



TARGETING THE FULL VALUE OF DIGITAL DISRUPTION

Innovating business models for capturing value from new technologies

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Prologue

The first significant wave of digital disruption centered on internet enabled platforms that facilitated transaction, interaction and exchange of value between participants (such as e-commerce). Advancements in mobile, cloud, and analytics, resulted in the rapid expansion of these platforms and more personalisation of offers. The platform companies that emerged from this shift captured significant value by monetising direct access to the customer and leveraging the benefits of network externalities, often by acting as intermediaries within ecosystems.

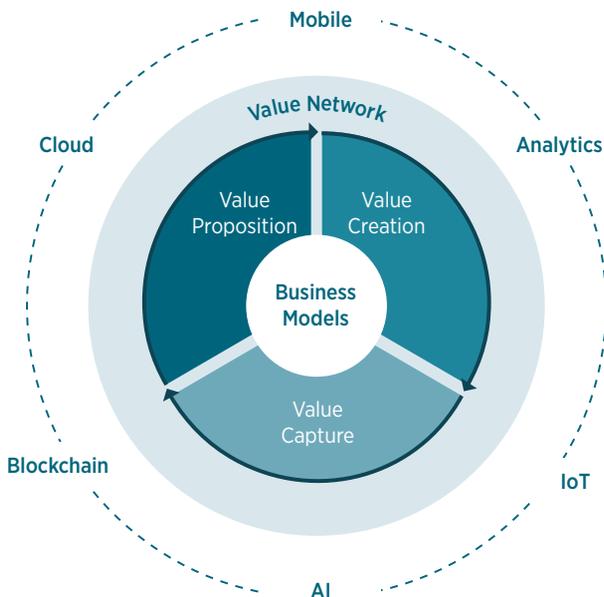
The maturity of cloud, analytics and mobile is now matched with the progress in IoT, AI & blockchain. Collectively these newly emerged technologies are changing the economics of industry value chains from end to end and are impacting every component of business models, the value proposition, value creation, value capture and value network (See Exhibit 1). The convergence of these technologies is driving further expansion of ecosystems and blurring of industry borders, enabling new value propositions and value creation opportunities across industries whilst creating new sectors. Together, these new digital technologies are creating intelligent engines that enable augmented human intelligence, autonomous decision making, more efficient machine-to-human interactions, and optimisation of systems in real time. The potential economic impact from

this “second chapter” of digital disruption is significant but often hard to quantify.

In search of value, firms across industries have been growing their investment in digital technologies (see Exhibit 2) but are challenged in targeting and capturing the full value potential. Most digital initiatives from these newer technologies have been focused on incremental product improvements and operational efficiencies. This is likely because firms can realise the benefits of such initiatives faster and can use well-established cost take-out KPIs to set targets and measure success. The impact from these cost-savings and productivity-gains will be significant - in the US we estimate that this will amount to \$1.8 trillion on average per year over the next 10 years.

However, efficiency gains represent only a portion of the value potential, and will not be evenly distributed across sectors. The real disruptive value of digital is in the emergence of new value propositions and associated business models which could contribute to significant growth and innovation. Companies that have been focusing their digital investments in both operational efficiency initiatives as well growth and innovation through new platform based business models have generated close to \$3 trillion of value in the past decade (see Exhibit 3).

Exhibit 1: Business model components: 4Vs



Source: Velu, C. Coopetition and Business Models, Routledge (2018) ¹

Exhibit 2: Industry spend in digital technologies

	Utilities	Manufacturing	Healthcare
IoT	23%	28%	20%
Cloud/Analytics	24%	23%	18%
Cognitive/AI	37%	34%	37%
AR/VR	96%	127%	49%
Blockchain	71%	77%	71%

	Financial Services	Retail	Transportation
IoT	52%	22%	17%
Cloud/Analytics	24%	16%	22%
Cognitive/AI	36%	41%	37%
AR/VR	70%	119%	234%
Blockchain	76%	75%	71%

Forecasted Annual Spend 2022

VERY HIGH	\$15Bn+
HIGH	\$10Bn - \$15Bn
MEDIUM	\$5Bn - \$10Bn
LOW	\$100Mn - \$5Bn



Source: IBM and Cambridge research and analysis

Our belief is that the second chapter of digital will disrupt a far broader set of business models than we have seen before. The next wave of digital technologies will impact every component of a company's business operations – eliminating costs, improving decision making and reinventing the economics of many industries. The combination of IoT, AI and blockchain, in particular, could enable strong network effects, whereby an established leader can drive a virtuous circle of adoption resulting in improved capabilities and economics. As such, it is imperative for organisations to assess value creation and capture opportunities through new value and expanded value networks, and innovative value propositions to quantify a value target for their business, and to form their ambition for digital.

From our research on digital business model innovation, and our experience of managing digital transformation efforts for enterprises across the globe, we make the following practical recommendations for how to increase the likelihood that digital transformation efforts are successful in targeting the full value potential. (See Exhibit 4)

The steps to targeting full value potential include:

1. Confirm your organisational ambition by mapping and reimagining your ecosystem and your value chain.
2. Identify opportunities and define initiatives across every component of the business model and make deliberate choices in prioritising them into a value roadmap.
3. Conduct a digital capability assessment to develop a capability roadmap in support of the value roadmap.
4. Align and engage the organisation behind the ambition and the value roadmap; shape a programme with strong governance.

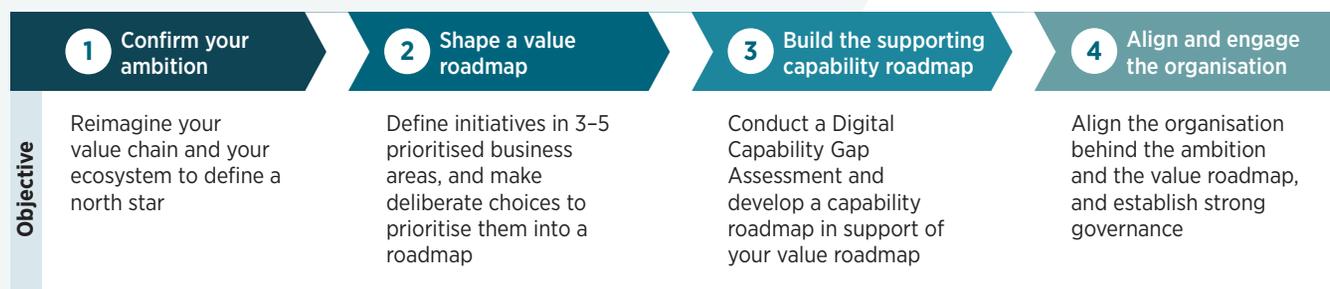
Exhibit 3: Market cap growth of platform companies

Market capitalisation 2008 – 2018 (\$Bn)		
Company	2008	2018
Apple	\$72	\$890
Google	\$100	\$768
Microsoft	\$333	\$680
Amazon	\$24	\$592
Facebook*	\$71	\$545
Total	\$600	\$3,475

* Listed in 2012

Source: Stockrow.com²

Exhibit 4: Four courses of action to target maximum value



Section 1: The unprecedented value opportunity

Early applications of digital technologies stressed digitising enterprise data so that it could be electronically manipulated and easily connected to drive productivity. The first real wave of disruption, however, was centered around platforms (such as e-commerce) that facilitated transaction, interaction and exchange of value between participants. E-commerce websites increased consumer power, shifted value closer to the consumer, and changed consumer experience. Sophisticated analytics augmented the transactional data from the e-commerce websites and made recommendations for more personalised offers and experiences. With advancements in cloud, analytics, and mobile, these platforms expanded rapidly, enabling new and disruptive business models and human experiences. Cloud allowed quick and low-cost deployment of the e-commerce and other software platforms globally and accelerated advancement in analytics. Transformation of these platforms into mobile enabled more innovative customer experiences, more engagement and further personalisation. Platform-based companies, and companies that adopted these technologies created significant value for all their stakeholders: shareholders, employees, and customers. The retail sector provides a clear example of how digital disruptors created significant value through business model innovation. In the past decade, top 10 retailers in the US grew revenues at a

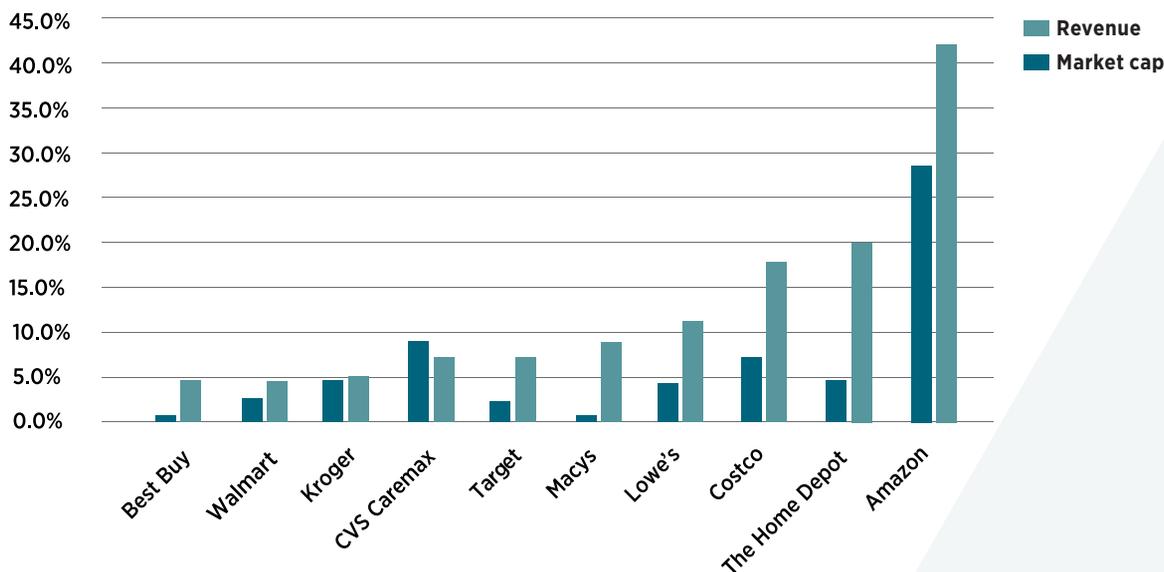
compound annual growth rate (CAGR) of 5.4%, while their market capitalisation grew at a CAGR of 15.9% to \$1.56 trillion. 63% of this market cap value was attributed to Amazon alone (see Exhibit 5).

The next wave of disruption involves more widespread use of digital technologies across entire value chains and across more sectors, and further expansion of platforms and ecosystems. IoT and AI together are enabling significant optimisation opportunities across the value chain: in supply chain, operations, and distribution (see Exhibit 7 on page 8).

Digital technologies are also causing dislocation and disintermediation of players in the value chain. IoT can create a digital view of most physical systems, enabling real-time monitoring and management of such systems. Cloud allows for aggregation and analysis of this data at scale and cost-effectively, and the application of AI to the vast data that IoT-enabled physical objects produce allows for improved and autonomous decision-making, automation and optimisation. Blockchain, IoT, and cognitive/AI technologies enable expansion of ecosystems and business platforms amongst competitors and beyond industry boundaries, further shifting value across the network of stakeholders.

Exhibit 5: US top 10 retailer market capitalisation vs revenue CAGR (2008-18)³

Top 10 US Retailers :
Total Market Cap in 2018= \$1,569bn, CAGR of 15,9%
Total Revenue in 2018 : \$1,523bn, CAGR of 5.4%



Source: Company annual reports and investor relations websites

The following examples demonstrate how digital technologies are resulting in innovative business models through extended value networks, and how they render some business models and players in the value chain irrelevant.

The Food Trust blockchain is an example of an industry partnership that improves transparency and efficiency across the entire food supply chain. This ecosystem includes retailers (Walmart, Kroger, Dole, Nestle, Tyson Foods, Unilever and others), growers, distributors and more, who collaborate to improve food safety by pinpointing contamination sources. Walmart is now able to trace food-based products back to the original source within 2.2 seconds. Each new supplier or distributor entering the Food Trust creates more value for all members; suppliers get access to a broader network of consistent demand, and distributors get access to a larger variety of supplies with diminishing costs.

Industry partnerships and co-opetition business models are emerging across more and more industries (see Exhibit 6). The rationale for co-opetition-based business models could be to increase the size of the current market, to create new markets, or to increase efficiency in resource utilisation in order to help

improve the firms' competitive position (Ritala et al., 2014, Velu 2018)^{4,5}.

Another example shows the cost of being left behind with a business model that has been superseded: American Tire Distributors, the largest distributor of tyres in the US, filed for Chapter 11 bankruptcy in 2018⁶. Their position in the value chain was disintermediated after the two of the largest tyre manufacturers in the US (Goodyear and Bridgestone) decided to go directly to consumers through their own networks, and Sears Holdings Corp. agreed in a partnership to install tyres bought on Amazon.com.

Adopting digital technologies and in particular becoming an intelligent enterprise is an imperative, not a choice. Digital technologies enable new value propositions, and new value creation and value capture opportunities, and extend value networks. As such, organisations should search for and assess the value potential not just in delivering the same value proposition more efficiently, but also in new value propositions and associated business models.

Exhibit 6: Co-opetition examples

Industry example	Value proposition	Value creation	Value capture	Value network
Electronic trading and bond markets - revolutionary business model innovation	Enable direct trading between investors in order to reduce costs and improve timeliness of trades	Banks provide credit guarantee for the trades	Banks charge a fee for acting as credit guarantor	Dominant banks cooperating in order to change the structure of the market in a revolutionary manner
Electronic book retailing - Amazon Marketplace	Enable customers to buy either new or used books from Amazon or its competitors by comparing them on a single page	Consolidating Amazon and third-party books on a single store page and providing comparisons of ratings, shipping costs, and returns policy	Amazon earns the margin on its own inventory and charges a commission on the sale of third-party products	Cooperate with competitors by enabling them to list books on the Amazon Marketplace website
Film and television distribution - Netflix	Enable customers to view Netflix, or competitor produced media content, on demand, for various platforms (tv, computers, tablets, etc.)	Offering a curated catalogue of films and television series available via web browser	Netflix earns a margin on licensed content through low distribution costs for an immense number of repeat subscribers	Cooperate with competitors to develop new content, which increases engagement for current subscribers and attracts prospects

Source: Ritala (2012); Velu (2018) and Cambridge and IBM research and analysis

Exhibit 7: Digital adoption trends in supply chain, operations and distribution



Source: IBM and Cambridge research and analysis, IBM Institute for Business Value⁷

Section 2: Challenges in estimating and measuring the value

Estimating and measuring the impact, and as a result maximising value, from digital technology investments remains a challenge for most enterprises. For businesses, improved profitability and productivity are often used to measure impact of digital initiatives. Digital technologies can increase profitability by reducing a wide range of costs across the value chain. These technologies are streamlining supply chain activities through integration, automation, tracking and better forecasting. They are also driving significant operational efficiencies through improved equipment utilisation, increased labour productivity, and enhanced monitoring and management. In distribution they help remove steps and activities between customers and how they use goods and services.

In spite of the prevalence of digital technologies, in aggregate there seems to be a persistent slowdown in productivity growth that has plagued modern economies for the past 10 years. This is widely known as the 'productivity paradox'. There are many possible reasons for the productivity paradox, including the impact of the financial crisis, the lack of diffusion of the benefits of digital technologies among small and medium sized enterprises, and mismeasurement of the digital economy. However, we posit that siloed approaches and too much focus on operational efficiencies and the lack of business model innovation following the adoption of digital technologies might be a major contributor to the productivity paradox.

The impact of cost optimisation-focused initiatives can be measured more easily with traditional KPIs (such as headcount reduction, energy costs, defect rate). On the revenue side, incremental revenue is mostly driven through a shift to more services, and productivity of the sales channels. But estimating revenue impact, and specifically new revenue streams, is more difficult. While digital channels may provide new mechanisms for

serving customers, distinguishing between new revenues and shifts across channels, or shifts between market competitors, especially between incumbents and new entrants, is more challenging.

Estimating the value of new ecosystem value propositions is even more challenging. In estimating value from extended ecosystems and new business models, such as data monetisation schemes, it is often unclear who actually captures the value. It is also usually hard to estimate how much value will be created, how much value each participant contributed, and how their contributions to the value pie changes over time. Companies that invested in digital technologies for operational efficiency but left money on the table by not thinking about innovating their offers were disrupted. New players such as Apple and Google entering the automotive industry with self-driving cars were disruptive to the incumbent automobile manufacturers who put their focus on significant operational efficiencies in their manufacturing and supply chain, causing them to play the hard catch up game. On the other hand, companies that started with the operational efficiency to create momentum and funds for their longer-term innovation-focused initiatives disrupted the market. Adidas has been on the cusp of utilising mobile and cloud to help distribute and market its products for a decade. Then more recently the company has reinvented its supply chain by leveraging additive manufacturing (3D printing) to develop its new Futurecraft 4D shoes⁸. These were developed in Adidas's new SpeedFactory and were sold out when it was showcased at pop-up stores in New York in January 2018.

Despite the challenges in estimating and effectively measuring value of new propositions and associated ecosystems, leaders are not just investing in one-off operational efficiency initiatives. Leaders are adopting a holistic lens on the possibilities, and are assessing new value propositions, and new ways of delivering the

Exhibit 8: Amazon diversifies its investments well beyond operational efficiencies⁹

Operational efficiencies	New products and services	Ecosystem economy	Autonomous economy
 <ul style="list-style-type: none"> • Warehouse robots • Amazon robotics 	 <ul style="list-style-type: none"> • Home automation data • Amazon Echo, Ring 	 <ul style="list-style-type: none"> • Smart fridge restock • Amazon Dash • Replenishment 	 <ul style="list-style-type: none"> • Autonomous delivery • Amazon Prime Air
<p>Use a fleet of inventory scanning, sorting, shifting, and packaging robots to reduce labour costs associated with daily warehouse operations</p>	<p>Alexa is learning about consumer, and further personalises interactions and offers. Homes have been penetrated by smart speakers, cameras, alarm clocks, mirrors and help extract the consumer data Amazon sells to others</p>	<p>Based on consumption habits and inventory, Amazon restocks fridges by delivering items at the moment of depletion</p>	<p>Amazon will attempt to provide a fully autonomous retail experience. Based on various sensor data items are purchased and delivered without any human involvement</p>

Section 3: Impact on sectors and value chains

To estimate the potential impacts of five core digital technologies (mobile, cloud/analytics, IoT, cognitive/AI, blockchain), we developed a value chain-based model. Value chains vary by sector, and even by company, but most commercial value chains have similar structures. We estimate \$1.8 trillion average annual value chain cost reduction opportunities from the 5 emerging technologies, over the next 10 years and just in the US (see Exhibit 9) (see Appendix A for methodology).

We estimated total impacts by cataloging how each technology could transform individual parts of each sector's value chain. (See Appendix B for sector value chain taxonomies) We assessed current and planned uses of emerging technologies for leading firms in each sector. We then mapped where in the value chain these technologies were being applied, and how they would create value, and documented any publicly disclosed estimates of the potential value or already delivered value. The full encyclopedia of unique use cases documents over 200 distinct applications (see Exhibit 10 for examples).

Exhibit 9: Estimated value chain impact



Exhibit 10: Use case examples

Audi	Kroger	Kiwi Rail	Oncor
Modular assembly with robotics¹⁰	Analytical customer monitoring¹¹	Predictive maintenance for rail¹²	Reduce outages through cognitive AI¹³
Target 20% productivity improvement	USD 250 million in labour savings. Target roll-out to 2400 stores	6% operational efficiency amounting to €20M per year	Reduced outages, improved service
<ul style="list-style-type: none"> IoT in the form of connected modular workstations transforms auto production lines Autonomous robots bring parts and equipment to workers on demand Workers are outfitted with barcode scanning gloves and AR headsets to guide the assembly 	<ul style="list-style-type: none"> Infrared cameras monitor checkout lanes and identify number of customers waiting in real time Historical data is then combined with the real-time queues to alert supervisors Optimal allocation of workers throughout the store in real time 	<ul style="list-style-type: none"> Captures detailed information shared in near real-time and allows supervisors to conduct predictive maintenance work Productivity of maintenance crews doubled and led to 83% faster generation of compliance reports 	<ul style="list-style-type: none"> AI applied to complex geospatial and time-based datasets collected by satellites, flights, IoT sensors and weather models AI applied to prioritise high-risk areas, and adapt maintenance operations to improve safety and reliability
Sources : Audi Group, AutoGuide.com, IBM and Cambridge research and analysis	Sources : Kroger, Business Insider, IBM and Cambridge research and analysis	Sources : Kiwi Rail, IBM and Cambridge research and analysis	Sources : Oncor, IBM and Cambridge research and analysis

While emerging technologies will impact all sectors, the value they create will not be evenly distributed. The amount of impact depends on a variety of factors including, but not limited to, which parts of the value chain are affected, which technologies dominate, and the speed with which different industries drive successful adoption of digital technologies. We have done a 'bottom-up' estimate on several sectors in order to see how different the impact could actually be (see Exhibit 11).

We focused our attention on five technology areas for estimating the impact of digital technologies going forward. (See Exhibit 12) Our analysis is showing the lower bound of the value because there are significant opportunities for digital technologies to create value from new business models that are not fully considered in our impact analysis.

Exhibit 11: Estimated technology impact potential by industry sector

	Retail	Auto	Hospitality	Healthcare	Electric Utility	Oil Refining	
Mobile	Moderate	Disruptive	Substantial	Disruptive	Disruptive	Substantial	Impact level (costs reduction) Disruptive 2.5 - 6% Substantial 1 - 2.5% Moderate 0 - 1%
Cloud/Analytics	Substantial	Substantial	Disruptive	Substantial	Substantial	Substantial	
IoT	Disruptive	Disruptive	Substantial	Disruptive	Substantial	Substantial	
Cognitive/AI	Disruptive	Substantial	Disruptive	Disruptive	Moderate	Moderate	
Blockchain	Disruptive	Substantial	Moderate	Moderate	Moderate	Moderate	

Source: IBM and Cambridge research and analysis

Exhibit 12: Selected technology groups



Blockchain
Hyper-ledger payments; advanced record keeping system



Cognitive and AI
Machine learning apps; automated decision-making systems; image and pattern recognition software



Internet of Things
Internet-connected devices; sensor-based tracking; smart equipment and devices



Cloud & analytics
Cloud-based infrastructure; statistical analysis



Mobile
Mobile phone applications; tracking and beacon technology; AR/VR

Section 4:

Recommended courses of action

Our value chain-based macro model predicts which sectors will realise the most value from digital, and which technologies will drive the most impact. For an individual enterprise, understanding how the industry value chain might get disrupted, identifying value opportunities from a technology or group of technologies, developing a value case, developing a clear vision and actionable plan, developing the capabilities to execute, and engaging the organisation to execute all create hurdles to success.

The CEO and the leadership team must prepare the organisation for a journey, and must answer three key questions to maximise business value from new digital technologies: 'How do we begin?' 'Where do we want to go?' and 'How do we get there?'

We recommend the following steps:

- Confirm your organisational ambition and define a "north star" by mapping and reimagining your ecosystem and your value chain.
- Identify opportunities and define initiatives across every component of the business model and make deliberate choices in prioritising them into a value roadmap.
- Conduct a digital capability assessment to develop a capability roadmap in support of the value roadmap.
- Align and engage the organisation behind the north star and the value roadmap; shape a programme with strong governance;

1. Confirm ambition

Start by mapping and scanning your value chain and ecosystem and developing a comprehensive and fact-based understanding of how your customers are changing. Use the 'Design Thinking' framework to re-imagine how ecosystems might be expanded, what work-steps can be removed across your value chain, how workflows can be accelerated, and in what new ways customers can be delighted (see Exhibit 13). Based on what you uncover, devise appropriate strategic approaches, and assess if your organisation should look at new value propositions and new value networks, or should focus on delivering the current value proposition more effectively and efficiently.

Exhibit 13: Steps for confirming ambition

- Map your ecosystem, assess expansion opportunities. Extend your view to movements in adjacent markets and cooperation opportunities.
- Map your value chain and re-imagine how technology can be applied to remove steps, accelerate workflows, drive effectiveness.
- Use data to develop a comprehensive understanding of how your customers are changing.
- Look outside your industry, assess risks of players crossing industry lines and how value is created in similar industries.
- Use Design Thinking to re-imagine your value proposition, your ecosystem and your value chain.

Confirm ambition

Decide whether emerging technologies will be used to drive optimisation or if they should span to include new value proposition and new ecosystems.

2. Shape a value roadmap

Based on your top-down assessment of where digital technologies could provide benefits across your value chain, you have a sense of how you can shape and extend your ecosystem(s) and you know what your customers need or want. Prioritise three to five business areas to make your efforts more focused and targeted (see Exhibit 14). Conduct a bottom-up assessment to confirm opportunities and define initiatives and for each initiative estimate value, cost, time to value, dependencies, and other factors.

Using the chosen set of criteria, prioritise and sequence these initiatives into a value roadmap. Consider three guiding principles in prioritisation:

- Adopt a balanced mix of initiatives between operational optimisation and new value propositions, even if your ambition is new value propositions, in order to deliver the customer experience.
- Lack of speed and momentum kills transformation. Prioritise opportunities with short time to value to build momentum.
- Self-funding programmes don't get stalled. Prioritise initiatives, for example inventory optimisation, that drive capital efficiency and release cash quickly to make your programme self-funding.

A prioritised, sequenced, and detailed set of digital initiatives with their value case tied back to business value lever becomes your strategic value roadmap.

Exhibit 14: Steps for shaping the value roadmap

- Prioritise three to five business areas based on your top-down assessment of the value chain, ecosystem, industry and customer needs and wants.
- Conduct a bottom-up assessment in these business areas to confirm opportunities, define initiatives, create use case inventory.
- Develop a value case for the initiatives, and make deliberate choices in prioritising and sequencing them into a value roadmap.
- Consider three key guiding principles:
 - Adopt a balanced view between short & long term, and operational efficiencies and new value propositions.
 - Prioritise initiatives with short time-to-value to build momentum.
 - Prioritise initiatives that drive capital efficiencies, and can release cash quickly to make the programme self-funding.

Share a value roadmap

A prioritised, sequenced, and detailed set of digital initiatives with their value case tied back to business value lever becomes your strategic value roadmap.

3. Build the supporting capability roadmap

Successfully bringing new digital technologies into your value chain will require a set of foundational capabilities. These capabilities include, but are not limited:

- Extensive data capabilities, focused on expanding ecosystem and orchestrating connections from across your industry, and beyond
- An insights engine to apply intelligence to the data to drive better decision making, automation, and insight-driven product innovation
- Innovation engine that enables fast execution, and consists of interdisciplinary teams and fluid work structures to enable collaboration
- Ecosystem partnership frameworks and value share models to allow expansion and monetisation of ecosystem partnerships
- Culture of agile innovation
- Value orchestration to monitor and manage value realisation, and ensures that the value roadmap does not stay static

Conduct a capability assessment of the foundational capabilities to develop a roadmap and prioritise capability development inline with your value roadmap. In provisioning the digital capabilities consider third parties in providing and enabling complementary assets, as digital changes the traditional make-buy logic.

4. Align and engage the organisation

Digital transformation requires empowering and engaging the whole organisation. The strategic value roadmap is a key resource for executing your transformation and should be a central part of communications and change management efforts that need to accompany digital transformation. Staff can quickly become focused on the one digital effort that involves them directly, but the roadmap enables them always to see how their efforts contribute to larger goals.

Establish a strong governance committee from the beginning to engage leadership in shaping and approving the strategic value roadmap, and in taking an active role in driving awareness and empowerment. Confirm the organisational ambition and the value roadmap with the governance committee, focusing on continuous communication and awareness.

Appendix A:

Approach in assessing value chain cost reduction impact of five emerging technologies

- 1. Identified sectors of the US economy** across the digital maturity spectrum with minimal overlap of business operations (e.g. auto is a subset of the larger manufacturing sector, but auto and oil refining have minimal overlap).
- 2. Identified the market size for each sector.** Used US revenue or net sales (excluding pass through sales) of a representative sample of companies operating in the sector to assess the total size by revenue of the sector. Ensured that the companies in the representative sample bucket did not have operations across multiple sectors of the US economy (e.g. Amazon is a retailer but also a software company through its Amazon Web Service product offering).
- 3. Estimated the market size over next 10 years.** Historical performance of the sector adjusted for recent macroeconomic events coupled with demographic changes and impact due to innovation in complementary sectors (e.g. impact on oil consumption over 10 years under scenarios of moderate to rapid progress in electrification of personal transport) is used to estimate market size.
- 4. Evaluated the cost structure of the sector** and prepared an income statement of the sector. From the income statement derived insights on true cost structure and margin (gross and operation). Assessed impact of discount pricing as part of marketing expense to improve reported revenue numbers and update the cost structure evaluation.
- 5. Derived true cost structure of the industry** by evaluating major cost components (i.e. direct and in-direct costs such as cost of goods and overhead costs vs accounting costs such as research and development). Estimated the true cost and margin for the sector.
- 6. Developed value assessment model and assessed value from cost reduction** for each digital technology for a given sector. The model takes as input the maturity of the digital technology across the true cost structure components of the sector (e.g. adoption of IoT across supply chain and distribution components of the cost structure). The cost saving potential of the digital technology for each sector across all the components of the true cost structure was then assessed over 10 years based on comparative analysis and on benchmarking analysis of the sector versus the wider US economy. Comparative analysis used a reference from another sector where a given digital technology has delivered benefit. The benefit was then adjusted by applying sector knowledge and insights. Benchmarking provided a comprehensive way to map a sector's position in terms of digital adoption and cost efficiency maturity in relation to other sectors. This helped to set upper bounds on the cost reduction possible within a given sector using digital technologies.
- 7. Key considerations used in developing the value assessment model**
 - a. Cost reduction for one sector is revenue impact for another sector – estimate of cost reduction must factor in lower revenue and hence lower direct and indirect costs for the sector due to cost reduction in upstream sector (e.g. cost reduction in retail will impact revenue estimate of manufacturing or logistics sector). A model that captures cross-sector economic forces and incentives is key to assessing realistic cost reduction potential.
 - b. Maturity of digital technology within a sector will determine time to value of cost reduction – each sector may require specific solutions within a digital technology family (e.g. current mobile technology might be enough for banking industry to reduce costs for next 10 years at a steady rate but AI and IoT will need to combine and operate seamlessly to reduce exploration cost of oil refining sector over the next 10 years) which may delay cost reduction opportunity. A maturity assessment framework for digital technologies and future roadmap of research and development per technology is important to assess the maturity path of the technologies.
 - c. Not all innovation will reduce cost - industries traditionally far removed from operational innovation could see negative value in the short term. Mismatch between speed of digital technology rollout and readiness of sector could misalign and cause negative benefits in the short term. External forces such as globalisation, regulation and public policy could limit pace of innovation in certain sectors of the economy. Having a framework to assess medium term global headwinds helps to scale future cost reduction estimations.
- 8. Scaled the cost reduction estimates to cover for the US economy.** Estimated the scaling factor based on total GDP of the US net of exports and by comparing it to the total US revenue of the sectors.

Appendix B:

Value chain taxonomies by sector



Retail

- Focused on wholesalers and grocers
- Excluding e-commerce
- **Industry-specific value chain:**



Hospitality

- Focused on hotel and restaurant chains
- **Industry-specific value chain:**



Automotive

- Manufacturers and sellers of vehicles
- Excluding ride-sharing
- **Industry-specific value chain:**



Healthcare

- Focused on delivery of healthcare (hospitals)
- **Industry-specific value chain:**



Electric utilities

- Regulated producers of electricity
- **Industry-specific value chain:**



Oil refining

- Focused on refining and delivery of liquid fuel
- **Industry-specific value chain:**



Appendix C:

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