WINNING WITH THE INTERNET OF THINGS—SUMMARY OF SURVEY FINDINGS

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PARTICIPANT REPORT

a report for research project participants with detailed methodology, analysis, findings, and references

THE INTERNET OF THINGS
IoT
SENSORS
ANALYTICS
BIG DATA
DATA MONETIZATION

In 2016, the MIT Sloan Center for Information Systems Research (CISR) investigated how companies are generating business value with the Internet of Things (IoT). In the first phase of this research (Q1–2 2016), we interviewed executives at ten large companies across nine industries to understand their IoT journeys to date. In the second phase (Q3–4 2016) we surveyed 227 executives who led, managed, sponsored, or championed an IoT project. This report summarizes research results and offers recommendations on how companies can generate business value from IoT projects. Key findings from the research highlight that articulating a desired outcome and coordinating capabilities associated with success for that outcome lead to maximized financial returns from the effort.

MIT MANAGEMENT SLOAN SCHOOL | CENTER FOR INFORMATION SYSTEMS RESEARCH (CISR)

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WINNING WITH THE INTERNET OF THINGS—SUMMARY OF SURVEY FINDINGS

In 2016, the MIT Sloan Center for Information Systems Research (CISR) investigated how companies are generating business value with the Internet of Things (IoT). We studied why companies are investing in the Internet of Things, how organizational capabilities and partners influence IoT efforts, what returns companies are realizing from their IoT investments, and how other company and project factors impact the returns.

The Internet of Things: *Everyday objects—from industrial machines to wearable devices—using built-in sensors to gather data and take action on that data across a network.*

In the first phase of this research (Q1–2 2016), we interviewed executives at ten large companies (annual revenues greater than $3 billion) across nine industries to understand their IoT journeys to date (see appendix A). In all cases, the companies were building digital capabilities. They were conducting strategic experiments and pilots to learn how to resolve IoT issues regarding security, data integration, data ownership, and data privacy. Their IoT project teams leveraged a variety of partners (e.g., IT vendors, consultants, academia) to help solve problems, fill capability gaps, and inspire innovations. And their teams drew upon a broad array of functional perspectives and expertise from within their companies to move their IoT projects forward. During this research phase, we observed two primary ways in which companies intended to generate value from IoT: 1) by improving core business processes and 2) by better serving customers with value-adding digital features and experiences or new IoT-based services.

In the second phase of the research (Q3–4 2016), we surveyed 227 executives[1] who led, managed, sponsored, or championed an IoT project. The executives represented a diverse set of companies that operated across the globe, and they described IoT projects that differed on a variety of dimensions, including maturity and scope. This report summarizes findings from our survey analysis.

THE 2016 IoT SURVEY: FINDINGS

Key findings from the research highlight that articulating a desired outcome and coordinating capabilities associated with success for that outcome lead to maximized financial returns from the effort:

Choose Your Course

IoT projects generate financial returns by improving operational efficiency and increasing market effectiveness. Each outcome requires a set of unique capabilities and commitments to achieve. From the outset, teams must choose a course for their IoT projects that directs the projects towards generating the desired returns. We refer to companies that achieve top financial returns from their IoT projects as IoT winners[2]: companies that achieve top returns through operational efficiencies are **IoT productivity winners**; companies that achieve top returns through top-line growth are **IoT revenue winners**.

1 MIT CISR's Winning with the Internet of Things survey (N=227) was distributed from July to December 2016.

2 We ran analyses that compared the means for survey items between launched IoT projects in the top and bottom third of outcome attainment. For operational efficiency outcomes, the samples for top and bottom thirds were N=51 and 26. For revenue outcomes, the samples for top and bottom thirds were N=47 and 33.

This participant report was prepared by Barbara H. Wixom and Stephanie L. Woerner of the MIT Sloan Center for Information Systems Research (CISR) and Karthic Kosgi of the MIT School of Engineering and the MIT Sloan School of Management. The authors would like to thank survey respondents for their participation in the research.

IoT Project Stages: Get Ready, Get Set, Go

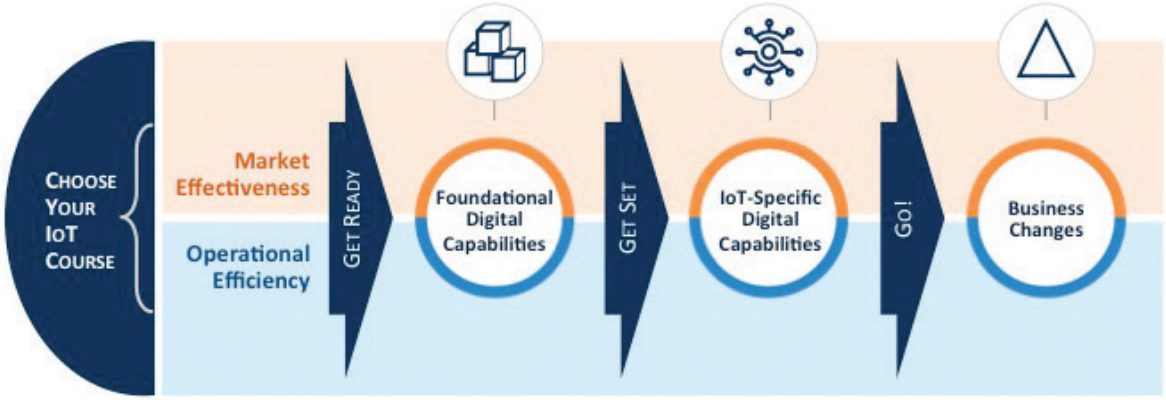
Get Ready: Companies prepare for their IoT journey by establishing foundational digital capabilities. IoT winners draw upon unique subsets of these capabilities to attain operational efficiency or market effectiveness.

Get Set: IoT project teams build IoT-specific digital capabilities for their companies, and IoT winners draw upon unique subsets of IoT capabilities based on their IoT course. All IoT teams launch their initiatives after they acceptably resolve IoT-related concerns regarding security, data privacy, data ownership, and data integration.

Go!: Companies generate financial business value from the Internet of Things by conducting business in different ways. IoT productivity winners change the responsiveness of their business processes to become more real time and/or proactive, which helps the IoT project generate operational efficiency returns. IoT revenue winners change the way they go to market, such as by engaging with customers differently or by selling new offerings, which helps the IoT project generate revenues. In both cases, IoT winners realize higher returns on their investments. IoT revenue winners also report new capabilities and greater competitive advantage as a result of their efforts.

The following figure summarizes these findings.

Figure 1: How Companies Win with the Internet of Things



IoT Governance

IoT project teams engage colleagues from a variety of organizational business units, and they establish external partnerships, such as with academia and data providers, to help build foundational and IoT-specific digital capabilities. The teams rely on involvement and support from customers, ecosystem partners, and top management to help drive business changes. IoT winners selectively involve stakeholders in governance strategies that are tailored to advance their desired IoT course.

The survey findings are based on statistical analyses—primarily correlations, regressions, and comparisons of means. We combined survey and interview analyses with other MIT CISR research to make conclusions about causality. In this report, we provide detail on the statistical results from the survey. We also draw upon our qualitative research to explain the phenomena we are observing.

THE SURVEY SAMPLE

From July to December 2016, MIT CISR distributed a survey titled "Winning with the Internet of Things" to executives from MIT CISR sponsor and patron companies; executives who had participated in past MIT CISR events or research or MIT Sloan Executive Education programs; and executives included in the researchers' LinkedIn contacts and groups. MIT CISR also reached out to IoT affiliate groups, which promoted the survey to their members.[3] In total, we reached out to thousands of executives to find leaders, managers, sponsors, and champions of IoT projects that were underway. By December 31, 2016 we received 227 unique, usable survey responses.[4]

Survey Companies

The survey sample represented companies of all sizes, with half having greater than $3 billion in annual revenues in 2015. About half of the organizations were publicly traded, and 68 percent had B2B business models. 156 of the companies were headquartered in the United States; however, the companies operated across the globe, and they represented a wide range of industries. (See figures 2–5 for associated survey respondent breakdowns.)

Figure 2: Survey Respondent Breakdown by Company Size

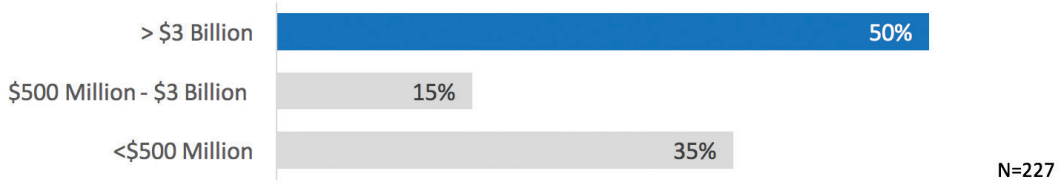


Figure 3: Survey Respondent Breakdown by Company Type

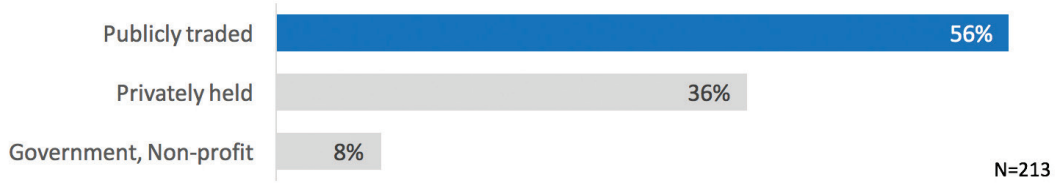
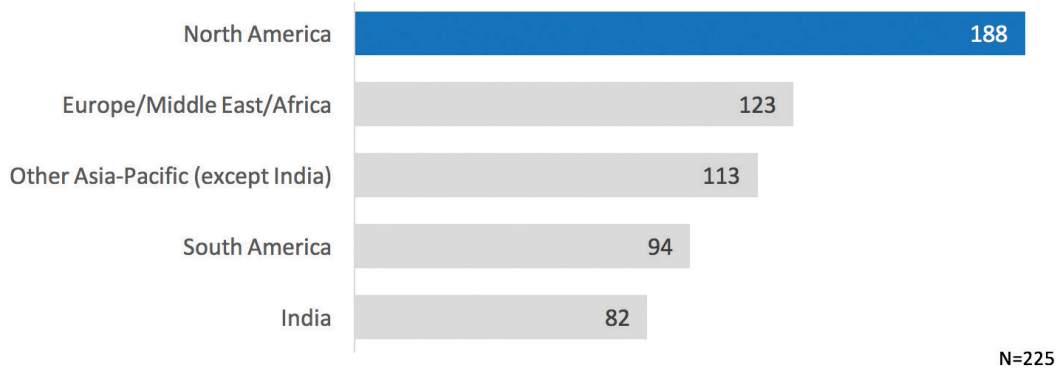


Figure 4: Survey Respondent Breakdown by Geographical Operations[5]

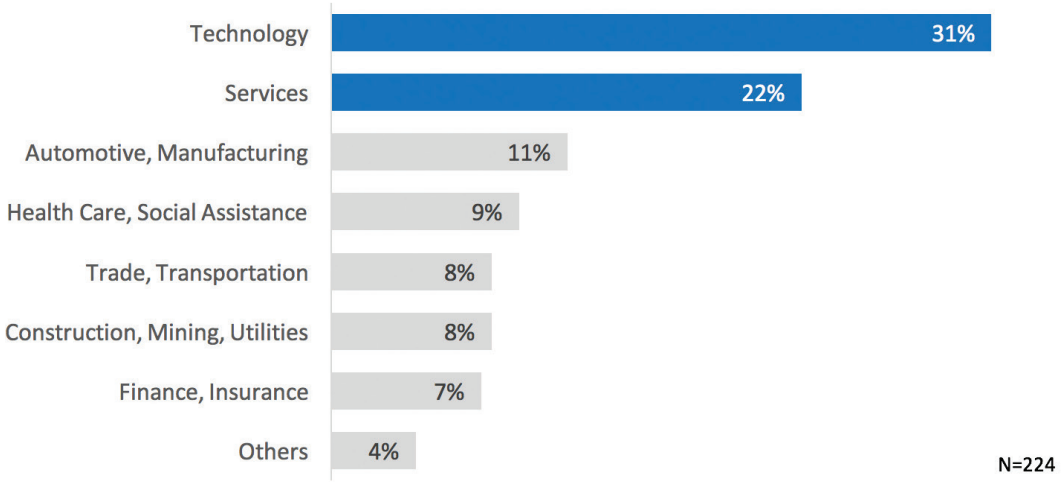


3 We would like to thank the affiliate groups that promoted the MIT CISR survey to their membership: IoT Central, Internet of Things Consortium, Boulder Business Intelligence Brain Trust (BBBT), US General Services Administration Digital Service Listserv, US General Services Administration Mobile Gov Listserv, DAMA New England, MIT Sloan CIO Symposium, Industrial Internet Consortium (IIC), Telecommunications Industry Association (TIA), IoT Australia Meetup group, Indy CIO Network, Communications Alliance Ltd., IoE Community Network, St. Louis IoT Meetup group. We truly appreciate the support that these groups provided.

4 Samples sizes for the different analyses varied as not all respondents answered every question.

5 Some respondent companies operate in multiple locations.

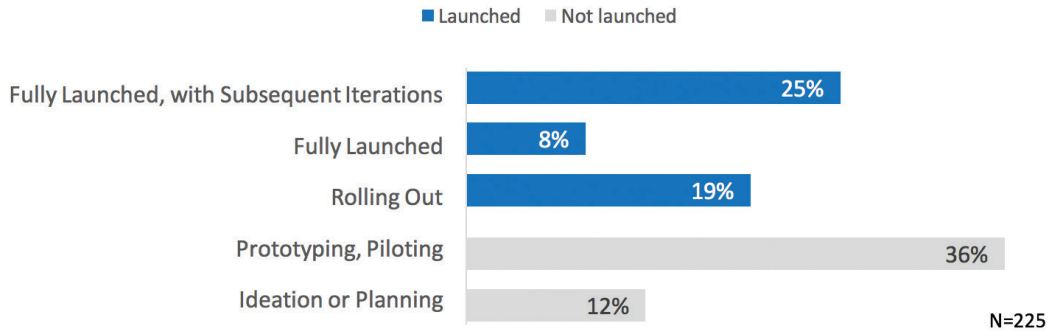
Figure 5: Survey Respondent Breakdown by Industry[6]



Survey Projects

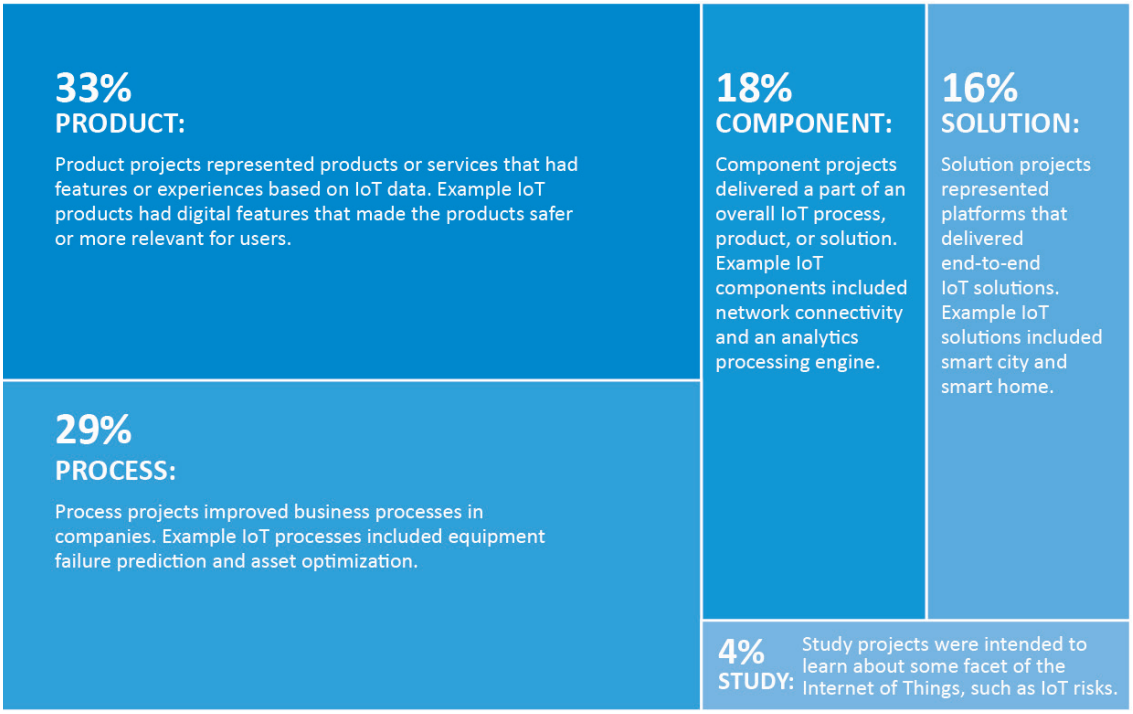
The IoT projects represented different levels of project maturity, with 52 percent in some state of launch. 65 percent of the projects were externally oriented, meaning that the IoT project served needs outside the company's boundaries; the remaining 35 percent of projects were internally oriented, focused on serving needs within the company. We classified projects into five types, reflecting a variety of project scopes in the sample; types included feasibility studies and deliverables such as IoT components, IoT-based product offerings, IoT-based processes, and extensive IoT solutions. See figures 6 and 7 for associated IoT project breakdowns.

Figure 6: Survey IoT Project Breakdown by Project Maturity



6 **Services** includes: Accommodation and Food Services; Information, Publishing, and Communications; Public Administration; Professional, Scientific, and Technical Services; Educational Services; and Other Services (except Public Administration). **Others** includes: Arts, Entertainment, and Recreation; Agriculture, Forestry, Fishing and Hunting; and Management of Companies and Enterprises.

Figure 7: Survey IoT Project Breakdown by Project Type



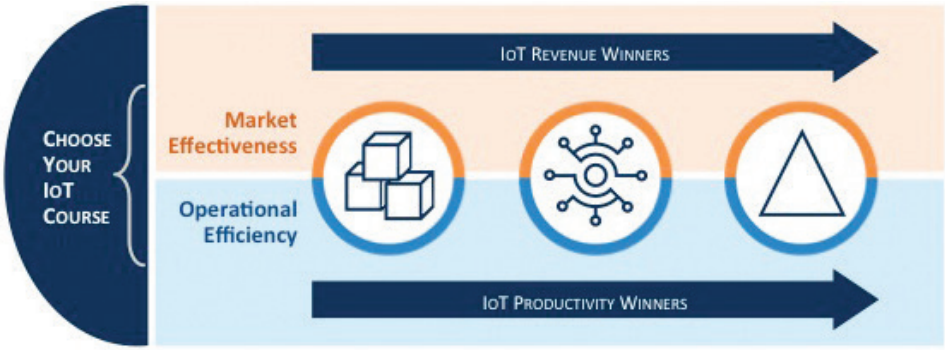
N=222

CHOOSE YOUR COURSE

Fundamentally, companies can create financial business value from the Internet of Things to (1) improve operational efficiency and (2) increase market effectiveness. To accomplish the first, companies do things better, faster, and cheaper with the help of the IoT, and thus generate associated returns; typically these returns improve the company's bottom line. To accomplish the second, companies increase top-line returns by improving the customer experience, creating features that differentiate products or services, and producing new digital offerings.

Our research identified that IoT project teams get what they ask for; in other words, they achieve outcomes consistent with their goals. When we investigated the realized outcomes of launched IoT projects (N=112), we discovered that the IoT productivity winners in our survey (i.e., companies that had achieved top returns through operational efficiencies) had rated the achievement of operational efficiency goals as significantly more important than their low-performing counterparts. Similarly, the IoT revenue winners in the survey (i.e., companies that had achieved top returns through market effectiveness) had rated the achievement of market effectiveness goals as significantly more important than low performers.

Figure 8: The Two IoT Courses that IoT Project Teams Can Pursue



When project teams strongly desire and pursue specific IoT outcomes, they are better able to attain them. This is because IoT projects are tough: they require that significant and varied organizational capabilities and commitments are purposefully combined.

Companies like APM Terminals establish a clear course for IoT projects. Choosing a course up front helps the IoT team assemble the optimal company resources for project execution. It also helps the team establish the right metrics to monitor success—and the right accountabilities to ensure that desired outcomes are achieved.

APM TERMINALS

APM Terminals was a global port and cargo inland services provider with revenues of $4.2 billion in 2016. The company was based in The Hague, Netherlands with a presence in 69 countries and handled over 37 million containers annually. APM Terminals employed 22,615 people, and had been investing heavily in automation: it launched the world's first fully automated container terminal in Rotterdam in 2014. Large, expensive equipment maneuvered millions of APM Terminal's containers around the world: on average, a single crane could cost $10 million, and some of the company's larger terminals used between thirty and forty cranes each.

APM Terminals used IoT technologies to maximize operational efficiency through real-time asset optimization, employing sensors on assets to tune equipment; inventory control, attaching sensors to handling gear to automatically control equipment; and operations optimization, analyzing sensor data to improve container transport and storage logistics. Tracking containers and managing port logistics was complex. Consider that a Maersk Triple E vessel could carry more than 18,000 containers; and for example, that one of the company's terminals offered 26,000 ground slots, each stacked four containers high. For the vessel to discharge 10,000 containers and load the equal number of replacements at this yard, APM Terminals would have to orchestrate six cranes, forty yard cranes, and several hundred terminal trucks.

As an asset-heavy company, APM Terminals continually sought methods to leverage an asset's value, such as by increasing the asset's moves per hour. IoT helped the company identify optimization opportunities and wasted resources, and advanced sensor data influenced the company's formerly highly-manual process methodologies. For example, the company's technical asset management group shifted from Lean Sigma OEE to continuous OEE[7] to reduce the time employees spent monitoring machines to capture data. This shift forced a cultural change and sparked collaboration between engineering and IT.

APM Terminals aimed to expand its capabilities in data and analytics through master data management and information security efforts and an enterprise analytics center of excellence. The company was evaluating external data opportunities (e.g., the collection and dissemination of weather data) and working with partners—including shipping companies, land logistics companies, and equipment suppliers—to clarify data sharing procedures and data ownership rights.

7 Overall equipment effectiveness (OEE) is a term coined by Seiichi Nakajima in the 1960s to evaluate how effectively a manufacturing operation is utilized. See *Wikipedia, The Free Encyclopedia*, s.v. "Overall equipment effectiveness," https://en.wikipedia.org/wiki/Overall_equipment_effectiveness.

Our findings suggest that the Internet of Things pays off for companies that commit to their desired IoT course. Both IoT productivity winners and IoT revenue winners in our survey reported higher returns on investment from their IoT projects. Productivity winners drive returns from greater operational efficiencies; and revenue winners drive returns by raising prices, generating more sales, creating new revenue streams, and increasing customer satisfaction. In addition to financial returns, our survey's productivity winners also reported more new capabilities and greater competitive advantage resulting from their efforts.

The rest of this report describes what it means to commit to an IoT course—and how IoT winners maximize financial returns.

GET READY

IoT is a digital phenomenon, and as such it requires a set of capabilities that are common to any digital business strategy (see figure 9). At MIT CISR, we refer to foundational digital capabilities as the operational backbone[8] and the digital services platform.[9] The operational backbone supports core business operations by ensuring seamless transaction processing, access to master data, and the scale, security, and reliability that global enterprises need to run their businesses. The digital services platform helps a company take advantage of emergent technologies by facilitating rapid introduction and deployment of new functionality.[10]

For the purposes of this IoT study, we developed a list of practices that MIT CISR research has identified as associated with foundational digital capabilities. The operational backbone practices include enterprise data governance, master data management, and data quality management, all of which help companies incorporate IoT data into enterprise data strategies (e.g., a 360-degree customer view). The digital services platform practices include enterprise data warehouse, an enterprise analytics center of excellence, APIs, and cloud; together these practices help companies move, process, and deliver data and insights at service levels sufficient for real-time processes and customer-facing services. Our survey confirmed the importance of the operational backbone and digital services platform within the IoT context: more than half of all respondents rated each of the operational backbone and digital services platform practices as "important" or "extremely important" for the successful execution of IoT projects (see appendix 2 for descriptive statistics).

8 For more information on the need for an operational backbone, see J.W. Ross, I.M. Sebastian, C.M. Beath, S. Scantlebury, M. Mocker, N.O. Fonstad, M. Kagan, K. Moloney, S.G. Krusell, and the Technology Advantage Practice of The Boston Consulting Group, "Designing Digital Organizations," MIT Sloan CISR Working Paper No. 406, March 2016; and J.W. Ross, I.M. Sebastian, and C.M. Beath, "How to Create a Great Digital Strategy," MIT Sloan CISR Research Briefing, Vol. XVI, No. 3, March 2016.

9 For more information on the digital services platform, see J.W. Ross, I.M. Sebastian, and C.M. Beath, "Digital Design: It's a Journey," MIT Sloan CISR Research Briefing, Vol. XVI. No. 4, April 2016 (Revised February 2017).

10 For a comprehensive examination of the operational backbone and digital services platform, see J.W. Ross, I.M. Sebastian, C.M. Beath, L. Jha, and the Technology Advantage Practice of The Boston Consulting Group, "Designing Digital Organizations—Summary of Survey Findings," MIT Sloan CISR Working Paper No. 415, February 2017.

Figure 9: Foundational Digital Capabilities that IoT Project Teams Draw Upon

Enterprise data governance
Master data management
Data quality management
Enterprise data warehouse
Enterprise analytics center of excellence
APIs
Cloud
Enterprise change management
Enterprise risk management
Enterprise vendor management

See the Bemis sidebar for a description of how one manufacturer fortified its digital capabilities in preparation for the Internet of Things.

BEMIS

Bemis Company, Inc. was a manufacturer and supplier of flexible and rigid packaging products. In 2015 the company had earnings of $4 billion, operated sixty-one facilities in twelve countries, and employed a workforce of 18,000. Founded in 1858 to produce cotton and burlap bags for millers along the Mississippi River, Bemis evolved and by 2015 specialized in making technologically advanced, pressure-sensitive packaging solutions.

In 2015 Bemis's CIO initiated IoT efforts at the company as it recapitalized its equipment. The CIO worked closely with Operations to determine how IoT-enabled sensors could help minimize operational disturbances by monitoring manufacturing processes and recommending proactive equipment maintenance. If the Internet of Things could help Bemis identify and resolve manufacturing deviations (e.g., a misaligned blade, a packaging flaw), the company's bottom line would benefit.

Bemis prepared for the IoT in several ways. First, the company studied how to segment and network-enable machines securely; it also advanced its ERP implementation to support future integration between IoT data and other company data. Then Bemis extended its data warehouse so that it could combine, harmonize, and analyze IoT data. And the company collaborated with the University of Wisconsin–Madison to explore how to manage large volumes of IoT data, identify high-impact use cases, and act upon IoT insights.

Bemis relied heavily on its vendor management capabilities to coordinate the many vendors—including device manufacturers and telecommunications providers—that contributed to planning and executing the company's IoT roadmap. Bemis also provided training for its engineers, who required not only an understanding of new equipment operations, but also of digital concerns and means to mitigate them such as cybersecurity.

The interviews and survey established that three organizational capabilities are required to manage foundational digital capabilities: enterprise vendor management, change management, and risk management. IoT project teams rely heavily on partnering and thus require vendor management skills to coordinate and control a variety of vendors and other partners like academia and start-ups. The IoT leads to new ways of working, which requires change management expertise to design new business processes and to entice users to work in new ways. Also, IoT projects require risk management so that companies advancing into new frontiers can identify and mitigate emergent concerns. Our survey results identified that enterprise vendor management and enterprise change management are particularly important for large companies (see sidebar Company Size Matters).

COMPANY SIZE MATTERS:

In our survey results, the importance of enterprise data governance was statistically significantly higher for large firms. In other words, respondents from large companies rated enterprise data governance as more important for successful execution of IoT projects than respondents from small or medium-sized companies. We also found a significant effect of company size on enterprise risk management and enterprise change management; respondents from large-sized companies rated enterprise risk management and enterprise change management as more important for the successful execution of their IoT projects than respondents from small and medium-sized companies. This suggests that IoT-based change and risk are significant for large companies, and these companies must be prepared to manage both effectively. The finding also suggests that all companies rely on enterprise vendor management to pull off IoT implementation: no matter your size, you have to work effectively with other companies to reach your goals.

Does your IoT course selection matter when it comes to foundational digital capabilities? It does if you choose to pursue market effectiveness outcomes (see figure 10). The survey's IoT revenue winners rated enterprise data governance, master data management, enterprise analytics centers of excellence, APIs, and cloud as significantly more important for their IoT projects than did survey respondents who reported earnings in the bottom third of market effectiveness returns. It is likely that project teams are drawing upon data governance, master data management, and analytics to integrate sensor data with other enterprise and external data and to deepen data-derived insights. They likely are using APIs and cloud to process and deliver digital services reliably and at high speeds to external consumers.

Figure 10: Foundational Digital Capabilities That Are Associated With IoT Winners

	Enterprise data governance
	Master data management
	Data quality management
	Enterprise data warehouse
	Enterprise analytics center of excellence
	APIs
	Cloud
	Enterprise change management
	Enterprise risk management
	Enterprise vendor management

GET SET

Although IoT projects draw upon capabilities that are foundational for any digital business strategy, they also require IoT-specific capabilities (see figure 11). For example, the IoT connectivity layer includes connected, IP-enabled assets (people and things) and the ability to sense and respond to data exchanged among those assets. To enable the latter, companies need a contemporary form of analytics, commonly referred to as edge analytics. Edge analytics represents a toolkit of analytical algorithms and techniques used to process and analyze data within distributed and/or real-time architectural environments. We asked survey respondents about the effectiveness of five edge analytics use cases for their projects:

1. Decisions processed on devices
2. Intelligent filtering
3. Pattern detection
4. Real-time response
5. Automated response

On average, IoT project teams reported that the effectiveness of their use of edge analytics for their projects was between Somewhat Effective and Effective (see appendix B for descriptive statistics).

IoT project teams also reported use of business process reengineering skills. These skills likely facilitate process changes when companies use IoT to perform activities in new ways. For example, with the help of business process reengineering, IoT teams might use automated response analytics to transition manual tasks to digital ones and to streamline or even eliminate activities.

Figure 11: IoT-specific Digital Capabilities that IoT Project Teams Build

Decisions processed on devices
Intelligent filtering
Pattern detection
Real-time response
Automated response
Business process redesign
Training in new IoT skills
New hires with IoT skills

Project teams should not expect to find sufficient IoT expertise within the company. Instead, they need to develop IoT talent by retooling existing employees or hiring people who have IoT skills. Our interviews suggested that IoT expertise ranges from technical know-how and digital-savviness to softer skills like those associated with change management and the identification of business requirements. IoT project teams in the survey sample relied on both internal and external talent-building strategies (see appendix B for descriptive statistics).

Does your IoT course selection matter when it comes to IoT capabilities? Yes, both market effectiveness and operational efficiency pursuits have unique IoT-specific digital capabilities that are associated with top-performing companies (see figure 12). IoT productivity winners have more effective edge analytics that enable automated and real-time response, and they report more effective business process reengineering. IoT revenue winners have more effective edge analytics that enable automated response and decisions processed on device; and they report more effective IoT talent from both new hires and existing employees who have been retooled.

Figure 12: IoT-specific Digital Capabilities Associated With IoT Winners

	Decisions processed on devices
	Intelligent filtering
	Pattern detection
	Real-time response
	Automated response
	Business process redesign
	Training in new IoT skills
	New hires with IoT skills

A Key Hurdle: Resolving Concerns

Whereas project teams need IoT capabilities to *exploit* the IoT connectivity layer, the teams also need strategies and practices that *protect* the connectivity layer. Our interviews helped us understand how difficult protecting can be. In fact, the IoT industry today is a bit like the Wild West—with few standards, rules, and best practices. As a result, project teams must establish guardrails in four key areas that help projects safely move forward:

- **Security:** the ability to protect networks and data from unwelcome access. Mainstream IoT security solutions are nascent at best, leaving firms vulnerable when IoT networks are opened up to the Internet. To combat this, many firms establish secure IoT networks by blocking sensor access to the open Internet or deploying heavy firewalls.
- **Data ownership:** the ability to assign accountability for data stewardship and permission for data monetization. Most IoT efforts exist within an ecosystem of partners, each of which has unique access to and interest in IoT data. These ecosystems must clarify data rights and duties and ensure that boundaries are maintained.
- **Data privacy:** the ability to define and enforce how the company will legally and ethically capture, manage, use, and dispose of IoT data. New opportunities for learning about and interacting with customers, employees, and other stakeholders create gray areas regarding data. Companies must extend current governance practices to address emergent data issues.
- **Data standards:** the ability to combine data across networks and platforms. For most firms, integration is achieved by creating middleware layers that integrate IoT data with enterprise platforms and other data sources.

TRINITY HEALTH

Trinity Health was a national, not-for-profit Catholic health system that in 2016 operated ninety-three hospitals in twenty-two US states, and 120 continuing care programs including home care, hospice, community care, and senior living facilities. Based in Livonia, MI, Trinity Health had 2015 operating revenues of $16.2 billion, assets of $23.4 billion, and 97,000 full-time employees.

Trinity Health had been exploring medical applications of the Internet of Things for about ten years. When in 2012 St. Joseph Mercy Oakland Hospital, one of Trinity Health's member hospitals, planned a facilities upgrade, Trinity Health considered the initiative an opportunity to invest in IoT technologies. It launched a pilot—the Intelligent Care System (ICS)[11]—to update and innovate the patient health experience. The pilot team outlined how integrated IoT-based point solutions would improve safety, clinical, and efficiency outcomes, and the satisfaction of patients, doctors, and staff. Pilot leaders identified eight technologies they believed would best support this vision.[12]

To preempt implementation obstacles, the pilot team studied past strategic experiments' successes and failures, and worked closely with vendor partners. Security was a key concern. Rather than pursuing open network architectures, Trinity Health opted for a closed network—not just for the component technologies, but for the entire hospital—to significantly reduce issues related to cybersecurity.

The proprietary nature of the ICS's networks, devices, and data formats introduced significant integration challenges. To bridge the technologies, the pilot team developed a semantic integration and reconciliation layer. By connecting IoT data to electronic medical records and the company's enterprise data infrastructure, the additional layer enabled a comprehensive and holistic patient profile.

In an effort to reinforce security, ease integration, and address concerns related to data ownership and use, the pilot team established a suite of updated policies and procedures. The team relied heavily on Trinity Health's vendor management, legal, and contracting capabilities to coordinate within and across external partners. Guided by HIPAA, Trinity Health secured business associate agreements[13] with most of its IoT partners, from device providers to data aggregators. HIPAA regulations designated ownership of proprietary data in the ICS system to patients.

11 Trinity Health's Intelligent Care System (ICS) is an integrated suite of healthcare technologies.

12 The video "St. Joseph Mercy Oakland (SJMO) Intelligent Care" (https://www.youtube.com/watch?v=n-cQR0iZjwU) describes the eight technologies piloted at the hospital.

13 A business associate agreement (BAA) is a contract between a HIPAA-covered entity and a HIPAA business associate that protects personal health information (PHI) in accordance with HIPAA guidelines. The agreement requires partners to share risk of data breach and to respect data use restrictions.

Source: B.H. Wixom, "Winning With IoT, It's Time to Experiment," MIT Sloan CISR Research Briefing, Volume XVI, Number 11, November 2016.

According to survey respondents, their IoT efforts have been addressing the concerns at a level best described as "acceptable for now" (see appendix B for descriptive statistics). In other words, most project teams expect that their solutions to problems will improve over time as the broader IoT market matures.

To analyze the importance of resolving IoT concerns, we created a composite score of each project team's ratings of how effectively it addressed the four issues. *The composite concern resolution score predicted both IoT project maturity and better outcomes.* We suggest that project teams seriously consider the following questions—and have answers—before moving ahead with their initiatives:

1. How will we protect devices and sensors from unwelcome access?
2. How we will assign accountability for data stewardship and permission for data monetization?
3. How will we control how data will be legally and ethically captured, managed, and used?
4. How will we integrate the IoT data with other kinds of data from inside and outside of our company?

See the sidebar case on Trinity Health to learn how one company effectively approached concern resolution.

GO!

Companies are ready to go with IoT projects when they are ready to change the way they conduct business. IoT-based financial returns are generated through business change (see figure 13). Companies generate operational efficiencies by changing the responsiveness of their business processes; companies generate market effectiveness by changing the way they go to market. Further, *the degree of change predicts the amount of returns*—so the more a company changes, the better its results. (See appendix B for a complete list of IoT business changes and associated descriptive statistics.)

Figure 13: Business Changes That Help IoT Project Teams Generate Results

Seeing across the supply chain in new ways
Seeing into a new supply chain
Accessing actual behavior (people or things)
Responding in real time
Acting proactively
Delivering new products and services
Delivering products and services in new ways
Understanding customers in new ways
Engaging with customers in new ways

We investigated change as reported by top-performing IoT projects. IoT productivity winners changed the way they responded: they reengineered business processes to respond faster and more proactively (see figure 14). They also reported greater supply chain transparency than low performers. Top performers have better visibility into and understanding about their current supply chains as well as new ones, which helps them understand how to operate better, faster, and cheaper.

At Schindler, changing responsiveness manifested in many ways, including making customer-facing roles—such as service technicians—more efficient. For example, the company used equipment sensor data to learn how to better understand equipment failures. Technicians could then better diagnose the need for spare parts and thus be better prepared for onsite service calls. See the sidebar on Schindler for more on how the company leveraged the Internet of Things to offer more proactive and predictive services.

SCHINDLER

The Schindler Group was a global provider of elevators, escalators, and related services founded in Switzerland in 1874. In 2016 the $9.7 billion public company, listed on the Swiss Exchange, had more than 58,000 employees and a network of more than 1,000 branches in over one hundred countries. Schindler was organized geographically, with each country or region operating three business models: new installations, services, and modernization. Services comprised the most significant—and profitable—part of the business. Over the past decade, Schindler transformed itself from a product-focused engineering company to a customer-oriented service provider.

To achieve this transformation, Schindler leveraged the Internet of Things, along with analytics and mobile technologies, to offer more proactive and predictive services. Sensors, which were able to collect between 750 and 1,000 data points from a single elevator, were deployed on the majority of new lifts and added to old ones. Schindler used sensor data to learn about impacts of elevator environments and then to enhance its products accordingly. Complex algorithms and business rules engines analyzed sensor data to predict equipment failure and spare part demand. Additionally, Schindler created services to help customers manage their own equipment. For example, the company designed an app with an intuitive interface to help facility managers track the performance of their equipment and services.

A number of organizational design changes were critical to Schindler's adoption of IoT technologies. The company invested in a digital platform that made IoT data available across business processes; the platform combined IoT data with other data, such as service contract information, and delivered data services as reusable business components. Schindler created a new digital business unit comprising multifunctional skills and perspectives to develop digital innovations. The digital business unit and Schindler's operational businesses collaborated—with end users when possible—to build and launch pilot programs.

Source: I.M. Sebastian and J.W. Ross, "The Schindler Group: Driving Innovative Services and Integration with Schindler Digital Business AG," MIT Sloan CISR Working Paper No. 411, April 2016.

IoT revenue winners changed the way they go to market. Specifically, IoT projects that were top performing in achieving higher top-line returns were more likely to change by engaging with customers in different ways, producing new products or services, and selling offerings differently. These top performers had better visibility into and understanding about their current supply chains as well as new ones, and they also had a deeper understanding of their customers. All of this likely helps revenue winners identify key market needs—and ways to effectively meet those needs through experiences and offerings.

Figure 14: IoT Business Changes Associated with IoT Winners

	Seeing across the supply chain in new ways
	Seeing into a new supply chain
	Accessing actual behavior (people or things)
	Responding in real time
	Acting proactively
	Delivering new products and services
	Delivering products and services in new ways
	Understanding customers in new ways
	Engaging with customers in new ways

Go-to-market changes represent significant business choices for most companies. In some cases, go-to-market changes represent foundational business model adjustments, such as when business-to-business divisions of companies like Ferrovial and Orange introduce new activities that reach end-consumers. Infrastructure company Ferrovial developed relationships with drivers who used its IoT-enabled toll roads by offering new toll services via mobile apps. Telecommunications provider Orange offered new consumer services through its partners, which required the creation of new revenue-sharing models to ensure fair revenue distribution among its IoT ecosystem. Learn more about the changes implemented by Ferrovial and Orange in the sidebars on these companies.

FERROVIAL

Based in Spain, Ferrovial, S.A. was in 2015 a $10.8 billion company in the infrastructure sector with a focus on four business lines: Services, Toll Roads, Construction, and Airports. The company was established in 1952 with an explicit focus on using innovation to execute complex projects efficiently and successfully and to generate value for customers. Ferrovial invested $45 million in innovation annually, and in 2016 spent an additional $20 million specifically on IoT development.

Ferrovial operated in highly competitive sectors and markets that include low-margin businesses like Construction and Services. Ferrovial believed that the Internet of Things provided an opportunity for the company to differentiate offerings within the company's divisions while creating new revenues, services, and business models.

For example, Ferrovial developed several IoT-based toll road applications. One used IoT technology to manage toll payments along two Ferrovial-managed Spanish highways. For this project, Ferrovial collaborated with a technology partner to create a mobile app that calculated a driver's toll payment based upon satellite position and kilometers traveled. Ferrovial launched a second toll road solution in Texas to track and manage high-occupancy vehicles: about 10,000 drivers used a mobile application to declare themselves high-occupancy vehicle operators (and therefore eligible for reduced toll rates).

Before the Internet of Things, Ferrovial considered highway drivers passive customers. The IoT, however, enabled Ferrovial to engage, connect directly with, and understand drivers, and to establish active customer relationships. Meanwhile, drivers benefited from convenient, user-friendly toll applications. The IoT not only enabled new services for drivers on the roads that Ferrovial managed, but it also opened up potential new revenue streams for the company by working in collaboration with potential partners worldwide.

ORANGE

Orange S.A. was a worldwide telecommunications operator—one of the largest operating in Europe and Africa—and a leading provider of global IT and telecommunication services to multinational companies. With sales of $43.5 billion in 2016, Orange was headquartered in France and had more than 155,000 employees and 263 million customers worldwide. The company's IoT vision encompassed a world of objects and machines connected together to make life easier for both its business and end user customers. In 2016, Orange supported 12 million connected objects and machines.

The Internet of Things was a key component of Orange's diversification strategy, set out in the company's Essentials2020 strategic plan. By building on its legacy assets—its networks and its affinity with business customers and consumers, Orange aimed to cover the entire value chain end to end, from connectivity to services, in making objects and data useful for customers.

Orange was also focusing on developing connected objects and advanced data analytics solutions, both independently and with partners. One consumer use case was solutions for smart homes, for which Orange partnered with objects makers—for example, remote management of home security enabled by partnering with camera manufacturers. On the business market, Orange launched Datavenue, to deliver innovative data and analytics services. One Datavanue use case involved the sale of traffic data as maps that indicated the flow of people to a given location. These maps helped the tourism industry predict traffic to French ski destinations during the winter months.

Orange anticipated that business models would change over time, and that expansion of both subscription business models and product business models would be necessary as the company's IoT services grew. New business-to-business-to-consumer (B2B2C) business models would allow Orange to offer services through its business partners, but would also require the creation of new revenue sharing models to ensure fair revenue distribution among partners in the IoT ecosystem.

To augment its cell networks with IoT connectivity, Orange invested in a low-power wide area (LPWA) network with LoRa® (Long Range) in France. The company was preparing for a progressive introduction of LTE-M technology across its 4G networks globally, starting with Belgium and Spain in 2017 to lead its European rollout.

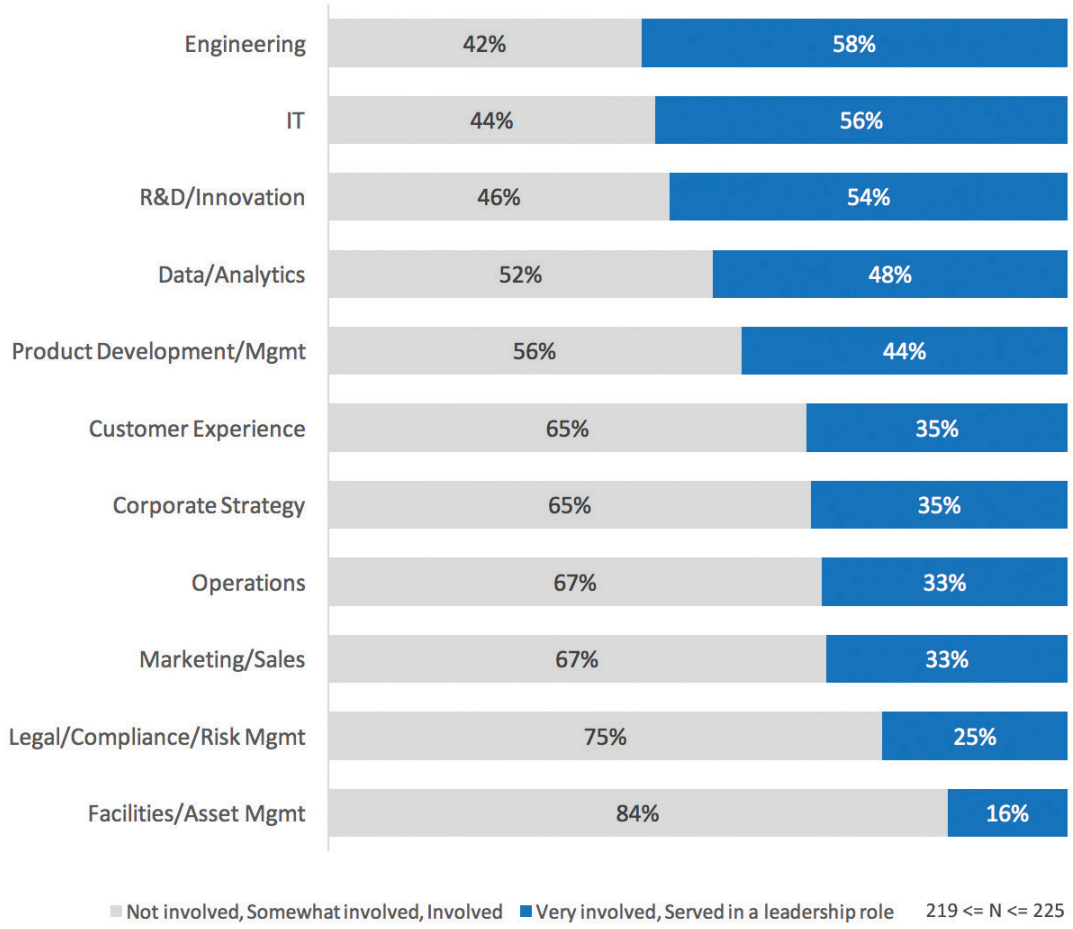
Sources: "Orange Pursues Its Internet of Things Strategy," Orange, https://www.orange.com/en/Press-Room/press-releases-2017/press-releases-2015/Orange-pursues-its-Internet-of-Things-strategy; "Orange accelerates towards the Mobile Internet of Things," Orange, https://www.orange.com/en/Press-Room/press-releases-2017/Orange-accelerates-towards-the-Mobile-Internet-of-Things.

IoT GOVERNANCE

As IoT project teams draw upon foundational digital capabilities, build IoT-specific capabilities, and enact business change, they establish IoT governance that draws upon expertise and support from across the company and from external stakeholders such as customers and partners.

Figure 15 illustrates the nature of IoT business unit engagement: survey respondents rated eleven business units regarding how involved they were on the IoT project. More than 48 percent of IoT projects reported heavy involvement or leadership from Engineering, R&D/Innovation, IT, or Data/Analytics.

Figure 15: Business Unit Involvement for Sample IoT Projects



IoT teams also reach beyond organizational boundaries for IoT support, and they develop relationships with a range of external partners. Our interviews uncovered that teams work with technology vendors—such as network providers, device manufacturers, software vendors, and data aggregators—to fill capability and skill gaps. And they leverage innovation partners—academia, start-ups, and consultants—to experiment with new or leading-edge technologies and approaches.

See the sidebar case on BT to learn how one company effectively managed a variety of partner relationships.

BT

BT Group plc[14] (BT) was one of the world's leading providers of communications services and solutions, serving customers in 180 countries. BT's principal activities included the provision of networked IT services globally; local, national, and international telecommunications services for use by customers at home, work, and on the move; broadband, TV, and internet products and services; and converged fixed-mobile products and services. BT consisted of six customer-facing lines of business: Consumer, EE, Business and Public Sector, Global Services, Wholesale and Ventures, and Openreach, which maintained the infrastructure connecting service providers and customers. In 2016, BT Group had $28.7 billion in annual sales.

In 2015, BT decided to actively engage in research into Internet of Things applications in collaboration with other companies. BT explored many practical applications of IoT technologies, such as prototype low-power wide area networks and IoT components, across a number of research fields.

BT increasingly assumed a leading role in its IoT ecosystems, working with partners to pilot IoT solutions. The Milton Keynes smart city initiative, MK:Smart, exemplified one such collaboration. Milton Keynes, a rapidly growing city in the UK, experimented with a portfolio of IoT-enabled city services that were intended to generate value for the city. One use case was smart parking, which relied on sensors embedded in the road surface to track and monitor parked cars. Data from the sensors helped the city understand parking habits and informed its pricing and policing strategies. The data helped optimize parking, too, as better utilization of existing unused parking spaces had the potential to generate substantial savings for the city: it cost £15,000—roughly $18,500—to create just one parking bay.

BT relied on a variety of IoT partnerships to plan and execute smart parking. Different partners contributed specialized technologies and capabilities, including the road surface device, network connectivity, information management, database technology, API platform, and a web application that identified available parking bays. BT led the initial smart parking effort by coalescing technologies and capabilities, managing the information, and offering secure solutions to third parties. To help coordinate the mix of partners, BT with The Open University and the Milton Keynes City Council created an IoT partner framework for the MK:Smart project, and devoted time and resources to developing efficient strategies for information gathering and sharing.

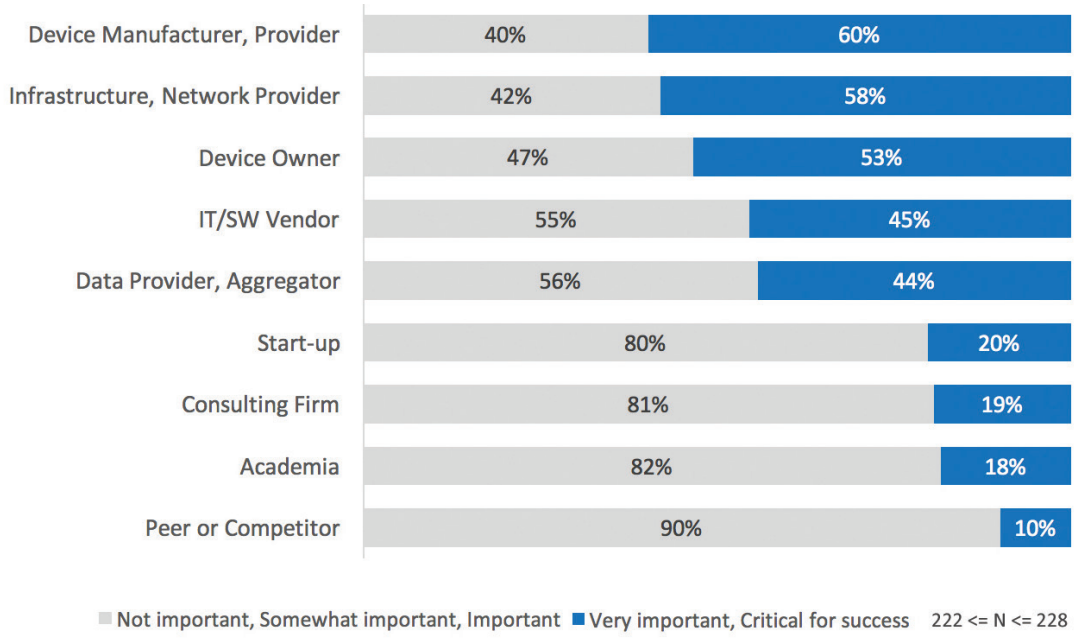
14 http://www.btplc.com

Sources: *BT Group PLC - company summary report*. (2016). OneSource. OneSource Information Service, Inc. Retrieved from OneSource Global Business Browser, June 12, 2017; "Case Study: Smart Parking in Milton Keynes," British Telecom, November 2014, http://www.globalservices.bt.com/us/en/casestudy/milton_keynes.

Reference: MK:Smart, www.mksmart.org.

According to the survey data, although all the project teams collaborated with a variety of IoT partners, their partnering patterns differed across technology and innovation relationships (see figure 16). Project teams had many technology relationships—sometimes leveraging all possible partners—to address the technical requirements of the project. The same teams, however, were more selective with innovation partners, choosing academia, start-ups, or consultants to help them innovate.

Figure 16: Partnerships for Sample IoT Projects

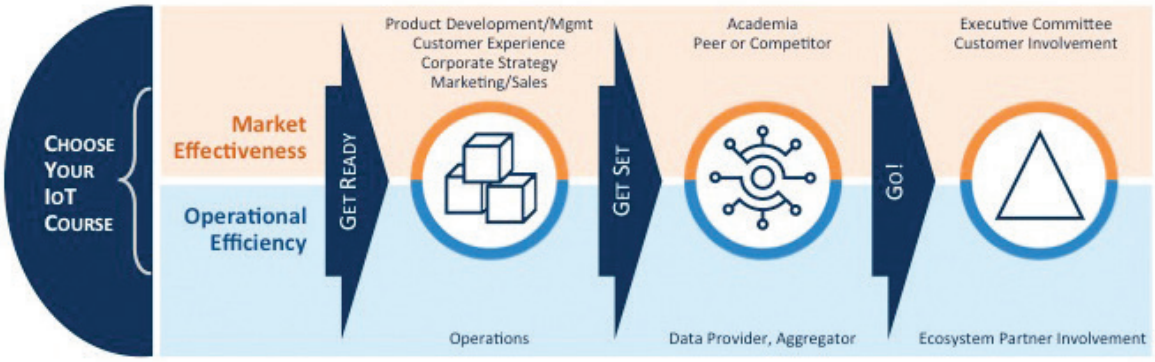


An IoT project team's desired course influences the IoT governance that a team should put in place (see figure 17). IoT productivity winners reported greater involvement with operations business units and data providers, and more effective ecosystem partnerships. Winners likely draw heavily on operations colleagues and external data as they use the Internet of Things to make core operational processes better, faster, and cheaper. And they likely rely heavily on ecosystem partners to ensure that IoT concerns are resolved in ways that preserve the stability and quality of operations.

IoT revenue winners reported greater involvement with four business units: strategy, customer experience, marketing and sales, and product. All of these market-facing units have the expertise and ability to craft effective new customer-facing strategies that impact a company's offerings. Revenue winners also reported greater importance for partnerships with academia and competitors and/or peers.

New customer-facing strategies that involve IoT can be quite exciting—but innovative opportunities typically involve risk and uncertainty. We suspect this is why IoT revenue winners reported higher levels of executive committee time and attention and a greater ability to establish and communicate a clear vision regarding how the company intends to deliver business value from an IoT project. When executives are engaged and have clear visions regarding IoT, they more easily identify and acquire the right resources for IoT projects. Revenue winners also reported higher levels of customer involvement. Customer involvement helps keep companies on track as they deepen customer intimacy, which then informs customer-facing strategies.

Figure 17: Winning IoT Project Teams Establish Governance that Helps Projects Advance



WINNING WITH THE INTERNET OF THINGS

Using IoT connectivity to understand and respond to real-time, actual, contextual behavior of physical and human assets promises to be transformational for any company. In fact, companies that have launched IoT projects believe that IoT investment pays off. Launching IoT projects, however, is no easy feat. It requires both that companies have foundational digital capabilities in place and that they build IoT-specific ones. Fortunately, IoT project teams can—and need to—get help from both internal and external stakeholders to advance their efforts.

IoT project teams need to take concerns regarding IoT seriously—particularly concerns related to security, privacy, integration, and data ownership. When companies are early stage in IoT investigations, it makes a lot of sense to invest in pilots and prototypes that help identify IoT problems in these areas and to formulate solutions. Companies can then draw upon lessons from the early-stage efforts and create acceptable resolutions that reduce future IoT-related risks and ready IoT efforts for prime time.

The Internet of Things is a transformational technology. Driving returns from IoT investments ultimately requires a company to make big changes to the way things are currently done. Thus, deploying the Internet of Things is much more than a technical challenge—it represents an organizational digital business strategy initiative. Deploying means reconfiguring a company to compete in a digital economy.

Companies need to appreciate that IoT project success requires making choices and committing to those choices. The requirements for operational goal attainment are quite different than requirements for growing company revenues. By selectively pursuing what IoT implementation will achieve, companies can ensure that the right capabilities, relationships, and support are put in place.

Ultimately, companies need to view the Internet of Things as a journey whereby digital capabilities are established and then evolved over time. As a company deepens in IoT maturity, IoT capabilities become more robust—to serve more complex and more demanding needs. Now is the time to start the journey. Choose your course. Get ready, get set … go!

This report represent the current findings from the MIT CISR research on Winning with IoT. We continue to study how companies can create viable IoT projects that deliver business value to the company and will distribute additional research findings as they become available.

Appendix A: Interview Phase Company Participants

COMPANY	INDUSTRY	HEADQUARTERS	COMPANY SIZE	HEADCOUNT	INITIAL IoT COURSE	IoT PROJECT TYPE	BUSINESS MODEL	SAMPLE USE CASES
ABC Agriculture	Agriculture	Asia Pacific	> $3 billion Revenues (2015)	NA	Operational Efficiency	Process	B2B	Production optimization; predictive equipment failure
ABC Insurance	Insurance	Asia Pacific	> $3 billion Revenues (2015)	NA	Market Effectiveness	Product	B2C	Safety offering
ABC Utilities	Utilities	Europe	$3 billion Revenues (2015)	NA	Market Effectiveness	Solutions	B2B	Smart buildings
APM Terminals	Shipping	Netherlands	$4.2 billion Revenues (2016)	22,615	Operational Efficiency	Process	B2B	Real-time asset optimization; inventory control; operations optimization
Bemis	Packaging	United States	$4 billion Revenues (2015)	18,000	Operational Efficiency	Process	B2B	Predictive maintenance; process monitoring
BT	Telecommunications	England	$28.7 billion Sales (2016)	88,500	Market Effectiveness	Solutions	B2B	Smart cities
Ferrovial	Infrastructure	Spain	$10.8 billion Revenues (2015)	74,000	Market Effectiveness	Product	B2C	Toll road driver services
Orange	Telecommunications	France	$42.5 billion Sales (2016)	155,000	Market Effectiveness	Solutions	B2C	Smart homes
Schindler Group	Vertical Transportation	Switzerland	$9.7 billion Revenues (2016)	58,000	Operational Efficiency	Process	B2B	Predictive equipment failure; spare part demand
Trinity Health	Healthcare	United States	$16.2 billion Operating Revenues (2015)	97,000	Operational Efficiency	Process	B2C	Staff optimization; right-time care delivery

Appendix B: Descriptive Statistics

How important were the following enterprise capabilities for the successful execution of your IoT project? (1=We do not have this capability; 5=Extremely important)

Full Sample:

FOUNDATIONAL DIGITAL CAPABILITIES	1	2	3	4	5	MEAN
Enterprise data governance	27	19	65	73	41	3.36
Master data management	24	22	70	71	37	3.33
Data quality management	17	18	68	69	51	3.53
Enterprise data warehouse (data lake and/or data integration)	14	19	58	74	59	3.65
Enterprise analytics center of excellence	35	23	49	61	56	3.36
APIs (that expose services to external customers)	27	19	44	76	56	3.52
Cloud (public or private)	15	26	49	67	68	3.65
Enterprise change management	18	37	77	62	30	3.22
Enterprise risk management (legal, privacy, and/or compliance)	12	29	58	61	64	3.61
Enterprise vendor management	14	45	80	64	21	3.15

How effective were the following IoT capabilities and activities for your IoT project? (1=Not Applicable; 5=Extremely Effective)

Full Sample:

IoT-SPECIFIC DIGITAL CAPABILITIES	1	2	3	4	5	MEAN
Decisions processed on devices	41	7	38	87	48	3.43
Intelligent filtering	35	17	40	81	49	3.41
Pattern detection	30	17	33	77	65	3.59
Real-time response	25	12	34	70	81	3.77
Automated response	31	12	36	72	69	3.62
Business process redesign	32	10	58	76	46	3.42
Training in new IoT skills	34	11	56	89	32	3.33
New hires with IoT skills	48	25	51	67	33	3.05

For your IoT project, to what extent have the following IoT ecosystem issues been resolved? (1=Not Applicable; 5=Completely Resolved)

Full Sample:

IoT CONCERN RESOLUTION	1	2	3	4	5	MEAN
Security	8	25	42	114	34	3.63
Data ownership	8	17	53	89	58	3.76
Data privacy	9	19	51	88	55	3.73
Data standards	7	27	65	94	31	3.51

How effectively is your IoT project helping your enterprise achieve the following strategic outcomes?
(1=Not Applicable; 5=Very Effectively)

Launched IoT projects:

IoT BUSINESS CHANGE	1	2	3	4	5	MEAN
Seeing across the supply chain in new ways	33	12	14	26	29	3.05
Seeing into a new supply chain	33	13	20	21	26	2.95
Accessing actual behavior (people or things)	6	2	10	34	63	4.27
Responding in real time	10	8	18	19	59	3.96
Acting proactively	8	4	9	28	65	4.21
Delivering new products and services	16	4	13	34	46	3.80
Delivering products and services in new ways	22	6	9	27	48	3.65
Understanding customers in new ways	14	6	11	31	50	3.87
Engaging with customers in new ways	12	4	14	27	55	3.97

How effective were the following IoT capabilities and activities for your IoT project?
(1=Not Applicable; 5=Extremely Effective)

Full Sample:

IoT GOVERNANCE	1	2	3	4	5	MEAN
Board time and attention regarding IoT	60	21	43	61	36	2.96
Executive Committee time and attention regarding IoT	34	14	41	84	49	3.45
A clear IoT vision	20	13	44	75	72	3.74
Customer involvement	31	10	51	77	54	3.51
Ecosystem partner involvement	14	6	35	102	68	3.91

How effectively is your IoT project currently generating the following performance outcomes?
(1=Not Applicable; 5=Very Effectively)

Launched IoT projects:

IoT OUTCOMES	1	2	3	4	5	MEAN
Generating operational efficiencies	12	2	12	35	51	3.99
Increasing sales	24	8	22	33	24	3.23
Increasing prices	38	19	28	19	7	2.44
Increasing customer loyalty/satisfaction	12	3	14	43	38	3.84
Generating new revenue streams	22	8	17	34	29	3.36
Developing new capabilities	7	0	4	41	60	4.31
Leapfrogging competitors	12	7	19	35	37	3.71
Generating the intended project ROI	6	4	24	58	19	3.72

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National Disability Insurance Scheme (Australia)
New Zealand Government—GCIO Office
Nielsen
Nomura Holdings, Inc. (Japan)
Nomura Research Institute, Ltd. (Japan)
Nordea Bank
Northwestern Mutual
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