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# **World Economic Forum White Paper** **Digital Transformation of Industries:** In collaboration with Accenture

## **Societal Implications**

January 2016

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## 1. Foreword

There is widespread recognition among leaders in most industries that the role of digital technology is rapidly shifting, from being a driver of marginal efficiency to an enabler of fundamental innovation and disruption.

Digitalization is the cause of large-scale and sweeping transformations across multiple aspects of business, providing unparalleled opportunities for value creation and capture, while also representing a major source of risk. Business leaders across all sectors are grappling with the strategic implications of these transformations for their organizations, industry ecosystems, and society. The economic and societal implications of digitalization are contested and raising serious questions about the wider impact of digital transformation.

While it is clear that digital technology will transform most industries, there are a number of challenges that need to be understood. These include factors such as the pace of changing customer expectations, cultural transformation, outdated regulation, and identifying and accessing the right skills – to name just a few. These challenges need to be addressed by industry and government leaders to unlock the substantial benefits digital offers society and industry.

Digital Transformation of Industries (DTI) is a project launched by the World Economic Forum in 2015 as part of the Future of the Internet Global Challenge Initiative. It is an ongoing initiative that serves as the focal point for new opportunities and themes arising from latest developments and trends from the digitalization of business and society. It supports the Forum's broader activity around the theme of the Fourth Industrial Revolution.

A key component of the DTI project in 2015 has been the quantification of the value at stake for both business and society over the next decade from the digital transformation of six industries. The 'compass' for these industry sectors is being set and it is imperative that all stakeholders collaborate to maximize benefits for both society and industry. Digitalization is one of the most fundamental drivers of transformation ever and, at the same time, a unique chance to shape our future. The World Economic Forum is committed to helping leaders understand these implications and supporting them on the journey to shape better opportunities for business and society.

In 2016, the DTI initiative will focus on the impact of digital transformation on an additional 10 industries, further deep-dives into industries from this year's project, as well as examine a number of cross-industry topics such as platform governance, societal impact, and policy and regulation.

The report was prepared in collaboration with Accenture, whom we would like to thank for their support. We would also like to thank the Steering Committee, the Working Group members, as well as the more than 200 experts from business, government and academia and over 100 industry partners who were involved in shaping the insights and recommendations of this project. We are confident that the findings will contribute to improving the state of the world through digital transformation, both for business and society.

Bruce Weinelt  
Head of Digital Transformation  
World Economic Forum

## 2. Executive Summary

The digital transformation of industries is generating a fierce debate among policymakers, economists and industry leaders about its societal impact. As digitalization disrupts society ever more profoundly, concern is growing about how it is affecting a wide range of issues, including jobs, wages, inequality, health, resource efficiency and security.

Within this context, the Digital Transformation of Industries program has explored three questions: what impact is digital transformation projected to have on key challenges facing society? What challenges need to be overcome if digital transformation is to make a positive contribution? What practical steps can businesses take in the near term to ensure that this is the case?

To help begin a new, evidence-based debate on the future impact of digital transformation, we have conducted a detailed quantitative analysis of the value at stake from the digitalization of four industries (automotive, consumer, electricity and logistics). In each case, we have calculated projections of the potential value of digitalization to the industry itself and emerging sources of value for society, as measured by an intentionally narrow set of indicators (for more information about our methodology, please see Section 4 of this report). Over time, this approach may be broadened and refined.

So how can the digital transformation of industries make a positive contribution to society? In the first year of the DTI initiative, we have focused on three key areas:

### 1. Creating a workforce for the machine age

Current estimates of global job losses due to digitalization range from 2 million to as high as 2 billion by 2030. There is great uncertainty about the overall impact of digital transformation on jobs, with concerns also about its impact on wages and working conditions. Against that backdrop, our analysis suggests that:

- Digitalization has the potential to be a net creator of jobs in the logistics and electricity industries, creating up to 6 million jobs worldwide between 2016 and 2025.
- However, while the net impact may be positive overall in the industries that we examined, automation will displace many tasks and activities traditionally performed by human beings.
- For example, in logistics, the implementation of digital platforms that enable cross-border trade and crowdsourcing of logistics routes could together create approximately 4 million jobs by 2025; equivalent to a net 8.4% increase in the number of people employed in the industry. However, this must be balanced with a view of potential job loss; the adoption of newer delivery capabilities such as drones, autonomous trucks and shared warehouses means that many existing logistics jobs will be put at risk.

With both winners and losers resulting from digital transformation, a huge premium rests on the near-term ability of businesses to upskill employees and shape the next generation of talent for the machine age.

### 2. Transitioning to a sustainable world

We have so far failed to decouple economic growth from emissions growth and resource use. The historic trend holds that for every 1% increase in global GDP, CO<sub>2</sub> emissions have risen by approximately 0.5% and resource intensity by 0.4%.<sup>1</sup> Current business practices will contribute to a global gap of 8 billion metric tons between the supply and demand of natural resources by 2030; translating to \$4.5 trillion of lost economic growth by 2030.<sup>2</sup>

Our analysis suggests that digital transformation could make a positive contribution to this challenge:

- Digital initiatives in the industries we examined could deliver an estimated 26 billion metric tons of net avoided CO<sub>2</sub> emissions from 2016 to 2025. This is almost equivalent to the CO<sub>2</sub> emitted by all of Europe across that time period, or the United States more than five times over.<sup>3</sup> By 2025, this will amount to 8.5% of global emissions.<sup>4</sup>
- In the electricity sector, if smart asset planning and management, and energy storage integration were universal, we estimate that up to 8.8 billion metric tons of CO<sub>2</sub> emissions could be saved by 2025, creating \$418 billion of new value for the economy.

Ensuring that this potential value can be realized and scaled even further requires a number of hurdles to be overcome, not least relating to the acceptance of new, circular business models, customer adoption and the environmental impact of digital technology itself.

### 3. Building trust in the digital economy

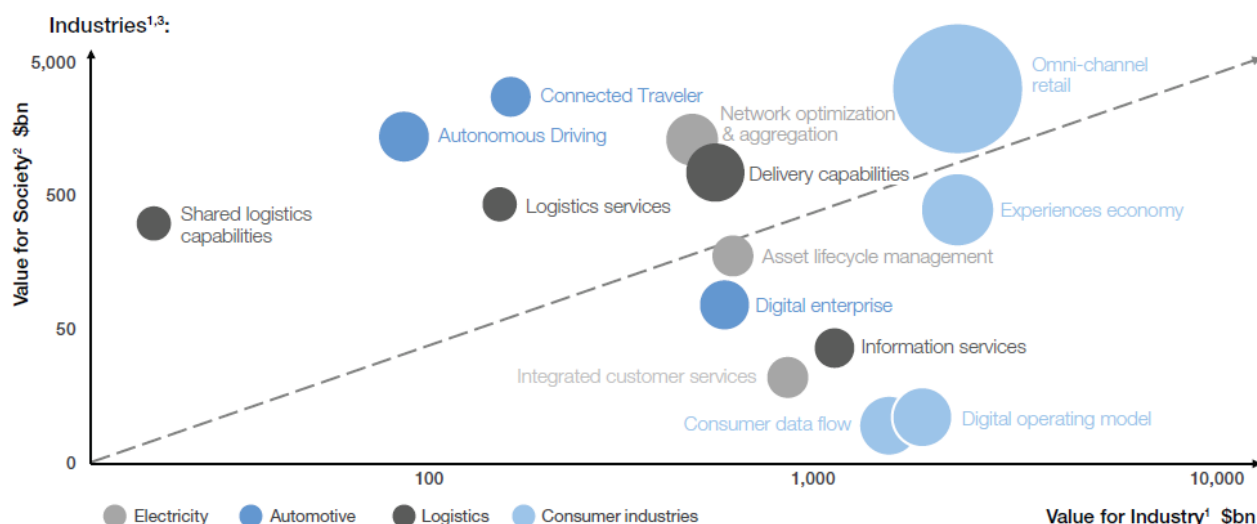
Social media, radio frequency identification (RFID) tags and user-generated websites such as TripAdvisor have all been instrumental in increasing the transparency of businesses and overcoming information asymmetries. However, according to the Edelman Trust Barometer, trust in all technology-based sectors declined in 2015, with concerns over data privacy and security a key factor. Beyond privacy and security concerns, broader ethical questions about the way organizations use digital technology threaten to erode trust in those institutions.

While this is a hugely complex challenge, our analysis helps highlight some of the potential benefits that can be delivered through the use of digital technologies that may appear contentious. For example, while usage-based insurance (UBI) has led to a number of concerns about data privacy, security and the ethical uses of data, UBI coupled with assisted driving technologies, could help reduce, by 2025, the projected annual death toll from road accidents of more than 2 million by 10%. In this way, we hope to contribute to a more evidence-based analysis of the relative benefits and harms that may accompany technological innovation. Going forward, establishing new norms of ethical behavior with digital technology and reaching higher levels of customer trust will be critical in a successful digital transformation.

#### Combining value to industry, with value to society

Our value-at-stake analysis has focused on a limited sample of industries and a narrow range of indicators (including jobs, carbon emissions, lives saved and consumer benefits) that have served as a proxy measure for emerging value to society (see Figure 1). However, in aggregate terms, these represent a cumulative 'combined value' opportunity of \$21.2 trillion for both industry and society between 2016 and 2025, with potential gains to society (\$12.7 trillion) exceeding the potential value for industry (\$8.4 trillion). Scaled up beyond the industries analyzed, this could mean a potential value opportunity of as much \$100 trillion by 2025 on a cumulative basis. As we move forward, these projections will be tested and refined further in the interests of stimulating an evidence-based conversation about the impact of digital transformation on society; we welcome any contributions to that endeavor.

**Figure 1: Our value-at-stake analysis projects the 'combined value' to industry and society of digital initiatives across four industries from 2016 to 2025.**



Of course, the potential value of digital initiatives to society and industry will not automatically be realized. A number of questions need to be addressed by both business leaders and policymakers if they are to maximize the combined value of digital initiatives for both industry and society.

#### For businesses:

- Are you aware of the value multiplier for society from your digital initiatives? Are you able to measure and track the socioeconomic impact of your future digital initiatives?

- How can you incubate digital initiatives that could in future deliver a high value to society and your business? Is your corporate affairs/social responsibility function suitably aligned with your corporate strategy team?

**For policymakers/regulators:**

- To what extent do you understand how industry-led digital initiatives could help you achieve specific policy objectives and targets? What policy tools could you use to incentivize industry toward digital initiatives that deliver value to society?
- Are you taking sufficient steps to digitize your own organizations? Do you have the right digital skills and talent in place? How can you learn and exchange lessons from the experience of private-sector organizations?

### 3. The Impact of Digital Transformation on Society

The digital transformation of industries is disrupting society, generating widespread concern about its impact across a broad range of issues including jobs, wages, health, resource efficiency and security. (See sidebar on ‘The great digital debate’). However, while it is clear that digital is already changing the way we live and work, what is less clear is how precisely digital transformation will reshape society in the future.

To understand the future impact of digital technology on different aspects of society, the World Economic Forum has already embarked on a number of programs, such as those on cybersecurity (‘Advancing Cyber Resilience’), digital inclusion (‘Access for All’), jobs (‘Employment, Skills and Human Capital’) and the effects on humans of increased exposure to digital platforms and content (‘Digital Media and Society’).

Within this context, the unique contribution of the Digital Transformation of Industries 2015 program is to provide an evidence-based perspective on how digital initiatives within industry contribute – often in small part – to the ability of business leaders and policymakers to address wider societal challenges. In 2015, we analyzed three challenges in particular:

#### 1. Creating a workforce for the machine age

Current estimates of job losses due to digitalization run as high as 2 billion worldwide by 2030. However, there is considerable variation in these projections. Taking the United States as an example, estimates range from 22.7 million job losses by 2025 to 80 million over the next few decades. Concerns about job losses from automation have entered the mainstream, with headlines referencing the ‘rise of the robots’ and even an online tool by the BBC that allows users to find out the likelihood of their job disappearing. At the same time, many commentators argue that such projections are overblown and that the actual impact of automation will be far less dramatic. Indeed, a common feature of much of the commentary on this topic is to conflate the automation of tasks with that of entire professions. A McKinsey study points out that, in the near to medium term, very few occupations (less than 5%) will be automated in their entirety.<sup>5</sup>

With concern about automation growing, how can industry make a positive contribution to this challenge?

#### 2. Transitioning to a sustainable world

The global economy is built on unsustainable foundations. Current business practices will contribute to a global gap of 8 billion metric tons between the supply and demand of natural resources by 2030, translating to \$4.5 trillion of lost economic growth by 2030.<sup>6</sup> Energy is a major part of the problem, with 75% of the world’s energy supply currently depending on nonrenewable sources such as coal, oil and natural gas.<sup>7</sup> With increasing pressure on the world’s resources and an urgent need to cut emissions, digitalization has an important role to play.

But digital transformation itself also comes at a significant environmental cost. Industry must act to tackle the rapidly increasing environmental impact of digital technologies. Growing mountains of electronic (e)-waste are posing a threat to human health and the environment, while increasing energy use by data centers is contributing to pollution and emissions. E-waste is one of the fastest growing streams of waste, with 40 million metric tons being discarded in 2014.<sup>8</sup> Only a small percentage is recycled, with just 29% of e-waste recycled in the United States in 2012.<sup>9</sup> At the same time, energy consumption by data centers is growing fast, by 12% a year. Data centers now consume 1.5% to 2% of global electricity and rarely obtain their power from clean energy sources.<sup>10</sup>

How can industry employ digital technology to help set the global economy on a sustainable footing?

#### 3. Building trust in the digital economy

The digitalization of the economy and business models in particular has eroded trust in organizations, both public and private. The rapid expansion of the data economy is raising important questions about data privacy and security, particularly in relation to the use of personal data. Business models created entirely around the value of individuals’ data are arguably one of the most important features of the digital revolution. The size and importance of this personal data economy is neatly illustrated by Facebook’s user base (1.5 billion people worldwide), current value (around \$245 billion)<sup>11</sup> and revenue growth (41% last quarter)<sup>12</sup>. While business models built around users’ personal data are not in themselves problematic, unease is growing among individuals around data-sharing activities, with 60% to 90% of individuals concerned about the use of their data online.

At the same time, other developments are undermining trust. Cybercrime is an increasing threat that cost the global economy \$575 billion in 2014, according to an approximate estimate by McAfee.<sup>13</sup> Fears are also emerging about the possible negative impact that digital technology can have on health and well-being, with growing worries about ‘digital

addiction'. Many of these issues remain unresolved, further undermining trust. The 2015 Edelman Trust Barometer discovered significant levels of distrust in technology, with 51% of people believing that the pace of change in business and industry is too fast.<sup>14</sup>

How can industry help ensure that digital is trusted as a force for good, creating a positive social impact?

## The great digital debate

The ever-increasing power of digital technology is changing the lives of many around the globe. At an individual level, technological advances are providing many of us with convenient access to an unprecedented wealth of services, goods and information. But, in parallel to these considerable benefits, the impact on society of this digital transformation is generating a fierce debate among policymakers, economists and industry leaders. Here we summarize some of the key questions:

### Will digital transformation...

#### 1. ...be a net creator of jobs?

Opinion varies widely on the overall impact of digital technology on job creation versus job destruction. One frequently cited study estimates that 47% of total US employment could be at risk from automation.<sup>15</sup> Other economists are more optimistic, however, that short-term job losses will be offset by workers moving to sectors that complement technology, as has happened after previous technological revolutions.<sup>16</sup>

#### 2. ...polarize wages?

Over the past two decades, wages have stagnated in most developed countries, falling behind economic growth. Economists have cited increased automation of routine jobs as a cause of this stagnation.<sup>17</sup> A growing body of opinion fears that further automation will polarize wages, by concentrating rewards in the pay packets of highly skilled workers performing cognitive or non-routine jobs, at the expense of less-skilled workers.<sup>18, 19</sup>

#### 3. ...be trusted as a force for good?

Digital technology is challenging information asymmetries, to open up an era of greater transparency across public- and private-sector organizations. Social media has also given customers more influence over brands, forcing companies to adopt higher ethical standards and address complaints. But the prevalence of business models based on personal data is opening up new ethical dilemmas for companies (such as, should companies monetize personal data without the user's knowledge?), which have the potential to undermine trust in technology.

#### 4. ...improve health and well-being?

Digitalization is driving benefits for society across a range of health outcomes, from the use of remote diagnostics to big-data analytics that can predict the likely need for treatments. However, negative impacts on health and well-being are also emerging. Digital addiction and the overuse of technology have even, in extreme cases, led to death (for instance, of a 28-year-old South Korean man, who died after a 50-hour gaming marathon).

#### 5. ... make the world safer?

Technology is playing a central role in the fight against crime and terrorism, with big-data analytics being used to predict crime hotspots and pinpoint terrorist locations. Yet the large-scale collection of data and digitalization of processes has made organizations increasingly vulnerable targets of hacking and cybercrime. Data breaches appear to be increasingly common and expensive, with the average total cost to a business increasing by 23% between 2013 and 2015.<sup>20</sup> As the process of digital transformation deepens, organizations will find themselves increasingly vulnerable to attack.

#### 6. ...reduce resource consumption?

There is great potential for smart technologies to make our resource usage more efficient. At an individual level, we can monitor our home utility bills and create electricity. At an organizational level, we can track our supply chain, use assets more efficiently and optimize our logistics network. And at a systems level, renewable energy is being integrated and its variability addressed. Yet evidence points to the negative environmental impact that digital technology itself poses, especially through increasing energy consumption by data centers and growing volumes of e-waste.



## 4. A New Framework for Public-Private Dialog

One of the central aims of the World Economic Forum's multi-year *Digital Transformation of Industries (DTI)* initiative is to provide an evidence-based insight into the potential value of digitization to both industries and wider society.

In this first year of the DTI project, a detailed quantitative analysis of the value at stake from digital transformation for four industries (automotive, consumer, electricity and logistics) has been conducted. In each case, projections of the potential value of digitization to the industry itself and emerging sources of value for society have been calculated, as measured by an intentionally narrow set of indicators (see note on methodology below).

The objective of this analysis is twofold:

- To provide new evidence and analysis on the potential contribution that industry-level digital initiatives could make to specific societal challenges.
- To provide a common framework for understanding the potential value of industry-level digital initiatives for both the industries and wider society.

As the DTI program moves forward, this analysis will be refined and improved – feedback is welcome to help build on these early findings.

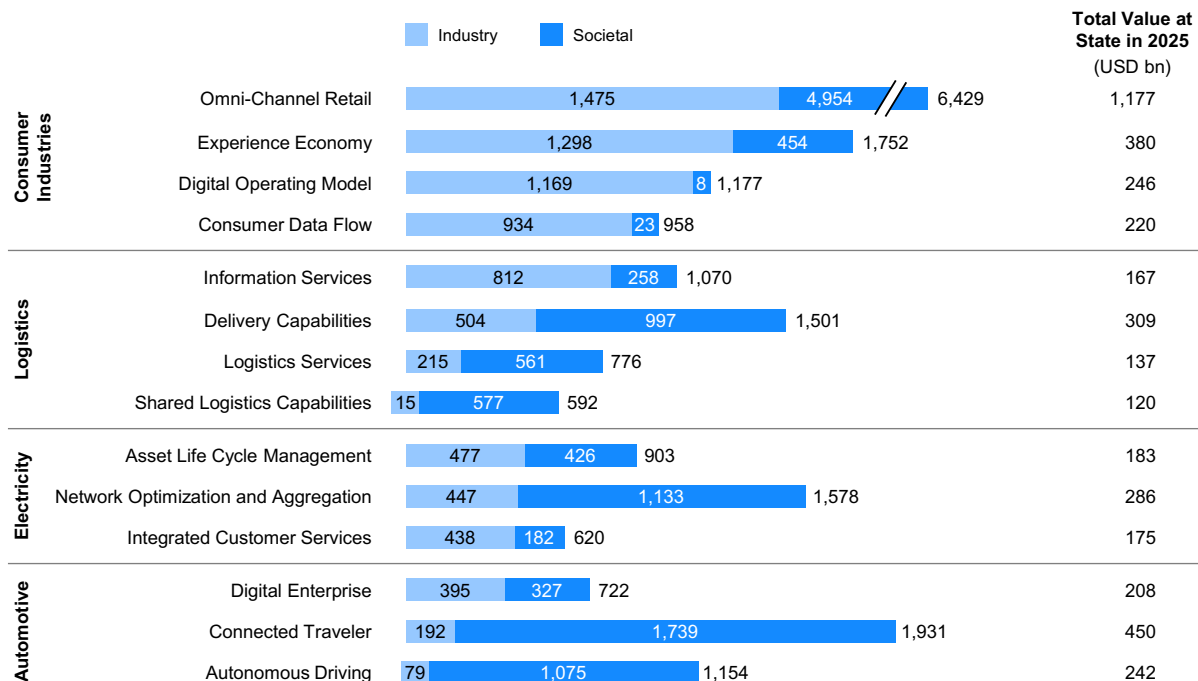
### Sizing the prize

The value-at-stake analysis has found that digital initiatives in each of the industries we looked at represent an immense opportunity for new value creation, often against a backdrop of a stagnating market, regulatory pressures, or changing consumer preferences.

Our analysis shows that the digital transformation of industries can make a positive contribution over the next decade (see Figure 2):

- In the four industries (automotive, consumer, electricity and logistics) we analyzed, we estimate a potential value for industry in the region of \$8.4 trillion and value for society of approximately \$12.7 trillion, between 2016 and 2025.
- Scaled up beyond these four industries, the size of the prize could be as much as approximately \$100 trillion in 'combined value' for both industry and society by 2025.
- Looking at a specific industry, optimizing the grid to manage real-time supply and demand is worth \$191 billion for electricity companies, while the value this could deliver to society is three times as much (\$623 billion). This is derived from cost savings for customers (offering an incentive to postpone consumption during peak hours), lower fuel emissions and jobs created.

**Figure 2: Digital Transformation of Industries – total potential benefit to industry and society**

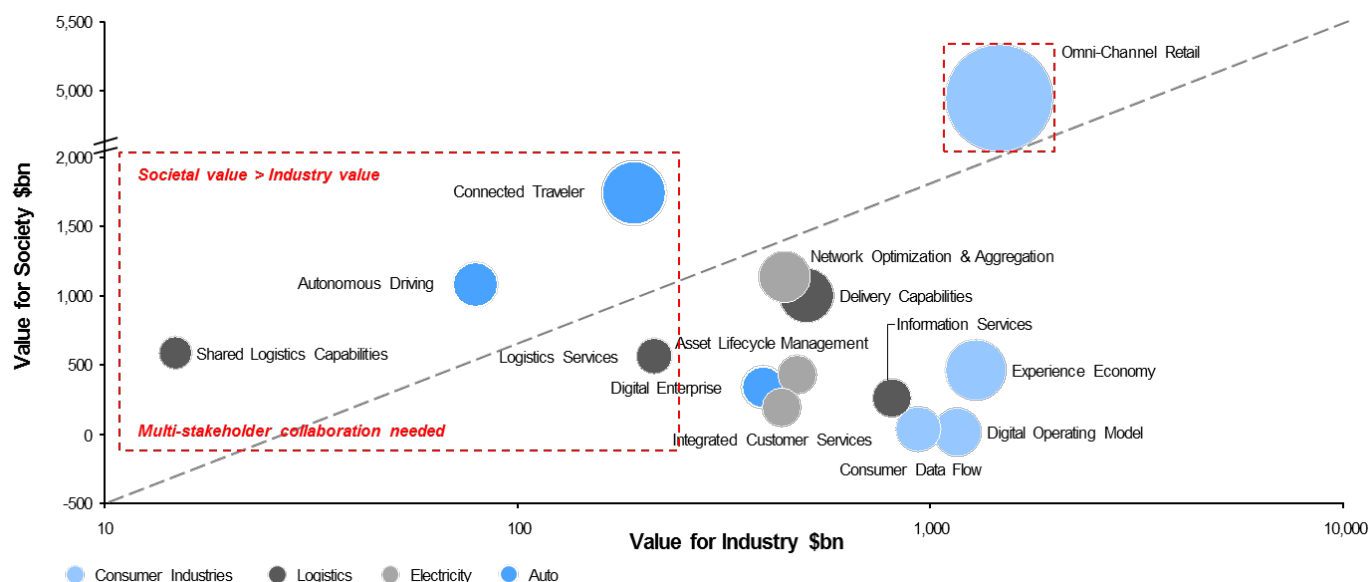


Source: World Economic Forum, Accenture analysis

### Finding ‘true north’

A starting point in developing a value-at-stake framework is to acknowledge that for digital initiatives that are projected to deliver high value to industry and help contribute to specific societal challenges, they are on the path to ‘true north’ where market and societal forces align (see Figure 3). In these cases, it is unlikely that significant levels of intervention (e.g., from regulators) will be required to ensure that those benefits are realized.

**Figure 3: Value-at-stake analysis provides a framework for maximizing value to society**



Source: World Economic Forum, Accenture analysis

In many instances, digital initiatives are projected to deliver high value to business and society. This 'true north' means that no intervention is likely needed to realize those benefits – industry has a clear incentive to act of its own accord. For example, omni-channel retail is likely to deliver such huge benefits to industry (estimated at \$1.4 trillion) and to society (from a \$5 trillion reduction in costs and productivity improvement, amounting to 300 billion hours saved), that there would appear to be little need for policy/regulatory intervention.

### Identifying unaligned incentives

However, what about those initiatives that deliver significant value to society, but less to business?

- In logistics, for example, the value to society of shared warehousing is equivalent to approximately 500 times the value to industry.
- In the automotive industry, the value to society of automotive partners agreeing on usage-based insurance to help reduce road deaths, insurance premiums and crash costs is worth approximately 200 times the value to industry.

It is these issues where multi-stakeholder collaboration is needed and, potentially, new incentives required to change the direction of the market. For example, telematics installation is not mandatory in most economies (see case study on usage-based insurance below). However, if stakeholders from industry and government could agree on an approach that bundles telematics solutions at the point of sale, it could help reduce accidents, save lives and lower costs for consumers. In those parts of the world where road fatalities are particularly high (such as India and South Africa), the impact could be very significant.

Realizing these benefits also require organizations to address concerns over data privacy and security and broader ethical questions relating to usage-based insurance. For example, should data on dangerous driving be automatically passed on to law enforcement agencies?

Mapping value in this way can also be helpful for businesses to understand initiatives that may have a high level of value to the industry, but limited value to society. These should be areas that businesses watch with caution as potentially posing reputational risks, or where, in the long run, regulators may look to intervene (e.g., through increased taxation).

#### Case study: Deliv and DHL crowdsourcing deliveries

One of the most promising digital initiatives in the logistics industry is the crowdsourcing of deliveries. For example, Deliv is a peer-to-peer delivery startup that offers large retailers the ability to offer same-day delivery to their customers. In 2013, Deliv signed an agreement with GGP (the second largest shopping mall operator in the United States) to provide crowd-shipping services. For example, customers can purchase goods from multiple stores before having them aggregated and delivered in one shipment.<sup>21</sup>

Incumbents are also realizing the potential to utilize the crowd to improve delivery. For example, in Sweden, the logistics company DHL has launched the MyWays service, which enables customers to tap into the crowd in order to find and pay people who are willing to deliver their goods when they themselves are unable to reach a DHL Service Point.<sup>22</sup>

#### Case study: Incentivizing the launch of usage-based insurance

The introduction of usage-based insurance for cars clearly illustrates how unaligned incentives can derail societal gains. Our value at stake analysis estimates that usage-based insurance could save 160,000 lives by 2025. However, it is not being widely rolled out in countries such as the United States because the profits and costs from the service are being unevenly distributed. In a low-margin environment, car manufacturers are not mandatorily installing telematics equipment that is needed for usage-based insurance. This is because the cost cannot be easily passed onto consumers, so insurers are currently reaping the benefits with optional add-ons. Accurately priced insurance means lower costs to consumers, fewer accidents and reduced crash costs for all stakeholders – a win-win-win for customers, industry and society that is not yet in place – much like seat belts, which were not standard in cars when originally conceived.



## Value-at-stake methodology

Value-at-stake is a framework designed for assessing the impact of digital transformation initiatives on the industry, customers, society and the environment. It provides a differentiated and evidence-based understanding of the extent of impact that digital transformation will have on selected industries, and where potential value creation opportunities exist. It provides likely value estimates of global industry operating profits that are at stake, from 2016 to 2025, and the contribution that digital transformation can make to customers, society and environment in that time frame.

### Industry value

Value-at-stake for the industry comprises two elements. First, the potential impact on an industry's operating profits that will be generated because of the digital initiatives (value addition). Second, operating profits that will shift between different industry players (value migration).

### Value to society

Value-at-stake for society includes three elements: customers, society and the environment. Each element is measured as follows:

1. Value impact for customers: the potential gain to customers (both B2B and B2C) in the form of cost and time savings, discounts and ability to earn additional profits (for B2B customers only).
2. Value impact for society: the impact (both financial and non-financial) of digital initiatives on productivity gains, jobs, reduced traffic congestion and lives saved.
3. Value impact on the environment: the estimated impact of the digital initiatives on increasing or reducing CO<sub>2</sub> emissions.

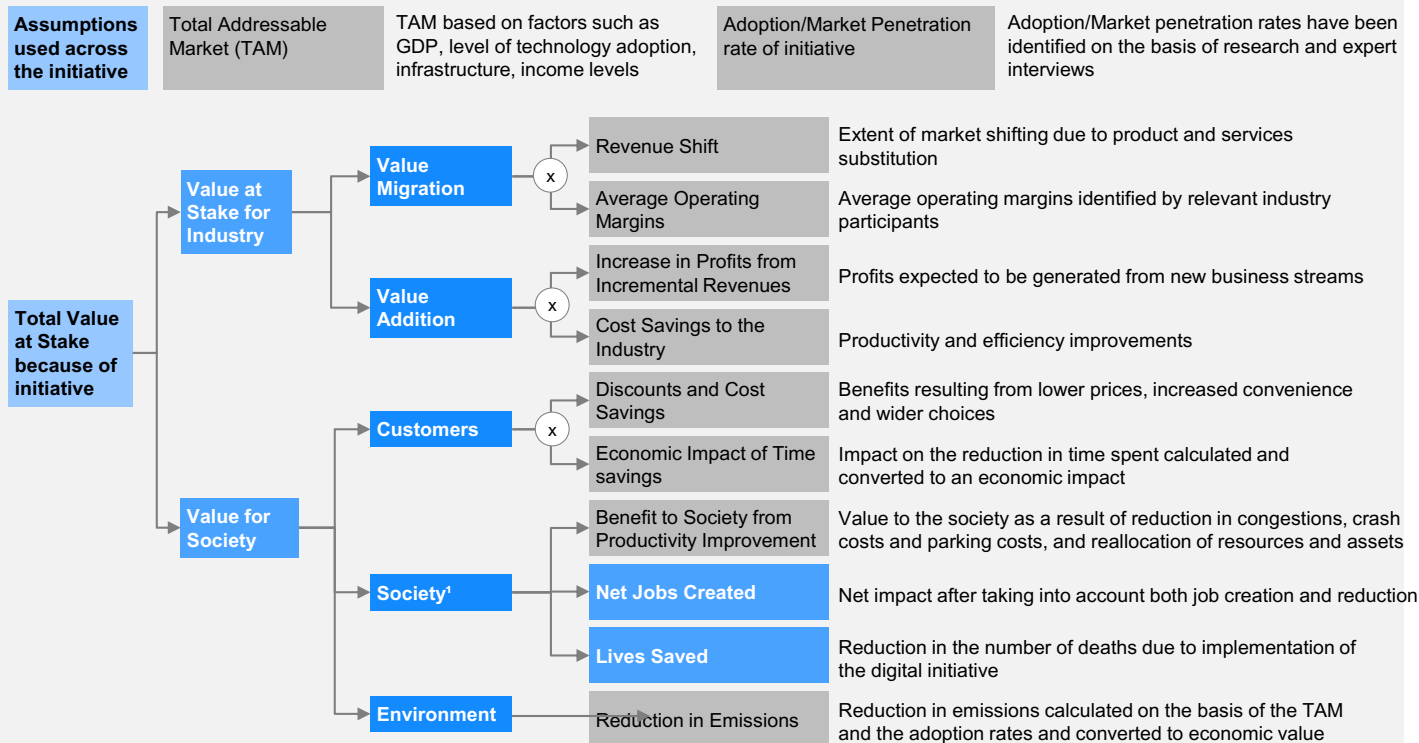
### Approach

The value-at-stake has been calculated using a top down approach involving three key steps:

1. Identification of the total addressable market and the adoption/penetration rates over the next 10 years for each digital initiative based on secondary research, industry reports, existing use cases and interviews with subject and industry experts.
2. Creation of a value tree to represent the different industry and society value categories mentioned above.
3. Testing, revision and validation of assumptions and results with academics, economists, DTI working group members and select industry partners of the World Economic Forum.

Figure 4 below shows in detail the approach that was used for estimating the value at stake.

**Figure 4: The Value at stake: Modeling approach**



Note: 1) Non-financial impact calculated for Lives Saved and Net Jobs Created; Source: World Economic Forum, Accenture Analysis.

## 5. Creating a Workforce for the Machine Age

The digital revolution has created new roles (such as search engine optimization managers and social media account managers), new types of organizations (cloud computing providers and social media agencies), and even new sectors of the economy (digital security and data science). And it is not just direct employment in digital sectors that is important. Digitalization has acted as a catalyst for employment growth in the wider economy. In India, for example, it is estimated that three to four jobs are created for every job within the business process outsourcing and IT-enabled services sectors.<sup>23</sup> Overall, studies have shown that investment in information and communications technology infrastructure creates 1.4 to 3.6 indirect and induced jobs for every direct job created.<sup>24</sup>

*“There is no doubt that over time technology creates much more work than it destroys. The real question is the degree that individuals and society are prepared for automation. We must reclaim this conversation.”*

**Parag Khanna, Managing Director of Hybrid Reality,  
Co-Founder and CEO of Factotum**

Today, however, the question of whether technology creates or destroys jobs is gaining momentum. Recent publications such as [The Rise of the Robots: Technology and the Threat of a Jobless Future](#) or [Humans Need Not Apply: A Guide to Work and Wealth in the Age of Artificial Intelligence](#) paint a grim picture of the future. Massachusetts Institute of Technology economists Erik Brynjolfsson and Andrew McAfee provocatively ask [Will Humans Go the Way of Horses?](#) It is time, they argue, “to start discussing what kind of society we should construct around a labor-light economy”, i.e., an economy in which there simply are no longer enough jobs to go round.

The truth is that we actually know quite little of what is going to happen – reflecting that, existing estimates of potential job losses related to automation vary considerably (see Figure 5). What will the economic impact of innovations be in the future? How will humans interact with machines and algorithms? What kind of skills do we need and how should we learn? How will all of this impact labor markets?

**Figure 5: Selected projections of job losses associated with digital technology**

Country	Projected job loss	Time horizon	% today's workforce	Source
Australia	5 million	2020-2025	40%	Committee for Economic Development of Australia, 2015
United Kingdom	10 million	2035	35%	Deloitte, Frey & Osborne, 2015
United Kingdom	15 million	Next few decades	–	Bank of England, Frey & Osborne
United States	–	A decade or two	47% (based on 2010 data)	Frey & Osborne, 2013
United States	22.7 million	2025	–	Forrester
United States	80 million	Next few decades	–	Bank of England, Frey & Osborne
Global	2 billion	2030	–	Thomas Frey, Futurist
Global	~1.25-1.5 billion	2020-2025	40-50%	Gerd Leonhard, Futurist

### The future of work

We can at least be sure that there will be three types of jobs, categorized by the percentage of codifiable tasks within the role:

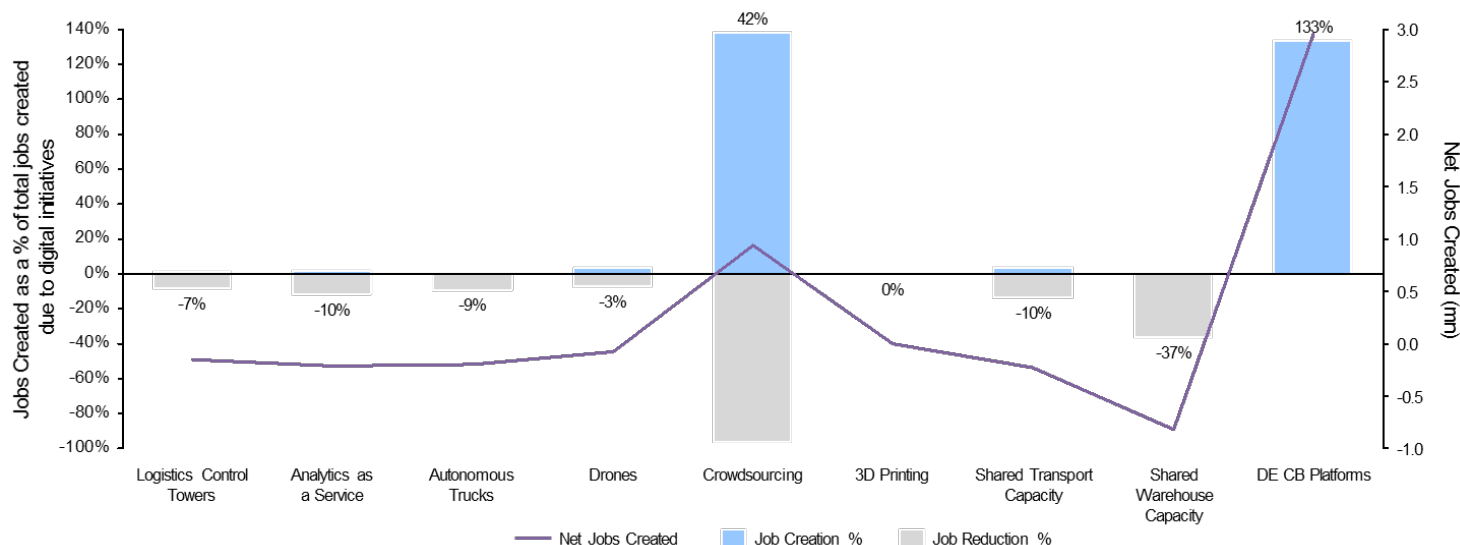


1. Those that will disappear (lost the race against the machine). For example, clerks and administrative staff, or truck drivers.
2. Those that are in collaboration with machines/algorithms (run with the machine). For example, those professions that rely on cognitive and social capabilities, such as doctors/surgeons.
3. Those jobs that are completely new or remain largely untouched (running faster than the machine or running a different race). For example, roles in the creative arts are unlikely to be automated, as are new roles that involve managing data and machines.

Within that context, our analysis suggests that digital transformation has the potential to create a significant number of jobs. Our value-at-stake analysis estimates that the overall impact of digital transformation across the industries we analyzed was a net gain of about 2.1 million by 2025.

But clearly there will be both winners and losers – as Figure 6 shows, while the net impact on jobs in the logistics industry could be positive, many sectors will experience job losses. There are initiatives that have high potential to create jobs – the implementation of digital platforms that enable cross-border trade, and crowdsourcing of logistics routes could together create 4 million jobs by 2025, equivalent to a net 8.4% increase in the number of people employed in the industry. Conversely, the adoption of newer delivery capabilities such as drones, autonomous trucks and shared warehouses means that many existing jobs will find themselves at risk.

**Figure 6: Digital Transformation of Industries – job creation in the logistics industry**



Source: World Economic Forum, Accenture analysis

## Challenges

Digital technologies fundamentally transform organizations, with the pace of technological change exacerbating the challenge. Organizations must have a coherent strategy that includes a plan to reskill workers. Whereas previous technological revolutions (most notably the Industrial Revolution) played out over a relatively long period of time, the speed of digital transformation is such that businesses need to move quickly.

For governments, the challenge is equally pressing. The potential inequality and wage deflation or even social unrest requires urgent action to prepare the workforce for a digital future.

### Case study: Singapore government and the SkillsFuture Credit portal

Since November 20, 2015, Singaporeans have had access to the [SkillsFuture Credit course directory](#) to explore the range of skills-based courses, which will be eligible for SkillsFuture Credit. The directory, part of the SkillsFuture Credit portal built by Accenture and launched on January 1, 2016, was released early to generate interest and enable eligible Singaporeans aged 25 years and above to plan their learning schedule. The courses on offer are funded and/or delivered by a range of key stakeholders including the Singapore Workforce Development Agency, institutions financed by the Ministry of Education, the Infocomm Development Authority's Silver Infocomm Junctions and other public agencies and prominent online course providers such as Coursera.

#### 1. A new digital divide? Patchy digital skilling strategies

The mismatch between the supply of and demand for digital skills has been widely acknowledged. Globally, Cisco has identified 1 million unfilled digital security roles.<sup>25</sup> The failure of education systems to meet the demand for digital skills is illustrated by the shortfall in graduates in STEM (science, technology, engineering and mathematics) subjects in certain countries (see callout). Recognizing the challenge, a number of governments around the world have launched their own digital skills flagship initiatives. However, it is not just technical skills that are needed. Increasingly, employees will need to differentiate themselves through activities that are hard to automate or codify. Skills such as creativity, teamwork and problem solving will be essential to find rewarding employment.

#### STEM: A deepening skills crisis

The shortfall in the number of suitably qualified STEM graduates from the education systems in many countries is being exacerbated by three factors:

##### 1. Women are underrepresented in STEM subjects

The skills crunch is exacerbated by the fact that women are currently underrepresented in STEM subjects, both in education and the workforce. Only 27% of current STEM graduates – and a mere 19% of majors in math, computer science and engineering – are women.<sup>26</sup> Women hold just one in four STEM jobs, although they make up almost one in two of the wider workforce.<sup>27</sup> Furthermore, the situation is not set to change quickly. In the United Kingdom, women currently make up 27% of the digital workforce (despite representing 47% of all workers), but this is expected to rise to just 30% by 2022.<sup>28</sup>

##### 2. Career changes by STEM graduates

Many STEM graduates decide not to follow a related career path, aggravating digital skill shortages in many economies. A study by Georgetown University found almost half of US STEM graduates were working in other areas just two years after graduation.<sup>29</sup> In total, there are 11.4 million STEM degree holders in the United States working in non-STEM industries; substantially more than the 277,000 annual STEM vacancies created each year.<sup>30</sup>

##### 3. A lack of mobility for STEM talent

In contrast to the shortages of STEM graduates in many countries, China and India continue to produce a healthy supply of STEM graduates. However, freedom of movement to countries with soaring demand for STEM talent is limited, through constraints based on family ties, language barriers and visa requirements, causing local shortages to persist.<sup>31</sup> These trends have led blue-chip technology companies such as Facebook, IBM and Microsoft to campaign for number of H-1B temporary visas, issued to skilled workers entering the United States, to be increased from 65,000 to 180,000 each year.<sup>32</sup>

### Case study: Italy's Ministry of Labor and Social Policy and 'Growing Up Digital'

The Ministry of Labor and Social Policy launched the project '[Growing Up Digital](#)' in collaboration with Google and Unioncamere in September 2015. The project offers the 84,000 young people who are members of the Youth Guarantee program the opportunity to deepen their knowledge and skills of digital through 50 hours of free online training. The training is delivered via [a dedicated platform developed by Google](#). The project also brings together young NEETs (not in employment, education or training) and companies: so far, 1,300 companies have joined the initiative and have offered paid internships to participants. As of November 13, 2015, almost 35,000 eligible young people have enrolled in the training course.

### Case study: French government providing access to MOOCs

In September 2015, French President Francois Hollande announced a [partnership](#) between the French Pole Emploi and OpenClassrooms allowing free access to MOOCs (massively open online courses), which was subsequently signed on October 15. All job seekers will be able to access more than 1,000 online courses in areas such as Web development, digital art and digital culture. Job seekers registered with Pole Emploi will also benefit from three months of premium membership.

## 2. New models of human-digital augmentation

Robotics and artificial intelligence systems will not only be used to replace human tasks, but to augment their skills. This, too, will provide challenges for businesses, which will need to reskill employees so that they can work effectively with new technology. Consider a surgeon who, with the aid of advanced robotics, can perform complex procedures with greater precision. This technology is already in play; robots from the da Vinci Surgical System were used in 570,000 operations around the world in 2014, covering a wide range of surgical procedures.<sup>33</sup> A surgeon working in this way will need a different skill set from that of a surgeon using more traditional techniques, especially the ability to work effectively with advanced robotics systems. To realize the full potential of technological augmentation, not just to increase productivity but to mitigate job losses from automation, reskilling will be critical.

### Five ways to get started

Organizations face a monumental task in tackling the twin challenges presented by the societal impact of jobs being displaced by automation and a severe shortage of digital skills. Given the scale of these challenges, we have not just recommended actions for companies to take alone but also initiatives to implement in collaboration with other stakeholders, ranging from industry peers to governments to non-government organizations (NGOs).

**1. Increase investment in digital skills development.** Companies should look to increase investment in the development of digital skills. According to a 2013 survey, no company spent more than 20% of its training budget on digital. In the same study, while 87% of businesses believed digital transformation to be a competitive opportunity, only 46% were investing in developing digital skills.

**2. Learn by doing.** Companies should look to prototype new technologies with employees to help understand and demonstrate the full potential of human-digital augmentation (see Airbus case study below).

### Case study: Airbus equipping employees with smart glasses

Airbus has simplified and speeded up the assembly of cabin seats by equipping its employees with Vuzix M100 smart glasses.<sup>34</sup> Instructions for assembling seats are relayed in real time, allowing people who are not skilled in seat assembly to learn on the job without reading a training manual. Accenture is looking to build on this proof of concept with Airbus and broaden its use in commercial aerospace and defense manufacturing.

**3. Explore new partnerships and innovative models for professional credentials, to find new ways of skilling.** Online education blended with classroom learning can provide a particularly powerful learning experience (see Udacity case study below). McAfee transformed its training program by adopting online platforms as its core teaching element and then dedicating classroom time to discussion-based exercises.<sup>35</sup>



#### Case study: Udacity partnering for course content ‘by Silicon Valley’

Udacity has already collaborated with industry leaders such as Google, AT&T, Autodesk, Cloudera, Salesforce.com, Amazon and Facebook to create course content “by Silicon Valley” that reflects the skills needed in the growing digital marketplace. With a view to improving the effectiveness of its MOOCs, Udacity has partnered up with a traditional learning institution (Georgia Tech) and AT&T to offer an online Master’s Degree in Computer Science – the first of its kind to be delivered through an MOOC platform.

**4. Collaborate with industry partners, academia and civil society to understand demand and supply for digital skills.** Businesses need to engage proactively with local educational institutions, government agencies and civil society organizations to devise common strategies for managing the transition to a digital workforce (see Alliance Industry case study below).

#### Case study: Alliance Industry 4.0 – preparing employees for digital transformation

In 2015, a number of companies, associations, research institutions and trade unions formed an alliance in the Baden-Württemberg region of Germany, which has traditionally been home to heavy industry (particularly automotive) and faces significant disruption from digital technology and automation in particular. A key concern of the alliance partners is to prepare their employees for the coming changes in their working environment. A specific working group has been set up to develop concepts to support employees and initiate specific training projects. Furthermore, the impact of new technologies will be explored jointly by research institutes and businesses.

**5. Shape educational curricula to include human-digital skills:** Businesses need to be more proactive in identifying future skills needs and working with policymakers to adapt educational programs accordingly. For example, the Confederation of British Industry (CBI) successfully campaigned for a redesign of the English school curriculum to promote computer programming in 2012. The government adopted their proposals, making coding a mandatory part of the primary school curriculum,<sup>36</sup> and it is now learned by 5 million children.<sup>37</sup> However, technical skills are not the only answer. In the longer term, teaching creativity, teamwork and interpersonal skills can help ensure that employees find rewarding work and get the best out of human-digital combinations.

*“Education can really help to alleviate the challenge of job losses; both in terms of up-skilling those at risk of automation and providing a meaningful occupation for people in the future”*

*Andrew Moore, Carnegie Mellon University*

#### Case study: United States ‘Upskill Initiative’ improving digital skills and capabilities

President Barack Obama has announced an Upskill Initiative that will partner with online education providers to develop digital skills in the workforces of participating businesses.<sup>38</sup> The initiative currently involves 100 companies that together employ more than 5 million people in the United States. The Upskill Initiative complements existing public-private programs in the United States, such as ALMMII, which brings together higher education institutions, manufacturing research laboratories, and businesses to train more than 1,000 students in the state of Indiana for new jobs in advanced manufacturing.<sup>39</sup> These public-private digital skills partnerships are also being implemented in developing countries. For example, Malaysia has brought together training providers and leading private-sector businesses to establish a program that will provide graduates with the digital skills needed to succeed in advanced R&D and high value-added technology manufacturing.<sup>40</sup>

## 6. Enabling the Transition to a Sustainable World

We have so far failed to decouple economic growth from emissions growth and resource use. The historic trend holds that for every 1% increase in global GDP, CO<sub>2</sub> emissions have risen by approximately 0.5% and resource intensity by 0.4%.<sup>41</sup> Current business practices will contribute to a global gap of 8 billion metric tons between the supply and demand of natural resources by 2030; translating to \$4.5 trillion of lost economic growth by 2030.<sup>42</sup>

But for the first time, the 21st UN Conference of the Parties (COP21) in December 2015 reached a legally binding and universal agreement on climate. The agreement aims to keep global warming 'well below' 2°C, with countries striving for 1.5°C above preindustrial levels.<sup>43</sup>

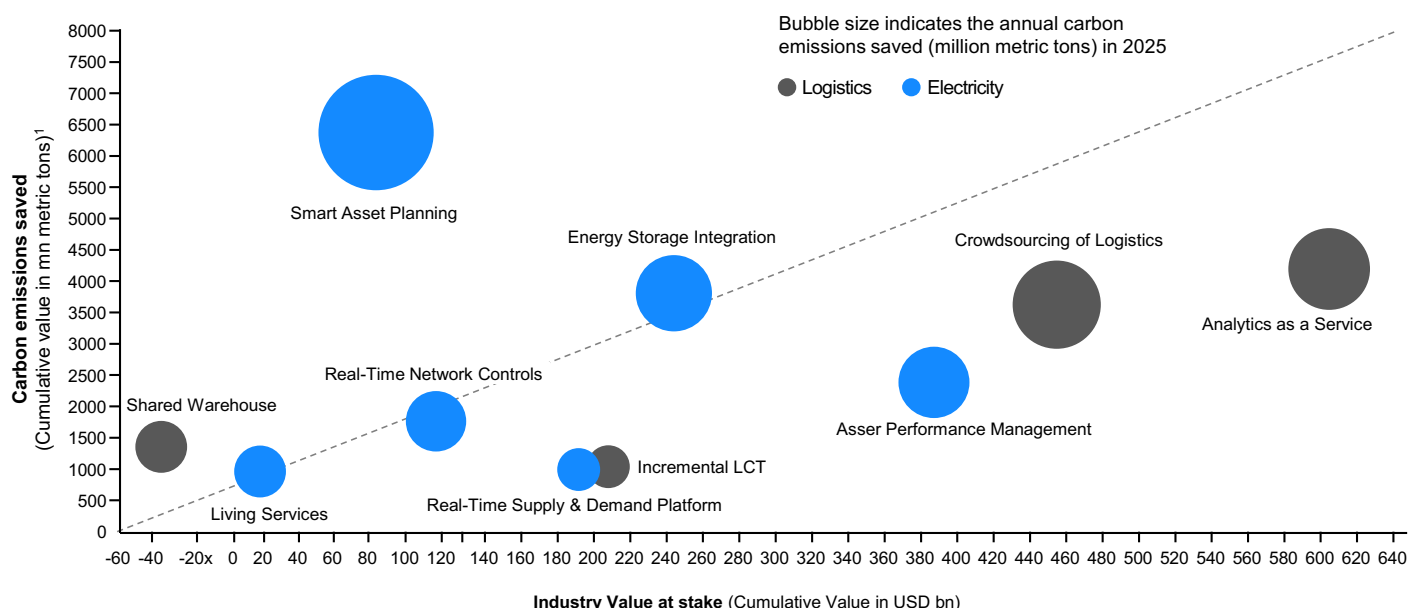
With increasing pressure on the world's resources and an urgent need to cut emissions, digital transformation can help set the world's economy on a sustainable footing.

### Boosting sustainability through digitization

What role can the digital transformation of industries play in meeting this challenge? Our analysis suggests that digital initiatives offer immense opportunity to help decarbonize the global economy (see Figure 7):

- There is the potential to avoid an estimated 26 billion metric tons of net CO<sub>2</sub> emissions from just three industries: electricity (15.8 billion metric tons avoided); logistics (9.9 billion) and automotive (540 million), from 2016 to 2025.
- This is almost equivalent to the CO<sub>2</sub> emitted by all of Europe across that time period, or the United States more than five times over (based on 2013 data).<sup>44</sup> By 2025, this would amount to 8.5% of global emissions.<sup>45</sup>
- In the electricity sector, if smart asset planning and management, and energy storage integration were universal, we estimate that up to 8.8 billion metric tons of CO<sub>2</sub> emissions could be saved by 2025, creating \$418 billion of new value for the economy.

Figure 7: Top 10 carbon-reducing initiatives



Source: World Economic Forum, Accenture analysis

In addition to our analysis, the Global e-Sustainability Initiative "GeSI" finds that digital technologies have the potential to reverse this 'high-growth, high-carbon' trend. With their framework also including the social and economic benefits of ICT, the GeSI 2015 report found that for each metric ton of CO<sub>2</sub> emitted by the ICT sector, it helps users save 10 tons.<sup>46</sup>

## Challenges

### 1. Digitization's growing environmental footprint

Digitization creates its own environmental damage; there are two particularly pressing challenges: growing quantities of e-waste and surging energy consumption by data centers.

*"The environmental impact of digital technology has grown rapidly; from increased consumption in terms of volume of content and number of people connected; as well as quantity of services. Businesses must think beyond the systems and infrastructure to address the environmental impact of this growth."*

**Julia King, Vice-Chancellor, Aston University**

#### a. E-waste

E-waste is growing, resulting in lost potential value from reusing or recycling devices, ever-growing mountains of landfill and increasing volumes of toxic chemicals being released into the environment. According to a United Nations study, 40 million metric tons of e-waste was discarded in 2014,<sup>47</sup> of which 7 million metric tons alone were from the United States and 6 million from China.<sup>48</sup> The American Environmental Protection Agency estimates that only 29% of e-waste tonnage was recycled in the United States in 2012.<sup>49</sup> Most of our e-waste is sent to developing countries, where improper recycling of e-waste is often carried out by poor workers in the informal economy. An International Labour Organization (ILO) survey<sup>50</sup> found that recycling workers were exposed to the inhalation and digestion of toxic substances and carcinogens (see e-waste case study).

#### Case study: Addressing e-waste and its hidden cost to human health

Most of our e-waste is sent to developing countries, where e-waste disposal and recycling is largely unregulated and informal. Improper recycling of e-waste, most often carried out by poor workers in the informal economy, can lead to significant health risks. This exposure can lead to breathing difficulties, coughing, pneumonitis, convulsions,<sup>51</sup> skin diseases, eye irritations and stomach disease.<sup>52</sup> India is one of the primary countries worldwide that takes e-waste for recycling, contributing to harmful levels of pollution. Approximately one sixth of all deaths in India, or 1.5 million people each year, are as a result of indoor and outdoor pollution. As a result of its poor air quality, India leads the world in deaths attributed to respiratory illness and asthma.<sup>53</sup>

*"Toxicity in the waste stream is still a significant risk, but something that is not being abated yet",*  
**Gary Cook, Greenpeace**

#### b. Energy consumption by data centers

Data centers contribute significantly to emissions due to their high power consumption and often inefficient cooling systems. Data centers currently consume 1.5% to 2% of global electricity, a rate that is growing at 12% a year.<sup>54</sup> Consumption is projected to increase to 140 billion kilowatt-hours annually by 2020. That would be equivalent to the annual output of 50 power plants and create carbon emissions of nearly 150 million metric tons of carbon annually.<sup>55</sup> With server racks processing data around the clock, data center operators face significant challenges in balancing energy efficiency with the right degree of cooling.

#### Case study: Technology companies leading the way in sourcing clean energy

Despite the significant challenges in managing the environmental footprint of our data, some leading companies are making great strides. In fact, 27 technology companies now use 100% renewable energy in their operations, including Intel, SAP, Datapipe and Motorola.<sup>56</sup> Apple sources 100% clean energy for its data centers and in 2015, announced a €1.7-billion plan to build and operate two data centers in Europe, each powered by 100% renewable energy. In addition, Apple has decreased the average total power consumed by Apple products by 57% since 2008, reducing their customers' electricity bills and carbon emissions by 350,000 metric tons of CO<sub>2</sub> in three years.

### 2. Barriers to scaling the circular economy

Progression toward the circular economy has so far been limited to pioneers and first-moving global companies. There are a number of barriers to widespread adoption; from the geographic dispersion of supply chains; to the complexity of



materials and deconstructing products. Digital and technology innovations are providing companies with the opportunity to overcome such barriers.<sup>57</sup>

*“The mind-set of companies must change if the circular economy is to scale. The values of collaborating, sharing and innovating is different to the culture many of these businesses grew up in”,*

*Kim Tjoa, Co-Founder FLOW2*

### Geographic dispersion of supply chains

Globalization and the increasing modularity of products, makes re-looping resources a significant challenge. As pointed out in a 2014 report by the World Economic Forum and the Ellen McArthur Foundation, a single power tool may have up to 80 components and be comprised of 14 raw materials, all sourced from different regions or countries.<sup>58</sup> Companies such as Nexia and Innoverne are using remote-control software to automate return logistics, in an attempt to address this barrier.<sup>59</sup>

### Complexity of materials

Separation of products and materials raises a key challenge, as much value is lost in smelting-based recycling processes. Take mobile phones as an example. Currently, just \$3 worth of precious metals (gold, silver and palladium) can be extracted from the device which, when brand new, contains raw materials worth about \$16.<sup>60</sup> Evolving engineering technologies, such as modular design and advanced recycling, are offering more cost-effective options for processing and recycling.

Digital technologies offer great potential to overcome barriers to scale. Machine-to-machine and data analytics enable companies to match the supply and demand for underused assets and products. ‘The cloud’, in combination with mobile and social media, can dematerialize products or even entire industries. Moreover, 3D printing creates opportunities for manufacturing inputs that are biodegradable.<sup>61</sup>

A barrier that digital technologies cannot address is the cultural norm around a ‘linear’ way of working, for instance as encompassed by the ‘lock-in’ of existing contracts, production facilities and assets. To succeed, circular economy principles must be embedded in the culture and leadership of a business.

### Case study: Emerging business models in the circular economy

Accenture recently published a book on growth strategies to move toward a circular economy. ‘Waste to Wealth’ presents five business models that will drive the circular economy:

- 1. Circular supply chain** introduces fully renewable, recyclable or biodegradable materials that can be used in consecutive life cycles to reduce costs and increase predictability and control. Leading examples include Natureworks biopolymers, derived from 100% renewable sources, and AkzoNobel’s paints and coatings made from bio-based materials.
- 2. Recovery and recycling** revives materials previously designated as ‘waste’ for other uses. Companies either recover end-of-life products to recapture and reuse valuable material, energy and components or reclaim waste and byproducts from a production process. Proctor & Gamble now operates 45 facilities on a zero-waste basis, which has created more than \$1 billion in value for the company over the past five years.
- 3. Product life extension** recaptures value that would have been lost by disposal. By maintaining and improving products through repairs, upgrades, remanufacturing or remarketing, companies can keep them economically useful for as long as possible. For instance, Panasonic operates a high-tech disassembly, reuse and recycling plant, now recycling around 700,000 products a year.<sup>62</sup>
- 4. Sharing platform** creates new business opportunities for consumers, companies and micro-entrepreneurs, who rent, share, swap or lend their idle goods. Fewer resources go into making products that are infrequently used, and consumers have a new way to both make and save money. Examples include Uber, Airbnb and Lyft among a growing field.
- 5. Product as a service**, where manufacturers and retailers start to bear the total cost of ownership, adjusting focus to longevity and reliability of products and building new relationships with customers. As an example, Philips has launched ‘pay by lux’ to charge for lighting by output instead of unit sales, Michelin now charges per kilometer for tires, moving away from tires as the end product.<sup>63</sup>

### 3. Consumer trust and adoption

Consumers must have confidence in digital technologies if the potential of digital to decouple economic growth from emissions growth can be realized. The 2015 Accenture Digital Consumer Survey found that by 2020, nearly half of consumers will own a connected Internet of Things (IoT) device, with strongest demand for home cameras and security, smartwatches and fitness devices.<sup>64</sup> There is significant potential for such devices to enable consumers to proactively manage their energy and water consumption, improve efficiencies and reduce utility bills. For such devices to scale, consumers must believe that their devices and data are secure and that their personal information will be protected.

#### Case study: Increasing consumer adoption of the connected home

Digitalization of the energy system is set to occur across the value chain; from smart grid infrastructure linking the grid to the customer; to digital customer services. A growing number of blue-chip vendors, such as Apple, Google, Samsung and Verizon, are partnering with hardware and software providers to offer a connected home service.<sup>65</sup> For the first time, customers will understand the peak periods when energy is more expensive and can change their usage accordingly – playing their part in better balancing the system. Smart thermostats, such as Google's Nest, or Hive from British Gas<sup>66</sup> collect usage and environmental data, thus 'learning' the user's behavior. However, customers are starting to raise concerns about offering their data when it comes to use of smart meters, thermostats and home devices, for instance on whether the data will be monetized.<sup>67</sup> While Nest have a comprehensive privacy policy, with partnerships being developed with lifestyle (Jawbone wristbands), home product (LIFX's smart lightbulbs) and even car companies (Mercedes-Benz)<sup>68</sup>, an effort to build trust will provide a license to operate in the connected home space in the long term.

#### Four ways to get started

**1. Embed circular economy principles.** To reduce their environmental impact and decouple future growth from resource constraints, organizations should embed circular economy principles in their business. For instance, by launching products that can be reassembled or recycled, offering services that optimize the use of existing assets, or creating collaborative platforms that link buyers and sellers (see case study).

#### Case study: Closing the loop on data and devices

**Brightstar** has resold close to 15 million used digital devices since 2009. Brightstar's program is one of the biggest in the world by volume and the largest in the world by geographic reach. Brightstar recovers more than 22 metric tons of printed circuit boards, 42 metric tons of screens and 35 metric tons of batteries every year. Their 'Buy Back and Trade In' (BBTI) program takes used devices from developed economies and markets them in developing economies, targeted at retailers and wireless operators.<sup>69</sup>

**Dell** implemented a major redesign across engineering, industrial design, procurement, logistics and marketing, to embed the use of post-consumer recycled plastics in its products. Dell has also developed the OptiPlex 3030, the first computer made using certified closed-loop recycled plastics. Working in over 78 countries, to help consumers find better ways to extend the life of their technology, Dell is also working to shape international standards and policies toward a circular economy.<sup>70</sup>

**Alcatel-Lucent** is a leading IP-networking, broadband-access and cloud-technology specialist, working to make communications more accessible worldwide. For over two decades, Alcatel-Lucent has been remanufacturing telecommunications equipment as an 'eco sustainable' alternative to manufacturing new equipment. Their 'Special Customer Operations' (SCO) unit use legacy equipment as a low cost alternative to new supply and these materials are blended into new customer orders as remanufactured products.

**2. Commit to transparency across operations, tracking assets and suppliers.** Digital technology can be used to better understand and therefore reduce the environmental impact of supply chains. By benchmarking potential suppliers, compiling corporate social responsibility scorecards and identifying improvement areas, companies can target the areas that will have the most impact (see Nike case study).

#### Case study: Nike managing impact across their supply chain

Nike developed an environment scenario tool that allows them to quantifiably assess the environmental and financial impact of changes to their supply chain; from using different materials to changing their sourcing. Before this tool was created, Nike had to manually calculate the impact of each change in their supply chain, which was time consuming and provided limited visibility, considering the complexity of Nike's 80,000 different material options and 1,500 vendors. Now, Nike can instantly see the potential impact over the next 10 years on the company's water, energy, CO<sub>2</sub> emissions, and waste impact, across the entire supply chain.<sup>71</sup>

**3. Collaborate to share excess capacity or waste streams across businesses and industries.** Businesses should look to platforms to optimize the use of existing assets or routes, or sell byproducts to a nearby waste-to-energy plant. In logistics, for example, businesses have a huge opportunity to reduce their environmental footprint through optimizing the value from existing routes (see logistics case study). Our value at stake analysis found that the value to society of crowdsourcing warehousing is worth 500 times its value to the logistics industry.

#### Case study: Reducing emissions through more efficient logistics

Crowdsourcing in the logistics industry (for instance for space in return trucks) could deliver almost \$1 trillion value to society, through helping the fragmented trucking industry improve utilization rates, in turn driving higher margins and leading to lower emissions. There are a number of businesses crowdsourcing logistics to make more efficient use of available capacity and thus reduce total driven miles. For instance, UberCargo in Hong Kong has a platform on which customers can place delivery contracts for private and corporate van and truck owners to fulfill.<sup>72</sup> In addition, DHL has launched MyWays. The customer adds a parcel using a tracking number and specifying the delivery address, then a third party finds the job through the app, picks up the parcel at a DHL service point and delivers it. The platform enables a better match of supply with demand, using third parties who are already on the road to deliver.

**4. Agree on both industry-level and cross-industry environmental standards for the IT sector:** Guidelines should cover appropriate disposal of e-waste, sourcing of clean energy, and improving the efficiency of data centers. While a number of companies have made significant progress in recent years, there is still a great opportunity for the technology industry to improve its reporting standards (see European Commission case study).

#### Case study: European Commission improving the sustainability of data centers

In 2008, the European Commission released a code of conduct for data centers, a voluntary initiative with 184 participants from businesses (such as IBM, BT, HP, Vodafone and Unilever) and the public sector (such as the United Nations).<sup>73</sup> The Code of Conduct establishes best practice and a framework of operation for the design, operation, maintenance and retirement of data centers. Participants must share energy meter and other data on an annual basis to ensure compliance and enable the European Commission to continually assess progress, set benchmarks and further develop the best practice guidelines.<sup>74</sup>

## 7. Building Trust in the Digital Economy

Digital technology has played a key role in driving transparency and trust. For example, organizations are using remote sensors and RFID technology to track their end-to-end supply chain, enabling more transparent business practices and enhancing product quality and safety. Social media has made it easier and quicker to share news of poor customer service or unpopular business practices to a global audience, putting more control over brand in the hands of individuals. The rise of the sharing economy and peer-to-peer websites (such as Airbnb and Uber) has enabled trust-based relationships to be developed with strangers from different backgrounds and locations, reinforcing positive behavior. In addition, public institutions have been able to open up traditionally closed processes (e.g., through participative budgeting and crowdsourcing policy recommendations), improving citizen engagement and transparency.

However, while still the most trusted of all industry sectors, declines in trust were seen across all technology-based industries in 2015, according to Edelman.<sup>75</sup> Privacy and security breaches have weakened trust in both technology products and the sector. According to an approximate estimate by McAfee, the costs associated with cybersecurity incidents amounted to \$575 billion in 2014.<sup>76</sup> Looking to the future, there is a broader set of issues playing out that threaten to undermine trust further and limit the ability of companies to innovate quickly. For example, ethical questions surrounding the use of data by organizations; the challenges of maintaining accountability in a world of algorithmic decision-making; and the impact on human capabilities of an increased reliance on machines.

*“People are no longer convinced that the incremental benefits of technological innovation are worth the price they are paying.”*

*Michael Stewart, CEO Edelman Europe and CIS*

How can the digital transformation of industries make a positive contribution to this challenge? Our value-at-stake analysis is providing new evidence of the potential benefits that can be delivered through digital initiatives. For example, by 2025 digital initiatives in the automotive industry could reduce the projected annual death toll from road-traffic accidents of more than 2 million by 10%, primarily through assisted driving and usage-based insurance. This could lead to an estimated \$1.8 trillion gain to the economy through reduced crash costs and insurance premiums.

However, these benefits must be set against the perceived risks and harms that attend such innovation. In this example there are concerns relating to the privacy of personal data, as well as the vulnerability of assisted-driving technologies to cyberattacks.

### Challenges

While digital initiatives may be able deliver emerging sources of value to society, these benefits need to be set against a wider understanding of the potential impact on consumers. If organizations want to ensure that digital transformation delivers its potential benefits, they will need to address these concerns.

#### 1. Institutional accountability

- **Concerns over privacy and security:** Data sharing can deliver many benefits to consumers and society more broadly, as highlighted above. Yet there are low levels of trust in companies keeping consumers' personal data private. A 2014 survey by the Pew Research Center found that only 11% of Americans were at least 'somewhat confident' that online video and social media sites would keep their personal data private.<sup>77</sup> Part of the challenge is the difficulty of segmentation of consumers by their attitudes to privacy, which are context-specific and defy generalization. But it's a challenge businesses need to address: nine in ten internet users in the United Kingdom and the United States would avoid doing business with companies that do not protect their privacy.<sup>78</sup>
- **Algorithmic governance:** Algorithms have been instrumental in delivering more personalized customer experiences and enhancing operational efficiency. But as we move to a world in which algorithms nudge individuals into specific behaviors, concerns have grown about the extent to which clear accountability structures can be maintained. Researchers at Georgetown University highlight that if a company uses an algorithm to identify potential recruits, but only selects young people, the algorithm will learn to screen out older applicants next time. Unless the programmers realize the potential for algorithms to adapt to human biases, such practices would continue.<sup>79</sup> Understanding where accountability lies for such decisions becomes a challenge.



*"We're in a Big Data Bubble. Over the long-run, CEOs will come to realize that collecting all this data will destroy more value than it will create once hacking breaches happen. Trust is the single most important pillar of digital transformation"*  
**Nico Sell, CEO Wickr**

## 2. Information asymmetries

- **Misunderstanding the 'freemium' economy:** Search engines and social media sites have connected populations, democratized knowledge and improved access to many essential services. However, they are also often maligned for the amount of customer data that they collect and monetize. Part of the challenge here is a disconnect or lack of transparency around the value exchange between customers and service providers. Reflecting this, a study by telecommunications company Orange found that 67% of European consumers surveyed believe that organizations benefit the most from using their personal data. Only 6% identify themselves as the main beneficiary.<sup>80</sup>
- **A lack of transparency and control over personal data:** Currently, businesses can manage their use of customers' personal data through terms and conditions or the 'end user license agreement' (EULA). However, in many cases these documents are difficult for the average individual to understand and invariably give the user few options for the ownership or management of their personal data.<sup>81</sup> One international study found that 63% of people do not fully read both documents on a website before accepting them.<sup>82</sup>
- **Online profiling:** Personalization and customer segmentation has been one of the key benefits to customers from digital business models. Yet there is a risk that profiling can have negative consequences, both intended and unintended. Researchers at Northeastern University found evidence of online price discrimination among several top e-commerce platforms, with significant differences in price, depending on variations in personal profile (such as zip code, mode of accessing website and shopping habits).<sup>83</sup> Beyond this, the increasing use of big data and algorithmic decision making could lead to more instances of individuals being deprived basic needs (such as housing, access to government services) on the basis of their online data profile.

A number of privacy-enhancing technologies are emerging that could help take the human decision making and ethical judgments out of data sharing processes.

### Case study: Ethereum – creating a digital governance system

**Ethereum** is a cryptocurrency platform that aims to allow a network of peers to administer their own user-created smart contracts in the absence of central authority.<sup>84</sup> This initial attempt to build a digital governance system includes services such as smart contracts, blockchain technology and autonomous banking.

### Case study: Wickr – providing peer-to-peer encryption

**Wickr**, established in 2012, is an instant messaging service that includes peer-to-peer encryption designed to secure all communications. Wickr already had 1 million users across 196 countries by 2014, and its technologies are enabling a range of new networks for both businesses and individuals. In 2014, it secured \$30 million in funding.

### Case study: DuckDuckGo – building trust through removing search history

**DuckDuckGo** is a search engine that users can access anonymously without their profile being shared. In early 2013, it handled about 1.7 million queries per day. Following the Edward Snowden revelations of government surveillance, the number of daily queries doubled in the second half of 2013. By early 2015, queries had reached more than 7 million.

## 3. Questions of digital ethics

- **Opinion-based value judgments:** Technology companies are being asked with increasing frequency to provide opinion-based value judgments in response to customer queries. While this level of joint decision making may indeed serve customers well, it also presents questions of trust and accountability. Where do the lines of liability and responsibility rest if consumers rely on decisions that cause them harm? The example of search engines points to a

broader set of ethical questions that will emerge in a world of machine-based decisions. For example, should an autonomous vehicle prioritize the safety of its occupants over that of other road users?

- **Human-digital integration:** A key feature of the future employment landscape is the prospect of humans and machines working in ever-closer harmony. This innovation promises to unlock new skills and capabilities within the workforce, driving productivity and efficiency. However, there are also ethical questions raised by this increasing interdependence. Will the use of robots lead to the enfeeblement of some human capabilities? Part of the challenge here is that a suitable framework or taxonomy for understanding the ethical issues raised by digital technology does not exist.

## Five ways to get started

Organizations face a considerable challenge to rebuild trust in the way that they use digital technology while also managing their own digital transformation. We have identified a number of key actions that enterprises can implement, either independently or in collaboration with other stakeholders, to help foster trust in digitalization.

**1. Measure the value of digital trust.** Businesses should develop valuation models to understand the risks and benefits attached to the use of new digital technologies, bringing fresh insight into how changes in stakeholder attitudes could impact financial metrics. Companies have already made progress in valuing trust and societal impact, providing a foundation on which new models can be built. Multidisciplinary expertise will be essential here – for example, bringing together data scientists with marketers, ethicists and sociologists who understand local norms, cultures and contexts.

**2. Improve transparency around data-driven business models.** Businesses should take steps to help consumers understand the dynamics of data transactions that may currently be opaque. Finding ways to develop a two-way ‘fair’ value exchange of data could help restore trust. For example, taking a cue from startups such as Datacoup or Tsū (see case study), active engagement with consumers on data monetization can help bring greater transparency and more trusted relationships.

### Case study: New business models that reward data-sharing

**Tsū** is an American online social networking service that differentiates itself from competitors by rewarding its users financially for the data they share on the site. It distributes 90% of its royalties gained through advertising revenue to its content creators and their networks, sharing the profits with its users. It also encourages users to donate their royalties to charities by using the ‘Transfer Funds’ button on each user’s wall. Tsū has experienced explosive growth reaching the milestone of 1 million users in five weeks. In comparison, it took Facebook 10 months to reach that number.

**Datacoup** is a New York-based startup that provides a marketplace for individuals to sell a feed of their personal data, such as social media activity and credit card transactions, to information brokers for a monthly fee. The idea is to give people the chance to make money from their information, while knowing exactly how all those details are being used, providing competition to big data brokers that sell their findings without affected parties knowing. Datacoup believes the market of data brokerage is worth around \$10 million. In 2014, Datacoup was paying approximately 1,500 users during its beta trial period, all of whom were making less than \$5.

**3. Collaborate with industry peers to develop best practice:** The areas of responsible use of data and digital ethics are highly emergent. It is often not clear what best practice looks like, should it even exist. Businesses need to take steps to create a safe forum in which challenges and success stories can be shared and replicated.

**4. Develop ‘data for good’ strategies.** Proactively demonstrating the positive impact of digital will help organizations to respond to concerns over how they are using digital technology. The example of usage-based insurance and its ability to reduce road deaths underlines how data can be used to make a tangible improvement to individual well-being. Beyond this, new partnerships can be established with researchers, NGOs and government agencies to explore the potential applications of data. More information about the World Economic Forum’s work on this topic is available [here](#).

**5. Form a multi-stakeholder consortium to collaborate on new norms and a code of digital ethics.** Businesses should collaborate with government and civil society to articulate a new code or taxonomy of digital ethics, creating a framework for organizations to understand the potential risks and harms associated with digital technology and data use. This should be made open-source, to encourage feedback and make it relevant for different regions, sectors and industries. It should also be multidisciplinary, enabling lessons and parallels from the fields of science and medicine.

With consortiums formed for the Industrial Internet, such as the Industrial Internet Consortium (IIC), the AllSeen Alliance and Open Interconnect Consortium (OIC), there are test cases to learn and build upon.

### Case study: Five principles of corporate digital responsibility

[Accenture research](#) identified five key principles that businesses should adopt in order to turn risks around the responsible use of personal data into opportunities for growth and differentiation:

- a. **Stewardship:** Managing digital assets in a way that meets the expectations of their stakeholders, especially as it relates to security and privacy. In what analysts believe could be a watershed moment for the industry, in 2015 Microsoft announced that customers in Europe would be able to store their data with a third party (Deutsche Telekom), addressing concerns about potential surveillance by US intelligence agencies if data was stored in America.
- b. **Transparency:** Increasing openness about the way companies use digital technology. A number of companies are opening up previously opaque data management processes to reassure their customers. For example, as one of the world's largest data brokers, Acxiom has data on 700 million customers worldwide with some 1,500 data points per person. In order to address stakeholder concerns about its database and build trust, Acxiom launched the portal [www.aboutthedata.com](http://www.aboutthedata.com) to show consumers records of their personal data.<sup>85</sup>
- c. **Empowerment:** Giving individuals greater control over data and using digital to improve decision making. For example, John Deere, a manufacturer of agricultural equipment, analyzes data on farmers' activity collected from sensors in its products and uses the data to advise farmers on how to improve crop yield. By doing so, the company is entering the precision-farming market, which is expected to grow by 12% annually and exceed \$4.5 billion by 2020.<sup>86</sup>
- d. **Equity:** Ensuring a fair return to customers in exchange for their data. Kreditech is a German startup whose business model is built on assessing credit risks. The company gives out small loans on the basis of personal data from social networks or e-commerce retail accounts. Since its launch in 2012, Kreditech has issued 1.5 million loans, rewarding customers for sharing more information about themselves.<sup>87</sup>
- e. **Inclusion:** Using digital assets in a way that enhances wider societal impact. In 2013, telecommunications company Orange worked with a think tank to map economic activity in Cote d'Ivoire using data on mobile signals and call patterns. Though initially designed to align urban development efforts with the country's economic needs, the effort also enables Orange to use the findings to refine its business operations in Cote d'Ivoire – and potentially commercialize the project's methodology in other markets.<sup>88</sup>

## 8. Recommendations

The digital transformation of industries can also help contribute positively to a number of areas that are of concern to policymakers. For example:

- **Employment:** The digital transformation of just two industries (logistics and electricity) could create a total of up to 6 million jobs worldwide between 2016 and 2025. Crucially, the overall impact of digital transformation across the industries we analyzed was a net gain of 2.1 million by 2025.
- **Emissions reduction:** Digital initiatives in the electricity, logistics and automotive industries could realize an estimated 26 billion metric tons of net avoided CO<sub>2</sub> emissions, helping facilitate the transition to a more sustainable economy.
- **Health and well-being:** If usage-based insurance/telematics solutions were to become mandatory in cars, approximately 1.1 million lives could be saved between 2016 and 2025.
- **Productivity:** Digital initiatives in the consumer industries are likely to reduce costs paid by consumers and improve productivity. Our analysis estimates up to \$3.1 trillion in productivity gains could be added to the global economy by 2025. This amounts to 338 billion hours, equivalent to 20 minutes of time saved per day for all US citizens over that time frame.

However, realizing this combined value for both industry and society requires concerted action by business leaders and policymakers alike. The following key questions can help point the route to success for digital and societal transformation:

### Questions for leaders of incumbent businesses

#### 1. Understanding the value at stake

- Are you able to measure and track the socioeconomic impact of your future digital initiatives? Do you include a societal component to your standard business case or investment appraisal for digital initiatives?
- Do you understand the key societal challenges and specific metrics/indicators that could be impacted – both positively and negatively – by your investments in digital technology? For example, do you understand how your digital initiatives contribute to the United Nations' Sustainable Development Goals?

#### 2. Finding new forms of future value

- How can you incubate digital initiatives that could, in future, deliver a high value to society and your business? Do you have a way of assessing whether to 'build' or 'buy' digital initiatives that could deliver high levels of societal value?
- Do you have a separate entity or vehicle within the company for incubating future growth initiatives?

#### 3. Driving growth through ecosystem orchestration

- Are your corporate affairs/corporate social responsibility functions aligned with your corporate strategy team to ensure that stakeholder insight and engagement acts as an enabler of growth? Are they able to demonstrate how they are contributing to your company's value levers through their stakeholder interactions?
- How do you identify the key stakeholder actions and contributions that are necessary to bring these initiatives into the 'sweet spot' of market forces and societal impact? To what extent do you have a real-time view of your ecosystem relationships and their current health/status?

### Questions for policymakers/regulators

#### 1. Scanning the horizon

- Are you actively identifying digital initiatives that could deliver significant value to society (e.g., economic growth, jobs, enhanced innovation) and engaging industry to put in place the right enabling conditions?
- How can you strike the right balance between avoiding 'picking winners' and helping promising initiatives that could benefit society significantly?



## 2. Setting the rules

- What policy tools could you use to incentivize industry toward digital initiatives that deliver value to society? Where could appropriate regulation unlock significant value to society?
- How do you define 'consumer interest' in a digital age – and what does this mean for how you assess the potential societal impact of new digital initiatives?

## 3. Building the right capabilities

- To what extent do you have the right talent to identify, initiate and manage multi-stakeholder collaborations in pursuit of industry and societal value?
- In what ways do you ensure the right level of knowledge sharing and learning about potential applications of digital technology by industry? What forums or platforms are needed to ensure the right level of industry-government dialog?

In sum, businesses have an important role to play in realizing the potential value of digital initiatives in society. Along with our targeted recommendations relating to employment and skills; trust and shared value; and the environment; there are three key traits that leading businesses will demonstrate. Firstly, businesses must develop a more consistent measurement of value and impact. Secondly, businesses will have an investment mechanism that incubates new initiatives to pursue societal and economic gains in parallel. Thirdly, improved alignment between corporate affairs and corporate strategy, with a clear role to manage the ecosystem of business, government and society.

The Digital Transformation of Industries is a multi-year initiative and will continue to provide insight into these dimensions in 2016 and beyond. The World Economic Forum believes it is uniquely placed to convene the right protagonists to spark multi-stakeholder collaboration, especially where there is no incentive for first movers. Societal value creation will continue to underpin the topics we prioritize over the coming years. Moving forward, our analysis and framework will be refined and improved – and we welcome input from business, government and civil society.

## 9. Acknowledgements

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