytics to improve the levels of efficiency within both the demand and supply sides of energy networks. Smart buildings and smart cities will be key drivers of enhanced efficiency in the energy sectors. Big data technology in the utilities sectors has the potential to reduce CO_2 emissions by more than 2 gigatonnes, equivalent to 79 billion euros (OECD 2013).

A successful data ecosystem would "bring together data owners, data analytics companies, skilled data professionals, cloud service providers, companies from the user industries, venture capitalists, entrepreneurs, research institutes and universities" (DG Connect 2013). A successful data ecosystem, which is a prominent feature of the data-driven economy, would see these stakeholders interact seamlessly within a Digital Single Market, leading to business opportunities, easier access to knowledge, and capital (European Commission 2014). "The Commission can contribute to this by bringing the relevant players together and by steering the available financial resources that facilitate collaboration among the various stakeholders in the European data economy" (DG Connect 2013).

Big data offers tremendous untapped potential value for many sectors; however, there is no coherent data ecosystem in Europe. As Commissioner Kroes explained, "The fragmentation concerns sectors, languages, as well as differences in laws and policy practices between EU countries" (European Commission 2013; Kroes 2013). During the ICT 2013 Conference, Commissioner Kroes called for a European public–private partnership on big data to create a coherent European data ecosystem that stimulates research and innovation around data, as well as the uptake of cross-sector, cross-lingual, and cross-border data services and products. She also

noted the need for ensuring privacy "Mastering big data means mastering privacy too" (Kroes 2013). In order for this to occur, an interdisciplinary approach is required to create an optimal business environment for big data that will accelerate adoption within Europe.

1.4 A Big Data Innovation Ecosystem

In order to drive innovation and competitiveness, Europe needs to foster the development and wide adoption of big data technologies, value adding use cases, and sustainable business models. While no coherent data ecosystem exists at the European level (DG Connect 2013), the benefits of sharing and linking data across domains and industry are becoming obvious. An ecosystem approach allows organizations to create new value that no single organization could achieve by itself (Adner 2006). A European Big Data Ecosystem is an important factor for commercialization and commoditization of big data services, products, and platforms. Within a healthy business ecosystem, companies can work together in a complex business web where they can easily exchange and share vital resources (Kim et al. 2010). If a Big Data Ecosystem is to emerge in Europe, it is important that the different actors within the ecosystem "define a shared vision and jointly identify gaps in the current data landscape" (DG Connect 2013). A successful big data ecosystem would see all "stakeholders interact seamlessly within a Digital Single Market, leading to business opportunities, easier access to knowledge, and capital" (European Commission 2014).

1.4.1 The Dimensions of European Big Data Ecosystem

An efficient use and understanding of big data as an economic asset carries great potential for the EU economy and society. The challenges for establishing a Big Data Ecosystem in Europe have been defined into a set of key dimensions (Cavanillas et al. 2014) as illustrated in Fig. 1.1. Europe must address these multiple challenges (Cavanillas et al. 2014) to foster the development of a big data ecosystem.

- **Data:** Availability and access to data will be the foundation of any data-centric ecosystem. A healthy data ecosystem will consist of a wide spectrum of different data types: structured, unstructured, multi-lingual, machine and sensor generated, static, and real-time data. The data in the ecosystem should come from different sectors, including healthcare, energy, retail, and from both public and private sources. Value may be generated in many ways, by acquiring data, combining data from different sources and across sectors, providing low latency

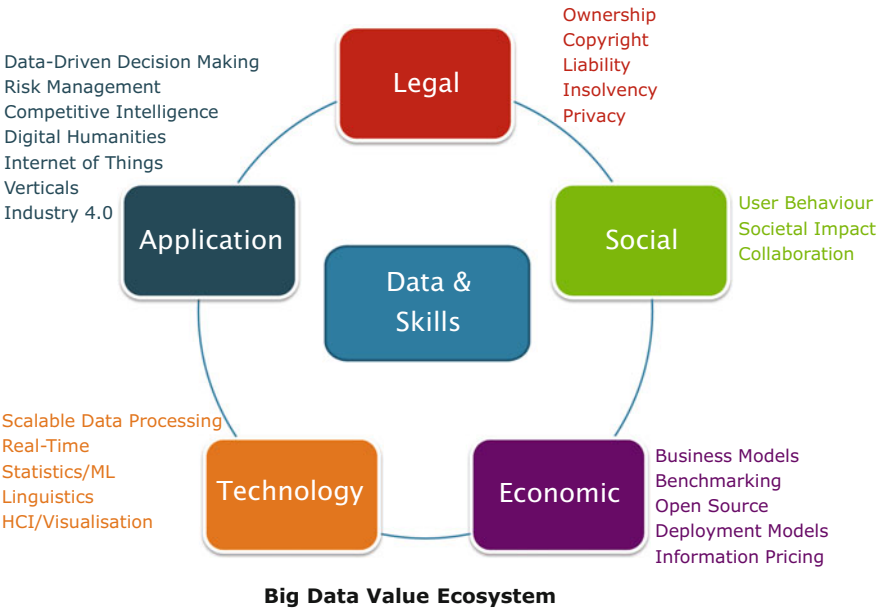

Fig. 1.1 The dimensions of a Big Data Value Ecosystem [adapted from Cavanillas et al. (2014)]

access, improving data quality, ensuring data integrity, enriching data, extracting insights, and preserving privacy.

- **Skills:** A critical challenge for Europe will be ensuring the availability of skilled workers in the data ecosystem. An active ecosystem will require data scientists and engineers who have expertise in analytics, statistics, machine learning, data mining, and data management. Technical experts will need to be combined with data savvy business experts with strong domain knowledge and the ability to apply their data know-how within organizations for value creation.
- **Legal:** Appropriate regulatory environments are needed to facilitate the development of a pan-European big data marketplace. Legal clarity is needed on issues such as data ownership, usage, protection, privacy, security, liability, cybercrime, intellectual property rights, and the implications of insolvencies and bankruptcy.
- **Technical:** Key technical challenges need to be overcome including large-scale and heterogeneous data acquisition, efficient data storage, massive real-time data processing and data analysis, data curation, advanced data retrieval and visualization, intuitive user interfaces, interoperability and linking data, information, and content. All of these topics need to be advanced to sustain or develop competitive advantages.
- **Application:** Big data has the potential to transform many sectors and domains including the health, public sector, finance, energy, and transport sectors.

Innovative value-driven applications and solutions must be developed, validated, and delivered in the big data ecosystems if Europe is to become the world leader.

- **Business:** A big data ecosystem can support the transformation of existing business sectors and the development of new start-ups with innovative business models to stimulate growth in employment and economic activity.
- **Social:** It is critical to increase awareness of the benefits that big data can deliver for business, the public sector, and the citizen. Big data will provide solutions for major societal challenges in Europe, such as improved efficiency in healthcare, increased liveability of cities, enhanced transparency in government, and improved sustainability.

1.5 Summary

Big data is one of the key economic assets of the future. Mastering the potential of big data technologies and understanding their potential to transform industrial sectors will enhance the competitiveness of European companies and result in economic growth and jobs. Europe needs a clear strategy to increase the competitiveness of European industries in order to drive innovation. Europe needs to foster the development and wide adoption of big data technologies, value adding use cases, and sustainable business models through a Big Data Ecosystem. Strategic investments are needed by both the public and private sector to enable Europe to be the leader in the global data-driven digital economy and to reap the benefits it offers with the creation of a European Big Data Ecosystem.

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