SAMSUNG: THE INTERNET OF THINGS[1]

In June 2016, Boo-Keun Yoon, the chief executive officer of Samsung Electronics Co. Ltd. (Samsung), was contemplating a potentially transformational decision for the multinational conglomerate. Two years earlier, in 2014, the Internet of things (IoT) was developing into a new industry with mass-market popularity, and Samsung had entered the consumer electronics segment of the global IoT market with ambitious goals.[2] Over the next two years, the company experienced a US$100 million[3] investment, a ground-breaking trade show presentation, and a cyber security scandal. At that point, the next step forward for Samsung was unclear.[4] Yoon wondered if Samsung should invest $1.2 billion in research and development (R&D) funding for IoT, which represented a possibly lucrative opportunity. Or, should the company instead scale down the project to shield itself from the looming risks?

GLOBAL CONSUMER ELECTRONICS INDUSTRY

The global market for consumer electronics in 2015 was estimated at $685 billion and was expected to grow by approximately 5 per cent to $718 billion by 2018. The consumer electronics market consisted of digital and electronic devices used for communication, entertainment, and home-office activities such as smartphones, printers, and television sets. All of these devices were usually sold by the same retailers to realize cost efficiencies in the distribution channel. Innovation was integral for success in the consumer electronics market. Companies had to constantly improve their existing products while creating new ones to stay competitive.[5] Various devices in this market could be used for more than one task. For example, smartphones could be used as radios, global positioning devices, or cameras, among many other functions.

SAMSUNG ELECTRONICS

Samsung was a subsidiary of Samsung Group, a multinational conglomerate established in 1938 that encompassed over 80 businesses in various industries such as electronics, engineering, heavy industries, and financial services. Samsung was headquartered in Suwon, South Korea, and had over 159 subsidiaries worldwide.[6] The company earned approximately $177 billion in revenue and $17 billion in net income in 2015 (see Exhibit 1). It accounted for about 17 per cent of South Korea's gross domestic product and 20 per cent of the country's net exports.[7]

This gave the firm considerable political influence and buyer power in the South Korean market. Samsung was the world's largest manufacturer of televisions (since 2006) and mobile phones (since 2011), and the second-largest semiconductor chip maker in the world (since 2016), with Intel Corporation (Intel) in first place.[8] The company was world-renowned for its design and innovation capabilities. In March 2016, Samsung won 38 International Forum Design Awards, which were considered the most prestigious awards in the industry.[9]

THE INTERNET OF THINGS

The IoT was a technological concept based on the interconnection of electronic devices with computing power embedded in everyday objects, enabling them to work together to create novel solutions for everyday life. The term itself was coined inadvertently in 1999 at a Procter & Gamble Company internal presentation on the notion of linking its supply chain to the then-red-hot topic of the Internet. *Forbes* described the IoT as "a giant network of connected 'things' (which also includes people). The relationships will be between people-people, people-things, and things-things."[10]

On a small scale, the IoT could involve consumer electronics functions such as controlling a thermostat through a phone, controlling a vacuum cleaner with a smart watch, or sending commands to a television from a smart screen on the refrigerator door. On a broader scale, the IoT could be applied to transportation networks to create "smart cities" aimed at improving efficiency in energy use, traffic flows, and waste management. For example, by using IoT networks to connect smart street crosswalk signs, traffic cameras, and global positioning systems in automobiles, cities could create novel solutions for traffic congestion and fuel the interweaving of autonomous vehicles into urban planning solutions, vehicle safety, and traffic optimization.[11]

There were industrial applications for the IoT as well, such as having sensors at different steps in a mechanical process to garner insights that could help increase efficiency and cost savings. The major challenges impeding industrial IoT applications from market success were that they usually required data that was detailed and relevant to the processes being controlled. This meant that mass-market devices and applications could not successfully capture the market. The problems that industrial clients faced needed unique, tailor-made solutions that specifically targeted the internal metrics that the client wanted to improve.[12] The global market for the IoT in 2015 was estimated at $743 billion and was expected to grow by approximately 88 per cent to $1.4 trillion by 2018.[13]

The industry was still in its infancy and represented a potentially lucrative growth opportunity for market participants, if they executed their strategies well. The concept had progressed slowly since inception but reached mass-market popularity in January 2014, when Google LLC (Google) acquired the smart-thermostat company Nest Labs for $3.2 billion. While the concept had existed for over a decade, 2014 was the first year that the IoT could become a reality due to advances by companies such as Qualcomm Incorporated, Intel, Texas Instruments Incorporated, and Samsung. These technological leaps provided inexpensive, power-efficient chips that enabled almost anything to connect to the Internet via Wi-Fi, or to a mobile phone via a network protocol standard called Bluetooth Low Energy. In the past, large-scale connectivity had been impossible; in 2014, however, the cost of adding connectivity to an everyday device fell to less than $5.[14]

Because the development cycle of the technology was still in early stages, it required a significant amount of investment and accompanied considerable risk. The fledgling IoT technology was extremely complex and fairly turbulent, given the entirely new technological structure, software language, and hardware components that still needed to be invented and fully developed. The IoT could face many potential issues that could lead it to failure such as lack of interoperable standards, security issues, customer adoption, and privacy concerns. These and other issues facing the technology suggested that any investment did not have a guaranteed return and carried a considerable potential for material losses. Most IoT electronic devices employed different "standards," which were essentially the communicative coding languages used to program the device to "talk" to other devices.[15]

Yoon realized that one of the biggest hurdles facing the IoT was the lack of interoperable standards. Just because a device could connect to other devices, it did not mean that the two devices could work cohesively together. The reality of the IoT was that it provided an avenue for endless opportunities and connections to transpire, many of which could not yet be understood. Yoon also worried about the risk that nimble start-ups could use the new technology to disrupt the industry and outperform the incumbents with leaner business models. In the book *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*, Clayton M. Christensen introduced and explored the theory of "disruptive innovation." He described disrupting technologies as "those that transform the landscape of an entire industry, or spark a new one altogether, because they solve a problem in an entirely new way or for an entirely new market."[16]

Christensen employed examples of successful and failed leading companies to posit that regardless of the industry, "an incumbent with established products will get pushed aside unless managers know how and when to abandon traditional business practices." This was because the new entrants would be able to deploy the technology at lower cost structures, and incumbents would only be able to compete by changing their business models to become less profitable, which was extremely difficult. To combat this phenomenon, Christensen recommended that incumbents try to disrupt their own product lines; but they had to exercise caution, because if the timing and execution were not carried out properly, it could be significantly detrimental to the company's future.[17]

THE INTERNET OF THINGS MARKET LANDSCAPE

In 2016, the market landscape for the IoT was heating up. Gartner Research forecasted up to 20 billion IoT capable devices generating 5 trillion gigabytes of data every year by 2020.[18] According to Bain & Company, a leading global management consultancy, executives across the industry reported finding it difficult to get a foothold and develop a clear strategy for the IoT because many had invested significantly but did not have a strong roadmap, due to the solutions still being in their infancy. The IoT was not one singular market but rather a set of overlapping markets with strong connections. Therefore, competitive "battlegrounds" began to emerge in industry verticals such as consumer electronics, industrial and enterprise markets, autonomous machines, network and gateway applications, and analytics.[19]

Deriving tangible and lasting customer value in this industry required a combination of a host of elements such as technology, strategic partnerships, data, and platforms and not just creating "cool" or "futuristic" products. As leading mobile platform providers such as Apple Inc. (Apple), Google, and Samsung Group began expanding into wearables, smart homes, cars, and other aspects of consumer life, fierce competition began to rise as firms tried to gain an advantage using developer communities, device partnerships, and businesses subsidized by data. Platform stickiness and bridging customers across verticals became integral to success. Analytics also became a critical platform battleground due to its ability to create value from IoT data.[20]

Traditional analytics companies, cloud service providers, and system integrators were also flocking into the IoT space to extend their customer relationships and move into tailored products and services.[21] Overall, by 2016, the IoT industry had become very competitive on a business-to-business scale, but the actual technology itself was still fledgling, which meant that any firm could still become the market leader. The nature of the R&D process in infant technologies was that one company could spend a long time trying to develop a new technology and follow a steady linear path to success, but another company could make a technological leap in a very short period and beat the first company to market using a leaner and more agile business model.[22]

SAMSUNG FORAYS INTO THE INTERNET OF THINGS

In June 2014, Samsung, Intel, Dell, Atmel Corporation, and Broadcom Inc. formed a joint venture called the Open Interconnect Consortium. The joint venture intended to set standards for connecting billions of

household devices[23] and establish a single solution for interoperability across multiple industries that would work on various operating systems. In August 2014, Samsung acquired SmartThings, the creator of the leading open IoT platform, signalling a major strategic move into the new industry. Founded in 2012 as a Kickstarter project, SmartThings "gave people the power to monitor, control, and automate their homes from wherever they were through a single mobile app [application]."[24]

David Eun, the president of Samsung NEXT and chief innovation officer of Samsung, made the following statement regarding the acquisition:

> Connected devices have long been strategically important to Samsung and . . . we want to improve the convenience and services in people's lives by giving their devices and appliances a voice, so they can interact more easily with them. We are committed to maintaining SmartThings' open platform, fostering more explosive growth, and becoming its newest strategic partner.[25]

The company was absorbed into the Samsung Strategy and Innovation Center (SSIC) in Palo Alto, California, and was allowed to operate as an independent entity with its own autonomy and strategy.[26]

The SSIC acted as an investment vehicle and start-up accelerator for US companies in which Samsung had an interest. This move enabled SmartThings to operate nimbly and grow fast as a start-up while having the financial and technological backing of a giant conglomerate. The SSIC also housed other Samsung-invested start-ups that were IoT focused, such as Unikey, a keyless entry platform that could integrate into any lock, and Vinli, a connected-car platform that turned a car into a tech hub with a small sensor that connected the car to all of a user's devices. The SSIC provided the start-ups with funding, mentorship, access to key contacts, and a network of firms that were trying to achieve similar goals.[27]

SAMSUNG AT THE CONSUMER ELECTRONICS SHOW

The Consumer Electronics Show was an annual electronics trade show held every January in Las Vegas, Nevada, organized by the Consumer Technology Association. The event typically hosted a slew of presentations on new products and emerging technologies. It was considered the gold standard for trade shows in the consumer electronics industry. At the January 2015 trade show, Yoon gave the opening keynote and pledged $100 million in funding for R&D to create an open system that would kickstart an IoT revolution. He also promised that by 2020, all of Samsung devices for sale would have full IoT capabilities, creating a connected ecosystem of Samsung products.[28]

Yoon explained the company's decision:

> I've heard people say they want to create a single operating system for IoT, but these people only work with their own devices. We can deliver the benefits of IoT only if all sensors can talk to each other. I'm making a promise that our IoT devices and products will be open. We will ensure that others can easily connect to our devices.

This was a tremendously lofty and difficult goal for the company to set, given how new the technology was. Yoon even remarked that "the opportunities and benefits of IoT are huge, but so are the challenges. We need an open system and to collaborate across industries, not just within technology."[29] Samsung's answer to the interoperable standards issue was its acquisition of SmartThings, but this was a temporary solution at best.[30] Although SmartThings had the potential to be a translator for IoT devices, the technology was not ready for mass application because the acquisition had only taken place a few months earlier. At the point of acquisition, the SmartThings team had not yet fully developed the platform and needed additional time and resources to reach completion. In addition, market participants such as Google, Apple, and Amazon Inc.

(Amazon) did not want to use interoperable standards because they wanted to maximize market share through platform effects.[31] Samsung needed more time to see if any solutions to the interoperable standards problem would materialize as they further developed the technology.

THE RESEARCH AND DEVELOPMENT MISCONCEPTION

While the prevailing wisdom was that companies with high R&D expenditure were the ones investing the most in innovation, and thus most likely to succeed, studies showed that expenditure did not always translate to innovation success. Booz & Company, a leading global management consultancy, detailed the top 20 companies by R&D spending in 2011.[32] Companies such as Apple, Facebook Inc., and Google were usually considered the top innovators in the market, but they were not among the top spenders.[33]

For example, Microsoft Corporation (Microsoft) was number five on the expenditure list, having spent nearly $9 billion and 13 per cent of revenue on R&D. However, in 2012, the company only released updates to its aging operating system and office automation software, which failed to register favourable reviews by industry experts, who saw the updates as useful but far from innovative. Another example was Nokia Corporation (Nokia), which had spent $8 billion on R&D in 2011 but did not release any new noteworthy technology. In fact, the company was on the verge of bankruptcy in 2012 and in subsequent years. The emergent pattern was that most of the main R&D spenders were just following historical patterns and spending vast amounts of money to try to replicate past success with past methods, while no impactful innovation materialized.[34]

In addition, managers in technology companies were highly susceptible to "escalation of commitment" and the "sunk cost fallacy."[35] Escalation of commitment referred to the "tendency for decision makers to persist with failing courses of action."[36] It arose in situations where additional investment could either remedy the situation or lead to greater loss, but uncertainty about the future obscured which outcome would actually transpire.[37] In the book *Thinking, Fast and Slow,* Nobel Prize laureate Daniel Kahneman defined the sunk cost fallacy as "the decision to invest additional resources in a losing account when better investment alternatives are available."[38]

This occurred because some managers believed that if they cancelled the project, there would be a sunk cost associated with that decision, which deterred them from taking action. The correct course of action was to review each decision independent of any costs that had been incurred up to that point and evaluate current opportunities on their merit only. In the cases of Nokia and Microsoft, it was evident that the R&D expenditure did not directly lead to increased innovation. Technology companies were especially susceptible to this phenomenon due to the nature of their product development cycle, which required them to constantly innovate and release new products.[39] Therefore, it was imperative that managers be extremely cautious when making material R&D expenditures.

SAMSUNG AND THE INTERNET OF THINGS IN 2016

Because Samsung was an industry incumbent, it already possessed the necessary infrastructure and distribution channels for IoT market penetration, so adding IoT capability to its devices would enable it to extract even more value from these products. For example, Samsung might have already manufactured the television, refrigerator, and dishwasher in that consumer's home, so by implementing the IoT through all these channels, it could immediately attain a value multiplier throughout the entire product development chain.

In addition, its parent company operated in numerous industry verticals, so the advances attained from R&D in the IoT could have had further applications in other verticals, such as industrial applications in its engineering businesses, thereby increasing the total value. It also had a small first-mover head start by

having acquired the leading IoT platform SmartThings, which, at the time of acquisition, "supported more than 1,000 different devices and 8,000 apps created by its community of device makers, inventors, and developers."[40] Using its vast resources, Samsung could theoretically address the interoperability issues with SmartThings and enable it to be a coherent translator for any and all IoT devices.

Concurrently, the major competitors in the space, such as Apple, Amazon, Google, Koninklijke Philips N.V., and Sony Corporation (Sony), all had large amounts of financial capital. They could achieve a technological leap and go to market at any moment.[41] Samsung was also one of the largest chip makers in the world. Advances in the computational power and cost efficiency of computer chips were the major reasons why the IoT was now possible, compared to the past, thus creating opportunities for material savings for Samsung through vertical integration.[42] Making all of its devices IoT capable would supply Samsung with a treasure trove of consumer data, which it could use internally to innovate its products and externally to sell unidentifiable data to other firms. Samsung could partner with incumbent analytics firms to extrapolate useful information from the large data sets, which could lead to novel insights and solutions.

There seemed to be a lot of positives that indicated the investment could potentially be very rewarding, but high reward also accompanied material risk, so it was important to remain cautious about the next steps. Many of the ideas and concepts in the development of the IoT at Samsung were dependent on a number of uncertain outcomes such as SmartThings being able to produce an interoperable standard solution, customers actually adopting the IoT despite security and privacy issues, and the entire project staying on budget and schedule. Successful completion of this project would be a significant undertaking that required substantial collaboration across departments at the firm over a long period.

CHALLENGES WITH THE INTERNET OF THINGS IN 2016

The lack of interoperable standards was still a major challenge with the IoT. In smart homes, many devices operated on different incompatible standards such as Apple's HomeKit, Google's Weave, and Samsung's SmartThings. Many companies rejected compatibility because they wanted to sell as many of their own proprietary standard products as possible, in an attempt to create a platform effect. However, most consumers did not purchase all their home electronics from one company; they shopped from various different brands. Another issue was the multiple methods for devices to connect with each other. Although Wi-Fi was the most widely adopted method, it was too complex for smaller devices (see Exhibit 2). Bluetooth was another popular method for connectivity, but it was not always sufficient for smaller devices.[43]

Smaller devices tended to use a lower-power mesh networking based on the wireless standard 802.15.2. The leading methods for small device connections were Zigbee and Z-Wave. Zigbee powered devices such as Phillips Hue, which was the leading smart light bulb, and was very open-source and flexible. Z-Wave, on the other hand, which was used by leading home security firm ADT Inc., was proprietary and required devices to possess Sigma Designs radio chips to work. Rory O'Neill, Samsung's chief marketing officer, said that he wanted to see the industry break down any barriers to entry and keep things simple by using common standards, so things would work together.[44] At the time, there was no real long-term solution to the interoperable standards issue, except having all market participants decide to adopt open-source approaches with the IoT and come together to create universal standards.

There was also a consumer adoption issue because many people were still skeptical about IoT devices due to the amount of data that was collected. Many consumers feared manipulation by "big business" based on the data that was collected about them. Customers were also very wary of the major security issues that were present with IoT devices, as they were highly susceptible to hacking. In March 2016, AT&T Inc. released its *Cybersecurity Insights Report*, which surveyed over 5,000 enterprises worldwide. The survey found that 85 per cent of companies were deploying or planning to deploy IoT devices, but only 10 per cent felt confident that they could secure those devices against hackers.[45]

SMARTTHINGS SECURITY VULNERABILITIES

In May 2016, researchers at Microsoft and the University of Michigan discovered multiple vulnerabilities in the security of Samsung's SmartThings smart home platform. The report stated that hackers could use these vulnerabilities to seize control of devices such as smart locks, security cameras, motion alarms, thermostats, and smoke detectors connected to the SmartThings system. The group staged four different attacks on the smart home platform, the most severe of which involved using an Android app that controlled services for different devices connected to SmartThings. The attack began with a spear-phishing email that would fool users into clicking a link that would take them to the real login page for the SmartThings site.[46]

The victim of the hack would then log in, but a flaw in the SmartThings web server would allow the attacker to steal the user's credentials. The researchers used this attack method to hack into the cloud-based controls for a Schlage smart lock that was connected to SmartThings. They then created a four-digit personal identification number to unlock it whenever they wanted. The other three attacks involved fooling users into downloading malicious apps from the SmartThings-dedicated app store. The most difficult part of these attacks was actually loading the apps onto the store, which the researchers did not do because of potential legal repercussions. However, a defect in the SmartThings privileges for apps allowed the researchers to use a malicious app that would activate devices or steal personal identification numbers for smart locks.[47]

Hackers could also find other vulnerabilities that would enable them to steal customer data, which could be extremely detrimental for the company. Sony, one of Samsung's main competitors, was hacked for customer data twice, in 2011 and 2014. The incidents cost the company an estimated $271 million.[48] The most expensive cyber-attack in history was the 2011 data breach at Epsilon, the world's largest email marketing firm, which resulted in damages estimated between $225 million and $4 billion.[49] The real possibility of a hack on the SmartThings platform could cripple Samsung, overwhelm it with legal issues, and lead to irreparable damage.

INVESTMENT DECISION

In June 2016, Yoon had to make a difficult decision. The company was at an inflection point for the IoT and had to invest $1.2 billion into R&D.[50] Yoon had to be decisive because this new industry was fiercely competitive, and a misstep could cost the company significant market share. Researchers had found security vulnerabilities in SmartThings only one month earlier, and the technology itself was still in its infancy, with numerous issues and no guarantee of a definite financial return. Samsung had already invested $100 million into R&D, which had not yielded any solutions to the interoperable standards issue. The company had also made a bold promise to have all of its devices interconnected by 2020. Perhaps Samsung would need to explore a potential strategic partnership with a competitor such as Google or Amazon to create a smart home platform or create an aggressive marketing strategy aimed at getting consumers to only use Samsung products in their homes.

Yoon must have been aware of the risks involved in investing in an infant industry, but he must also have known that this technology, if developed and executed properly, had the potential to provide the company with considerable cash flows and a competitive advantage for a long time. Would another investment sink the company deeper into a barren hole, or would it strike gold? Samsung could make a full investment into the IoT or make a smaller investment to scale the project down to hedge against the looming risks. The company could instead choose to pull out of the space altogether for some time and let others bear the initial risk. Were there any additional viable alternatives that Yoon had not yet considered? If he decided to make a smaller investment, how would he determine how much to invest and what components were deemed critical enough to receive funding? If he moved forward with an investment, how would it be implemented? What key milestones would be set in the timeline for execution, and when would they occur?

**EXHIBIT 1: SAMSUNG ELECTRONICS BALANCE SHEET AND INCOME STATEMENT, 2015
(IN THOUSANDS OF US$)**

Samsung Electronics Co., Ltd. and Subsidiaries		
Select 2015 Balance Sheet Line Items		
	2015	**2014**
Assets		
Cash and cash equivalents	20,009,497	14,886,207
Short-term financial instruments	39,095,554	36,851,212
Trade receivables	22,246,995	21,828,525
Inventories	16,628,475	15,307,614
Property, plant, and equipment	76,440,476	71,486,741
Total Assets	**214,071,883**	**203,679,800**
Liabilities and Equity		
Liabilities		
Trade and other payables	5,469,187	6,996,114
Short-term borrowings	9,860,713	7,097,409
Other payables	7,835,568	9,120,841
Accrued expenses	10,279,094	11,382,283
Provisions	5,675,420	5,296,128
Long-term other payables	2,688,665	2,264,891
Deferred income tax liabilities	4,556,521	3,622,214
Total Liabilities	**55,793,968**	**55,100,124**
Equity		
Preferred stock	105,602	105,602
Common stock	687,746	687,746
Share premium	3,892,772	3,892,772
Retained earnings	163,645,376	149,853,800
Other components of equity	(15,540,044)	(11,252,000)
Non-controlling interests	5,465,428	5,220,952
Total Equity	**158,277,915**	**148,579,676**
Total Liabilities and Equity	**214,071,883**	**203,679,800**

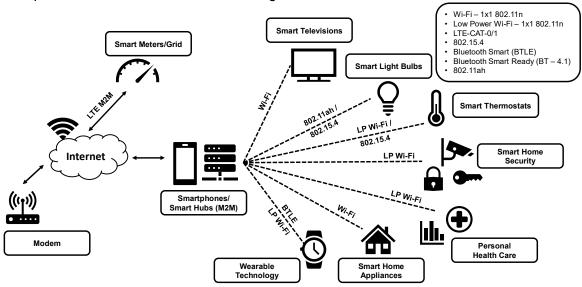| Samsung Electronics Co., Ltd. and Subsidiaries		
2015 Income Statement		
	2015	**2014**
Revenue	177,365,404	182,273,479
Cost of sales	109,150,639	113,390,613
Gross Profit	**68,214,765**	**68,882,866**
Selling and administrative expenses	44,866,898	46,762,235
Operating Profit	**23,347,867**	**22,120,631**
Other non-operating income	1,490,274	3,360,167
Other non-operating expense	3,291,288	1,997,469
Share of profit of associates and joint ventures	974,040	302,763
Financial income	9,294,510	7,301,184
Financial expense	8,867,472	6,447,452
Profit before Income Tax	**22,947,931**	**24,639,824**
Income tax expense	6,099,929	3,960,643
Profit for the Year	**16,848,002**	**20,679,181**
Profit attributable to owners of the parent	16,524,908	20,403,517
Profit attributable to non-controlling interests	323,094	275,664
Earnings per Share for Profit Attributable to Owners of the Parent		
Basic	**111.65**	**135.34**
Diluted	**111.64**	**135.33**

Source: Samsung Electronics Co., Ltd., *Consolidated Financial Statements of Samsung Electronics Co., Ltd. and Subsidiaries*, 3–6, accessed December 14, 2018, https://images.samsung.com/is/content/samsung/p5/global/ir/docs/2015_con_quarter04 _all.pdf.

EXHIBIT 2: INTERNET OF THINGS WIRELESS COMMUNICATIONS STANDARDS AND CHANNELS

Internet of Things Connectivity
Complex network of different devices using different standards

Note: M2M = Modem-to-Modem; LP Wi-Fi = Low Power Wi-Fi; BTLE = Bluetooth Low Energy.
Source: Adapted by the case authors from "Connectivity for IoT," Imagination Technologies, accessed December 14, 2018, https://cdn57.androidauthority.net/wp-content/uploads/2015/08/imgtec-ensigma-and-iot-1280x720.png.

ENDNOTES

[1] This case has been written on the basis of published sources only. Consequently, the interpretation and perspectives presented in this case are not necessarily those of Samsung Electronics Co. Ltd. or any of its employees.

[2] Knud Lasse Lueth, "Why the Internet of Things Is Called Internet of Things: Definition, History, Disambiguation," IoT Analytics, December 19, 2014, accessed December 14, 2018, https://iot-analytics.com/internet-of-things-definition.

[3] All currency amounts are in US$ unless otherwise specified.

[4] Samuel Gibbs, "Samsung Pledges over $100m to Make an Open 'Internet of Things' Finally Happen," *The Guardian*, January 6, 2015, accessed December 14, 2018, www.theguardian.com/technology/2015/jan/06/samsung-pledges-over-100bn-to-make-an-open-internet-of-things-finally-happen.

[5] Euromonitor International, "Consumer Electronics," Passport, accessed December 14, 2018, www.portal.euromonitor.com/portal/statisticsevolution/index#.

[6] Samsung Electronics Co., Ltd., *Consolidated Financial Statements of Samsung Electronics Co., Ltd. and Subsidiaries*, 4, accessed December 14, 2018, https://images.samsung.com/is/content/samsung/p5/global/ir/docs/2015_con_quarter04_all.pdf.

[7] James Estrin, "Samsung and the South Korean Success Story," *New York Times*, November 13, 2015, accessed December 14, 2018, https://lens.blogs.nytimes.com/2015/11/13/samsung-and-the-south-korean-success-story.

[8] Jay Yarow, "13 Mind Blowing Facts about Samsung," Business Insider, April 3, 2013, accessed December 14, 2018, www.businessinsider.com/mind-blowing-facts-about-samsung-2013-4?op=1#samsung-lists-145-products-on-its-web-site-under-the-cell-phones-category-apple-has-three-phones-in-two-different-colors-11.

[9] "Samsung Electronics Wins 38 iF Design Awards," Samsung Electronics Co., Ltd., May 31, 2016, accessed December 14, 2018, www.samsung.com/levant/news/global/samsung-electronics-wins-38-if-design-awards.

[10] Jacob Morgan, "A Simple Explanation of 'the Internet of Things,'" *Forbes*, May 13, 2014, accessed December 14, 2018, www.forbes.com/sites/jacobmorgan/2014/05/13/simple-explanation-internet-things-that-anyone-can-understand/#390e1cf81d09.

[11] Knud Lasse Lueth, "The 10 Most Popular Internet of Things Applications Right Now," IoT Analytics, February 2, 2015, accessed May 26, 2019, https://iot-analytics.com/10-internet-of-things-applications.

[12] Anna-Katrina Shedletsky, "Why Industrial IOT Is Usually a Failure—and How to Fix It," *Forbes*, August 6, 2018, accessed December 14, 2018, www.forbes.com/sites/annashedletsky/2018/08/06/why-industrial-iot-is-usually-a-failure-and-how-to-fix-it/#e1bf31b42eda.

[13] "Global Internet of Things Market Size," Statista, accessed December 14, 2018, www.statista.com/statistics/485136/global-internet-of-things-market-size.

[14] Christopher Mims, "2014 Is the Year of the Internet of Things—No, Seriously, We Mean It This Time," Quartz, December 5, 2013, accessed December 14, 2018, https://qz.com/154064/2014-is-the-year-of-the-internet-of-things-no-seriously-we-mean-it-this-time.

[15] Gary Marshall, "The Automated Home Is a Mess," TechRadar, March 6, 2016, accessed December 14, 2018, www.techradar.com/news/world-of-tech/the-automated-home-is-a-mess-1316149.

[16] Clayton M. Christensen, *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail* (Boston, MA: Harvard Business School Press, 1997).

[17] Ibid.

[18] Thilo Koslowski, Anurag Gupta, and Peter Middleton, "Forecast Analysis: Internet of Things—Endpoints, Worldwide, 2015 Update," Gartner, December 15, 2015, accessed December 14, 2018, www.gartner.com/en/documents/3178626.

[19] Anne Bosche et al., "How Providers Can Succeed in the Internet of Things," Bain & Company, August 28, 2016, accessed December 14, 2018, www.bain.com/insights/how-providers-can-succeed-in-the-internet-of-things.

[20] Ibid.

[21] Ibid.

[22] Christensen, op. cit.

[23] Amit Chowdhry, "Samsung, Intel and Dell Launch 'Internet of Things' Consortium," *Forbes*, July 9, 2014, accessed December 14, 2018, www.forbes.com/sites/amitchowdhry/2014/07/09/samsung-intel-and-dell-launch-internet-of-things-consortium/#d5ab3d01880a.

[24] "Samsung to Acquire SmartThings, Leading Open Platform for the Internet of Things," Samsung Electronics Co. Ltd., August 15, 2014, accessed December 14, 2018, https://news.samsung.com/global/samsung-to-acquire-smartthings-leading-open-platform-for-the-internet-of-things.

[25] Ibid.

[26] "Start-Ups: The Secret Ingredient of Samsung's Open Innovation," Samsung Electronics Co. Ltd., September 21, 2015, accessed December 14, 2018, https://news.samsung.com/global/startups-the-secret-ingredient-of-samsungs-open-innovation.

[27] Ibid.

[28] Gibbs, op. cit.

[29] Ibid.

[30] Jared Newman, "Why the Internet of Things Might Never Speak a Common Language," Fast Company, March 18, 2016, accessed May 26, 2019, www.fastcompany.com/3057770/why-the-internet-of-things-might-never-speak-a-common-language.

[31] Marshall, op. cit.

[32] Adam Hartung, "Top 20 R&D Spenders—Not Good Investments," *Forbes*, November 5, 2011, accessed December 14, 2018, www.forbes.com/sites/adamhartung/2012/11/05/top-20-rd-spenders-not-good-investments/#23be5fb44805.

[33] "The World's Top 10 Most Innovative Companies of 2015 in Big Data," Fast Company, accessed May 26, 2019, www.fastcompany.com/3041638/the-worlds-top-10-most-innovative-companies-in-big-data.

[34] Hartung, op. cit.

[35] Urban Nulden, "Escalation in IT Projects: Can We Afford to Quit or Do We Have to Continue?," Department of Informatics, Goteborg University, Sweden, 1996, accessed December 14, 2018, https://pdfs.semanticscholar.org/1774/65e7db3a074707 3118276aa457119ee995e3.pdf.

[36] Joel Brockner, "The Escalation of Commitment to a Failing Course of Action: Toward Theoretical Progress," *Academy of Management Review* 17, no. 1 (1997): 39–61.

[37] Barry Staw and Jerry Ross, "Knowing When to Pull the Plug," *Harvard Business Review*, March 1987, accessed December 14, 2018, https://hbr.org/1987/03/knowing-when-to-pull-the-plug.

[38] Daniel Kahneman, *Thinking, Fast and Slow* (New York, NY: Farrar, Straus and Giroux, 2011).

[39] Nulden, op. cit.

[40] "Samsung to Acquire SmartThings, Leading Open Platform for the Internet of Things," Samsung Electronics Co. Ltd., August 15, 2014, accessed December 14, 2018, https://news.samsung.com/global/samsung-to-acquire-smartthings-leading-open-platform-for-the-internet-of-things

[41] Marshall, op. cit.

[42] Mims, op. cit.

[43] Marshall, op. cit.

[44] Ibid.

[45] Andrew Meola, "A Major Red Flag about Security Could Threaten the Entire IoT," Business Insider, March 3, 2016, accessed December 14, 2018, www.businessinsider.com/iot-cyber-security-hacking-problems-internet-of-things-2016-3.

[46] Andrew Meola, "Researchers Discover Multiple Vulnerabilities in Samsung's SmartThings Platform," Business Insider, May 3, 2016, accessed December 14, 2018, www.businessinsider.com/samsung-smartthings-platform-iot-security-issues-internet-of-things-2016-5.

[47] Ibid.

[48] Lisa Richwine, "Cyber-Attack Could Cost Sony Studio as Much as $100 Million," Reuters, December 9, 2014, accessed December 14, 2018, www.reuters.com/article/sony-cybersecurity-costs-idUSL1N0TT1YO20141209.

[49] Vinod, "10 Shocking Figures Which Show the Cost of Cyber Security Breaches," CBR Online, May 10, 2016, accessed December 14, 2018, www.cbronline.com/business/10-shocking-figures-which-show-the-true-cost-of-cyber-security-breaches-4888746.

[50] Aaron Tilley, "Samsung Will Invest $1.2 Billion Into US for 'Internet of Things,'" *Forbes*, June 21, 2016, accessed December 14, 2018, www.forbes.com/sites/aarontilley/2016/06/21/samsung-will-invest-1-2-billion-into-us-for-internet-of-things/#fda943 95a6e0.