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THE IMPACT OF DATAFICATION ON STRATEGIC LANDSCAPES
INDUSTRY TRANSFORMATION

# THE IMPACT OF DATAFICATION ON STRATEGIC LANDSCAPES

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## PREFACE

This series of reports on Industry Transformation provides insights into how the strategies of market players in various industries are being impacted by the macrotrends of digitisation and datafication. The methods consist of a blend of quantitative and qualitative analysis including:

- A series of in-depth interviews with a broad range of business people within traditional industries in order to understand the shifting boundaries as a result of datafication
- The integrated industry analysis models of Imperial College Business School to forecast trends and gauge the digital capabilities of various industries.
- Information-Driven Global Value Chain analysis that provides a framework for understanding how data will contribute to re-defining industries
- Macroeconomic methods

Ericsson conducted this report series in collaboration with Imperial College Business School and the RCUK Digital Economy Sustainable Society Network+. It consists of multiple parts examining the general impacts of datafication on strategic landscapes as well as an in-depth analysis of several industrial structures, covering various market sectors including utilities, retail, food and agriculture, digital money, media and broadcasting, transportation, and governance, among other ongoing studies.

Imperial College London

Sustainable Society Network

Special thanks to Dr. C.E.A. Mulligan from Imperial College, London without whose insights, authorship and research leadership this report series would not have been possible. In addition, the contributions of Drs. Zeyenp Gurguc and Giaime Berti were invaluable to the development of the concepts and ideas contained in these reports.

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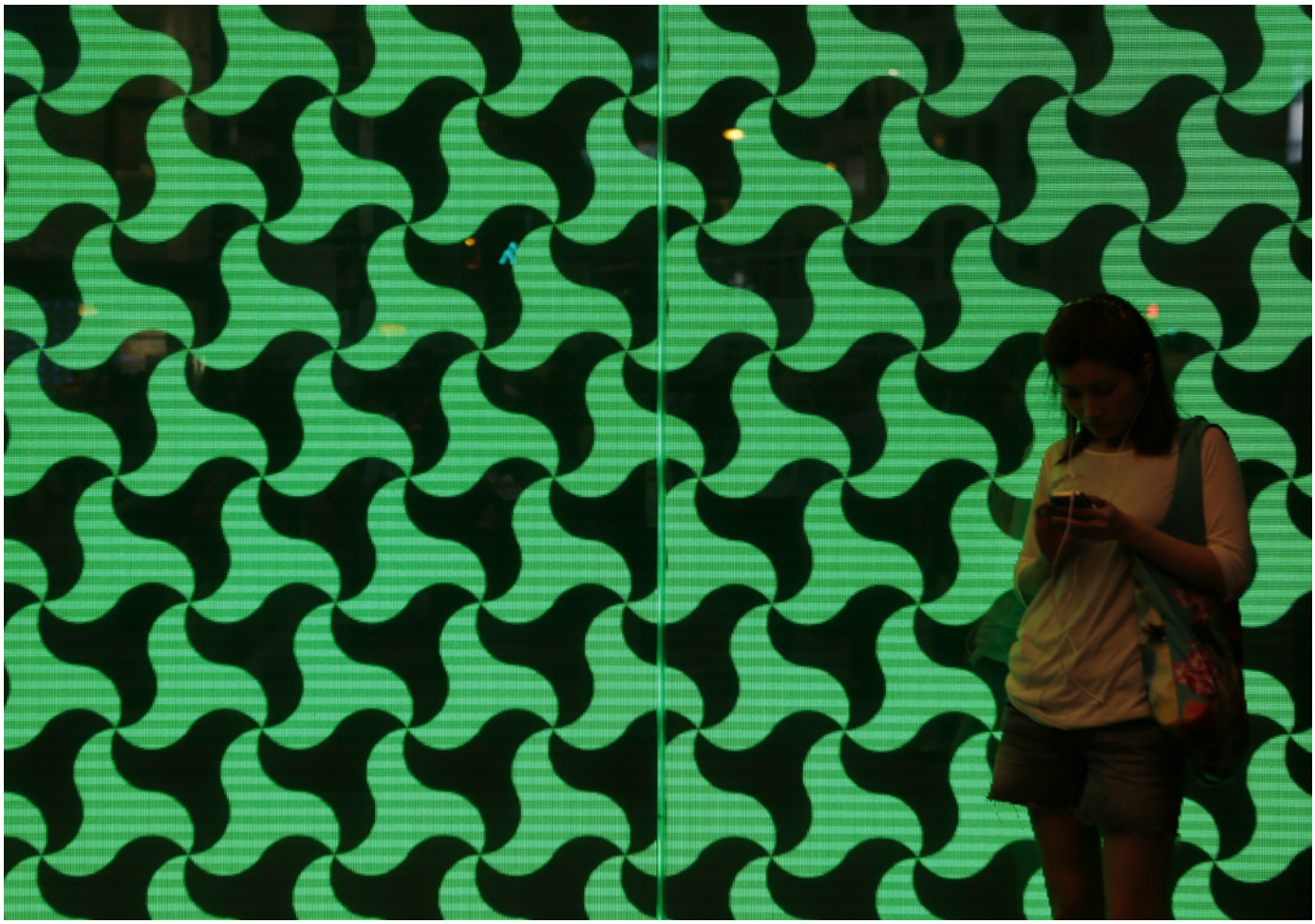


# INTRODUCTION

Since the 1960's, digital technology has been redefining how companies and humans co-ordinate business activities and with one another. In a process of dramatic digitalisation communication networks, data centres and computing capacity were installed and now span nearly every part of our globe, instantly connecting people and companies with one another and the information they need to make their daily decisions. From large-scale financial transactions to where to buy a decent cup of coffee in an unfamiliar location, satellites, copper, fibre, routers, switches and radio waves all combine together dedicated to our common human need to communicate news, our ideas, our hopes and business plans with others.

This is not the end of the story, however, as a new process of datafication[1] is emerging across the world. In contrast to digitalisation, which enabled productivity improvements and efficiency gains on already existing processes, datafication promises to completely redefine nearly every aspect of our existence as humans on this planet. Significantly beyond digitalisation, this trend challenges the very foundations of our established methods of measurement and provides the opportunity to recreate societal frameworks, many of which have dictated human existence for over 250 years.

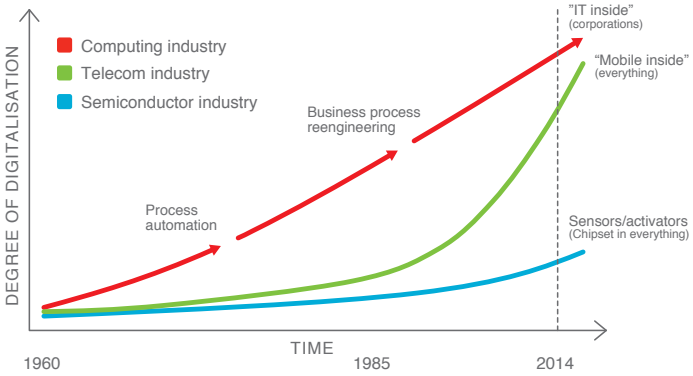
**Datafication creates a fundamentally new strategic landscape. Any company, large or small, any NGO, in fact any organisation active in society now needs to fully explore the new value creation space instigated by datafication.**

[1] Lycett, 2013

# 1.1 DIGITALISATION VS DATAFICATION

Much analysis investigates the role of digital technologies from the perspective of digitalisation. In this report, however, we investigate the emergence of a new phenomenon – datafication, which is set to have a dramatic impact on the economy and broader society. It is useful, therefore to begin with a definition of the differences between these two concepts.

Figure 1: – Evolution of digitalisation and datafication

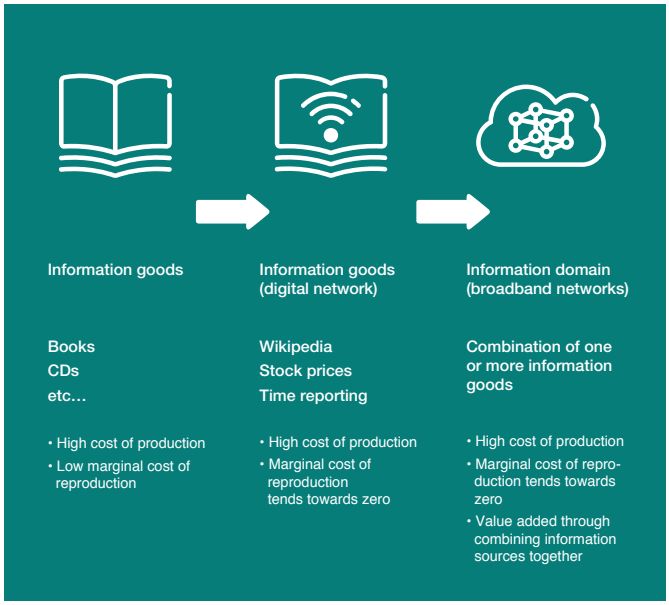



DIGITALISATION + DATAFICATION = Disruption of economy, society, everything

Digitalisation is a process that has been active within society since the late 1950s, with the birth of the semiconductor industry. It refers to the conversion of pieces of information into digital formats, for example text into HTML pages, music into MP3s, images into JPEG or similar. As the process of digitalisation has progressed, the amount of data that could be processed has increased exponentially. Digitalisation, therefore, from a simplistic perspective may be viewed as the embodiment of idea creation – it is capturing human ideas in digital form for transmission, re-use and manipulation, as illustrated in Figure 2.

Digitalisation has been primarily about productivity improvements in corporations, allowing for the creation of economies of scale that span the globe. Through implementing IT in payroll, finance, human resources and other core business processes of a corporation, these solutions were able to streamline the processes of doing business, link together disparate data sets for

Figure 2: Evolution of digitalisation as a result of increasing bandwidth and cloud computing




deeper insights and use digital technology platforms in order to create a 24-hour information-technology driven business. The evolution of this process is illustrated in Appendix A - Evolution of digitalisation and impact on R&D processes.

## 1.1 DIGITALISATION VS DATAFICATION

Datafication, meanwhile, relates to the use of digital technologies to unembed the knowledge associated with physical objects by decoupling them from the data associated with them. Datafication is manifesting itself in society in a variety of forms and is often – but not always – associated with sensors/actuators and the emerging Internet of Things (IoT). Datafication may take many forms and in many cases a mobile device is enough to create unembedded knowledge of a person, a thing or a piece of infrastructure. There are many examples, from putting sensors on a bridge to monitor structural integrity, monitoring parking spaces, performing a 3D scan of an object to print it out later, to measuring the activity levels of a person for health, etc… The evolution to unembedded knowledge is covered in Appendix B - Evolution of Embedded and Unembedded Knowledge.

Datafication is a relatively new phenomenon compared to digitalisation and is characterised by an interaction between digital and physical objects and mass customisation of products and services for – and by – end-users rather than merely process automation or efficiency improvements, although datafication techniques can of course be used for this as well. The manner in which process improvements will be implemented is fundamentally different for datafication, however, and it implies a different strategic landscape, as well as the necessity for new managerial capacities in order to handle these issues effectively.

A key differentiating aspect between digitalisation and datafication will be the manner in which data analytics is applied to the problem spaces that they cover. Digitalisation will use data analytics based on traditional sampling mechanisms, while datafication will over time come to rely on the new forms of quantification and associated data mining techniques.

Table 1: Characteristics of Digitalisation and Datafication

| DIGITALISATION | DATAFICATION |
|---|---|
| Platform economics | Unfinished products and platforms. |
| Process automation, corporate control over value chain | Mass customisation, end-user control over value chain. |
| Complementary products (3rd party apps) | Maker culture and augmented manufacturing. |
| Digital only | Digital and interaction with physical world. |
| Data analytics based on sampling | Data analytics based on quantification. |

Digital technologies are recognised as creating disruption of established industries, etc… but we are currently in the throes of something much more profound – datafication does not change just how we do business with one another, or how we manage our companies, lives and cities – it begins to challenge some of the fundamental mechanisms upon which society has always depended upon – from the basis of the techniques used in the scientific method to how the economy is measured and structured. In the following sections, we investigate a few of these changes.

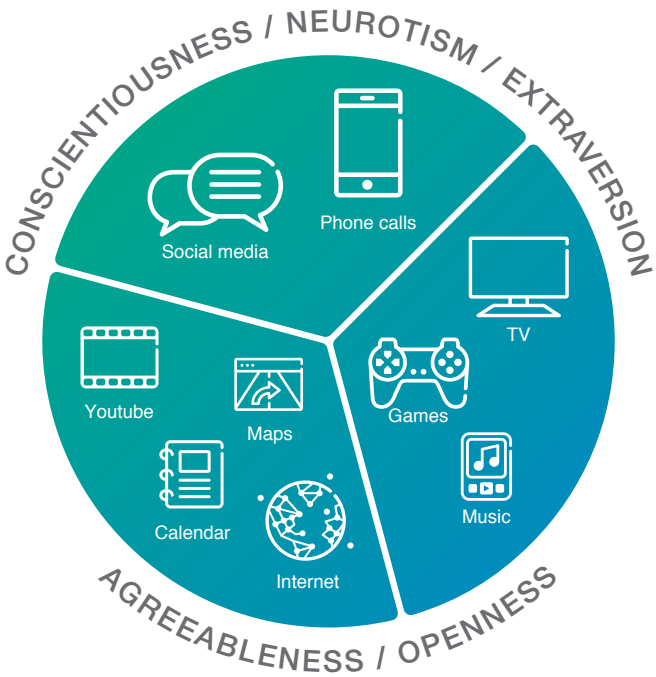
# 2. DATAFYING PERSONALITY

As stated, datafication does not have to rely on sensors or actuators – it represents changes at work in markets rather than solely within the technology domain. For example, as mobile devices have evolved to hold our preferred music selections, our social networks, our video and TV choices and the third party games and applications we select to augment the base software with, it opens up the mobile to a range of new possibilities. A mobile device is sold as a 'platform' to end-users – it is in some sense ready to be "finished" by the end-user who purchases it with apps and other personalisation of the software. The nature of the mobile device nearly everyone has in their pocket is therefore deeply personal and the records of their usage of the device divulge deep details about who they really are.

Let's take the example of personality, which most people will agree cannot be "digitalised". Within psychology, there are five broad factors that form the most widely accepted and used model of personality. The five factors are: openness, conscientiousness, extraversion, agreeableness, and neuroticism. Traditionally, personality is measured by interviews and self-assessment questionnaires through sampling techniques. Using nothing more than standard mobile network CDRs, however, it is possible to reliably predict personality[2]. The ability to accurately predict personality types using mobile phone data holds the potential for "cost-effective, questionnaire-free investigation of personality-related questions at a scale never seen before" (De Montjoye et al, 2013).

A mobile device, however, allows us to take datafication significantly further than just understanding the user's personality. The manner in which an end-user chooses to use the games they have installed can also provide detailed indications of trustworthiness, credit ratings, risk profile and many other aspects of a human being's interactions with companies can be "datafied" through analysing mobile phone logs.

**Figure 3 – Datafication of personality**




[2] Predicting people personality using novel mobile phone-based metrics

# 2.1 IMPACT OF DATAFICATION OF PERSONALITY ON INDUSTRIES

Datafication of personality has the potential to disrupt several industries and also the manner in which social science research itself is conducted. Usage of games such as Angry Birds (what is a person's willingness to take risk?) and Bejeweled Blitz can give away a lot about a person's approach to risk and financial management. This may affect, for example, how insurance companies develop the risk profile of end-users. In addition, traditional mobile billing records provide extremely detailed information about how likely it is that an end-user is going to repay a loan on time. Such data is already being used in several nations in order to help the unbanked access financial services but is also an indication of the possible disruption to the manner in which credit ratings are developed and maintained globally.

Human Resources, meanwhile, can start to have a more detailed understanding of their employees – for example would companies like an early warning mechanism that allowed them to identify managers displaying risk for fraudulent behavior through the use of their mobile devices? The recruitment process itself, meanwhile, may be fundamentally disrupted. Instead of relying on the traditional personality measurements and the associated intermediaries, new personality measures will be developed and new digitally enabled intermediaries will emerge to handle the required analytics to replace existing personality and aptitude exam providers.

Social science research itself will also be disrupted. The traditional methods of sampling in order to develop personality and associated social aspects is challenged through datafication – instead of using traditional sampling methods, it may instead be more powerful to analyse the data for emerging patterns.

Table 2: Impact of datafication of personality on industries

| INDUSTRY / AREA | IMPACT OF DATAFICATION ON PERSONALITY |
|---|---|
| Insurance | Data used to update risk profile development and business models. |
| Banking | Data used to establish trustworthiness and likelihood of a person paying back a loan. |
| Human resources | Data used to identify e.g. employees risk-taking profiles. |
| Hiring and recruitment | Data used to replace personality tests. |
| Social science research | Datafication replaces sampling techniques and restructures the manner in which social science research is performed. |
| Media and broadcast | Data is used to redefine how content is created by datafication being used to inform content rather than recommendation systems. |

# 2.1.1 DATAFICATION OF PERSONAL BEHAVIOUR – THE CASE OF NETFLIX

While the datafication of personalities will create large-scale changes on the manner in which various industries are run and measured, the datafication of personal behaviour may create the possibility for disruption of well-established industries. An example is Netflix – which applied a detailed statistical analysis of many years worth of viewing data and user behavior in order to change its role in the television industry – from a content delivery mechanism to a content creator.

Traditionally, recommendation engines have been used to identify what other types of content an end-user might like to hire or purchase based on similar user profiles and advanced personality analysis. Based on your social influences from social networks, the make-up of your household and your income levels, content would be suggested to you.

Netflix instead turned this model on its head and instead of using the recommendations for making content suggestions, used it to define an intersection of genre, actors and directors (Lycett, 2013), which it developed into its own content – the now well-known House of Cards, which has received Emmy and Golden Globe nominations.

This is indicative of an emerging challenge to the established industrial structure of the television industry, which has traditionally relied on bundling – where customers bought access via a cable TV provider to a variety of channels. Essentially, in order to access the content they wanted, users had to purchase a whole set of channels that they did not want. Advertisers, meanwhile, had to buy access to a large set of customers in order to reach the ones they really did want to advertise to.

Through datafication, Netflix has shaken up this business model to some extent – using its proximity to customers to challenge the traditional bundling model of media and broadcast. Rather than user-generated content, it is content tailored specifically for its user base based on their aggregated personal selections.

# 3. DATAFYING BUSINESS PROCESSES

One of the most obvious examples of datafication occurs in business process improvement, where different types of datafication are used to streamline and improve existing business processes. For example, datafication can be used to reconfigure existing supply chains and restructure financial services flows within companies. As will be discussed later, a more disruptive result can be seen in the creation of new forms of supply chain emerge based on data and information.

The lowering costs of sensors, increased processing capacity and availability of low-cost bandwidth mean that datafication is starting to enter into business processes that have until recently been un-monitored – this process is forcing a reconstruction of existing supply chain processes and in some cases even helping to create different forms of supply chain.

Financial services, for example, is starting to be changed by the use of micropayments, which are payments that cover small, incidental costs for example the purchase of a coffee or chocolate bar at a train station or as an individual moves through town for different meetings.

These small scale purchases were previously 'unknown' within most business processes – the purchase of goods was mainly understood via large scale purchases. The purchasing patterns of individuals, meanwhile, were limited to mainly larger purchases via credit cards. A more detailed understanding of how and when individuals are making small purchases can have a large impact on e.g. supply chains, however. For example, a fast moving consumer goods (FMCG) corporation can make dynamic adjustments to their production processes based on the real-time purchases of their products. Aggregating large amounts of these micropayments can be used to gain in-depth understanding of how money actually flows around the economy in small amounts. This will provide much more in-depth analysis of where money is being spent, by whom and how – allowing for the restructuring of commercial real estate management by providing more in-depth knowledge and understanding of when and where different types of enterprises might want to locate their stores to gain access to the correct type of clientele for their products.

# 3.1 IMPACT OF DATAFICATION OF BUSINESS PROCESS ON INDUSTRIES

Table 3: Impact of datafication of business processes on industries

| INDUSTRY / AREA | IMPACT OF DATAFICATION OF BUSINESS PROCESSES |
|---|---|
| Micro and 'short' supply chains | Datafication eases the creation of short supply chains, creating micro supply chain business processes encapsulated via low cost technologies such as mobile devices. |
| Agriculture and food | Increased traceablility and removal of intermediaries in the industrial supply chain. |
| Manufacturing | Feedback from products 'in use', rather than sampled provides improved product development practices, shared data across multiple manufacturers allows increased efficiencies across supply chains. |
| Commercial real estate management | Redefining how different parts of a city are classified for industrial use. Increased levels of detail for real estate customers to understand where to locate their businesses for best impact and foot flow. |

# 3.1.1. DATAFICATION OF BUSINESS PROCESSES – THE CASE OF MICRO SUPPLY CHAINS

Applying low costs sensors and mobile devices in new ways is allowing people to reduce the transaction costs of creating agile, micro supply chains in a digital economy. These supply chains connect people together in something that is similar to a traditional business process in a corporation but without the traditional overheads of supply chain interactions. Relatively cheap technology means that datafication is able to help small companies and individuals create these micro supply chains for a dramatically cheaper price than existing systems from large-scale ICT suppliers.

Individuals with goods and services to offer are able to develop multiple streams of business through interacting with such micro supply chains, offering their wares to assist in different processes as and when required. More importantly, it is possible to use such a micro supply chain to smooth supply so that customers can be guaranteed to receive goods when they need it.

# 4. DATAFYING CITIES

Much has been written about the role that new forms of technology can play in a city – both from a top-down and a bottom-up, citizen-led perspective. ICT will be used in a multitude of different manners that will allow the creation of new data streams in a city space, assisting with issues such as transport, energy and water management at a city level, urban planning, etc… A very simple example of datafication in the city context is the use of twitter by end-users when there are problems with public transport or traffic jams on roads – this datafication of customer sentiment can be useful in identifying when problems have occurred and to interact with customers to move towards other forms of public transport or to provide updates on the service. Customers are also able to take greater control over their transport choices - for example, by subscribing to information about their usual routes, an end-user may be able to know in advance that there is no point in going to the train station, but may instead take a bus or an alternative train line route. Datafication within a city context therefore enables a range of disruptive solutions for cities and citizens alike.

Datafication of cities will impact industries such as transport and logistics in dramatic ways – for example the datafication starting to become the norm in cars means that logistics companies are now able to make deliveries to your car (ref), rather than to your fixed address, streamlining the manner in which logistics services operate in cities. Individuals and the physical services that they interact with on a daily basis will therefore become unbundled as a result of datafication – this will reform the manner in which our physical infrastructure in cities needs to be built – the division of space in our urban areas could become dramatically different as a result of datafication.

As cities increasingly need to compete on a global, rather than national, level the quality of life and environment that they are able to provide citizens is increasing in importance.  An emerging area within cities, therefore, is the datafication of environmental factors. For example, many cities have and are investing in environmental monitoring equipment for various natural resources, for example measuring water or air quality. This will have a disruptive impact on industries through the manner in which environmental regulation is created and implemented. Today, environmental regulation is handled by setting standards that are based on data collection, sampling and estimates of damage developed over several decades. These are then combined with catastrophe planning and estimates of damage to natural environments based on rough models of environmental ecosystems. Through applying datafication, cities and regions could understand in greater detail the impact of pollution and other industrial activity on the natural resources in question. Regulation could be based on more detailed knowledge and understanding of the damage of the activity in question and real-time measurements could change not just the manner in which industries pollute, but the manner in which nations decide to regulate that activity – regulation may be implemented in real-time.

# 4.1 IMPACT OF DATAFICATION OF CITIES ON INDUSTRIES

Table 4: Impact of datafication of cities on industries

| INDUSTRY / AREA | IMPACT OF DATAFICATION ON CITIES |
|---|---|
| Manufacturing | End of pipe regulation will become adaptive. |
| Telecom | New partnerships required to handle the changing demands on operators. |
| Retail | New demands will be placed on retail to respond to the mass customisation available to consumers. In conjunction with 3D printing, this will see the reformation of the high street. |
| Transport | Transport will become more responsive to end-users, rather than running according to a timetable. Autonomous cars will redefine how urban centres are planned. |
| Logistics | Data changes manner in which deliveries are made, when they are made and where they are delivered. |

# 5. DATAFYING PRIVATE LIVES

Perhaps one of the most obvious examples of datafiction is the role that cheaper sensors and IoT are starting to play in our private lives. A multitude of different technologies are now available from small and large companies that help individuals monitor and measure things that were previously difficult or impossible to quantify. Everything – from how much energy and water I use, what my food purchasing habits are, how I use social networks, the air quality of my local neighborhood, when I am awake and asleep, knowing when I am stressed or when a certain temperature level has been reached in the air around me, what road I select to drive to work as a result, how many cups of coffee I drink in the morning, how I brush my teeth and what TV programs I decide to let my kids watch in the back seat of the car on long journeys – can now be measured, quantified and compared to other people.

A plethora of new 'wearable' technologies have emerged as a result of the continued reduction in size of chipsets and batteries – from smart meters to Fit-Bit®, individuals are now able to 'quantify' themselves in ways previously unimaginable. From the amount someone sleeps, their heart rate, the oxygen and sugar levels in their blood, to the amount of exercise they are taking can be measured and quantified on a near real-time basis. A near continual flow of information can now provide deeper insights into a person's real state of health. Whereas previously a snapshot in time was taken at a GPs office of an individual's health when problems were suspected, today there is a real-time flow of information – about how a person is when they are well, as well as when they are feeling sick.

This type of information can revolutionise the manner in which clinical research is performed[3] . Traditional medical research has focused on disease, rather than wellness, often due to constraints on data – for example research into diseases has focused on how to treat people once they have it. People go to the doctor when they feel sick or are displaying symptoms and a snapshot in time of their overall health is taken to assess whether they need medication, further testing or hospitalisation. The new quantification of self may allow for more detailed understanding of how a disease forms in the first place. Rather than just rely on a snapshot in time, a person's state of unwellness can be compared to a data set of a much longer period of time – including data from when a patient was feeling well. Over time, traditional sampling techniques can be augmented with new data analysis techniques that investigate emerging disease patterns across much larger datasets, allowing for much earlier detection and the development of tailored drugs that are more effective and reduce side effects for individuals.

More than just 'measure', however, these devices are increasingly being used to create 'triggers' that encourage new types of behavior from the end-users in question. Some early examples can be seen in the use of smart meters, which allow end-users to compare and contrast how an individual's energy consumption compares to that of their neighbors, or the app that informs an end-user when their posture needs correction.

[3] Types of Study in Medical Research:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2689572/

# 5.1 IMPACT OF DATAFICATION OF PRIVATE LIVES ON INDUSTRIES – THE CASE OF HEALTHCARE

Healthcare has traditionally been a binary system – once a patient was defined as ill and needed to enter hospital, there were two main outcomes that the systems was built to deliver – either a patient was cured and left hospital, or their treatment failed and they died.

With the dramatic improvements in healthcare over the last approximately 60 years, however, the majority of major health problems in many nations and the ones that require the most funding from governments are 'life-long' diseases, such as diabetes or heart disease. These require a different form of healthcare management. Initially, using datafication allows for the creation of 'triggers' that can improve end-user behavior and reduce pressure on the health care systems. Over a longer period of time, however, datafication completely redefines how the healthcare industry will be structured and operate. While datafication of private lives forms only one part of the forces redefining healthcare, it is an increasingly important one*.

Figure 4 – Healthcare system – binary approach


In Figure 4, we illustrate some of the possible forces affecting the healthcare industry – the arrows indicate where datafication has a role to play in changing either our understanding of those forces or the manner in which healthcare is delivered as a result.

* The author would like to thank and acknowledge the contribution of a discussion with Prof. Rifat Atun regarding data and the impact on healthcare for this section.

## 5.1 IMPACT OF DATAFICATION OF PRIVATE LIVES ON INDUSTRIES – THE CASE OF HEALTHCARE

The nature of our world has changed – we are now a 'city planet' – the majority of the earth's population live in cities and associated urban areas, travel is increasing both locally in cities and globally. At the same time, climate change and population growth are changing the manner in which humans interact with the planet and how we manage natural resources – the role of datafication in this respect was covered to some extent in the previous section. Within a healthcare context, however, these create changes in the nature of 'environmental stressors' (Evans & Cohen, S., 1987) – for example climate change may lead to changes in temperature, increased air pollution may have an impact as well as the 24/7 mobile connected work environment. It is important to remember that every individual reacts differently to the environmental stressors in question – and this is one reason that the datafication of private lives can provide real extra value to individuals.

Thanks to IoT and datafication of various parts of the healthcare value chain, there is now data that was not available previously, eg.. E.g. genomic data at both an individual level and population level data. Epidemiology has also changed – datafication can now help with lifelong disease management – providing patients with better care through real-time analysis of diseases such as diabetes or asthma and in turn reducing the overall costs of healthcare for the nation in question. Datafication has also helped to change patho-physiology, for example with the link between individual genome data and interaction with environmental stressors now more clearly defined.

One of the most important angles for datafication to work in the healthcare industry is protection of privacy and security. We cover these issues in section 6.

Table 6: Impact of datafication of private lives on industries

| INDUSTRY / AREA | IMPACT OF DATAFICATION ON PRIVATE LIVES |
|---|---|
| Healthcare | Fundamental reshaping of how industry handles patients and how medical research / drug development is performed. |
| Emerging industry / industry roles | Protection of data and creation of secure brokers for private information. |

Figure 5 – Healthcare and datafication

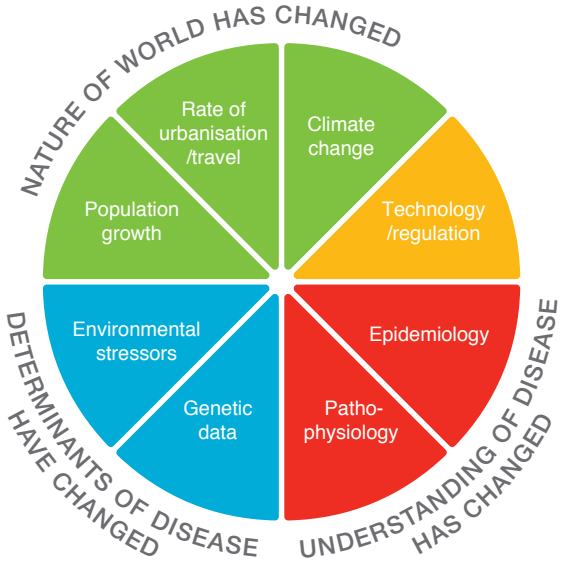



Table 5: Environmental stressors and datafication (adapted from Evans and Cohen, 1987)

| ENVIRONMENTAL STRESSOR | IMPACT | ROLE OF DATAFICATION |
|---|---|---|
| Heat | Up to 32 degrees, increase in riots.<br><br>Change in temp = increase in cardiovascular disease. | Measure heat islands in cities through IoT and other means.<br><br>Measure temperature of individuals to monitor possible cardiovascular disease. |
| Noise | Associations with psychological symptoms, psychiatric admissions, use of tranquilisers, cardiovascular disorders.<br><br>Deficits in information-processing tasks with multiple signals.<br><br>Decrements in incremental memory. | Real-time measurement of noise levels that an individual is experiencing.<br><br>Measurement of tension and activity indicating that an end-user may wish to take a break or find someone quiet for their lunch break . |
| Crowding | Catecholamines, blood pressure, heart rate, skin conductance, cortisol levels. | Measurement of the real impact of urbanisation on larger populations. |

# 6. PREPARING YOUR INDUSTRY FOR DATAFICATION

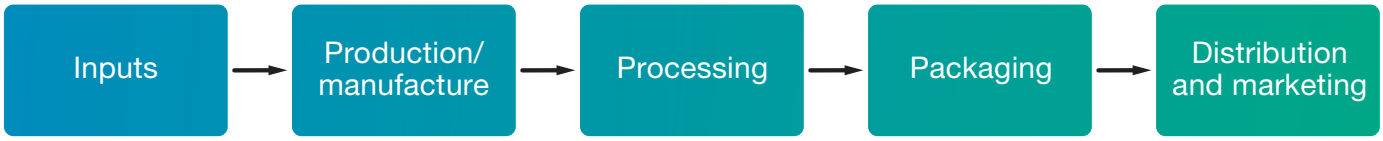
As datafication becomes more common and the impact of peoples' lives more widespread, the development of new frameworks for understanding is becoming increasingly necessary. In addition, datafication requires a significant re-assessment of several areas of an industry's operation. Here we briefly outline a few areas, including frameworks for understanding how value chains of data are emerging alongside traditional supply and value chains and several governance issues industries need to take into account and effectively implement datafication.

# 6.1 DATAFICATION AND INFORMATION VALUE CHAINS

One of the main issues to understand is how data works together and is combined, rather than solely how it is managed within one company or process itself. Datafication requires much more than solely putting sensors around a city or within business processes – it actually requires new business and industry processes solely for the management of data. For the sake of simplicity, we can view 'sensing' or 'datafying' through to the creation of a viable 'information product' as a value chain in and of itself – an Information Value Chain, illustrated in Figures 6 and 7.

- Inputs: Inputs are the base raw components used in manufacture to create a product. Examples could be cocoa beans for the manufacture of chocolate or data from a sensor, e.g. a sensor gathering individual data points from a truck's engine, that will be collated with other data and turned into a piece of information. Examples relevant for datafication include: Devices/Sensors: Open Data, OSS/BSS, Corporate Databases.
- Production/manufacture: Production/Manufacture refers to the process by which raw inputs are put through various processes in order to become part of a value chain. For example, cocoa beans may be dried and separated before being transported to overseas markets. Data, meanwhile, needs to be verified and tagged for provenance. For example, open data often needs to be 'cleaned' in order to make it ready for various forms of data analysis and processing. Examples include: Asset Information databases, Open Data Sets, Network Information, Corporate Information Databases.
- Processing: Processing refers to the process whereby a product is prepared for sale. For example, cocoa beans may now be made into cocoa powder, ready for use in chocolate bars. For a datafication solution, this refers to the aggregation of multiple data sources to create an information component - something that is ready to be combined with other data sets to make it useful for corporate or public service decision-making.

Figure 6 – Overview of an information value chain

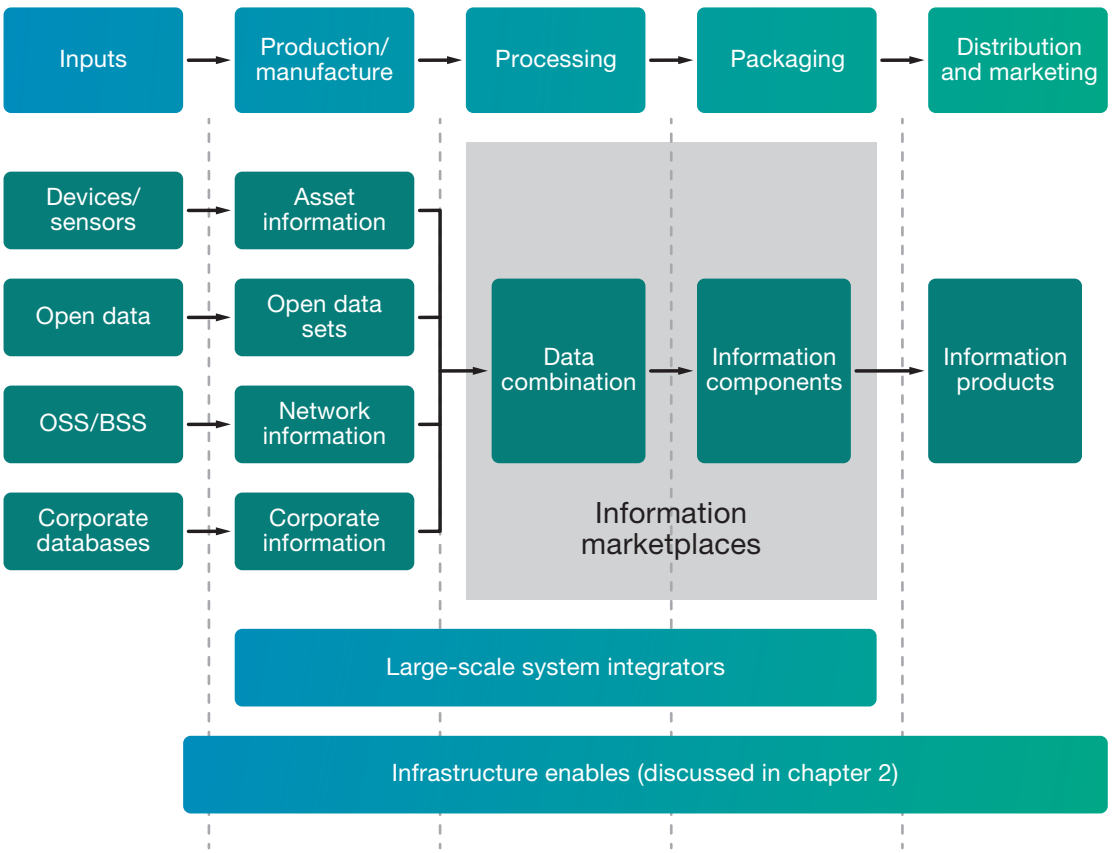



Source: Höller et al, 2014, From M2M to IoT: An introduction to a new era of intelligence

## 6.1 DATAFICATION AND INFORMATION VALUE CHAINS

- Packaging: Packaging refers to the process whereby a product can be branded as would be recognisable to end-user consumers. For example, a chocolate bar would now be ready to eat and have a red wrapper with the words “Kit Kat” on it. In information value chains, however, the data will have to be combined with other information from internal corporate databases, for example, to see whether the data received requires any action. This data would be recognisable to the end-users that need to use the information, either in the form of visualisations or an Excel spreadsheet. The branding of data is also extremely important as data branded with the “Office of National Statistics”, or ONS is considered more reliable – and therefore often more valuable – than data that is compiled by unknown sources uncovered with a Google search.
- Distribution/marketing: This process refers to the channels to market that a company selects for selling its products. There are a broad variety of such channels in many different industries. For example, a chocolate bar may be sold at a supermarket, a kiosk, or even online. A datafied solution, however, will generally have produced an Information Product that can be used to create new knowledge within a corporate environment - examples include more detailed scheduling of maintenance based on real-world information or improved product design due to feedback from solution. Alternatively, these information products could be offered for sale to other players in the industrial structure that would benefit from access to tailored ‘knowledge’ from the different parties.

Figure 7 – An information-driven value chain




Source: Höller et al, 2014, From M2M to IoT: An introduction to a new era of intelligence

# 6.2 OVERCOMING CRITICAL BARRIERS

Datafication is far from solely a technical issue – as outlined within this document, it touches on every aspect of an industrial structure from regulation to business workflows as well as the management and strategy processes of companies involved. The economic and social value may be tempered by privacy and trust concerns and in some cases, these concerns may even prevent usage by individuals and citizens. In order for the benefits to be accrued therefore, certain value chain governance issues need to be thought through and addressed appropriately. Each industry will face its own distinct barriers to the use of datafication and every industry will therefore need to develop its own unique approach to the issues presented by datafication. This section presents some of the most common issues that are shared across industries.

While technology will play a role in solving these issues, many must also be the focus on in-depth discussion across industry about the role that we wish data to play in our lives and our societies – and where we are willing to draw the line between public and private lives and corporate and broader social and governmental responsibility. Our aim with this report series is not to provide definitive answers, but rather to trigger much-needed debate about how to establish proper boundaries in. These issues will be covered in more detail in the reports for each industrial sector.

# 6.2.1 SECURITY AND PRIVACY

One of the most commonly discussed barriers in the digital economy is the effective management of security and privacy for corporations, individuals and government institutions – often these even appear to be conflicting interests. In many of the new information-driven value chains, however, users are required to trust that their data is being used appropriately, in a manner that they would approve of and by entities that they would ensure such data to. Many datafication solutions rely on cloud computing and data analytics as core components – users are unlikely, therefore, to ever have detailed knowledge of the exact location of how and where their data is stored (and the legal ramifications of the data being stored there), or what other data it is being stored with.

Many different methods have been proposed for solving the issues of privacy – from creating private stores for personal digital data to a broad variety of security mechanisms. Each industry will need to implement its own privacy standards and assess which technical solution will work best within its industrial boundaries.

Failures to protect this privacy and security may lead to legal issues, as discussed in Section 6.2.4.

# 6.2.2 RISK AND INSURANCE

As datafication, in particular within industrial value chains, becomes prevalent, the amount of risk associated with the use – and most importantly – the potential re-use of data by third parties creates new forms of risk for companies and individual economic actors. Traditionally, risk is transferred to another party via insurance. Many industries have well-established catastrophe planning models that help 'price' risk and the associated insurance to cover for that risk.

While cyberinsurace does exist in some forms, it is often unclear as to whether datafication and associated techniques are actually covered. Insurance related to data mainly covers a company from data attacks – e.g. the recent breach of Target's data systems and theft of credit card data which cost $61 million in expenses, with $44 million insurance receivable offset . This, however, is insurance in the face of a nefarious attack against Target.

Within an information value chain, however, an 'accordion' of contracts is created – often via the use of Open APIs that allow companies to interact, access and use one another's data via a series of digital contracts implemented mainly in computer code and terms of use. It is currently unclear whether cyberinsurance actually covers what happens when others use data created by a different economic entity in their product development or decision-making processes – who bears the liability for bad data used within an information value chain? As datafication becomes more deeply embedded in our day-to-day lives, the possibility of an information value chain process causing catastrophic damages on people or property increases.

Each industry will therefore need to investigate which cybersecurity standards are appropriate and implement best practice around such standards. In addition, each industry will need to work to develop a clearer understanding of the kinds of amounts of loss that incidents across an information value chain can cause for individuals, companies and governments as a result of implementing such techniques.

A key aspect of proving liability for data is the use of data provenance techniques in the development and implementation of information value chains.

[4] Target Q4 2013 results, www.target.com

# 6.2.3 DATA PROVENANCE

With the proliferation of datafication the need to know where data originated and how it has been manipulated in transit is increasingly important. This 'lineage' information may be stored in machine readable format to be included in data processing along any information value chain, telling the next user in the chain how the data has been processed and manipulated in previous stages. Such information can be used to help determine whether data is "fit for purpose" as it transforms into an information product.

Different industries will require provenance to be delivered in a different form for a multitude of purposes. For example, the provenance of health data may need tagged for, e.g. location and virus data for aggregated analysis of health crises across the nation but contain more detailed provenance data about an individual if required for creating, e.g. tailored drugs for a patient.

# 6.2.4 REGULATION

Regulation poses one of the biggest challenges as datafication progresses – how should societies effectively regulate for large scale information value chains where data is possibly shared across corporate, government and even national boundaries about individuals and combined into a variety of new information products? Regulatory bodies have so far failed to keep up to date with the existing technological changes and they are now faced with a technological change that may have dramatically more impact on individuals and corporations alike. The area of how to best regulate the rise of data's importance in our lives is hotly debated in various circles. Regulation needs to be dramatically updated to reflect issues related to protecting individuals from personal harms related to data analytics or "predictive personal data harms" (Crawford & Schultz, J., 2014), where individuals may be put at risk from harms that are derived from collecting, aggregating, processing and analysing how individual's use data or other parts of their digital 'footprint'.

Regulation is therefore a challenging area for industrial structures as regulatory bodies struggle to understand and define the impact of datafication on its particular area. Industries and individuals therefore need to foster the technological understanding and discussions on regulation associated with datafication as soon as possible.

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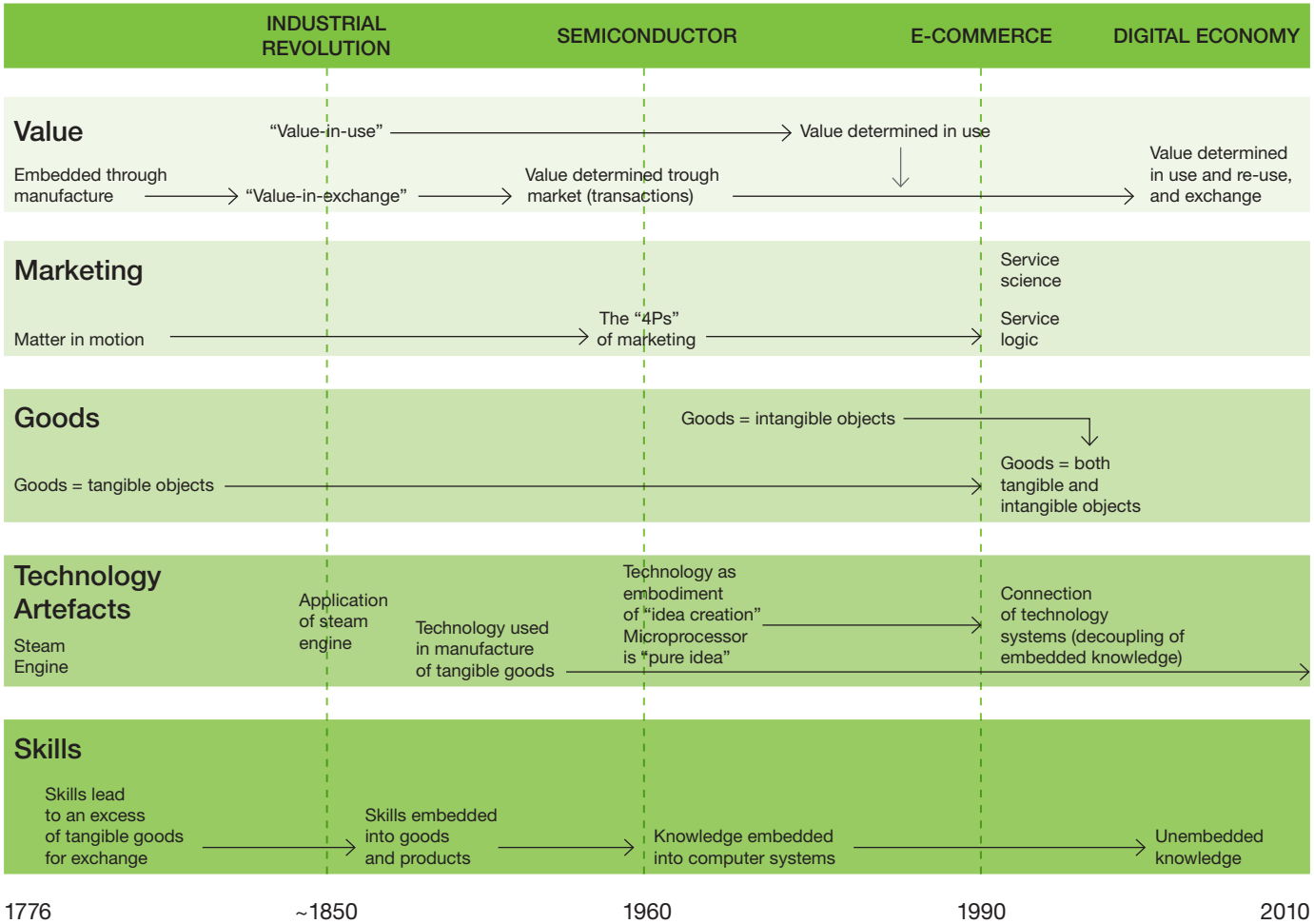
# APPENDIX A – EVOLUTION OF DIGITALISATION AND IMPACT ON R&D

| ERA | ECONOMICS OF API USAGE | IMPACT ON R&D |
|---|---|---|
| 1960s – 1970s | APIs are used for the division of labour internally in companies. | Different programming teams can use each others code. Code re-use. |
| Late 1970s – early 2000s | APIs used to fuel internationalisation of production and the globalisation of industry, in particular supply chains and value networks. | Different teams located in different parts of the world can use each other's code.<br><br>System integration becomes a key issue for R&D. |
| Late 2005 – onwards | Competitive clash of platforms based on open APIs.<br><br>APIs create temporary monopolies on mobile devices, not just internet.<br><br>Supply chains reconfigure and some become 'virtual'. | Underlying platforms dominated by total cost of ownership.<br><br>Data analytics increases in importance the system Integration leads to massive amounts of data from both internet and mobile devices that needs to be understood. |

Source: Mulligan, 2011

# APPENDIX B – EVOLUTION OF EMBEDDED AND UNEMBEDDED KNOWLEDGE




Source: Mulligan, 2011

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