EVERY. THING. CONNECTED.

A study of the adoption of 'Internet of Things' among Danish companies

CONTENTS

EXECUTIVE SUMMARY

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Previous years have seen massive attention around the Internet of Things (IoT) but have brought little knowledge of its adoption among Danish companies. This report seeks to change that.

The report shows that the Danish companies surveyed have a much stronger faith in the potential of IoT than foreign counterparts but are less likely to have acted on the opportunity.

What causes this contradiction?

Our analysis identifies five key roadblocks for IoT adoption:

- A perceived high cost of IoT that holds companies back.

- A challenge of identifying the value capture in a company-specific context - despite an almost unanimous belief in the potential of IoT.

- A clash between IoT and companies' traditional governance structures, as IoT still presents both uncertainties and a lack of historical precedence.

- Paralyzation that occurs when IoT requires a company to undergo change to a degree that it stifles action.

- Knowledge gap on IoT, especially among top management.

At the same time, there is potential for improving structures that would be instrumental in overcoming the barriers. 60 percent of Danish respondents do not believe they have the organizational capabilities, and three of four do not believe they have the processes needed, to capture the IoT opportunity. At the same time, less than a third is increasing investments in IoT by more than ten per cent. As a result, there are more Danish respondents that do not feel better prepared than competitors to capture the value of IoT than do feel better prepared.

Finally, the report suggests four critical steps to take to get started with IoT:

1. Appoint dedicated leadership to drive IoT momentum

2. Evaluate value captures using both experiences from four industries and a maturity continuum

3. Create IoT adoption plan, categorizing projects into Simmer, Pilot, and Scale

4. Explore partnerships to fast track adoption

Figure 1: Respondents from Danish companies employ only a small share of the potential use of IoT

-Danish companies mapped on the IoT Maturity Model

Monitoring	Control	Optimization	Autonomy	System Autonomy
52%	29%	29%		
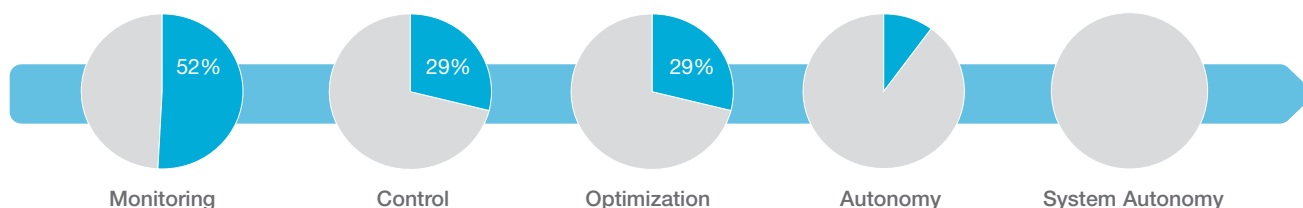
METHODOLOGY

METHODOLOGY

This report is the first of its kind to explore the adoption of Internet of Things (IoT) among Danish companies. It is the result of a questionnaire survey among 35 high-ranking IT and business leaders from Danish companies with extensive knowledge of their organization's IoT strategy, as well as ten qualitative interviews with company business leaders. In addition four expert interviews have been conducted. The experts that participated in qualitative interviews included: Dan Martin Angel investor in utility-related companies; Emil Berthelsen, IoT researcher and expert from Machina Research; Peter M Jensen, CEO of Parstream, an IoT analytics platform based in Silicon Valley and Germany; and Erik Kruse, Networked Society Evangelist, Ericsson.

More than half of the participants in the questionnaire survey were large Danish companies (cf. figure 2). Among the 35 questionnaire responses, there were seven from each of the following four industries: Transport, Buildings, Utilities, and Healthcare. Seven were from other industries, including e.g. Retail, Software, and Media.

Of the companies that participated in qualitative interviews, eight out of ten generate >5 billion DKK annual revenue, putting them among the top100 biggest companies in Denmark. Two of the companies are C20 companies. These large companies all have a prominent role in their respective industries and in society in general, and they have the financial capacity to invest in IoT. Interviewed companies include among others DSB, Torm, Dong, Grundfos, and Vestas. There were at least two interviews conducted in each of the four industries covered. Comparative international studies on IoT-adoption have little to no data on Danish companies. Our methodology allowed us to identify patterns that could be followed by further, future statistical investigations.

This study was carried out during August and September, 2015 by Monitor Deloitte for Ericsson Denmark in cooperation with DI Digital (Danish ICT and Electronics Federation).

Figure 2: The majority of respondents from Danish companies were large and distributed evenly across industries

-Distribution of questionnaire respondents (revenue and industry)

respondents
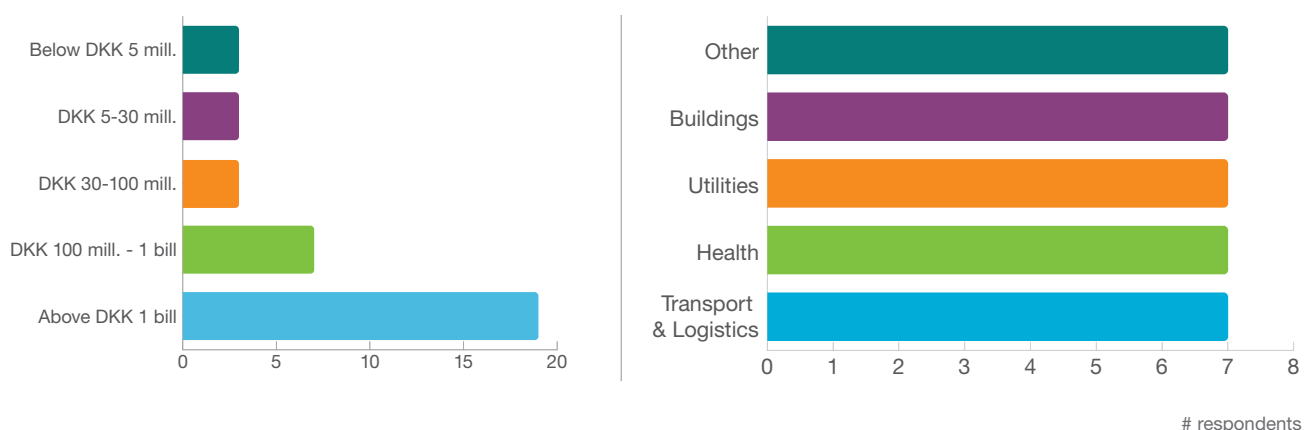
IOT IN
A NUTSHELL

IOT IN A NUTSHELL

First the definition. The Internet of Things (IoT) refers to the network of physical things that combines internet connection, electronics, software, and sensors to enable exchange of data with the producer and/or other physical things. IoT builds on earlier developments like Machine-to-Machine communication - used in industrial equipment for monitoring for decades[1] – but with IoT, processing power and connectivity have become so cheap and widespread that there are now exponentially more opportunities for companies to pursue, one being Big Data.

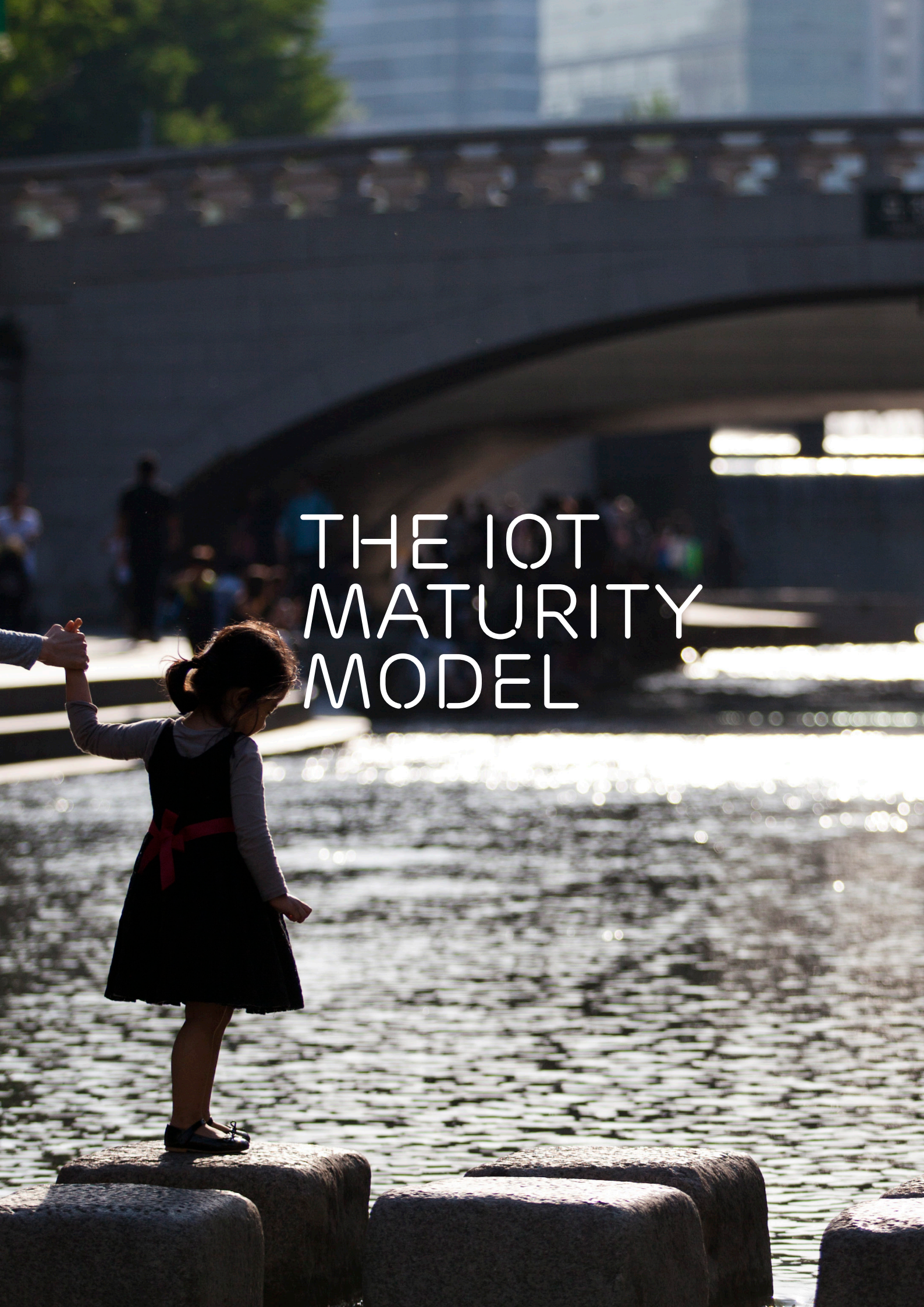IoT is not just a thing of tomorrow. Right now, there are about 14 billion IoT units installed[2], and by 2020, this number will have reached 26 billion devices globally[3]. This affects not only companies but has the potential to change society, what we expect of our surroundings, with things interacting seamlessly and independent of humans and generating almost unlimited data points.

So what is the opportunity for Danish companies? The worldwide IoT market is expected to grow to more than $7 trillion by 2020[4], way beyond the entire worldwide IT spending of $4 trillion in 2014[5].

At the same time, however, most companies have only just begun the IoT journey. A journey of multiple steps.

1. Unclogging the IoT Data Faucet
2. The Internet of Things: Making the most of the Second Digital Revolution
3. Ericsson connected device vision
4. For Tech Makers, Collaboration Is Critical for Creating the Best 'Internet of Things'
5. Gartner Says Worldwide IT Spending on Pace to Reach $3.8 Trillion in 2014

THE IOT
MATURITY
MODEL

THE IOT MATURITY MODEL

A maturity continuum can be used to illustrate this (cf. figure 3)[6]. In the continuum, IoT can be related to five steps of maturity. Companies need capabilities to climb earlier steps of the continuum in order to be able to reach subsequent steps. As we will see, however, some companies skip earlier steps entirely if those steps do not deliver the value they are looking for. The continuum does not imply that all companies should focus on reaching the last step. Instead, a company decides which features will deliver real value to customers relative to its costs. The model does not illustrate that a company on the first step is 'immature', instead it serves to illustrate the magnitude of the IoT opportunity remaining, even when the first steps have been taken.

Value from IoT can come from both internal efficiency gains, e.g. within supply chain and production, and companies' customer offerings.

The vast majority of literature written on IoT is about just the first step of the continuum, Monitoring. Using sensors, IoT-enabled devices allow for substantial monitoring of product condition, the external environment, and product use. By enabling Big Data, this step alone presents not only a great opportunity but also a daunting task.

On the second step, Control, product functions respond to specified changes in its condition or environment (if X occurs, Y is performed), using algorithms and software.

On the third step, the product is additionally capable of Optimization, where analytics enable the product to continuously and automatically optimize performance. The real-time data collected combined with the ability to control product function via software enables more timely preventive – as opposed to time-based - maintenance and even remote repair.

The fourth step combines the capabilities of the previous three, but on this step the product is able to work in Autonomy, without human interference, continuously adjusting itself to data on the environment and its users' preferences.

Finally, the fifth step is System Autonomy, to illustrate that the full potential of IoT lies in the ability of a product to not only work autonomously but also in continuous dialogue with other connected things, impacting the function of both.

Figure 3: IoT-enablement can happen on five levels

-The IoT Maturity Model
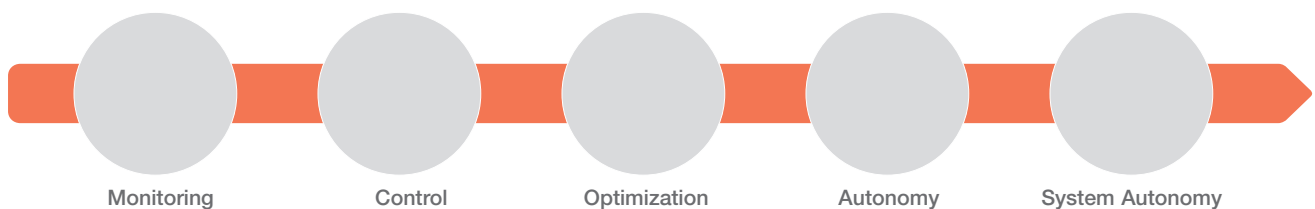
| Monitoring | Control | Optimization | Autonomy | System Autonomy |

6. Adaption of the Porter/Heppelmann framework in How Smart, Connected Products Are Transforming Competition

ADOPTION
IN DENMARK

ADOPTION IN DENMARK

This section will show that Danish companies have an advantageous starting point for IoT-adoption. The Danish companies surveyed are convinced about the potential of IoT – and more so than foreign counterparts – and the advanced infrastructure in Denmark supports IoT-roll out. Despite this, fewer Danish respondents than their foreign counterparts have ongoing IoT-initiatives.

When applied to the surveyed Danish companies, the maturity continuum reveals that Danish companies still have potential to not only utilize IoT more, but also to sophisticate how IoT is used.

The right conditions

There are two striking elements that give Danish companies an advantageous starting point for IoT adoption.

The first is the almost unanimous belief among Danish companies in the potential of the IoT. Three quarters of the surveyed Danish executives believe that IoT will transform their business, or offer significant financial opportunity. This is significantly higher than a global 2014 Gartner survey that showed 40% of companies globally found the same to be true.

Figure 4: Danish company respondents exhibit greater belief in IoT than foreign counterparts

-**Questionnaire results**: "I expect the IoT to Transform my business or offer significant new revenue or cost-savings opportunities within the next 3 years"-
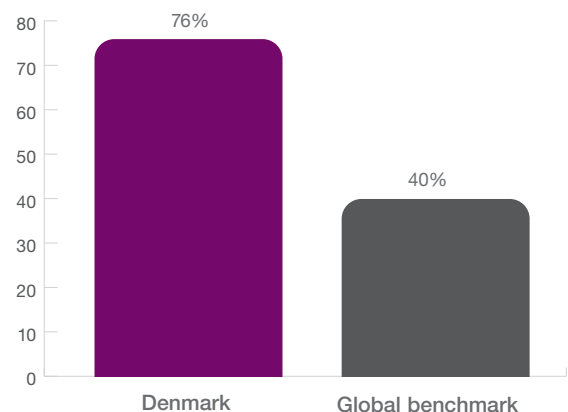
% of Danish company respondents that answered "Yes' vs. global benchmark
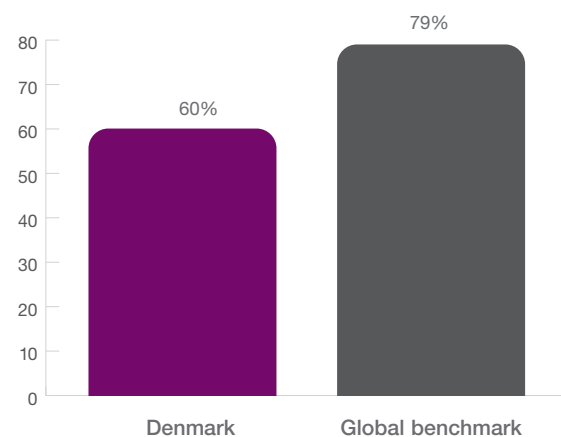
(Gartner)

The second is the characteristics of the Danish market. The Nordic region grows roughly twice as fast as the global market in IoT adoption and is expected to reach almost 4 connected "things" per person by 2018, due to advanced Information and Communication Technology infrastructure (high internet penetration through fixed and mobile networks), a stable regulatory environment, and vibrant user communities[7].

Slow start

Both in Denmark and abroad 60% of companies have an IoT-initiative ongoing. However, the 60% share of Danish companies surveyed that have IoT initiatives in place is subpar to international survey results of almost 80%.

Figure 6: Danish company respondents are less likely than foreign counterparts to have IoT initiatives

-**Questionnaire results**: "We currently have IoT initiatives ongoing"-

% of Danish company respondents that answered "Yes' vs. global benchmark

(Gartner)

So despite having a much more solid faith in IoT than foreign counterparts, the Danish respondents exhibit a tendency to lag behind when it comes to execution.

We explore reasons for this in the 'Roadblocks' section.

Exploring the maturity continuum for Danish companies, figure 5 shows the percentage of surveyed Danish companies who responded that they currently have the IoT functionality listed in their current product / service portfolio. With a little more than half of the respondents utilizing the first step of 'Monitoring', it presents the

Figure 5: Respondents from Danish companies employ only a small share of the potential use of IoT

-Danish companies mapped on the IoT Maturity Model

| Monitoring | Control | Optimization | Autonomy | System Autonomy |

52% — Monitoring
29% — Control
29% — Optimization

% of Danish company respondents that use IoT for this purpose
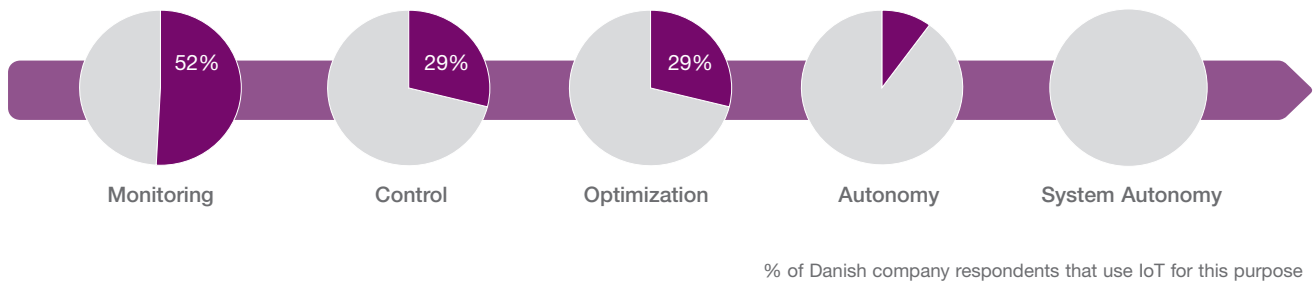
most common way to capture value of IoT. Globally, there is a multitude of examples of products currently on the market that utilize IoT-enabled monitoring (cf. section 'Inspiration from four industries).

With equal adoption rates, the next steps of Control and Monitoring seem to be considered intertwined, or penetrable at the same time.

Most of all, however, the white spaces in the circles of figure 5 illustrate the potential that Danish companies have yet to reap with IoT.

Not set up to capitalize - yet on par

Although 60% of the Danish companies surveyed have an IoT initiative in place - either in the shape of internal process improvement or as customer offering - future adoption is challenged by two impediments that Danish companies in fact share with their foreign counterparts.

Figure 7: Companies exhibit cautious investment behavior

-**Questionnaire results**: "Our investment in IoT is anually increasing by..."-

	Over 10%	Under 10%	No investments
Denmark	27%	41%	32%
Global benchmark	33%	43%	24%

● Denmark ● Global benchmark

% of Danish company respondents that answered "Yes' vs. global benchmark
(Gartner)

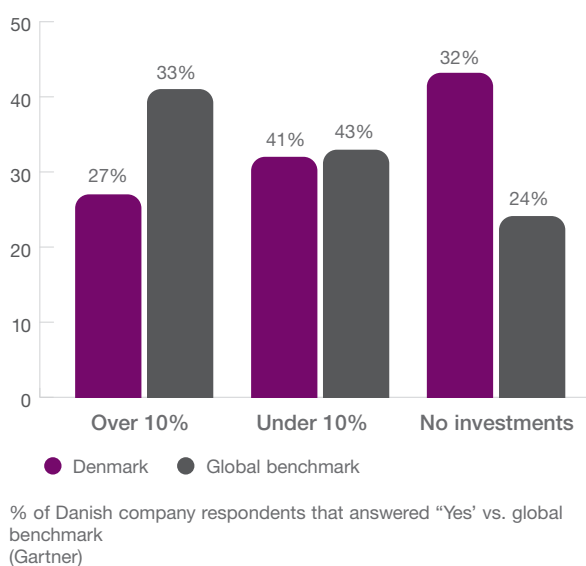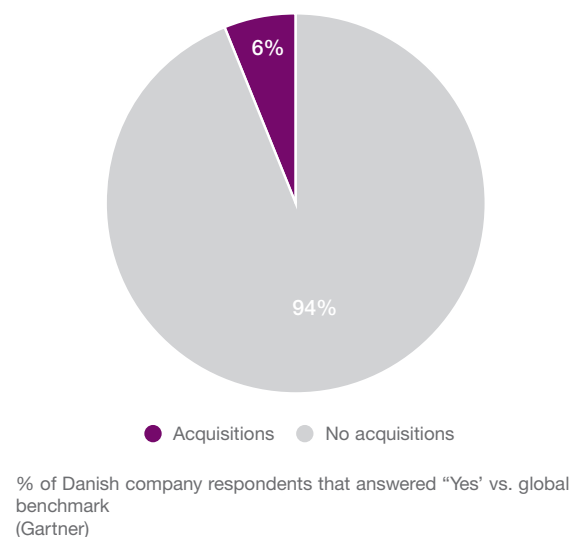The first impediment is financial investment, which can be seen as a sign of commitment and of what to expect in the coming years. About 40% of both foreign and surveyed Danish companies currently increase investment in IoT by less than 10% annually. The Danish companies, however, are slightly more likely than their foreign counterparts to invest nothing in IoT.

Figure 8: Only 6% of Danish respondents pursue acquisitions as a way to develop their IoT efforts

-**Questionnaire results**: "Select the option that best represent the way you develop within IoT" - option 'Acquisitions'

6%
94%

● Acquisitions ● No acquisitions

% of Danish company respondents that answered "Yes' vs. global benchmark
(Gartner)

Another indicator of companies' financial commitment to IoT is their willingness to invest in acquisitions, a strategy that could provide a shortcut in IoT-adoption, especially when internal capabilities do not suffice (please see section Roadblocks – Knowledge Gap). Virtually none of the Danish companies – 2 of the 35 respondents - said they were developing on IoT through acquisitions.

Figure 9: Only a fourth of companies have defined clear leadership for IoT

-**Questionnaire results:** "We have defined a clear leadership and ownership for our IoT efforts"

	Denmark	Wordwide
	26%	25%
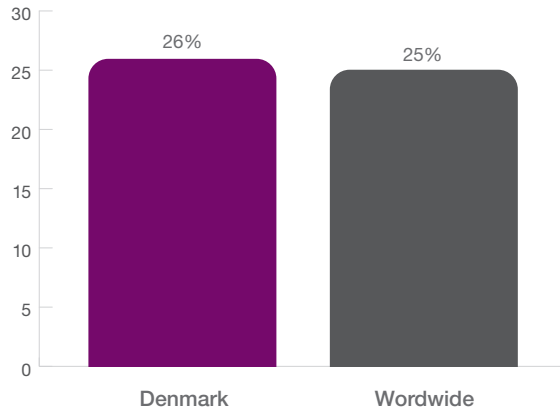
% of Danish company respondents that answered "Yes' vs. global benchmark

(Gartner)

The second impediment is the lack of a clearly defined ownership of the corporate IoT-effort. Only about a fourth of surveyed Danish companies have defined clear leadership for its IoT efforts. This puts Danish companies on par with foreign counterparts.

Whether a symptom or a cause, several of the companies that participated in this study have adopted a wait-and-see strategy for IoT. Meanwhile, the number of IoT-enabled products are increasing on the global market within all the four industries explored.

"I wish we were much further in our adoption of IoT. Today we do not capture the significant potential that IoT offers through predictive maintenance, which would significantly reduce tied up capital." Martin Börjesson, CIO, DSB.
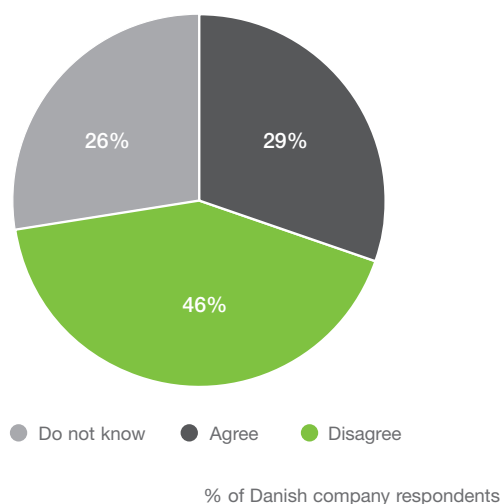
ROADBLOCKS
TO IOT
ADOPTION

ROADBLOCKS TO IOT ADOPTION

Where does this leave Danish companies compared to foreign counterparts? One of the results from the survey sums it up: Among the Danish survey respondents, **there are significantly more companies that do not feel better prepared than competitors to capture the value of IoT than do feel better prepared.**

Figure 10: A significantly larger propotion of respondents do not feel better prepared for IoT opportunity than do feel better prepared

-**Questionnaire results:** "We are better prepared to capture the value of IoT than our competitors"

- Do not know - Agree - Disagree

% of Danish company respondents

What is holding leading Danish businesses back? The following section presents five key roadblocks for adoption.

The five roadblocks constitute a deep dive into the two most important IoT barriers, as ranked by the Danish questionnaire respondents (cf. figure 12). The first is 'lack of convincing business case', which is elaborated on in the roadblocks "Evaluating value capture", "Cost" and "Clash". The second barrier was 'handling new technologies', which is elaborated on in the roadblocks "Paralyzation" and "Knowledge gap"

Cost

Among several respondents, the high cost of IoT, including the sensors, was highlighted as a barrier to transition.

At one Danish company, it had been five years since the last evaluation of IoT. Back then the company chose not to pursue IoT further. A lot has happened on the cost side since then.

Figure 11: The cost of sensors has dropped significantly during past years

- Development in the cost of sensors

EUR/unit
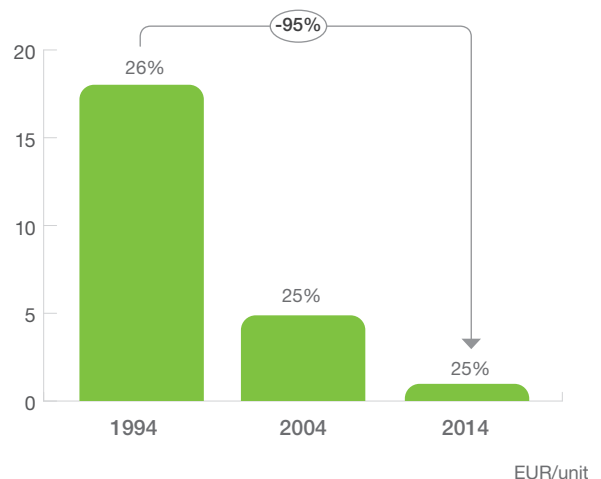
As can be seen in figure 11, the cost of sensors has fallen dramatically [8]. Sensors are just one element of the IoT solution but this trend is representative for the whole. According to Emil Berthelsen, Machina Research, the drop in total IoT cost is driven by IoT module price drops coupled with greater availability of highly competitive IoT enablement platforms as well as usage billing models. This has caused a complete change of markets: Five years ago an IoT project and proof of concept could cost EUR 27-54,000 with a time-to-market of 6-18 months. Today a corresponding project using RFID tagging devices would cost EUR 1-4,000 with a time-to-market of 3-12 weeks.

8. Sensors prices on the decline
9. Infographic: Why the 'Internet of Things' Hasn't Really Caught On Yet

Walter Hannemann, Head of Systems, Technical Division, Torm, highlights another important consideration on cost:

 "Obviously, if you do not yet know how to create value from IoT-enabled data – for customers or in the form of cost savings – the cost easily becomes too high."

This leads to the next roadblock, which focuses on finding the value.

Evaluating the value capture

While strongly believing in the potential of IoT companies struggle to pinpoint exactly where the value of IoT lies for them. Therefore it is not surprising that consumers also have a hard time understanding how IoT brings real value to their lives: Other studies have shown that, globally, 57% of consumers believe that IoT will be revolutionary but a majority do not know how or why.[9]

 "The challenge for IoT adoption is not technical – roughly speaking, anything can be achieved technically – but is more about finding the value. I do believe that IoT has potential to bring value and then it is our job to find out where that value lies." Lars Enevoldsen, Group Vice President, Global Research & Technology, Grundfos.

Knowing where the value of IoT lies for the company is decisive for how to capture it. As long as it is unclear where to capture value, non-action risks being the consequence.

For a Danish healthcare company, the question was whether the value of IoT lies in developing the best algorithms, or in owning the data? The answer to that question is decisive to the strategic choice of entering into exclusive collaborations instead of making data open-access.

Trouble with evaluating the value capture is an important roadblock. Notice how the surveyed Danish companies ranked the barriers to adoption (cf. figure 12): The most important one was 'Lack of convincing business case'.
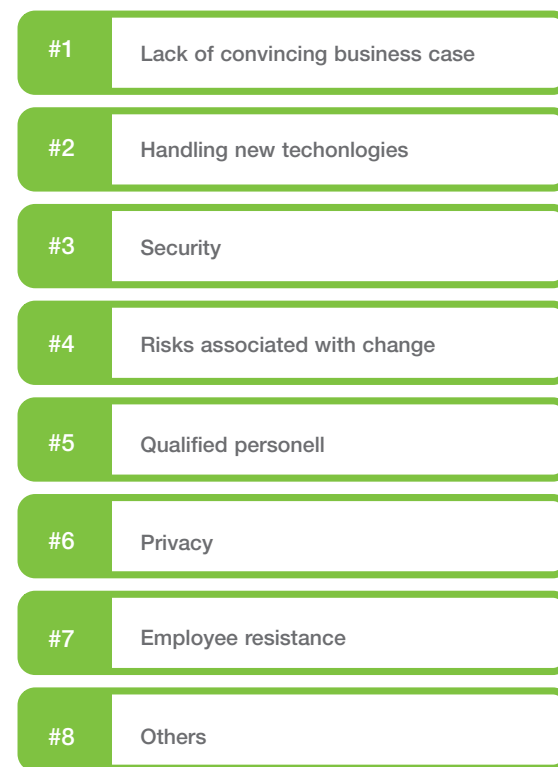
How does this add up with three quarters of executives saying "I expect the IoT to transform my business or offer significant new revenue or cost-savings opportunities within the next 3 years"?

Companies believe in the potential of IoT but are not able to define the concrete value that it will bring to them.

According to Erik Kruse, Networked Society Evangelist, Ericsson, a main barrier for IoT adoption is that companies are challenged with a lack of knowledge of what is actually achievable with IoT.

Figure 12: Despite the deep belief in IoT, Danish companies say 'lack of convincing business case' is the most important barrier

-Barriers to IoT adoption, ranked according to importance for Danish company respondents

#1	Lack of convincing business case
#2	Handling new techonlogies
#3	Security
#4	Risks associated with change
#5	Qualified personell
#6	Privacy
#7	Employee resistance
#8	Others

Clash

IoT remains at early stages of adoption, and therefore companies experience that traditional governance structures - otherwise effective for prioritizing mature business areas - cannot embrace IoT. In this context, 'governance structures' refers to the process with which company boards prioritize the pipeline. This often builds on a business case with a financial forecast.

"We have a zealous governance system… that does not easily embrace an unconventional business case like the Internet of Things" said one respondent from the healthcare industry.

At the front edge of innovation, it is common that a decision to invest is taken without a financial forecast, as there is no historical baseline to project from, and therefore it would be a highly speculative exercise.

The absence of the financial forecast does not mean that decisions are not taken on the basis of data. Measuring customer response, adapting, and measuring again - those are the data points that support investment decisions. 'Failing fast' is seen as a requirement for succeeding due to the possibility to learn.

Interestingly, while multiple of the Danish companies surveyed have piloted IoT, few have measured their effect. In fact, one respondent said the lack of quantifiable use cases was an obstacle, but at the same time the company had not measured the effect of their IoT initiatives.

Thus, IoT adoption is challenged both by a clash with mature companies' traditional governance structures, and a neglect to measure impact.

In the questionnaire survey, **72% of the Danish companies disagree that they have the processes needed to support their work with IoT.**

Figure 13: Almost three quarters of Danish respondents do not have the processes needed to support IoT

-**Questionnaire results:** "We have the processes needed to support our work with IoT"

● Agree   ● Do not agree
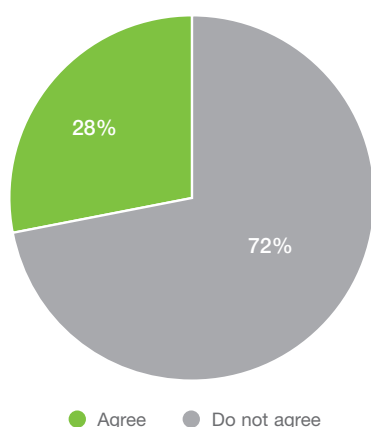
% of Danish company respondents that ticked of 'Acquisitions'

This is discouraging for the adoption of IoT, and more broadly, for innovation in general.

Paralyzation

'Disruption'. Start-ups change the dynamics of entire industries by rethinking how to deliver the best customer experience. It is easy to quote the famous examples of Airbnb and Uber. It is less easy when it is happening to your company.

In one Danish company, the main barrier to IoT adoption was its power to disrupt the company's current business model. When years of development work has gone into providing a successful product line in one way, it is not an easy transition to entirely rethink an approach. In this case, in the face of uncertainty, they were waiting for the market dynamics to play out.

Even when disruption was not foreseen, a common theme in the interviews was that (further) action on IoT was pending competitor moves, customer pull, or regulatory requirements.

10. The Internet of Things Business Index

According to Erik Kruse, Networked Society Evangelist, Ericsson, "One of the most important barriers for IoT adoption is that it is a painful process for legacy companies to forget what they have been doing for decades and instead pursue a radically new approach to serving their customers."

This increases the risk of other companies disrupting the industry, as opposed to companies themselves preempting or driving disruption in a desired direction.

Knowledge gap

Previous international studies have showed that a lack of IoT skills and knowledge among employees and management is one of the biggest obstacle to using the IoT more extensively.[10]

Several of the Danish companies interviewed specifically highlighted the lack of understanding among top management as a barrier to IoT-adoption.

"In general, top management today lacks a good understanding of IoT, probably due to the fact that we talk about IoT in Computerworld instead of Børsen", says Martin Börjesson, CIO, DSB.

Emil Berthelsen, Machina Research, finds the IT stronghold to be particularly apparent among Scandinavian companies:

"IoT initiatives in Scandinavia tend to be pursued within the traditional IT context. This has narrowed the commercial ownership of IoT to IT, causing companies to miss significant IoT opportunities and impacting IoT's prioritization within the business."

The knowledge gap is not limited to the executive level. In the questionnaire survey, almost two thirds did not believe they had the organizational capabilities needed to work with IoT.

Figure 14: More than 60% of Danish company respondents do not have the organizational capabilities needed for IoT

-**Questionnaire results:** "We have the organisational capabilities needed to support our work with IoT"

● Yes   ● No
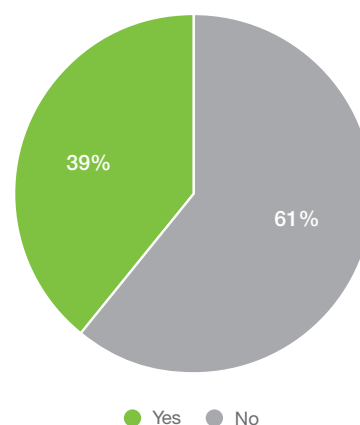
% of Danish company respondents

INSPIRATION
FROM FOUR
INDUSTRIES

INSPIRATION FROM FOUR INDUSTRIES

Addressing the challenge that Danish companies experience – identifying the value capture - this section provides global examples of value capture from IoT in each of the four industries covered. In addition, it illustrates how far each industry has moved on a global scale, which puts into perspective the challenge that many Danish companies seem to be waiting for the moves of other industry players.

The four industries of healthcare, transport, buildings, and utilities have all begun to explore IoT opportunities, and together they elicit different levels of adoption.

Please see Appendix 1 for a list of selected IoT-enabled products on the global market today within the four industries.

Healthcare

The three main value captures within heathcare include:

1	Higher quality of life
2	Lower costs
3	Better Care
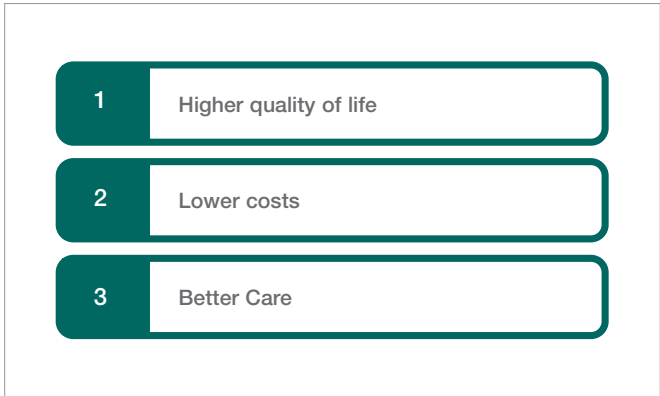
Higher quality of life

IoT-wearables help users maximize training and minimize health challenges. In 2014, there were more than 35 million connected wearable devices in use. They are able to track basic data such as blood pressure, glucose, temperature, and pulse,[11] and mainly deliver monitoring - and in some cases alert - capabilities.

The area of consumer wearables is still the fastest-growing segment of IoT. Beyond current capabilities, it is interesting because of its potential to become central hubs for remote health care in the future.[12] When pills and artificial organs can connect to smartphones, they could also connect to wearables.

Lower costs

Remote monitoring is possible to an unprecedented extent with IoT, allowing better treatment but also lower cost of care, as the caregiver does not need to engage in data collection and analysis.[13]

Remote monitoring is made possible via connected, sensor-enabled devices, which transmit vital sign measurements from the human body. In addition to wearables, there are more invasive measures on the market like sensors under the skin that inform health care professionals and patients of everything from patient blood-glucose levels to heart rates to medication levels.

Better care

The same innovations that enable lower cost actually also improve the quality of care by enabling constant attention and reducing the risk of error.

Better care comes not only from Monitoring capabilities but also from IoT-enabled Control. For an example, a
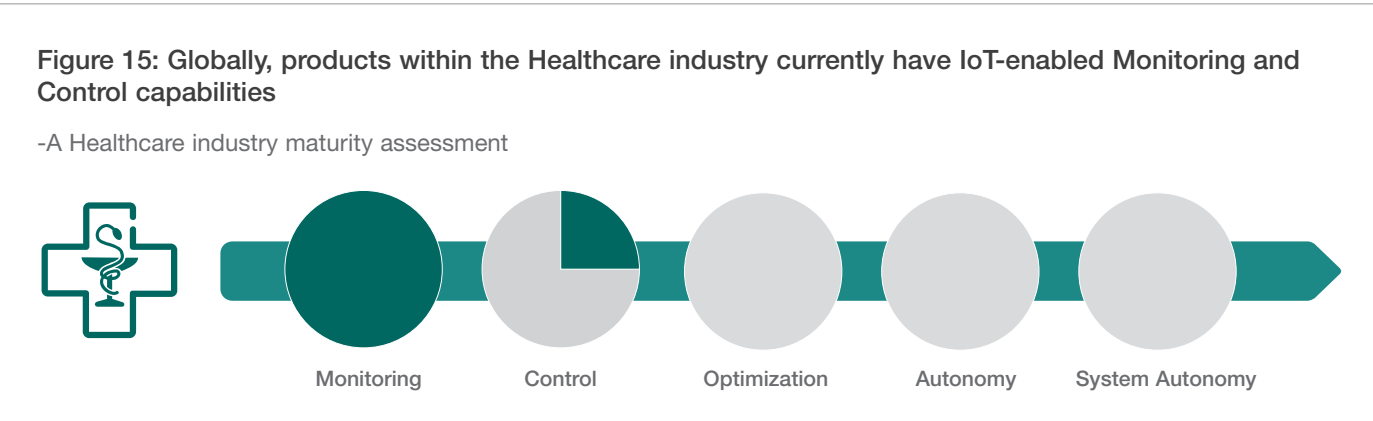
Figure 15: Globally, products within the Healthcare industry currently have IoT-enabled Monitoring and Control capabilities

-A Healthcare industry maturity assessment

Monitoring   Control   Optimization   Autonomy   System Autonomy

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11. Building the Hyperconnected Society
12. How the Internet of Things Will Connect Our Bodies to the Cloud
13. Building the Hyperconnected Society

connected artificial pancreas can automatically stop insulin delivery and notify the patient when blood glucose levels falls below pre-set levels.

IoT-maturity in Healthcare

IoT-enabled Monitoring has thus penetrated everything from prevention to remote monitoring to clinical care. Single innovations on the market have also enabled Control.

IoT adoption is accelerated by partnerships. In September, 2015, the US Food and Drug Administration accepted an application to evaluate Proteus – which monitors patient medication taking via a sensor that knows when a tiny chip hidden inside a pill is swallowed - in combination with Abilify, a popular antipsychotic.[14] Medication adherence is especially a problem among patients with serious mental illnesses. In one study, 74 percent of patients with schizophrenia stopped taking their prescribed drug within 18 months.

At the same time, company pipelines tell a tale of Autonomy. Researchers are currently developing smart bandages for wounds that require ongoing care. In addition to delivering medicine, the bandages will be able to monitor vital signs of healing, such as oxygen levels and temperature, and make adjustments when needed, as well as communicate the information to (remote) health professionals.[15]

Potential

Using IoT-enabled devices to monitor patients - particularly those with chronic conditions - can improve patient adherence to prescribed therapies, avoid hospitalizations, and improve quality of life. This has been estimated to have an economic impact of $170 billion to $1.6 trillion per year in 2025 based on improved health, and reduced cost of care for patients with chronic diseases.[16] Healthcare and Life Sciences companies project that IoT initiatives will boost revenue by 12% from 2015 to 2018.[17]

Transport

The three main value captures within transport include:

1	Improved utilization
2	Location transparency
3	Machine performance
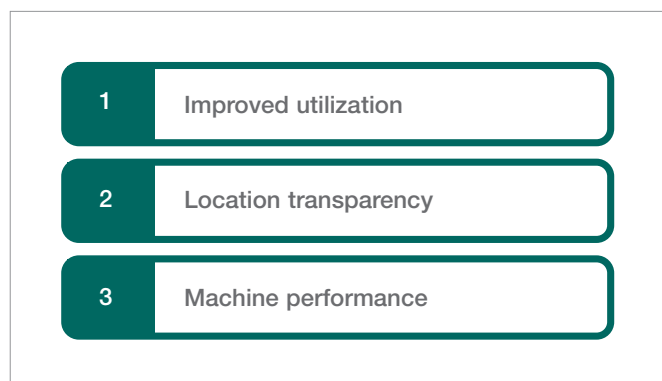
Improved utilization

IoT can facilitate better car utilization in two ways.

The first is via parking management systems, which an increasing number of cities are adopting to help alleviate congestion - 30 percent of cars in congested downtown traffic have been shown to be cruising for parking.[18] They identify empty parking spaces using data from sensors, both to inform drivers of empty spaces but also to collect information about traffic patterns for future planning. But changing infrastructure is a huge task and most cities are only just piloting solutions.

The second comes from the fact that IoT encourages the shared car usage model – disruptive to the car industry - by delivering new levels of real-time information.

Location transparency

Location transparency illustrates how low cost IoT-transformation can be if only very limited data points are enough to deliver customer value.

For an example, it costs about $2 to embed e.g. a Sigfox radio into a device when only short messages like GPS signals need to be transmitted.[19] This cost is low enough for Nigiloc to connect bicycles with GPS signals to track the bicycle if stolen.

This opens up doors for improvements in logistics flow.

Machine performance

Larger and more complex machinery provides a good contrast to the low cost/limited information example of the previous paragraph. The significant cost associated with running machines allows for it to more easily absorb the additional cost of IoT-enablement but also presents higher complexity.

As in the Danish example of Maersk that realized significant fuel savings, IoT has facilitated significant fuel consumption reduction within aviation.[20] In addition, sensors in aircraft engines can now detect and isolate developing problems, in part by measuring the temperature of a jet engine's exhaust and communicating to pilots and ground crews while in operation.[21]

A similar picture can be found within the rail business. Britain's Network Rail Telecom and Cisco are in the process of installing sensors in and beside the tracks to inform a centralized command centre if they need maintenance, or are threatened by nearby landslides or flooding, with a consequent saving on rail inspections.[22]

14. Why pharma wants to put sensors in this blockbuster drug
15. Not Just a Band-Aid: How 'Smart Bandages' Will Change Medicine
16. Unlocking the potential of the Internet of Things
17. The complete reimaginative force
18. Free Parking or Free Markets
19. Meet the French startup set to revolutionize the Internet of things
20, 21, 22. 8 ways the Internet of things will change the way we live and work

Figure 16: Globally, products within the Transport industry currently have IoT-enabled Monitoring capabilities

-A Transport industry maturity assessment

Monitoring · Control · Optimization · Autonomy · System Autonomy
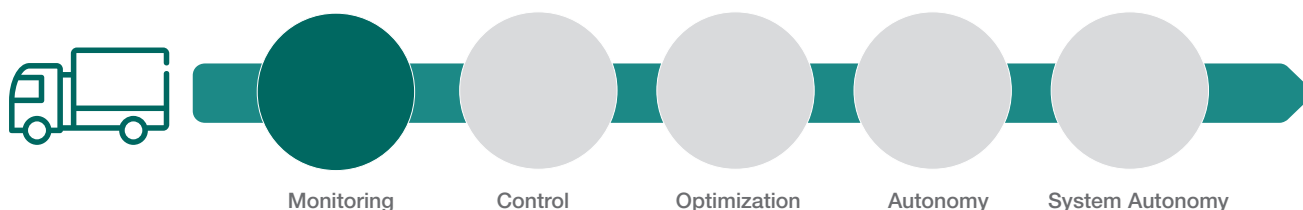
At the port of Hamburg, 10,000 ships and many of the nine million containers that move through the port continuously transmit their precise arrival times, so trucks can arrange just-in-time pickup and drop-off.[23] Hyundai, which has about 15 percent share of the shipbuilding market, is designing a connected ship with a network of sensors and analytics software to help monitor information on the ship's (and thus allow for optimization) general voyage, equipment status, alarms, and connectivity health.[24]

IoT-maturity in Transport

These advances illustrate the amount of change already realized at only the first step of the Maturity-model. A rich impact, yet bound for something bigger.

Automotive companies are actively exploring sensors for both their ability to detect pedestrians, road lane markings,[25] and imminent collisions to enable evasive action.

This year, Volvo, debuted a connected bike helmet that alerts both the wearer and car drivers of imminent collision via the cloud.[26] Volvo is also piloting a cloud service for car-to-car communications that can warn drivers of road conditions by collecting friction information and communicating from the car to the cloud.[27]

These are signs of Autonomy. Value creation will show itself in factors like the fact that autonomous cars can eliminate 85% of head-on collisions.[28] Also, easing traffic can be achieved as IoT enables cars to communicate positions to each other, allowing them to drive much closer together than before. This is thought to help save drivers part of the 90 billion hours they currently spend in traffic, wasting at least $1 trillion in fuel costs and lost productivity.[29]

Developments within mobility management are also expected. The coming years will focus on improving traffic flow that allow drivers to reach a destination quickly, safely and in a cost-efficient manner. This can be achieved with a broader roll-out of current solutions on the market. But also within product development, the future could build on drone technology that scout ahead for traffic problems and relay vital information on emergency situations.[30]

Potential

The potential for IoT to monitor and improve performance of planes, trains, and road vehicles while in use has been estimated to generate $210-740 billion per year by 2025.[31]

IoT in the transportation and distribution sector has been estimated to grow 83% Year on Year.[32]

The Maersk story

When you have several thousand refrigerated containers, the task of checking them manually is substantial. Therefore it was no small step forward when Maersk connected its entire shipping fleet - including both ship and containers - enabling real-time data management from the containers on the exact temperature inside.

But once you have connectivity, the possibilities for optimization are vast. Maersk discovered that it would save 45 million EUR every year by using less fuel through better route planning and fuel efficiency by connecting vessels. Now, Maersk is able to monitor the entire fleet in real time, meaning that the ship can have ongoing dialogue on optimal routes, speed, etc. with land-based colleagues. The data also enables proactive maintenance instead of error messages.

23. 8 ways the Internet of things will change the way we live and work
24. Hyundai building smart ships for data-driven sailing
25. Building_the_Hyperconnected_Society
26. EMEA: Odd connections on the IoT
27. Volvo develops car-to-car social networking for road safety
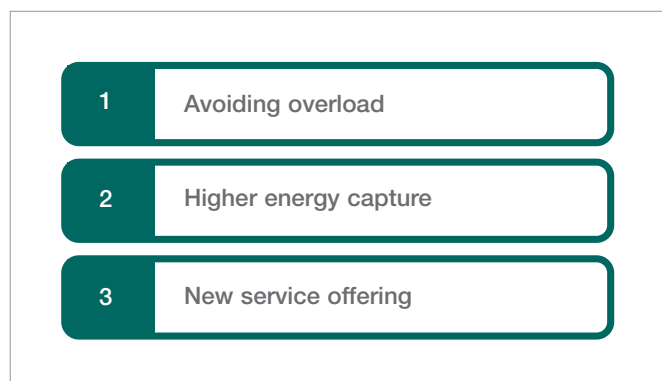28, 29. 8 ways the Internet of things will change the way we live and work
30. Listen Now… How Drones Can Aid Transportation Tech Chat at C3 SXSW
31. Unlocking the potential of the Internet of Things
32. The Internet of Things 2015

Utilities

The three main value captures within Utilities include:

1	Avoiding overload
2	Higher energy capture
3	New service offering

Avoiding overload

Significant efforts are being deployed to transition to 'smart' grid. Smart meters basically allow utilities to remotely read energy usage but also allows savings for consumers that move their energy usage to times when it is in low demand/low cost.

The smart grid roll-out is an entire infrastructure upgrade, a major undertaking, but it also allows major savings.

In Denmark, the decision to convert to smart grid has been driven by the need to accommodate increasing electricity demand.[33] Smart grid evens out electricity demand and the consequent reduction in peaks reduces the need to invest in the traditional distribution grid. The EU estimates that smart grids can reduce infrastructure capacity needed to meet demand by up to 30%.[34]

The intention of the smart grid roll-out is to provide infrastructure for commercial actors, who can use it by offering consumers to take over control of their devices, for example making sure that electric cars adjust charging patterns or the heat pump stops when the grid is at peak. According to Jan Staack, Lead Enterprise Architect, DONG Energy, this opportunity has led Dong to consider whether to offer consumers IoT-enabled products to support smart grid and utility solutions at home.

The EU has set a target for the 28 member countries to replace 80% of meters with smart meters by 2020, and estimates that smart grid could enable savings of about €100 billion per year, nearly €200 per citizen.[35] In Denmark 100% is expected to be converted by 2020.

Higher energy capture

A true example of Autonomy is seen within renewable energy, where sensor data makes real time decisions to adjust wind turbine blades for better performance.

Vestas, which had implemented IoT before the concept was even coined, embarked on the journey because of the pressure to become a viable alternative to other energy sources, arguing "you can optimize on the mechanics but without IoT you will not get far".

Responding to Vestas' leadership within the area GE showed the first insights into its 'Digital windfarm' concept March, 2015.[36] According to GE, the combined effect of building the right farm at the right place and using data from dozens of sensors inside each turbine could boost a wind farm's energy production by 20%.[37]

The Vestas story

Renewable energy illustrates how far companies can take IoT in four ways:

1. **Data as a value driver.** At first, Vestas used data to monitor the condition of windmills to optimize service technicians' time. Now data is used to open up a new business area: Data on wind, weather, performance, as well as relevant diagnostics tools, constitutes an add-on service offering– an offering that enables predictability and allows customers to optimize trading on energy marketplaces for buying and selling energy.

2. **Autonomous operation.** Windmills continuously respond to the data collected by sensors, optimizing performance, without human intervention. Blades in turbines automatically adjust angles to increase energy capture based on the data collected by sensors.

3. **Sustained customer engagement.** Using in-build software and connectivity, upgrades are pushed to customers with older windmills, allowing them to optimize alongside Vestas when new knowledge is created.

4. **Inform future designs.** Vestas uses the data from 27,000 windmills, each with average 1,300 measuring points, to improve future designs.

33. Smart Grid / Danmark 2.0
34. Smart grids could be Europe's shale gas, Commission says
35. Smart grids could be Europe's shale gas, Commission says
36,37. Wind in the cloud?

New service offering

IoT-enabled data can be provided to customers as a service offering. Vestas, for instance, provides data on wind, weather, performance, as well as relevant diagnostics tools, as an add-on service offering, enabled by the information collected by sensors. This gives customers better predictability, which they can use to optimize trading on Denmark's marketplace for buying and selling energy.

This value capture has broader implications for companies trying to find the value of IoT. It is worth noting that independently from the Vestas case, two of the experts interviewed in this report noted that a central value capture – one that has not had broad application yet – is to use IoT to create an add on service.

IoT-maturity in Utilities

Smart meters allow for remote energy monitoring, and beyond the innovation itself, focus is on the major undertaking of rolling it out. Both in Denmark and abroad countries are working to create an infrastructure that will support Control-capabilities of appliances. Smart appliances that utilize the possibility to respond to electricity prices must function without the active involvement of the user because the marginal benefit of such activity would not be sufficiently high.[38] Products that can exploit this are expected to become the norm in the future.[39]

Within electricity, Autonomy is still years into the future. Even the start-up scene in Silicon Valley considers Autonomy a daunting task. "Autonomy might be possible, but currently a lot of the required maintenance is hardware failure that cannot be done remotely," says Dan Martin, Angel investor in smart grid related companies: Also within the area of water, Grundfos does not believe in autonomously operating robots in the near future.[40]

Due to the sensitivity of the information, Vestas did not want to disclose its plans for IoT in the future, only that

it remains an important value driver that also has a place in Vestas' strategy in the future.

Potential

Previous studies have shown that 36% of energy and utilities companies have extensively adopted IoT,[41] and energy companies project that IoT initiatives will boost revenue by 15%[42] -19%[43] from 2015 to 2018, meaning a US$201billion worldwide IoT revenue opportunity for the utilities industry by 2018.[44] The number of IoT connections in the energy and utilities sector is estimated to grow 49% year on year.[45]

Buildings

IoT in buildings enables intelligent spaces that not only optimize efficiency, safety and comfort for people, but has the potential to achieve this at a lower cost and provide add on services that will reduce building owners' return on investment.

The three main value captures within Buildings include:

|	
1	Efficiency improvement
2	Increase safety and comfort
3	Improved resource utilization

Efficiency improvement

Today, products on the market can provide live Monitoring on heating, ventilation, air conditioning, and energy use, allowing for better utilization of resources. But especially because of innovations that have reached the Control- and Optimization-steps, it is hard to find a space for IoT that gives you a more vivid visual image

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Figure 17: Globally, products within the Transport industry currently have IoT-enabled Monitoring capabilities

-A Transport industry maturity assessment

Monitoring   Control   Optimization   Autonomy   System Autonomy
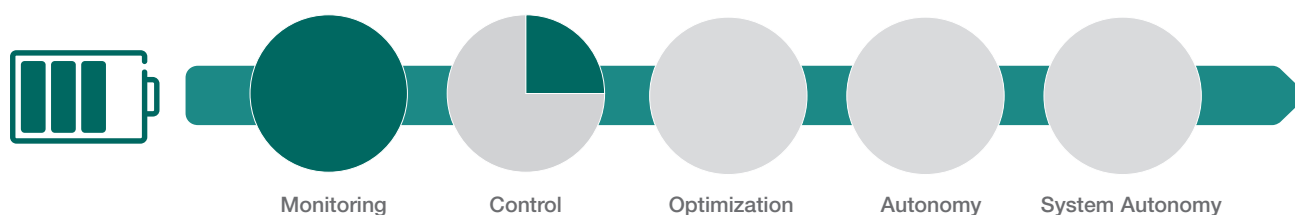
38,39. Smart Grid / Danmark 2.0
40. Grundfos har taget hul på intelligent milliardmarked
41. The Internet of Things 2015
42. The complete reimaginative force
43,44. Worldwide Internet of Things Spending by Vertical Market 2014–2018 Forecast
45. The Internet of Things 2015

of IoT's transformative power than the office space. Sensors detect that you enter into a meeting room, and it automatically books it for you. Before you even entered, the thermostat sensed that you were coming and adjusted temperatures accordingly.

According to Emil Berthelsen, Machina Research, a concrete example of IoT's disruptive force is the case of GE and Phillips. Pressured by the ability of emerging markets to produce cheaper light bulbs, IoT helped them transition from product to service providers, thus regaining their competitive edge. This was achieved by offering lighting fixtures that could measure temperatures and movement, working as an active contributor in the intelligent building.

Increase safety and comfort

When you leave the office building, lights will remember your habits and mimic them to discourage burglars, and will blink red if an intruder is detected while communicating with your smartphone. Smoke detectors will automatically switch on cameras in case of fire (for insurance purposes), and automatically switch off heating.

Improved resource utilization

An example of IoT-adoption among Construction companies can be seen in one of the top 20 construction companies in the world, Consolidated Contractors Company (CCC). CCC's IoT-enabled real-time visibility into the maintenance condition of 16,500 assets across 40 countries has allowed for 11% more predictive maintenance versus corrective maintenance, and cut yearly expenditures by an estimated $1,100 per asset.[46]

In regards to Danish companies' use of IoT, Enemærke & Petersen said it does not actively utilize IoT today but is cautiously exploring it. Kim Gjetting, Enemærke & Petersen, said that the company had neither experienced market pull for IoT-enabled

solutions, nor an adoption of IoT among other Danish construction companies. For the projects that E&P bid on, competition comes entirely from other local players.

IoT-maturity in Buildings

Unlike the Transport industry, whose current IoT-offerings are mostly focused on Monitoring, Control-capabilities are found among many appliances in Buildings.

The road ahead is one of higher adoption rates. Many of the products (heating, ventilation, lighting, security, elevators, and fire detection) that enable a smart building are ready for IoT. As M2M technologies are widely implemented in existing buildings,[47] the potential for augmenting these systems with full IoT capabilities should be within reach. At the same time, however, many of the new IoT-enabled systems can today, cost-effectively, primarily be implemented in new building projects, which accounts for a very small percentage of the full market potential.

In terms of system autonomy, there is not only potential in the building itself but also in drawing from other data sources to enable the building to respond to the outside climate like weather or pollution conditions. This puts the smart building in the wider context of the smart city.

Most innovation thus far has occurred within vertical silos while the true potential lies in connecting 'things' across domains.

Potential

The global home and office market for IoT has been estimated to be $20 billion in 2015,[48] roughly doubling since 2013.[49] The market value of IoT in the office space specifically has been estimated to increase to $60 billion by 2020,[50] or $70-150 billion by 2025, driven by energy management and security optimization, as digital security cameras with advanced image-processing capabilities enable monitoring without the need for guards.[51]

Figure 18: Globally, products within the Buildings industry currently have IoT-enabled Monitoring and Control capabilities

-A Buildings maturity assessment
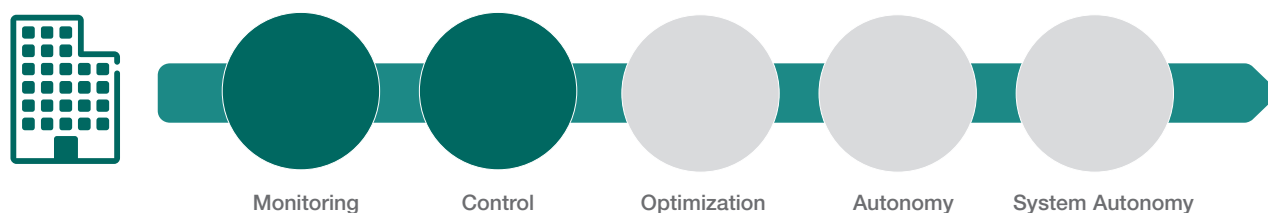
Monitoring   Control   Optimization   Autonomy   System Autonomy

46. The Internet of Things is giving the construction industry a new strategy
47. Today's Smart Buildings are Not Good Enough; Building Internet of Things is the Solution
48. 8 ways the Internet of things will change the way we live and work
49. The Sectors Where the Internet of Things Really Matters
50. 8 ways the Internet of things will change the way we live and work
51. Unlocking the potential of the Internet of Things

HOW TO
GET
STARTED

HOW TO GET STARTED

Based on the findings in this study, companies are recommended to take the following four steps: Appoint dedicated leadership, evaluate value capture, create IoT adoption plan, and explore partnerships.

#1 - Appoint dedicated leadership

In order to capture the IoT opportunity, time and resources need to be invested to perform strategy work, to design the pilots, and to drive change.

In many cases a true IoT-transformation is no small feat but requires change management. In the maritime industry, for example, "using IoT to create central visibility into data - which could also enable centralization of decisions - would represent an entire cultural shift away from the autonomy that ships operate under today," says Walter Hannemann, Head of Systems, Technical Division, Torm.

A guiding team - or person – is therefore needed to drive change effectively. Such a team should consist of individuals with appropriate skills, leadership capacity, organizational credibility, and the connections needed to see the change through.[52]

To address the knowledge gap - the challenge of finding personnel that understands IoT – there are multiple options: Train staff, recruit IoT talent (a perceived challenge among Danish companies), or use consultants.

The team's aim would be to show the value of IoT to the stakeholders involved and/or impacted and help bridge functional silos. The latter would help address the frustration that top executives do not understand the IoT opportunity.

According to Erik Kruse, Networked Society Evangelist, Ericsson, companies that spearhead IoT adoption often have internal visionaries that speak the IoT cause. This responsibility would be formalized through the dedicated leadership.

#2 – Evaluate value capture

Identifying the value capture of IoT in the company-specific context was highlighted as one of the main barriers to IoT adoption.

The task of the dedicated leadership is therefore to consider:

• Would IoT-generated data bring value to your customers and could you capitalize on it as an add-on service?

• Could some of your offerings be programmed to automatically respond to data on product use or changes in the surrounding environment?

• Could information about product usage be used to create a better customer experience, e.g. through informing training programs?

• Would IoT-enabled real-time traceability bring value to your customer offering?

• Would you benefit from being able to push software upgrades remotely via our IoT solution?

• Would it matter to your business if you were able to carry out preventive maintenance, as sensors provide real-time insight into the status of product parts

• Could IoT-enabled alert functionality improve the customer experience?

It is recommended to that you use the 'Inspiration from four industries'-section to perform this task.

The natural next question is 'how'. For this, recall the maturity continuum that illustrates how IoT can be used to achieve different functionality. Note that the wind sensors attached to the top of Vestas' windmills were thought to trigger automatic response by the windmill from the beginning. So the company did not journey through the stages of the IoT maturity continuum but went directly for the Autonomy-step because a manual process would be too resource demanding.

#3 – Create IoT adoption plan

Based on the evaluation of the value capture, it is suggested to create an IoT adoption plan that maps the IoT opportunities identified into Simmer, Pilot, and Scale. This will provide a foundation for ensuring that potential future IoT initiatives (the ones that 'simmer') are continuously reevaluated, and that the impact of pilots are continuously measured before selected for scaling.

Simmer

The 'Simmer' stage covers specific IoT possibilities that would create value but are not yet being pursued because of prioritization choices.

As underlying drivers in the business case are still changing – like the rapid cost and time-to-market reduction – there is a need to continuously re-evaluate the IoT possibilities to pursue.

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52. Kotter and Cohen (2002): The heart of change

Pilot

Many of the Danish companies interviewed in this report have either carried out pilots with IoT, or have small-scale IoT initiatives ongoing. But what is not done currently, is to get ready for scaling: Most respondents actually do not measure the impact of those initiatives. Pilots should be executed as dual purpose tests: Both with the aim of testing the technology and with the commercial aim of proving its worth.

As one respondent said, it is difficult to measure the share of sales that is directly related to IoT-enablement. While that is true, there are other measuring points that can be used. Results from customer test groups, use of resources before and after IoT-enablement, etc. Quantifying impact is a way to increase management commitment when leaps of faith are not enough.

At the same time, two respondents highlighted the challenge of trust in data quality. When IoT-enablement is tested in pilots before scaling, verification can be done in a small-scale environment that allows easier check of measuring points, and corrective action can be taken before scaling. The transparency created in a small-scale space helps build trust, but it also generates valuable experiences for the scaling phase.

Scale

Based on the quantifiable impact, the most successful pilots are selected for scaling.

According to Erik Kruse, Networked Society Evangelist, Ericsson, a company that is about to scale its IoT initiatives needs to evaluate whether there is a need to reengineer business processes to succeed with IoT. Tesla, for instance, has rethought business processes and starts the development process by thinking software, and only subsequently considers hardware. This means that they are now able to push software updates out if needed, helping them overcome hassles like recalls.

When scaling, organizational adjustment has to be in place. At this stage companies also need to be ready to handle privacy and security concerns. Big data can bring great value but it also needs to be handled with care.

However, it is also at this stage that IoT will prove its real worth.

#4 - Explore partnerships

Exploring the partnership opportunity allows companies to fast track the penetration of an area that may be outside the realm of core capabilities. This is a strategy adopted by rest-of-world industry players already:

- Home security giant ADT has partnered up with Nest.[53]

- KLM (Royal Dutch Airlines) and Amsterdam Airport provided seed funding for Dutch IoT startup Undagrid, which provides IoT solutions for locating baggage carts and cargo trailers at airport aprons.[54]

- Sanofi and Google have entered into collaboration with the aim to use data and miniaturized technology to enable better support and treatment.[55]

As laid out in this report, this is an option that only a third of the surveyed Danish companies are exploring.

At an even deeper level of commitment, IoT could be incorporated into companies' general collaborative innovation set-ups,[56] like innovation outposts, accelerators, and venture capital arms.

Most of all, the recommendation is plainly - to get started.

53. ADT's deal with Nest includes a free thermostat for certain customers
54. Undagrid
55. Sanofi to Collaborate with Google Life Sciences to Improve Diabetes Health Outcomes
56. Collaborative Innovation

Inspiration from four industries: Value that is currently being captured

UTILITIES

Avoiding overload

- **ABB**. Smart grid tech that transmits energy equipment data, alerting in case of overload
- **Curb**. Energy use sensors that enable partners to remotely control appliances
- **Elster**. Smart gas/water meters that enable communication with utility providers

Higher energy capture

- **GE-turbines**. Software and turbine sensors optimize angles to increase energy capture
- **Envision Energy**. Sensors on wind turbines spot maintenance issues and improve forecasting – but also enables real-time decisions to adjust blades

New service offering

- **Vestas**. Data from 27,000 windmills with each 1300 sensors are converted into an add-on service offering for customers

HEALTHCARE

Higher quality of life

- **Medtronic**'s digital meter. Alerts before a threshold blood-glucose level
- **Bee+** (Vigilant) insulin injection tracker. Transmits injection data to smartphone
- **Fitness bands** (Nike, Jawbone, Fitbit). Transmit data on activity, sleep, etc.

Lower costs

- **St. Jude Medical Accent Pacemaker**. Remote monitoring of disease status.
- **CareTRx**. Tracks feedback from asthma medication, gives real time notifications
- **Proteus**: Ingestible sensor that monitors and transmits data on medication taking

Better care

- **HealthID Band**. Transmits info on medical condition in case of emergency
- **Cortrium**. Automatic transmission of vital sign measurements
- **Verasense orthosensor**. Real time info about knee implant performance

BUILDINGS

Efficiency improvement

- **Concrete Sensors**. Transmits info on temperature/humidity from inside concrete
- **Dash**. Botton for any appliance that senses stock before adding to cart
- **Robin's**. When entering a meeting room it is booked for you on the spot

Increase in safety and comfort

- **Dropcam Pro**. A networked camera that sends life feeds to the smartphone
- **Philips** Lighting hue lightbulbs. Blinks red if an intruder is detected
- **Nest Protect**. When sensing smoke, a camera activates for insurance purposes

Improved resource utilization

- **Daikin** Applied. Provides actionable data on e.g. heating - failure prediction
- **Sensorist**. Sensors monitor e.g. air quality and sends data to smartphone
- **Danalock**. A lock that senses person and unlocks, hands free

TRANSPORT

Improved utilization

- **Waze**. Pushes real time traffic/warnings info from and to connected mobile devices
- **Streetline**. Sensors under parking spaces to communicate via mobile app, Parker
- **Tap & Park** app. Using sensors, it pilots drivers on the shortest route to free parking

Location transparency

- **Nigiloc**. Bicycles connected with Sigfox radios to report GPS signals if the bicycle if stolen. The low cost ($2/Sigfox radio) opens up doors for improvements in logistics flow

Machine performance

- **Rolls Royce aircraft** sensors measure engine function to detect malfunctions
- **GE Aviation** evaluates expected vs. actual performance of hundreds of engine sensors
- **Taleris** aircraft sensors identify anomalies and determine replacement timing

Methodology

This report is the first of its kind to explore the adoption of Internet of Things (IoT) among Danish companies. It is the result of a questionnaire survey among 35 IT and business leaders from Danish companies who have extensive knowledge of their organization's IoT strategy, as well as 10 qualitative interviews with company business leaders. In addition four expert interviews have been conducted. The experts that participated in qualitative interviews included: Dan Martin Angel investor in utility-related companies; Emil Berthelsen, IoT researcher and expert from Machina

Research; Peter M Jensen, CEO of Parstream, an IoT analytics platform based in Silicon Valley and Germany; and Erik Kruse, Networked Society Evangelist, Ericsson.

More than half of the participants in the questionnaire survey were large Danish companies, as we strived to include the largest players in each industry. Of the 35 responses, there were seven from each industry covered: Transport, Buildings, Utilities, and Healthcare. Seven were from other industries, which included e.g. Retail, Software, and Media.

Figure 2: The majority of respondents from Danish companies were large and distributed evenly across industries

-Distribution of questionnaire respondents (revenue and industry)
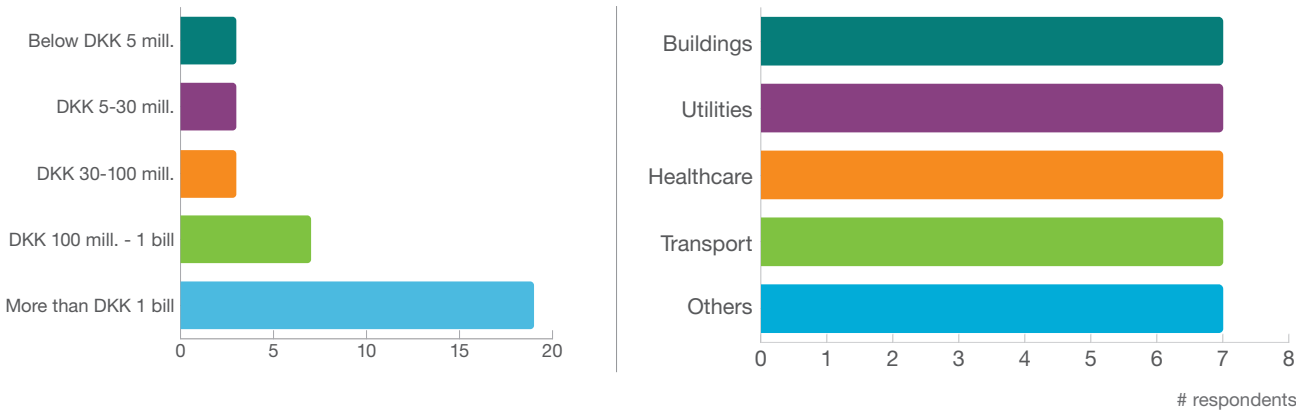
Eight of ten companies that participated in the qualitative interviews have >5 billion DKK annual revenue, putting them among the top100 biggest companies in Denmark. Two of the companies are C20 companies. Large companies were selected due to their importance – at least in terms of revenue – for their industry, and their financial capacity to invest in IoT. Interviewed companies include among others DSB, Torm, Dong, Grundfos, and Vestas. There were at least two interviews conducted in each industry covered. Comparative international studies on IoT-adoption have little to no data on Danish companies. Our methodology allowed us to deep dive into the dynamics of IoT.

Throughout the report, we compare the results among Danish respondents to benchmark studies by Gartner and the Economist Intelligence Unit (EIU). When benchmarked, the questionnaire for the Danish respondents strived to include the exact formulation that the benchmark studies had used. The respondents in the Gartner study included 463 IT and business leaders who had knowledge of their organization's IoT strategy. The EIU survey included 779 senior business leaders from across the world, with 29% based in Europe, 29% in, North America, 30% in Asia-Pacific, and the remaining 12% from Latin America, the Middle East and Africa.

We use a Maturity continuum to describe the levels of sophistication with which IoT can be deployed. The continuum presents an adaption of a framework originally created by Porter/Heppelmann (2014). While the original framework has four steps, the continuum has split the fourth step of 'Autonomy' into two - 'Autonomy' and 'System Autonomy'. This serves to underline that a company with IoT solutions on all four steps has still not reached the full potential of IoT - this would require that IoT had enabled not only autonomous product function but autonomous system function, meaning an ability to also interact with other products. In addition, the original model was presented as a staircase.

This study was carried out during August and September, 2015 by Monitor Deloitte for Ericsson Denmark in cooperation with DI Digital (Danish ICT and Electronics Federation).

The 'Inspiration from four Industries'-section was built primarily using secondary sources to get an understanding of the use of IoT on a global level. In some cases, the qualitative interviews were used to draw parallels to Danish companies.

Appendix - 3

Questionnaire

Danish (language of publishing)	English (translation)
Q1 - Hvilken branche opererer din virksomhed primært indenfor?	Q1 – Which industry does your company primarily operate within?
Q2 - Hvad omsætter jeres virksomhed ca. for på årlig basis?	Q2 – What is your company's approximate annual revenue?
Q3 - Min stillingsbetegnelse	Q3 – My position
Q4 - 'Internet of Things' er netværket af fysiske ting, der med en kombination af internetforbindelse, elektronik, software og sensorer er i stand til at udveksle data med producenten og/eller andre fysiske ting. IoT falder under mit ansvarsområde	Q4 – The 'Internet of Things' refers to the network of physical things, which with a combination of internet connection, electronics, software, and sensors, is capable of exchanging data with the producer and/or other physical things. IoT falls under my area of responsibility
Q5 - Jeg har en klar forståelse af hvad 'Internet of Things' er	Q5 – I have a clear understanding of what the 'Internet of Things' is
Q6 - Jeg har en klar forståelse af hvordan 'Internet of Things' vil påvirke min industri	Q6 – I have a clear understanding of how the 'Internet of Things' will affect my industry
Q7 - Jeg forventer at 'Internet of Things' får en betydelig effekt på vores forretning, eller vil give betydelige muligheder for forbedring af omkostninger eller omsætning, indenfor de kommende 3 år	Q7 – I expect that the 'Internet of Things' will transform our business or offer significant new revenue or cost-savings opportunities over the next three years
Q8 - Jeg forventer at 'Internet of Things' får en betydelig effekt på vores forretning, eller vil give betydelige muligheder for forbedring af omkostninger eller omsætning, om mere end 5 år	Q8 - I expect that the 'Internet of Things' will transform our business or offer significant new revenue or cost-savings opportunities in more than five years
Q9 - Vi har initiativer i gang indenfor 'Internet of Things' i dag	Q9 – We currently have 'Internet of Things' initiatives ongoing
Q10 - Vi bruger data, som er indsamlet fra objekter der udnytter 'Internet of Things', til at (sæt minimum et kryds) • Optimere virksomhedens upstream-aktiviteter (ind- og udgående logistik, produktion)) • Optimere virksomhedens downstream-aktiviteter (markedsføring og salg samt service) • Optimere støtteaktiviteter (f.eks. virksomhedens infrastruktur)) • Specifikt til vores produktudvikling	Q10 – We use data collected from IoT-enabled objects to (mark minimum one option): • Optimize the company's upstream activities (in- and out-bound logistics, production) • Optimize the company's downstream activities (marketing, sales, and service) • Optimize support activities (e.g. infrastructure) • Specifically for product development • Do not know • Other (please note in the comment-box)
Q11 - Vi har defineret et klart lederskab og ejerskab for vores 'Internet of Things'-indsats	Q11 – We have established clear business leadership for our 'Internet of Things' efforts
Q12 - Ansvaret for 'Internet of Things' falder under følgendes ansvarsområde	Q12 – The responsibility for 'Internet of Things' falls under the area of responsibility for the following
Q13 - Vælg de muligheder, som bedst repræsenterer hvordan I udvikler jer indenfor 'Internet of Things' (der må gerne vælges flere) • (Opkøb) • (Partnerskaber) • (Intern udvikling) • (Indkøb eller samarbejde med underleverandører) • (Andet)	Q13 – Please select the options that best represent your development within the 'Internet of Things' (possible to select multiple options) • Acquisitions • Partnerships • Internal development • Purchasing or cooperation with sub-suppliers • Other
Q14 - Vi har den infrastruktur, der skal til for at understøtte vores arbejde med 'Internet of Things'	Q14 – We have the infrastructure needed to support our work with the 'Internet of Things'

Q15 - Vi har den organisatoriske kunnen, der skal til for at understøtte vores arbejde med 'Internet of Things'	Q15 – We have the organizational capabilities needed to support our work with the 'Internet of Things'
Q16 – Vi har de processer, der skal til for at understøtte vores arbejde med 'Internet of Things'	Q16 – We have the processes needed to support our work with the 'Internet of Things'
Q17 – Vi er bedre klædt på til at realisere værdien af 'Internet of Things' end vores konkurrenter	Q17 – We are better positioned to realize the value of the 'Internet of Things' than our competitors
Q18 – Vores investeringer i 'Internet of Things' stiger årligt med	Q18 – Our investment in the 'Internet of Things' is annually increasing by
Q19 – Vores nuværende portefølje inkluderer produkter/serviceydelser, som med en kombination af internetforbindelse, elektronik, software og sensorer, er i stand til at (sæt minimum et kryds) • (Monitorere (produktets tilstand, dets brug og/eller det eksterne miljø monitoreres, evt. med alarmer)) • (Kontrollere (produktets funktioner og personalisering kontrolleres af resultaterne fra monitoreringen)) • (Optimere (ud fra monitoreringen forbedres produktets præstation og muliggør proaktiv reparation)) • (Fungere autonomt (selvkørende funktion og autonom produktforbedring og personalisering)) • (Fungere i system-autonomi (som 'fungere autonomt' men med selv-koordinering med andre produkter)) • (Ingen af ovenstående) • (Ved ikke)	Q19 – Our current portfolio includes products or services that with a combination of internet connection, electronics, software, and sensors, is capable of • Monitoring (product condition, use, or external environment is monitored, possible alert functionality) • Control (product function and personalization is controlled by the results of the monitoring) • Optimization (based on the monitoring, product performance is enhanced and predictive maintenance is enabled) • Autonomous function (autonomous function and product improvement and personalization) • System autonomy (as 'Autonomous function' but with self-coordination with other products) • None of the above • Do not know
Q20 – Indenfor de kommende 5 år vil vores portefølje inkludere produkter/serviceydelser, som med en kombination af internetforbindelse, elektronik, software og sensorer, er i stand til at • (Monitorere (produktets tilstand, dets brug og/eller det eksterne miljø monitoreres, evt. med alarmer)) • (Kontrollere (produktets funktioner og personalisering kontrolleres af resultaterne fra monitoreringen)) • (Optimere (ud fra monitoreringen forbedres produktets præstation og muliggør proaktiv reparation)) • (Fungere autonomt (selvkørende funktion og autonom produktforbedring og personalisering)) • (Fungere i system-autonomi (som 'fungere autonomt' men med selv-koordinering med andre produkter)) • (Ingen af ovenstående) • (Ved ikke)	Q20 - Within the coming 5 years, our portfolio will include products or services that through a combination internet connection, electronics, software, and sensors, is capable of • Monitoring (product condition, use, or external environment is monitored, possible alert functionality) • Control (product function and personalization is controlled by the results of the monitoring) • Optimization (based on the monitoring, product performance is enhanced and predictive maintenance is enabled) • Autonomous function (autonomous function and product improvement and personalization) • System autonomy (as 'Autonomous function' but with self-coordination with other products) • None of the above • Do not know
Q21 – Rangér følgende valgmuligheder efter hvor betydningsfulde de er i at hindre omstilling til 'Internet of Things' (kryds af således at der kun er én prik for hvert tal - nr. 1 er mest betydningsfuld, nr. 2 er næstmest betydningsfuld, osv.) • (Bekymringer omkring sikkerhed) • (Bekymringer omkring privatliv) • (Mangel på overbevisende forretningsgrundlag) • (Skaffe egnet personale til at skabe IoT-strategi og -systemer) • (Risici forbundet med forandringer og nye forretningsmodeller) • (Håndtere nye og uprøvede teknologier og serviceydelser) • (Medarbejder-modstand mod nye teknologier, praksisser eller politikker) • (Andet (noter venligst nedenfor))	Q21 – Rank the following options according to their importance in holding back the transition to the Internet of Things • Concerns about security • Concerns about privacy • Lack of convincing business case • Access to qualified personnel to create IoT strategies and systems • Risks associated with change and new business models • Handling new and untried technologies and services • Employee resistance to new technologies, practices, or policies • Other

Appendix 4 – Quotes translated

Danish	English
"Jeg ville ønske at vi var meget længere med anvendelsen af IoT. I dag fanger vi ikke det signifikante potentiale der er i IoT i form af forudseende vedligehold, hvilket ville kunne skabe en betydelig frigivelse af bunden kapital, " Martin Börjesson, CIO, DSB	"I wish we were much further in our adoption of IoT. Today we do not capture the significant potential that IoT offers through predictive maintenance, which would significantly reduce tied up capital." Martin Börjesson, CIO, DSB
"Selvfølgelig er det sådan at hvis man endnu ikke ved hvordan man skal skabe værdi med IoT – for kunder eller i form af besparelser – bliver omkostningen hurtigt for høj", Walter Hannemann, Head of Systems, Technical Division, Torm	"Obviously, if you do not yet know how to create value from IoT-enabled data – for customers or in the form of cost savings – the cost easily becomes too high." Walter Hannemann, Head of Systems, Technical Division, Torm
"Udfordringen for IoT udrulning er ikke af teknisk karakter – groft sagt kan alting opnås teknisk – men det drejer sig mere om at finde værdien. Jeg tror på at IoT har potentialet til at skabe værdi og så er det vores job at finde ud af hvor værdien ligger. " Lars Enevoldsen, Group Vice President, Global Research & Technology, Grundfos	"The challenge for IoT adoption is not technical – roughly speaking, anything can be achieved technically – but is more about finding the value. I do believe that IoT has potential to bring value and then it is our job to find out where that value lies." Lars Enevoldsen, Group Vice President, Global Research & Technology, Grundfos.
"Vi har et nidkært governance system der har svært ved at rumme en ukonventionel business case som Internet of Things", Anonym respondent	"We have a zealous governance structure… that does not easily embrace an unconventional business case like the Internet of Things" Anonymous respondent
"En af de vigtigste barrierer for IoT er, at det er en smertefuld proces for virksomheder med en lang arv, at glemme hvad de har gjort gennem årtier for i stedet at forfølge en radikalt ny tilgang til at betjene deres kunder" Erik Kruse, Networked Society Evangelist, Ericsson	"One of the most important barriers for IoT adoption is that it is a painful process for legacy companies to forget what they have been doing for decades and instead pursue a radically new approach to serving their customers." Erik Kruse, Networked Society Evangelist, Ericsson
"Generelt mangler topledelser i dag en god forståelse af IoT, sandsynligvis fordi vi taler om IoT i Computerworld i stedet for i Børsen", Martin Börjesson, CIO, DSB	"In general, top management today lacks a good understanding of IoT, probably due to the fact that we talk about IoT in Computerworld instead of Børsen", Martin Börjesson, CIO, DSB.
"Der er en tendens i Skandinavien til at IoT-initiativer forfølges indenfor en traditionel IT-ramme. Det har indsnævret det kommercielle ejerskab af IoT til IT, hvilket betyder at virksomheder går glip af betydelige muligheder med IoT, og at IoT's prioritering i virksomheden påvirkes," Emil Berthelsen, IoT researcher and expert, Machina Research	"IoT initiatives in Scandinavia tend to be pursued within the traditional IT context. This has narrowed the commercial ownership of IoT to IT, causing companies to miss significant IoT opportunities and impacting IoT's prioritization within the business." Emil Berthelsen, IoT researcher and expert, Machina Research
"Du kan optimere på mekanikken, men uden IoT kommer du ikke langt". Torben Høeg Bonde, CIO, Vestas	"You can optimize on the mechanics but without IoT you will not get far". Torben Høeg Bonde, CIO, Vestas
"Autonomi er muligvis muligt, men lige nu skyldes meget vedligehold hardware-fejl som ikke kan håndteres på afstand," Dan Martin, Angel investor	"Autonomy might be possible, but currently a lot of the required maintenance is hardware failure that cannot be done remotely," Dan Martin, Angel investor
"Dét at bruge IoT til at skabe central gennemsigtighed til data – hvilket også kan muliggøre centralisering af beslutninger – ville repræsentere et helt kulturelt skifte væk fra den autonomi som skibe sejler med i dag," Walter Hannemann, Head of Systems, Technical Division, Torm	"Using IoT to create central visibility into data - which could also enable centralization of decisions - would represent an entire cultural shift away from the autonomy that ships operate under today," Walter Hannemann, Head of Systems, Technical Division, Torm

Results from questionaire survey

Figure 2: The majority of respondents from Danish companies were large and distributed evenly across industries

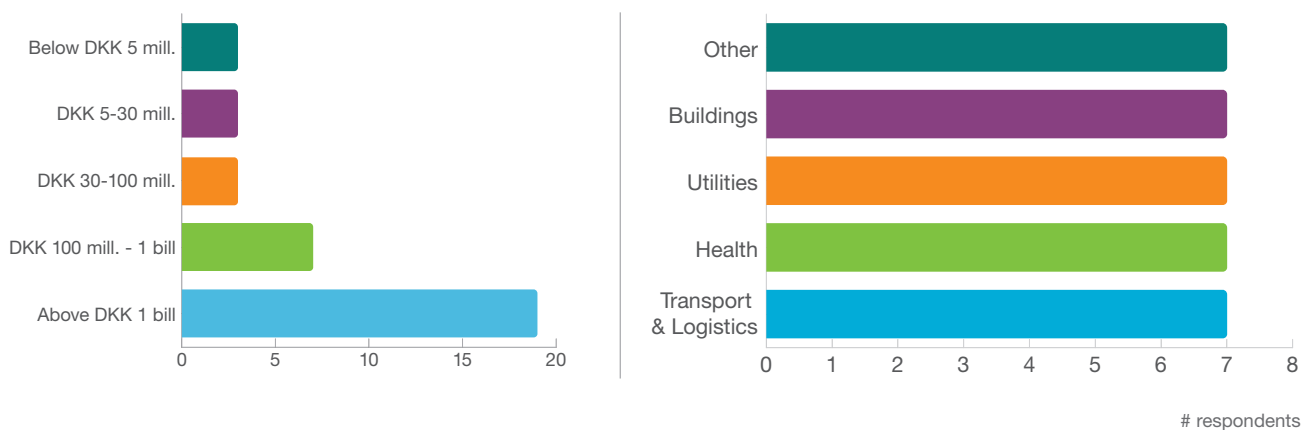-Distribution of questionnaire respondents (revenue and industry)

respondents

Figure 4: Danish company respondents exhibit greater belief in IoT than foreign counterparts

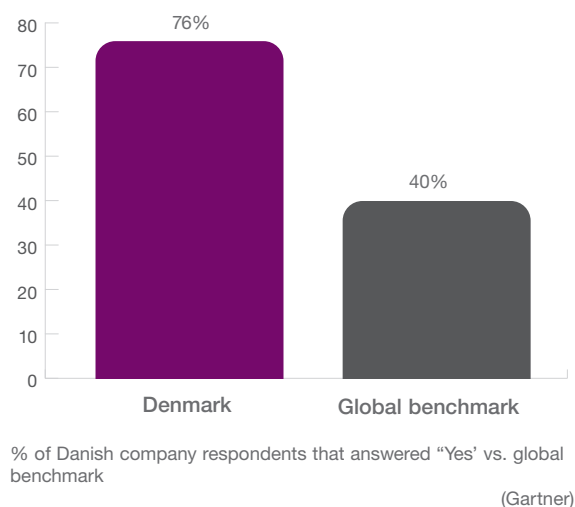-**Questionnaire results:** "I expect the IoT to Transform my business or offer significant new revenue or cost-savings opportunities within the next 3 years"-

% of Danish company respondents that answered "Yes' vs. global benchmark

(Gartner)

Figure 6: Danish company respondents are less likely than foreign counterparts to have IoT initiatives

-**Questionnaire results:** "We currently have IoT initiatives ongoing"-

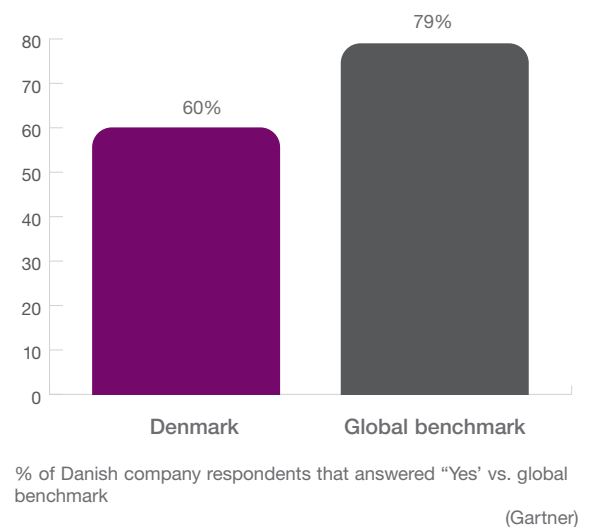% of Danish company respondents that answered "Yes' vs. global benchmark

(Gartner)

Figure 5: Respondents from Danish companies employ only a small share of the potential use of IoT
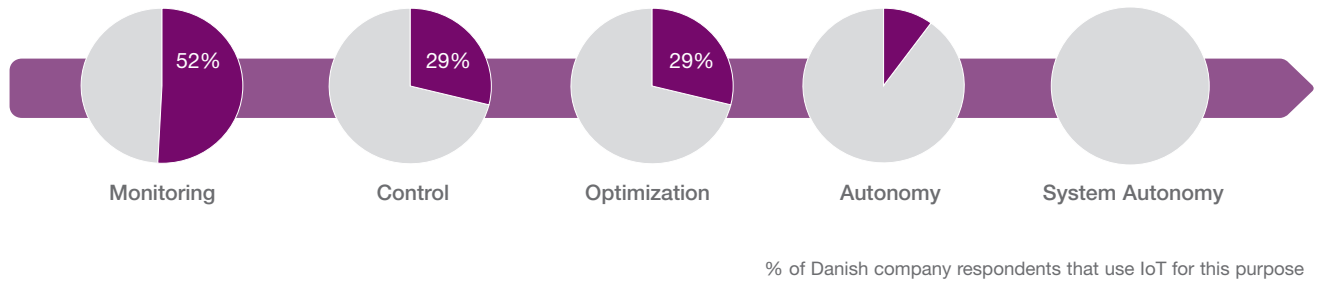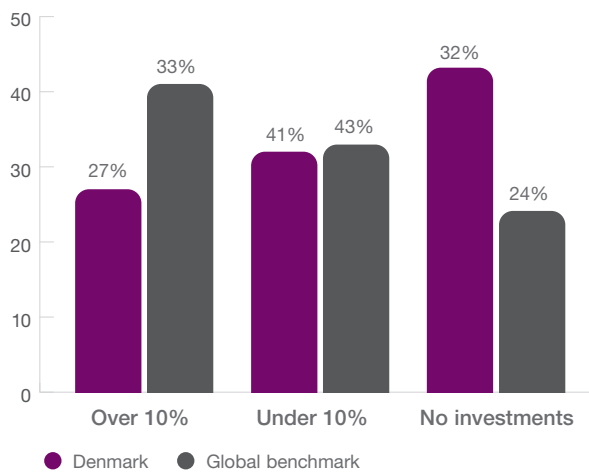
-Danish companies mapped on the IoT Maturity Model

| Monitoring | Control | Optimization | Autonomy | System Autonomy |

% of Danish company respondents that use IoT for this purpose

Figure 7: Companies exhibit cautious investment behavior

-**Questionnaire results**: "Our investment in IoT is anually increasing by..."-

- Denmark
- Global benchmark

% of Danish company respondents that answered "Yes' vs. global benchmark
(Gartner)

## Figure 8: Only 6% of Danish respondents pursue acquisitions as a way to develop their IoT efforts

-**Questionnaire results**: "Select the option that best represent the way you develop within IoT" - option 'Acquisitions'

- Acquisitions
- No acquisitions
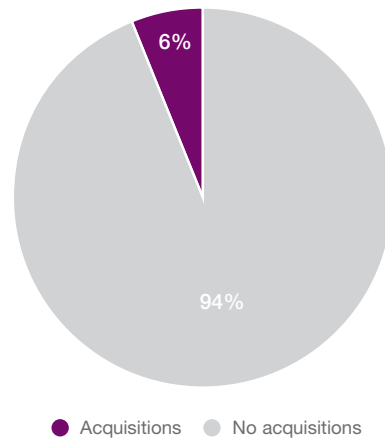
% of Danish company respondents that answered "Yes' vs. global benchmark
(Gartner)

## Figure 9: Only a fourth of companies have defined clear leadership for IoT

-**Questionnaire results**: "We have defined a clear leadership and ownership for our IoT efforts"

26%   25%

Denmark   Wordwide
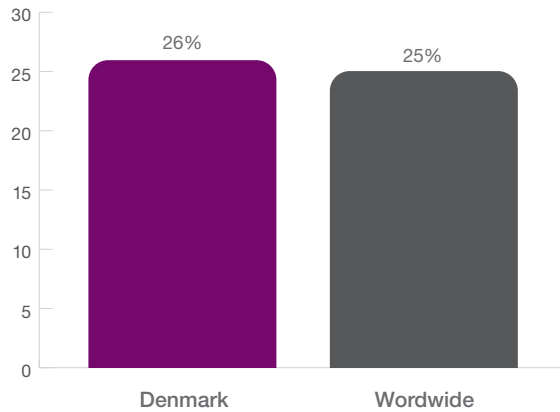
% of Danish company respondents that answered "Yes' vs. global benchmark

(Gartner)

Figure 10: A significantly larger propotion of respondents do not feel better prepared for IoT opportunity than do feel better prepared

-**Questionnaire results**: "We are better prepared to capture the value of IoT than our competitors"

26%   29%

46%

● Do not know   ● Agree   ● Disagree
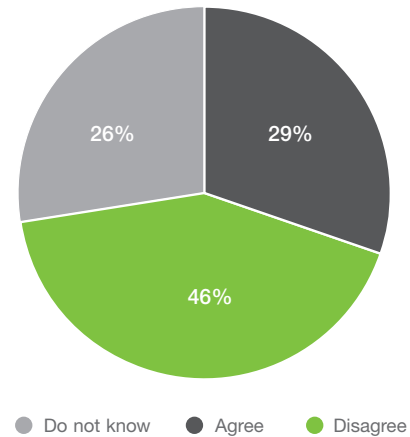
% of Danish company respondents

Figure 12: Despite the deep belief in IoT, Danish companies say 'lack of convincing business case' is the most important barrier

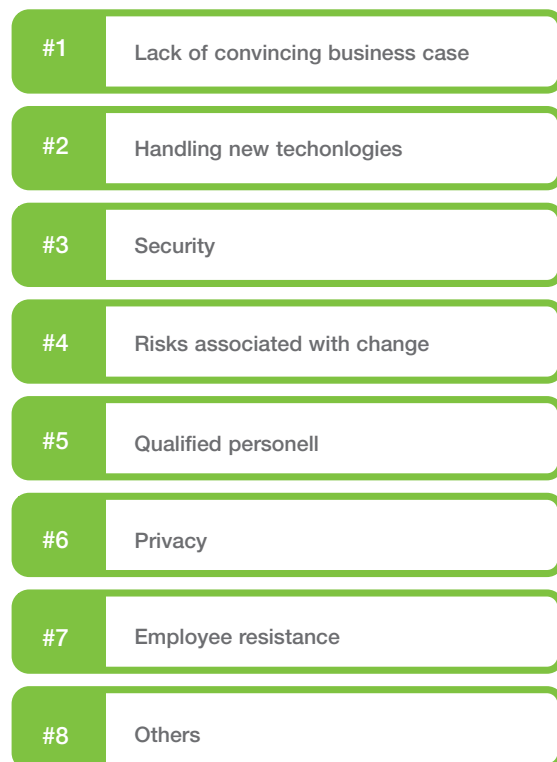-Barriers to IoT adoption, ranked according to importance for Danish company respondents

#1	Lack of convincing business case
#2	Handling new techonlogies
#3	Security
#4	Risks associated with change
#5	Qualified personell
#6	Privacy
#7	Employee resistance
#8	Others

Figure 13: Almost three quarters of Danish respondents do not have the processes needed to support IoT

-**Questionnaire results:** "We have the processes needed to support our work with IoT"

- Agree
- Do not agree

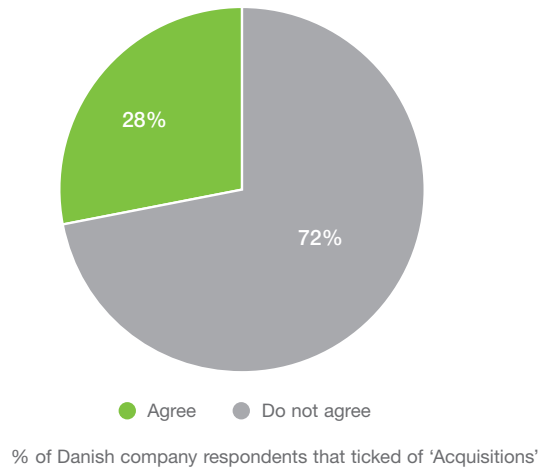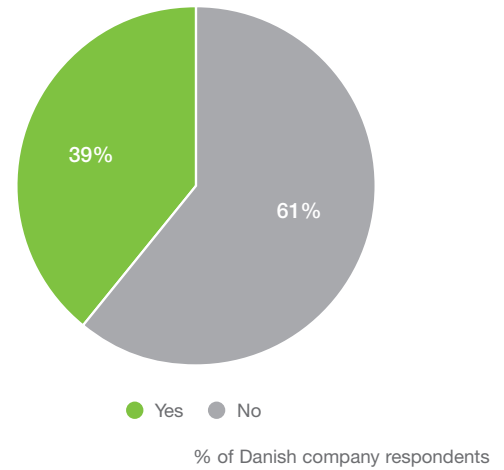% of Danish company respondents that ticked of 'Acquisitions'

Figure 14: More than 60% of Danish company respondents do not have the organizational capabilities needed for IoT

-**Questionnaire results:** "We have the organisational capabilities needed to support our work with IoT"

- Yes
- No

% of Danish company respondents

Footnotes

1. Unclogging the IoT Data Faucet
2. The Internet of Things: Making the most of the Second Digital Revolution
3. Ericsson connected device vision
4. For Tech Makers, Collaboration Is Critical for Creating the Best 'Internet of Things'
5. Gartner Says Worldwide IT Spending on Pace to Reach $3.8 Trillion in 2014
6. Adaption of the Porter/Heppelmann framework in How Smart, Connected Products Are Transforming Competition
7. The Nordics – at the forefront of the M2M-revolution
8. Sensors prices on the decline
9. Infographic: Why the 'Internet of Things' Hasn't Really Caught On Yet
10. The Internet of Things Business Index
11. Building the Hyperconnected Society
12. How the Internet of Things Will Connect Our Bodies to the Cloud
13. Building the Hyperconnected Society
14. Why pharma wants to put sensors in this blockbuster drug
15. Not Just a Band-Aid: How 'Smart Bandages' Will Change Medicine
16. Unlocking the potential of the Internet of Things
17. The complete reimaginative force
18. Free Parking or Free Markets
19. Meet the French startup set to revolutionize the Internet of things
20. 8 ways the Internet of things will change the way we live and work
21. 8 ways the Internet of things will change the way we live and work
22. 8 ways the Internet of things will change the way we live and work
23. 8 ways the Internet of things will change the way we live and work
24. Hyundai building smart ships for data-driven sailing
25. Building_the_Hyperconnected_Society
26. EMEA: Odd connections on the IoT
27. Volvo develops car-to-car social networking for road safety
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29. 8 ways the Internet of things will change the way we live and work
30. Listen Now… How Drones Can Aid Transportation Tech Chat at C3 SXSW
31. Unlocking the potential of the Internet of Things
32. The Internet of Things 2015
33. Smart Grid / Danmark 2.0
34. Smart grids could be Europe's shale gas, Commission says
35. Smart grids could be Europe's shale gas, Commission says
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37. Wind in the cloud?
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39. Smart Grid / Danmark 2.0
40. Grundfos har taget hul på intelligent milliardmarked
41. The Internet of Things 2015
42. The complete reimaginative force
43. Worldwide Internet of Things Spending by Vertical Market 2014–2018 Forecast
44. Worldwide Internet of Things Spending by Vertical Market 2014–2018 Forecast
45. The Internet of Things 2015
46. The Internet of Things is giving the construction industry a new strategy
47. Today's Smart Buildings are Not Good Enough; Building Internet of Things is the Solution
48. 8 ways the Internet of things will change the way we live and work
49. The Sectors Where the Internet of Things Really Matters
50. 8 ways the Internet of things will change the way we live and work
51. Unlocking the potential of the Internet of Things
52. Kotter and Cohen (2002): The heart of change
53. ADT's deal with Nest includes a free thermostat for certain customers
54. Undagrid
55. Sanofi to Collaborate with Google Life Sciences to Improve Diabetes Health Outcomes
56. Collaborative Innovation