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The European IoT Hub

Growing a sustainable and comprehensive ecosystem for Next Generation Internet of Things

D4.2: Report on best practices for IoT use cases

Version 2

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Abstract

This deliverable accounts for the outcome produced by the EU-IoT project in regard to best practices for IoT use cases. Results from data collection and analysis are presented, including how these results shall guide and impact the future European IoT ecosystem. The case catalogue of 30 IoT use cases exemplifies best practices through success stories that document how IoT-empowered solutions are successfully developed and/or deployed. The study across the cases provides insight into collective factors that characterize the successes of the use cases and companies achieved in the IoT area. Results of this report offer industry, innovators, IoT learners, and policy makers inspiration and general guidelines on how novel technologies can be leveraged in the fast-changing landscape, and thereby lower the barriers for European stakeholders to adopt best practices for achieving success in the IoT area.

Deliverable D4.2 reports the work carried out by the EU-IoT COACH in the scope of Task 4.1 under Work Package 4 in the period from October 2020 to October 2022.

Keywords: IoT, Use Case, Best Practice, Success Story, Digital Maturity, Business Model, Business Model Pattern, Business Model Configuration, Business model Innovation

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Disclaimer

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Nature of the deliverable:	R	

Dissemination Level		
PU	Public, fully open, e.g. web	√
CI	Classified, information as referred to in Commission Decision 2001/844/EC	
CO	Confidential to EU-IoT project and Commission Services	

EXECUTIVE SUMMARY

European stakeholders are mobilising forces to ensure the foundation of a digital transformation continuum able to strengthen the European data economy and society towards the next generation internet. This requires the growth of a sustainable ecosystem structured as a community of communities for European actors to join forces and align on core initiatives to nurture successful European sovereignty. The EU-IoT guiding principle is to build a vibrant and impactful European IoT ecosystem, and within this context, the EU-IoT COACH ambition is to foster the development of business models, innovation activities, and skills building lowering the barrier to adoption and development of IoT-empowered solutions.

This report is a revised version of deliverable D4.1 “Best Practices for IoT Use Cases” that presents the resulting outcome of the activities carried out. This includes an IoT use case catalogue that exemplifies best practices for IoT by documenting use cases as success stories, and a study of the cluster of use cases that provides insight into factors that are archetypical for their successes in the IoT area. Complementary information to the results presented in this report was released in October 2021 in the D4.1 report, outlining the methodology for the data collection and analysis underlying the results.

Among a variety of European companies that are considered frontrunners in the IoT area, data have been collected on 30 IoT use cases that were found suitable for our exploration. Interviews were conducted with people of significance for the use case of these companies, and surveys were conducted that assess the corporate digital maturity, business model patterns, the configuration of the business model for innovation, and technology trends. An analysis of the data was performed, leading to the results presented in this report:

- The use case catalogue encapsulates the qualitative results of the exploration, taking departure in the individual use cases. Each use case is documented in a unique story that articulates the IoT success achieved by the specific company. The use case stories are presented in an online catalogue where they exemplify inspirational and relatable best practices for the successful development and deployment of IoT solutions for practitioners.
- The use case study encapsulates the quantitative results of the exploration, taking departure in findings derived through a multiple case study conducted across the cluster of the 30 use cases. Insights from this study enable us to make generalising make inferences upon the levels of digital maturity, business model patterns, business model configurations for innovation, and technology trends that are archetypical for the use cases and the case companies. Findings thereby provide insight on collective factors that characterise the successful cases and companies, thus offering practitioners a guiding point of reference on the best practices to be applied towards achieving success in the IoT area. The findings are presented in a section with conclusions and impact assessment, where they are accompanied by recommendations.

Eventually, the reported results on best practices for IoT use cases have led to a superior understanding of the dynamics for successful development and deployment of IoT–empowered solutions. The intent is for European stakeholders to adopt these best practices in the fast-changing IoT landscape, and for the results to inspire and support industry, innovators, IoT learners, and policy makers with insights and guidelines to be leveraged to lower the barriers IoT-empowered solutions to be adopted in the European ecosystem.

During the remaining period of the EU-IoT project, activities regarding IoT skills development and IoT business models acceleration will build upon the results of best practices for IoT use cases. The consortium further expects to intensify efforts to disseminate the use case catalogue and the use case study insights. The EU-IoT COACH remains committed to maximising the impact and sustainability of the results presented in this deliverable, by sharing the success stories and the success factors of best practice IoT use cases in alignment with the EU vision, thereby contributing to converging European digital autonomy and technological sovereignty; Boost

industrial competitiveness, and; Promote sustainable development in the European landscape.

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ABBREVIATIONS

AI	Artificial Intelligence
BM	Business Model
BMI	Business Model Innovation
BMP	Business Model Pattern
CSA	Coordination and Support Action
DMAT	Digital Maturity Assessment Tool
EC	European Commission
EU	European Union
ICT	Information and Communications Technology
IoT	Internet of Things
IP	Internet Protocol
KPI	Key Performance Indicator
NB-IoT	Narrowband Internet of Things
NGIoT	Next Generation Internet of Things
RIA	Research and Innovation Action
R&D	Research and Development
T	Task
TRL	Technology Readiness Level
WP	Work Package

1. INTRODUCTION

Over the past decade, the Internet of Things (IoT) has undergone rapid and extensive changes, becoming a key enabler of digital transformation, as well as it has evolved into a paradigm that integrates a broad set of technologies, each of which are in themselves advancing at a rapid pace. Businesses of all sizes and in all sectors are facing a world where technology is changing the landscape around them. Transitioning from the back-end offices of organisations into the hands of customers, employees and society. Faster development cycles, disruptive business models and increased competition are highlighting the increasingly vital role that technology and data take in business. This means that the success of businesses, now and in the future, relies heavily on the optimal utilisation of technology.

Efforts driven by the European Commission push for an evolution of the Next Generation Internet (NGI), so that - thanks the to the utilisation of increasingly decentralised architectures automating processes at the Edge - a variety of semi-autonomous and real-time IoT applications can be offered and new business opportunities can arise. Key drivers of this evolution include Edge computing, distributed AI and analytics, augmented reality, tactile Internet, data-centric/secure architectures, 5G/6G networks, etc.

However, to properly support and accelerate development of the needed IoT skills and business models for optimal utilisation of novel technologies, it is necessary to create an understanding and alignment that enables European actors to adopt best practices for achieving success in the fast-changing IoT landscape. The Commission embraces several initiatives that focus on the increasing number of novel technologies across verticals that allow for the proliferation of new IoT solutions. EU-IoT is one of them.

This report is a deliverable of the EU-IoT Coordination and Support Action under grant agreement no 956671. EU-IoT is part of the Next Generation IoT initiative and has received funding from the European Union's Horizon 2020 Research and Innovation Programme.

A pillar of the EU-IoT project and this deliverable is the vision to grow and consolidate the NGIoT initiative and establish a competitive advantage for Europe, by overcoming the current fragmentation of efforts to succeed in the IoT landscape. The outcome of this deliverable aims to become a lodestar that spreads knowledge, offers guidance, and disseminates accordingly the stories, outcomes, and learnings of successful IoT frontrunners. The challenge is to overcome fragmentation and identify a set of commonly agreed upon practices that are key to fostering successful development and deployment of IoT-empowered solutions in a broader perspective of the European ecosystem.

As part of the work carried out by the EU-IoT consortium, this deliverable has the ambition to help converge and join forces around some essential core principles:

- Ensure European digital autonomy and technological sovereignty.
- Boost industrial competitiveness and sustain economic recovery and growth.
- Promote sustainable development of our society in the respect of the environment.

The EU-IoT guiding principle is to build a vibrant and impactful European IoT ecosystem. In this respect, the realisation of the EU-IoT principles builds upon the efforts of the consortium to support the ability of the ecosystem to overcome the barriers for adopting IoT-empowered solutions - and to do it successfully! To this end, the ambition of this EU-IoT deliverable is to effectively amplify the results and impact of various IoT initiatives represented by practical examples (hereinafter referred to as use cases) that outline the Next Generation Internet, in order to document aligned practices for the successful development and deployment of IoT solutions. This, for other European actors such as industry, innovators, learners and policy makers to leverage from best practices to support and accelerate the adoption of IoT business models and

skills.

1.1 Purpose of deliverable

This deliverable reports the results from exploring best practices for IoT use cases. In this regard it outlines the qualitative and quantitative outcomes from assessment and analysis of a cluster of 30 IoT use cases.

The EU-IoT consortium has set itself the goal of understanding the business dynamics of companies that have successfully developed and/or deployed IoT-empowered solutions and their business models (BMs) and based on the findings provide recommendations for others to leverage from best practices (cf. Figure 1).

We have selected, evaluated and systematically analysed 30 IoT use cases that reflect best practices for successful IoT development and/or deployment across a variety of industry verticals and geographical origin. These use cases illustrate real-world examples on how Start-ups, SMEs and business unit innovators have successfully developed and/or deployed IoT-empowered solutions. These examples resemble successful frontrunners in the field of IoT, and we have explored them to identify the key factors and dynamics accountable for their success.

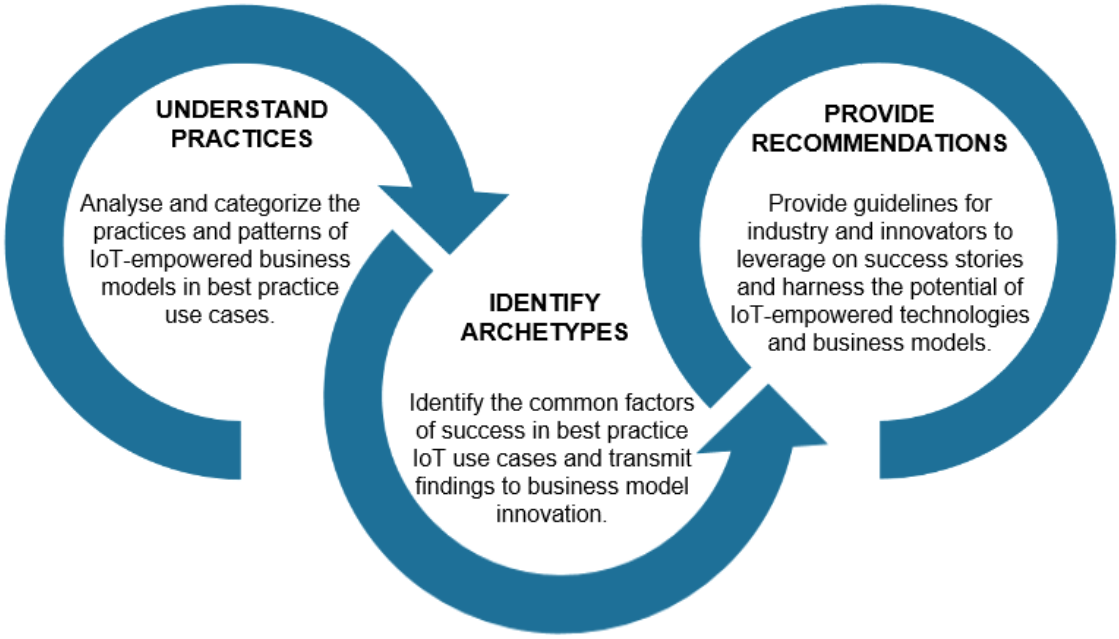


Figure 1: Purpose statement

The main objective of our exploration is to expose European companies to relatable IoT use cases that inspire and encourage them to evaluate their own BM, as well as to stimulate transparency of the practices and BM patterns and configurations shared by IoT frontrunners including significant factors of their success. While aiming to offer insights on best practices for achieving success in the diverse and ever-growing IoT landscape, our exploration will also reflect the stories of the individual use cases.

The intended outcome of this deliverable is an online use case catalogue that effectively amplifies the results and impact of successful IoT initiatives that underpin the Next Generation Internet. By offering a catalogue of best practices, stakeholders of the European IoT ecosystem will be able to find inspiration and general guidelines on how IoT can be successfully developed and/or deployed. Industry, innovators, IoT learners and policy makers are thereby offered the insight needed for utilising novel technologies to achieve success with their IoT-empowered solutions as well as to leverage the knowledge of frontrunners in the IoT field.

Hence, with the collection, documentation and analysis of best practice IoT use cases, this deliverable will increase the impact of subsequent activities related to IoT skills development, business modelling and acceleration support. Ultimately, to lower the barriers for developing and deploying IoT-empowered solutions and thereby inspire stakeholders to contribute towards growing the European IoT ecosystem.

1.2 Scope of deliverable

Aarhus University (AU) acts as EU-IoT COACH, which is the lead beneficiary on work package 4 (WP4). In this role, AU contributes to the project by reporting on best practices for IoT use cases.

The rapidly used phenomenon 'best practice' and 'success' are considered holistically in regards of a cluster of IoT use cases held by frontrunners in the IoT landscape.

At the heart of the results presented in this deliverable is an analysis of 30 IoT use cases (see Table 1 for a use case overview). The use cases have been carefully selected, from a backlog of ~50 relevant cases, to be documented in an online catalogue and to serve at units of analysis. The consortium wants to emphasize that this collection does not claim to be exhaustive and does not constitute a special distinction for the named practical examples.

The premises behind the results presented in this report - the methodology for the collection and analysis of best practice use cases, including clarification of the scientific and theoretical frame of reference - was presented in the intermediate D4.1 report, and will be recapped shortly in this report. Hence, for detailed information on the premises behind the results presented in this deliverable, you may access the intermediate version D4.1 report here.

All the work presented in this deliverable is to be considered within the scope of the EU-IoT project

VISIONS

At the core of the NGIoT vision is the ambition to enable a major shift: from digitally enabling the physical world towards automation and augmentation of the human experience with the connected world thanks to secure, resilient, safe, and trustworthy IoT.

At the core of the EU-IoT vision is the ambition to act as an accelerator for the whole European IoT ecosystem towards transforming the current IoT community of researchers and innovators in Europe into an increasingly cohesive, dynamic, participatory and sustainable ecosystem, as an essential part of the Next Generation Internet initiative. It assists stakeholders to engage and create value, as well as set up a self-sustaining European IoT community.

under the NGIoT initiative, and in alignment with the visions of those.

While reporting on best practices for IoT use cases, the rapid development in the IoT landscape brings in the need to rethink technology interfaces to integrate and adapt to human behaviour and human activities (EU-IoT Scope area 1: *Human / IoT-interfaces*). It also requires rethinking computational and networking architectures (EU-IoT Scope areas 2-3: *Far Edge (device) and Near Edge (gateway)*, taking into consideration behaviour learning; the need for data and user privacy; the larger volumes of sensitive data to be analysed, and the requirements to handle such data. Then, it requires addressing interconnection and networking aspects (EU-IoT Scope area 4: *Infrastructure*) and data sovereignty aspects across decentralised data spaces (EU-IoT Scope area 5: *Data Spaces*). Please note that the IoT landscape – and so the foundation for the reporting of EU-IoT – is changeable in nature.

1.3 Work process

The process for reporting on best practices use cases has unfolded in three steps towards achieving the previously defined purpose. The process follows a value chain approach and is composed of the steps as illustrated in Figure 2.

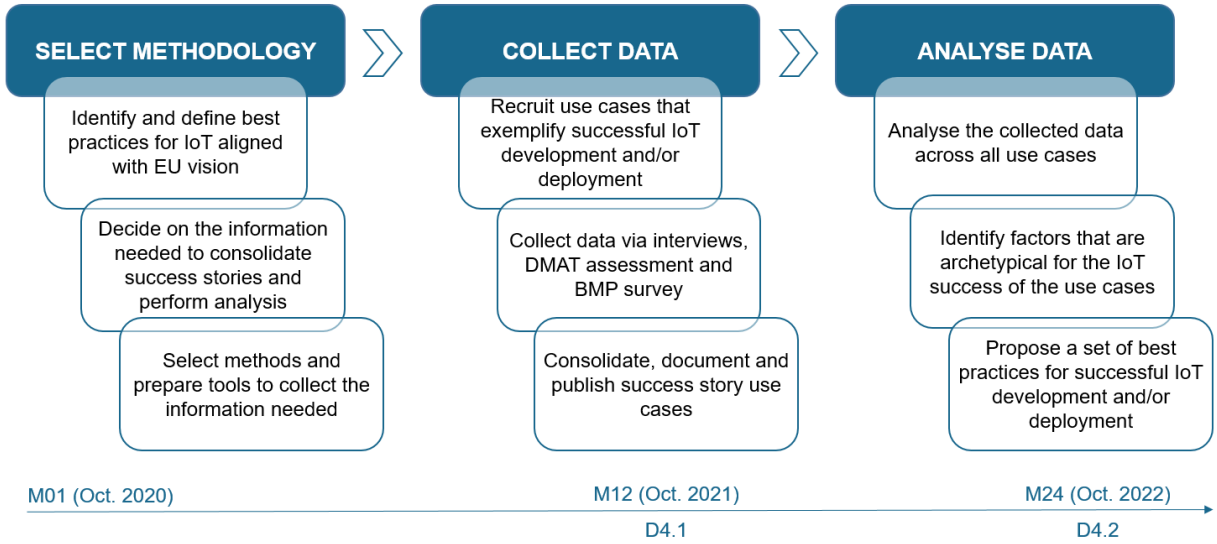


Figure 2: Process for reporting on best practices for IoT use cases

Outcomes of the process include:

- Use case catalogue of written success stories that introduce the explored IoT use cases. The catalogue covers cases across 12 countries and 7 domains and in the scope of 18 different advanced technologies
- Insights from analysis across all cases to identify and define archetypical factors for achieving success with IoT-empowered solutions (factors such as digital maturity levels on various dimensions, BMPs and BM configurations for innovation).
- Overview that concludes upon analysis insights and sums up the identified best practices for IoT use cases, serving as a guide for successful IoT development and deployment'.

Results of the process are presented in this deliverable D4.2. The methodology of the process was presented in the intermediate version deliverable D4.1. For a detailed overview of all the data governed by this deliverable, we refer to the joint Data Management Plan of the EU-IoT project, presented in deliverable D6.3.

At the point of time for submission of this deliverable, the EU-IoT project is reaching M24, and our reporting on best practices for IoT use cases thereby covers the second and final year of activities conducted in regards to T4.1 under WP4.

1.4 Structure of deliverable

This deliverable represents a preliminary step to building and ensuring the growth of a vibrant European IoT ecosystem. The following topics will be discussed in the subsequent sections:

- **Section 2** is dedicated to: The **methodological premises** for reporting on best practices for IoT use cases, outlining the scientific and theoretical frame of reference for collection and analysis of qualitative and quantitative data sources.

- **Section 3** is dedicated to: **Use case overview**, presenting the results from data collection prior to analysis, and with that, the cluster of IoT use cases that have been selected as suitable units of analysis. Results cover a board overview of the 30 use cases and background information on the case companies.
- **Section 4** is dedicated to: **Use case catalogue**, presenting the qualitative results of data collection and analysis. The catalogue documents the individual use cases in stories that articulate the successful IoT development and/or deployment.
- **Section 5** is dedicated to: **Use case study**, presenting the quantitative results of data collection and analysis. The study provides insights on factors that are archetypical in characterising the success achieved in the IoT area across the cluster of use cases.
- **Section 6 and 7** are dedicated to: **Conclusions and impact assessment** upon the results presented on best practices for use cases, and finally, a Status and plan for continuity is provided to assess past, current, and future performance of the task and work package

The results accounted for in this deliverable reflects both finalised and ongoing activities. The results serve as input to the further activities of WP4 to support and accelerate IoT BMs and skills building. Outcomes of these activities will be documented in the deliverables D4.5 and D4.7 that are planned for submission in March 2023.

2. METHODOLOGICAL PREMISES

This section shortly outlines the methodology applied by the EU-IoT COACH, in the scope of T4.1 under WP4, to report on best practices for IoT use cases, and hereby the scientific and theoretical frame of reference for collection and analysis of qualitative and quantitative data sources. Please note that this section is a modified recap of the more detailed information that was provided in deliverable D4.1.

2.1 Research structure

Best practices for IoT were explored as a 'contemporary phenomenon in its real-world context', and a case-based approach with many IoT use cases was found the most appropriate for that purpose [1]. A multiple case study was therefore applied to enable both in-depth analysis of individual use cases and cross-sectional analysis of the collective cluster of use cases. Furthermore, because evidence created from a multiple case study is measured strong and reliable [2].

Our research unfolded upon three steps:

1. First, we conducted interviews, to derive key information about the IoT-empowered solution that has been developed and/or deployed as well as the contextual setting of it.
2. Second, we conducted a digital maturity assessment, to evaluate the level of digital maturity on different dimensions of the case company.
3. Third, we conducted a survey of the BM, IoT applicable BMPs, and the technology trends that characterise the use case.

Findings throughout the three phases are documented for each individual use case as a success story (cf. Sec. 4). When information from all use cases were collected and documented, our research proceeded into a multiple case study of the entire cluster of use cases (cf. Sec. 5). This qualified us to analyse the data not only at the level of the individual use case but also across the cases, to understand differences and similarities between the cases and for the findings to be correlated with the success of the IoT use case [*Ibid.*].

2.2 Data sources identification and assessment

The process of finding and selecting data sources to conduct the research on started with considering the full European IoT ecosystem. IoT success as a notion for best practice was outlined to scope use cases of relevance for our exploration. A clear definition for a best practice IoT use case, and a set of delimitations for a case company as unit of analysis, was developed, processed and agreed upon by partners in the EU-IoT consortium.

The recruitment of use cases leveraged a bottom-up exploitation of synergies across networks of relevance to the European IoT ecosystem. Hence, the call for best practice IoT use cases was shared with relevant CSAs, RIAs, and other associations, projects, and stakeholders operate in the scope of the Next Generation Internet and Horizon Europe (see appendix A1 for use case recruitment sources).

By prioritising companies endorsed by the EU-IoT partners, the number of potential IoT use cases was narrowed down to the ~50 most relevant and consistent ones. These ~50 use cases were gathered in a case backlog and sorted by geographical origin and industry vertical for the further evaluation process to ensure board and representative coverage of the European IoT landscape. The rationale for geographical and industry coverage was a balance between relevance and accessibility of the use cases, as elaborated in D4.1. The use cases in the backlog were then

referenced to six key domains deducted from praxis of the European IoT ecosystem (cf. Figure 3).

Figure 3: Use case domains

By prioritising a relatively even distribution across the domains, the evaluation process led to the selection of 30 cases from the backlog that was found to be suitable units of analysis. Prior to exploration, the use cases were categorised by type and level to make a distinction between noticeable different conditions for the success of the IoT use case. Hence, we have classified the use cases by two case types, being either a technological or a business use case, and we have sorted the use cases into four levels that clarify to what extent the technology of the specific IoT solution is proven, implemented, commercialised and operational, whether it is novel and whether it positively impacts business of the case company (cf. appendix A2 - Case type and level).

Each use case is based on the development and/or deployment of a specific IoT-empowered solution, and the case company is considered at the level of a strategic business unit.

2.3 Data collection and analysis methodology

The methodology for our collection and analysis of data relies on a range of methodological tools and techniques:

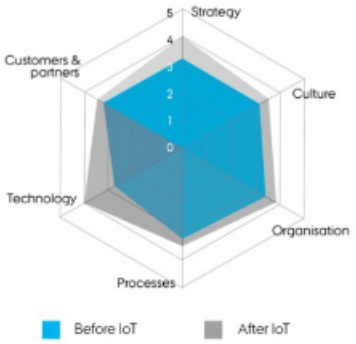
- For the collection data, our research has employed a range of methodological tools. These constitute the scientific frame of reference for establishing an appropriate mechanism to gather information on best practices for IoT use cases: Interviews, Digital Maturity Assessment Tool and Business Model Pattern Survey.
- *It should be noted that data collection has relied on self-assessment methodology, and results are therefore influenced heavily by the case companies' own self-perception.
- For the analysis of data, our research has further employed a range of methodological techniques. These constitute the theoretical frame of reference for establishing a common understanding of the concepts that are essential in exploring best practices for IoT use cases: digital maturity, BM patterns, and the configuration of BMs for innovation.

The methodological tools and techniques are employed in symbiosis to explore the IoT use cases and produce the results that will be presented in this report. The methodology is presented in a simplified overview illustrated in Figure 4.

Interview

The interviews are conducted with one or more employees from each case company to represent both a technical and a business perspective. Results from interviews reflect the success story of individual IoT use cases and are presented in the use case catalogue.

Digital Maturity Assessment



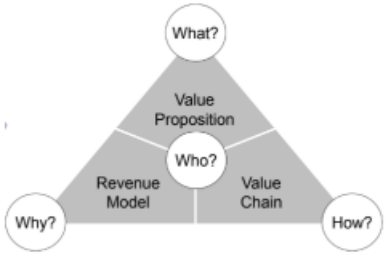
The DMAT is an online assessment that measures and evaluates the digital maturity of a company through six dimensions. Results from DMAT reflect the ability of case companies to digitally transform and to adopt new technology.

Business Model Pattern Survey

SUPER-PATTERN	SUB-PATTERN			
Integration	Crowd-sourced innovation	Production as a service	Mass customization	
Servitization	Life-long partnerships	Product as a service	Result as a service	
Expertization	Product-related consulting	Process-related consulting	Product-related platformization	Process-related platformization

The BMP survey provides a structured overview of the IoT applicable patterns used to shape the business models of the IoT use cases. Results from the survey reflects patterns that are archetypal for the successful leverage of IoT technology across the use cases.

Business Model Evaluation



The BMI evaluation determine the impact of an IoT solution on the configuration of the four business model dimensions. Result of the evaluation reflects the correlation between business model innovation and the IoT solutions developed and/or deployed by the use cases.

Figure 4: Methodological overview

Qualitative results will be presented in sec. 4 in terms of the use case catalogue. These results are derived largely on the basis of interviews serving as the methodological tool to explore IoT best practices and document the success story of each individual use case.
Quantitative results will be presented in sec. 5 in terms of the use case study. These results are derived largely by assessing digital maturity, surveying BMPs and evaluating BMs as the methodological tool to explore IoT best practices and generate insights on IoT successes across the cluster of cases.

INTERVIEWS

Information and insights on IoT use cases are derived from dialogue with the people that are/or have been severely involved in the use case. Hence, the tool for data collection has been interviews based on a range of predefined questions to cover all relevant aspects and align the stories of the use cases. The interviews were conducted with one or more employees from each case company to ensure that their roles in developing and/or deploying the IoT solution represent both a technical and a business perspective.

DIGITAL MATURITY ASSESSMENT

The assessment of digital maturity is based on research by Aagaard et al. [3], and data collection was facilitated by The Digital Maturity Assessment Tool (DMAT) that is also developed by Aagaard. The DMAT is an online tool in terms of a questionnaire that can be accessed via the link: https://dbd.au.dk/dmat/.

The term digital maturity refers to the measure of an organization's ability to create value through the implementation of digital solutions. Digital maturity is a key predictor of success for companies that initiate a digital transformation and high levels of digital maturity are often associated with having a competitive advantage. The DMAT assesses digital maturity along the dimensions of strategy, culture, organisation, processes, technology and/or customers and partners.

BUSINESS MODEL PATTERNS SURVEY

The study of BMPs is based on research by Weking et al. [4], and data collection was facilitated by a survey developed for the specific purpose of the EU-IoT project by the Interdisciplinary Centre for Digital Business Development, Aarhus University. The BMP survey is an online questionnaire that can be accessed via the link: https://survey.au.dk/LinkCollector?key=9492NPF6LPCK.

The patterns of a BM help us to understand the outline of the business. By using Weking et al.'s taxonomy from 2020 to explore the BM patterns of our use case cluster, it is made very clear that they are all using the internet – or IT - as a fundamental source for building and innovating their BMs. The taxonomy depicts the super-patterns: Integration that innovates its BM around new processes, Servitization around new products, and Expertization around a hybrid of products and processes.

BUSINESS MODEL EVALUATION – INNOVATION AND CONFIGURATION

The evaluation of BMs is based on research by Gassmann et al. [5], and data collection was facilitated by the combination of the employed methodological tools. The concepts of BM Innovation and BM configuration are explored with the theoretical framework of St. Gallen University [*Ibid.]* that depicts four dimensions of a BM.

The four dimensions of a BM describe the rationale of how an organization creates, delivers, and captures value [*Ibid.*]. Ultimately, the configuration of the dimensions is a plan for the successful operation of a business and it provides the conceptual structure that supports the viability of the business. BM innovation is the process of reinventing or enhancing the BM by making simultaneous, and mutually supportive, changes to the dimensions.

TECHNOLOGY TRENDS

As a final aside to the study of best practices for IoT use cases, includes an exploration of the specific technologies that are being deployed by the case companies. This exploration pinpoints the role of technology and the trends of technology.

IT and IoT can either play a role that is constitutive, value increasing or irrelevant for the overall BM of a company [6]. This role outlines the prioritisation and urgency a company ascribes to technology development and deployment. Our exploration of technology trends across the IoT use cases is facilitated by a framework developed by consortium for the specific purpose of the EU-IoT project. The framework outlines specific technologies that address the points of interaction between the physical elements making up the human to cloud continuum. The framework was published as part of the strategy white paper “Towards a vibrant European IoT Ecosystem” and can be accessed via the link: EU-IoT deliverable D2.1.

3. USE CASE OVERVIEW

This section will provide the results from data collection prior to analysis and outline the cluster of IoT use cases explored by the EU-IoT COACH in the scope of T4.1 under WP4. The results cover a board overview of the 30 IoT use cases, and background information on the case companies that have been selected as suitable units of analysis.

Find below in Table 1 an overview of the IoT use cases grouped by domain.

Table 1: Overview of use cases

Domain	Use case description	Case company
Agri-Food 	Intelligent platform for pest and disease management in horticulture supports the transition to greener and more efficient farming practices	Fauna Smart Technologies
	Artificial intelligence platform for increased animal welfare and sustainability in livestock production	DunavNET
	Artificial intelligence platform for optimised cultivation and supply chain transparency	DunavNET
	Precision agriculture enabled by federated machine learning and autonomous farming procedures	Synelixis
Energy & Utility	Smart metering enables energy management and flexibility of Smart Grids	ASM Terni
	Smart water infrastructure enabled by NB-IoT and energy harvesting technology	Aqua Robur
	Intelligent water metering enables new service business model and service add-on for citizens	Herning Vand
Health & Care 	Virtually engaging software facilitates interactive exercise for physical rehabilitation	GoodLife Technology
	IoT solution to increase autonomy and quality of life of older adults, supporting and extending independent living in own homes	MySphera
	Technology facilitates “senior ready” living environments to support residents, their families and care providers	Technosens
	Smart remote treatment supported by artificial intelligence enables personalised medication for bipolar disorder diagnosed patients	NTT Data
Manufacturing 	Artificial intelligence applications predict and prescribe actions to empower industrial efficiency and sustainability	QiO Technologies
	Intelligent industrial intralogistics facilitated by automated guided vehicles unified with robotic arms	ASTI Mobile Robotics
	End-to-End IoT solutions make asset smart, automate processes and deliver actionable insights into industrial operations	Aloxy

	Efficient operation through leverage of data from production processes of acoustic panels	Troldtekt
Mobility & Transportation	Distributed Ledger Technology for enabling vehicular collective perception on the road towards automated driving	Veoneer
	Digital platform connects all port industry equipment and systems for improvement of performance and efficiency	Terminal Link
	Digitalising sea-port-land operations with an open data platform for intelligent maritime logistics	Awake.AI
	Smart e-mobility charging stations with remote control and Edge capability	Emotion
	Automated driving systems for sustainable mobility in urban connected environment	Tecnalia
	Reactive bike lights utilise sensor technology to protect cyclists and help cities improve infrastructure	See.Sense
Smart Cities & Communities	Artificial sensing and intelligence for increased understanding and management of natural ecosystems	Fold.AI
	Smart Mirror with deep learning algorithms and distributed AI serves as interface between residents and smart environments	CITEC, University of Bielefeld
	Plug-and-play solution helps save water and energy by nudging people towards sustainable behaviour in the shower	Aguardio
	The near Zero Energy Building (nZEB) Smart House - an innovation hub, IoT testbed and ecosystem	CERTH
	Smart urban development and improved liveability through data-driven environmental monitoring	HOPU
Other	Cybersecurity: Artificial intelligence platform increases cyber-security by authenticating users through behavioural patterns	Quadible
	Telecommunications: 5G enabled autonomous and remote controlled intelligent mobile robots	Fivecomm
	Telecommunications: Private 5G mobile networks enable industry verticals to adopt and deploy Next Generation technologies	Cumucore
	Cross-domain: IoT projects made into reality through IoT hardware design, manufacturing and consultancy	AllThingsTalk

USE CASE DOMAINS

The use cases are distributed across the six key domains as illustrated in the below Figure 5:

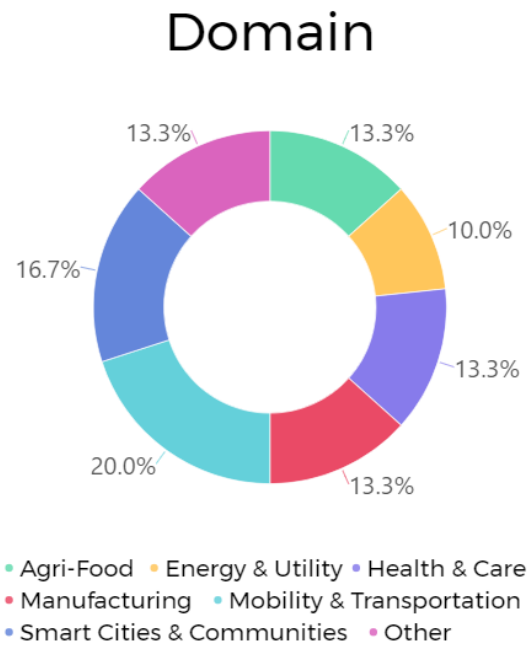


Figure 5: Use case domain distribution

The seventh domain 'Other' covers cases in the areas of telecommunications, cyber security and cross-domain application.

USE CASE GEOGRAPHY

The use cases are distributed across a variety of geographical origins as illustrated in the below Figure 6:

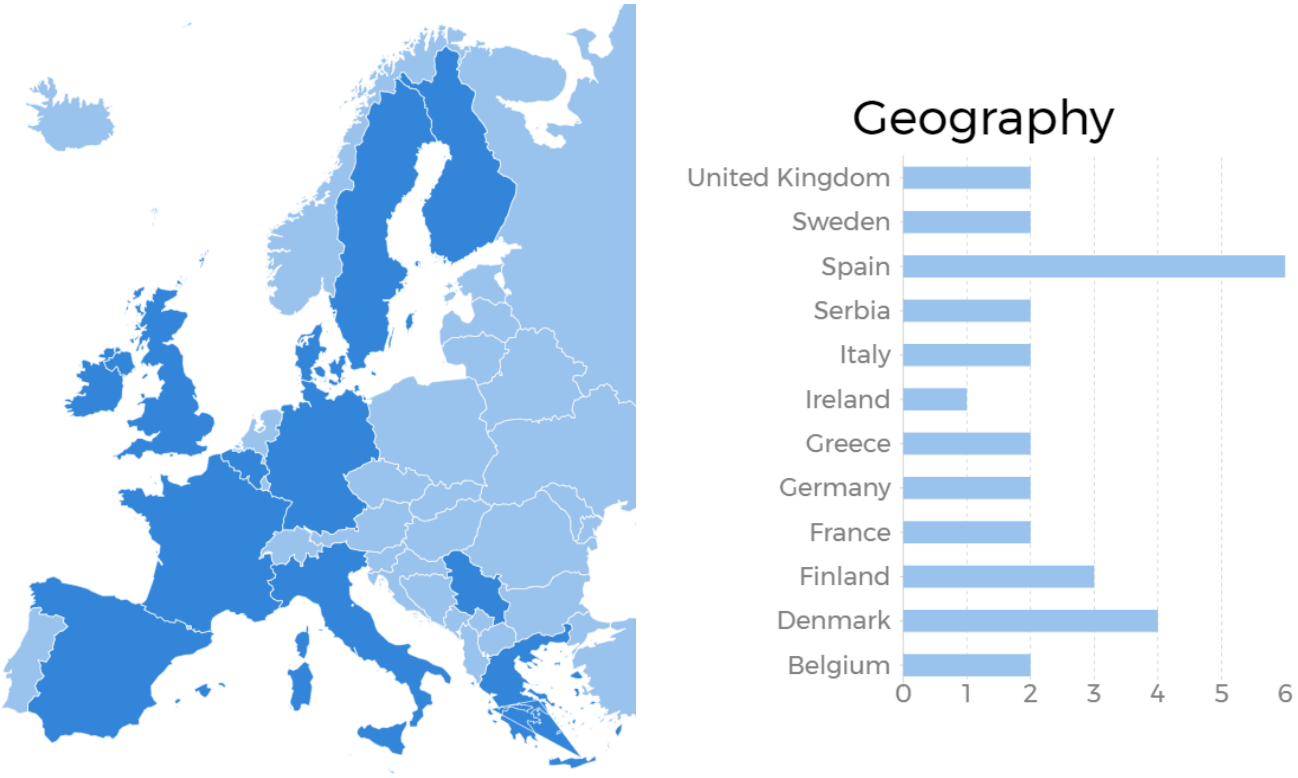


Figure 6: Use case geographical distribution

For the sake of representative transparency, find in the below Figure 7 an illustrated overview of the distribution of domains across geographical origins the use cases:

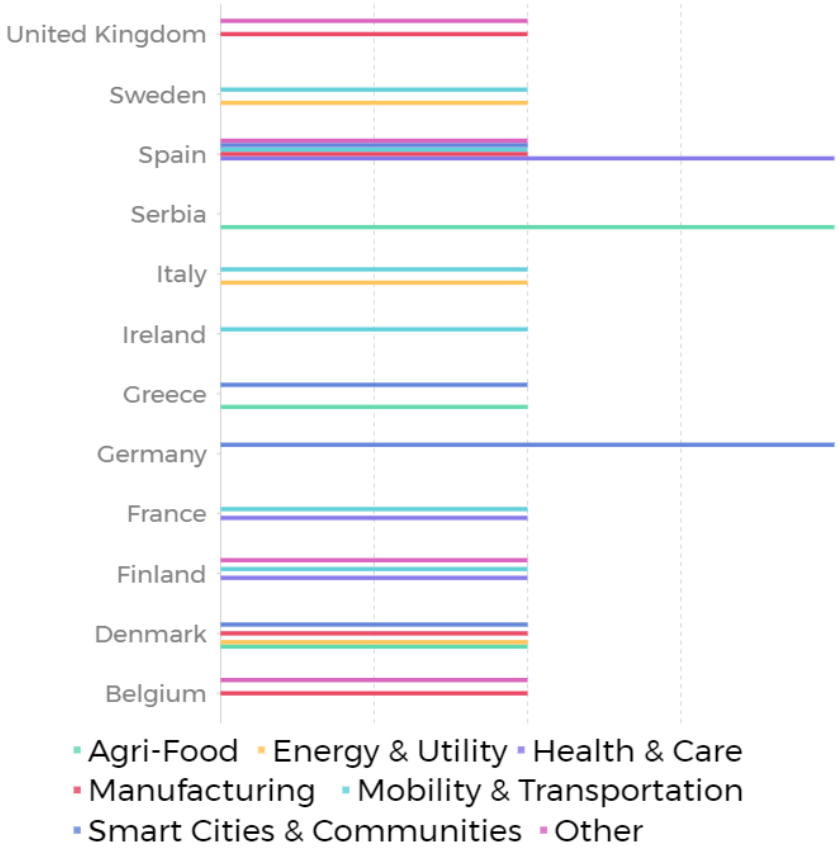
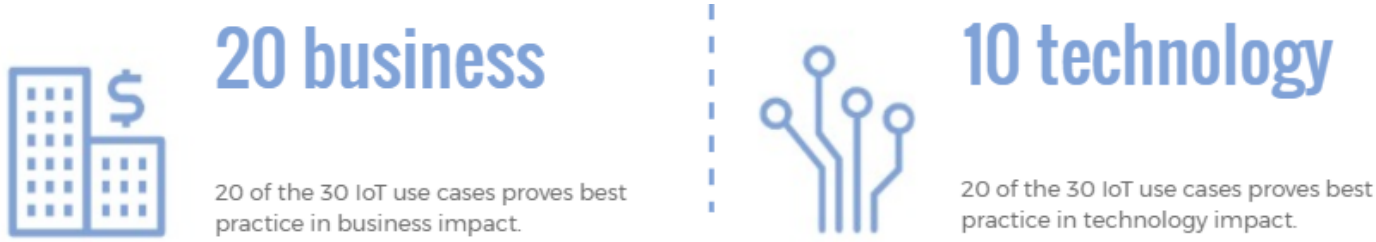


Figure 7: Use case domain and geographical distribution

USE CASE TYPE

All collected use cases exemplify best practice for IoT either through business success or through technological success.



The distinction between the case types is defined by:

- Business success, referring to the development and/or deployment of an IoT-empowered solution that significantly impacts business (typically containing favourable changes that are noticeable on the bottom line) for the use case and potentially for actors in the wider value network.
- Technological success, referring to the development and/or deployment of an IoT-empowered solution that significantly impacts novel technology progress (typically holds potential to advance or transform tradition) in entire ecosystems and/or value networks of the use case.

In a business use case, the case company generates valuable impact by leveraging IoT technology **in** a solution, and in a technology use case, the case company generates valuable impact by offering IoT technology **as** a solution. Hence, Business use cases focus on IoT as value creation, and Technology use cases focus on IoT as value proposition.

USE CASE LEVEL

All collected use cases are based on a specific IoT-empowered solution. These solutions differ on the current and potential financial impact it may have on the business, and the readiness and novelty of the technology, which ultimately determines how well the use case conforms to the definition of an IoT success story (cf. D4.1, sec 2.2.1). Based on the conformity and considered parameters, the use cases are sorted into three as illustrated in Figure 8:

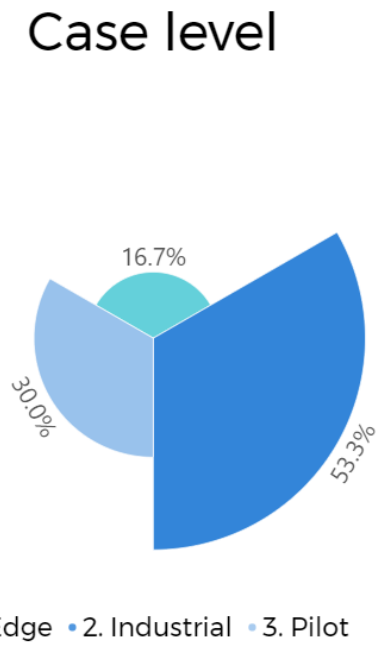
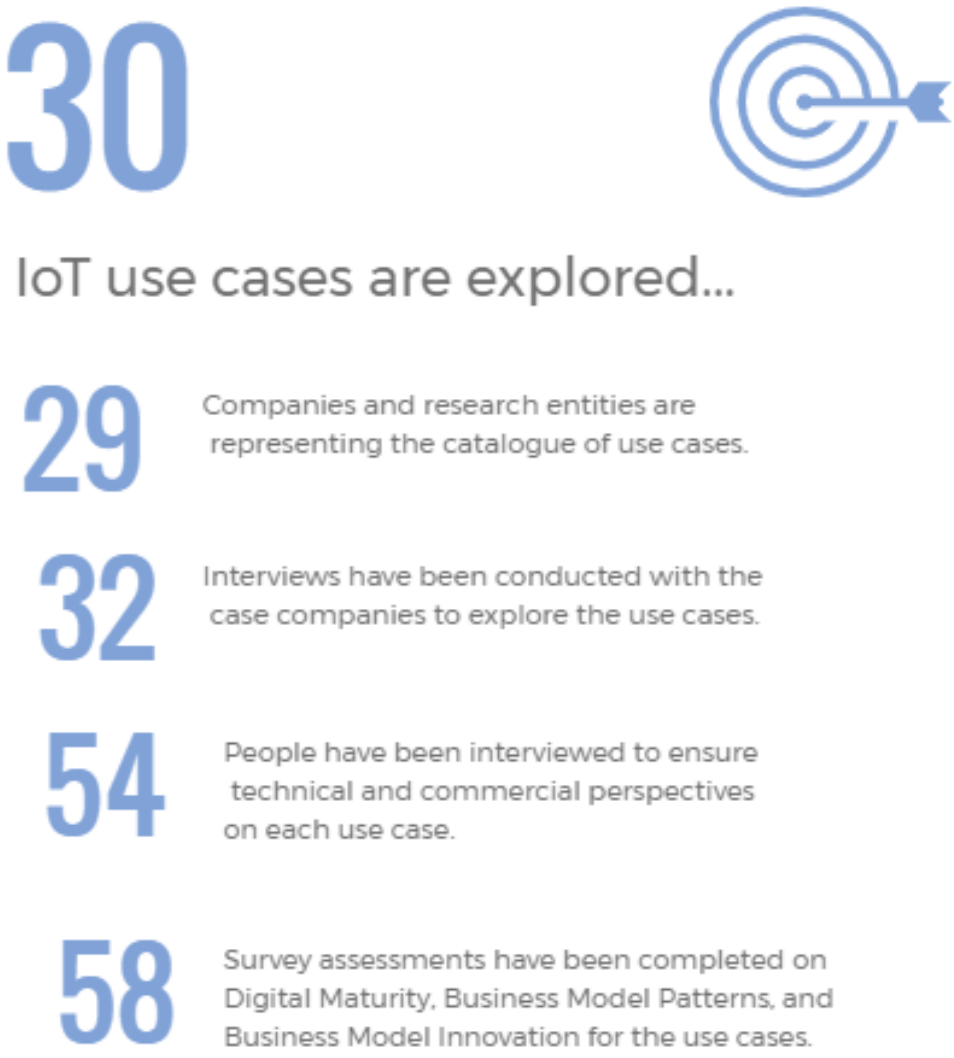


Figure 8: Use case levels

Of the 30 use cases, 5 are on the 1. Edge level, 16 are on the 2. Industrial level and 9 are on the 3. Pilot level. Hence, more than two thirds of the explored use cases are based on IoT-empowered solutions that are commercialised, and thereby to some extent does demonstrate financial proof-of-concept. The argument for including also IoT-empowered solutions that are not yet commercialised in the exploration (i.e., use cases on level 3. Pilot), is the constant addition of technological trends that continuously broaden the IoT concept – hence, we did not want to exclude high-potential technologies that are simply still *too* novel to occur in existing commercialised solutions.

3.1 Case data overview

To establish a complete picture of best practices for IoT use cases, data has been collected both qualitatively and quantitatively to ensure that our exploration considers both the individual specifics of the cases and the collective totality of the cluster. Key numbers of the data collection include:



3.2 Case companies overview

To make visible the data sources for the exploration – the foundation for our findings on best practices for IoT use cases - the case companies that have been selected as units of analysis will be presented in the below subsection.

The people who represent the case companies are varying in gender, age and professional role in the organisation. All are, or have been, severely involved in the IoT use case, and all are volunteered interviewees.

CASE COMPANY SIZE

The cluster of case companies represent varying sizes measured on personnel numbers:

Between 4 and 139,500

is the number of people working in the case companies.

80 % of the case companies can be defined as SMEs (i.e., having less than 250 employees), and the cluster thereby represents the backbone of European economy well, where 99% of all businesses are in the defined group of SMEs (cf. Figure 9).

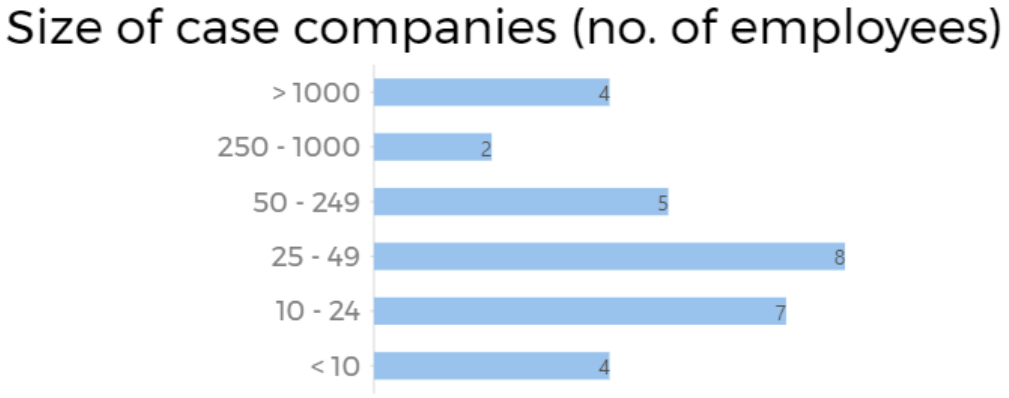


Figure 9: Case company size

CASE COMPANY TIMING

Some relevant information to consider in the exploration of best practices for IoT include the timing of significant milestones achieved by the case company with regards to the use case. First and foremost, when was the company founded? And secondly, when was the IoT use case initiated?

All the case companies covered in the cluster were founded between 1935 and 2019, with the average year of founding being 2006, as illustrated in Figure 10:

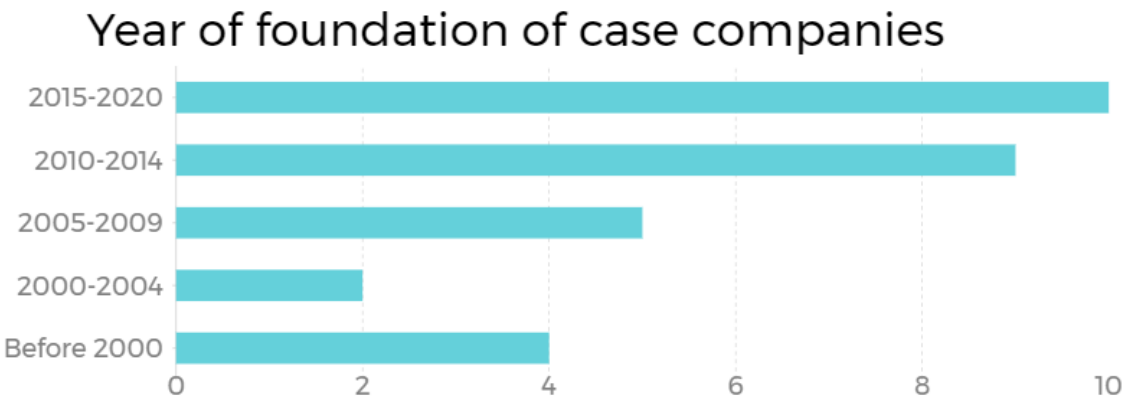


Figure 10: Year of foundation of case companies

Hence, majority of the case companies are founded in the most recent decade, with precisely 63 % in the period 2010-2020.

All the use cases covered in the cluster were initiated between 2007 and 2020, with the average year of founding being 2016, as illustrated in Figure 11:

Figure 11: Year of IoT use case initiative in case companies

80 % of the IoT use cases were initiated in the period from 2015 and onwards. Only one of the 30 use cases was initiated before 2013.

INSIGHTS

- The data indicates that the **corporate world has started to realise the value** of developing and/or deploying IoT technology during the recent decade. This reflects the increasing trend and overall growth in IoT solutions in the Europe Landscape.
- None of the explored IoT use cases were initiated after 2020, which may indicate that a period of some years must occur after the initiation of an IoT initiative to **mature it into a successful use case**.
- Majority of best practice companies seem to be **born digital** and are founded on the basis of an IoT initiative, or adopts an IoT initiative within a short period of time after

For an overview the data presented in sec. 3.2, at the level of individual use cases, please see appendix A3 for case company background information.

4. USE CASE CATALOGUE

This section will provide the qualitative results of data collection and analysis conducted by the EU-IoT COACH in the scope of T4.1 under WP4. Our reporting on best practices for IoT reflects findings across the use case cluster, however, our exploration of best practices for IoT takes departure in the individual use cases. Each use case uniquely exemplifies best practice for IoT, and each use case is therefore documented in a story that articulates the successful IoT development and/or deployment made by the specific company. The use case stories are presented in a catalogue where they collectively exemplify best practices for achieving success in the IoT area.

4.1 Catalogue presentation

The use case catalogue is made available online on the official website of EU-IoT / NGIoT, and can be accessed via the link: https://www.ngiot.eu/use-cases/

The complete catalogue consists of 30 IoT success stories that aim to inspire industry, innovators, IoT learners and policy makers by demonstrating best practices for developing and/or deploying IoT solutions, eventually helping them to understand how they can create the most optimal premises for themselves and for the ecosystem to succeed with IoT.

The catalogue is offered online and free of charge as an open-source resource, to foster widespread proliferation and use in terms of website traffic growth.

USE CASE CATALOGUE - ONLINE INTRODUCTION

Show-casing novel IoT solutions, and the products and services which underpin those solutions, the EU-IoT use case catalogue highlights best practices from IoT developments and deployments around the world.

Whether you are a professional in the IoT field, a researcher, a developer, an end-user or just curious about the potential of IoT, the catalogue of use cases will help you navigate and learn how novel technological solutions, disruptive business models and ambitious stakeholders contribute to growing a vibrant European IoT ecosystem.

Your company can share successes, or learn from the success of others, connecting directly with the stakeholders involved. Browse solutions based on sector, technology domain or geographical origin.

Find below in Figure 12 and 13 online snapshots illustrating the dedicated page of the use case catalogue (located under resources > use case catalogue) and a banner redirect to the use case catalogue from the front page of the official EU-IoT / NGIoT website.

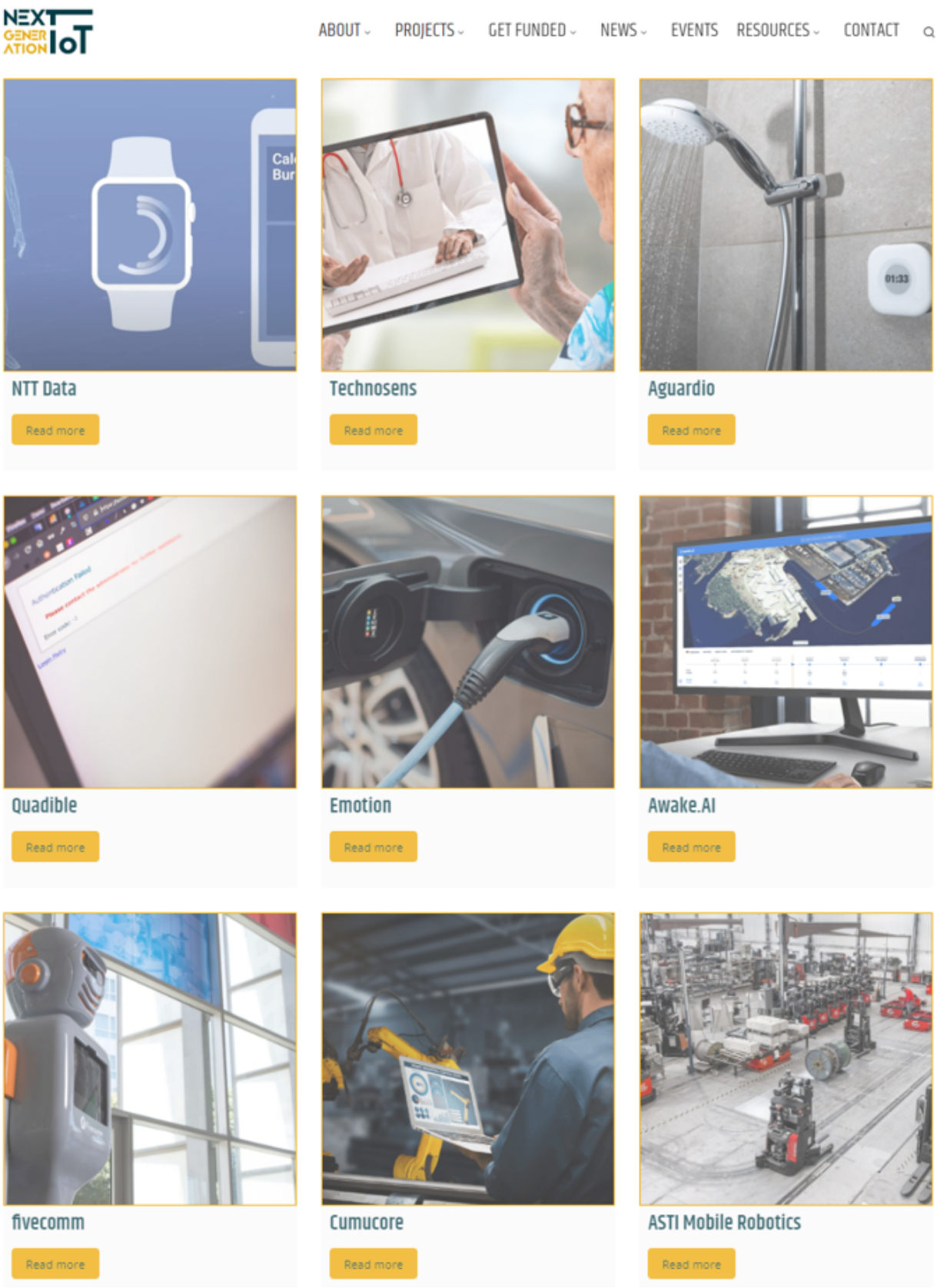


Figure 12: Online snapshot of the use case catalogue

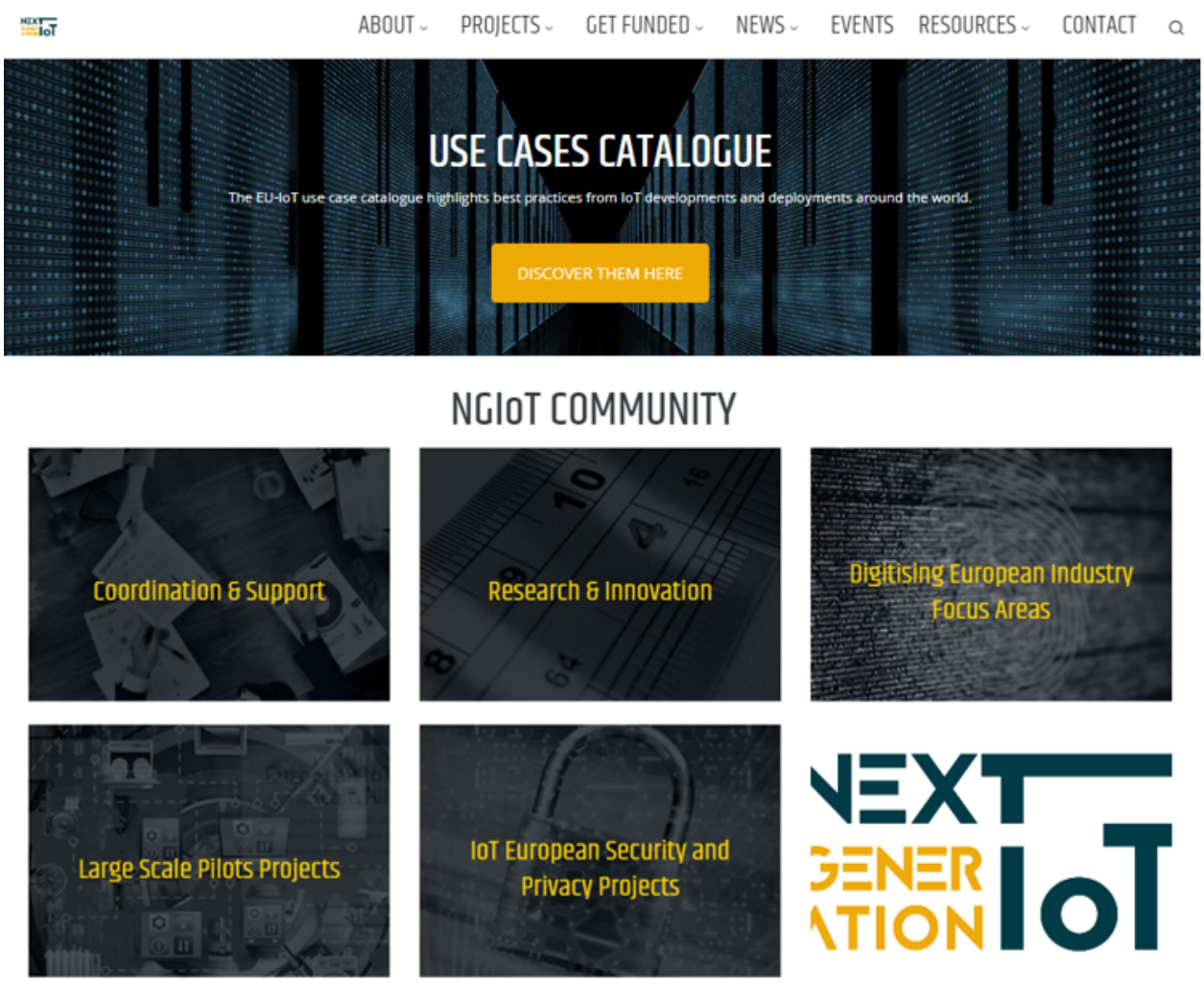


Figure 13: Online snapshot of the use case catalogue banner redirect

In addition to the domain of the official EU-IoT / NGIoT website, the use case catalogue is made available also on the domain for the website of Aarhus University, Interdisciplinary Centre for Digital Business Development, via the link: https://dbd.au.dk/case-studies/.

The intention behind making the use case catalogue available via two separate domains is to create binary online presence that ensures continuity of the catalogue beyond the EU-IoT project. Hence, with the finalisation of the project, and probable close of the project website, a replica of the use case catalogue will be safely stored at another domain that continues to be available.

4.2 Catalogue structure and status

The IoT success stories in the use case catalogue can be filtered by domain, geographical origin and technologies (cf. Sec. 3 and Sec. 5.3), making it easy for users to sort through and discover use cases of particular relevance to them.

The IoT success stories presented in the use case catalogue generally follow the same outline:

- **Short introduction** that introduces the case company, some background information and context of the use case
- **IoT incentive** that reveals the cause and motivation of the case company to initiate development and/or deployment of an IoT solution
- **IoT solution** that describes hardware and software as well as enabling technologies and features of the specific IoT solution
- **Outcome** that accounts for the effects and the value generated by the IoT use case both internally by the case company end externally in the ecosystem
- **Learnings and recommendations** that offer advice and inspiration to innovators that consider engaging in IoT development and/or deployment.

For all IoT success stories, the result of the digital maturity assessment is illustrated, and it is further indicated which Sustainable Development Goals the use case engages. All stories include relevant image material, and some include video material and/or additional text sections.

CATALOGUE STATUS

At the time of submission for this deliverable, 25 of the 30 use cases are published as success stories and available via the online use case catalogue. The remaining 7 success stories are in proceedings of approval from the case companies and are expectedly published prior to the finalisation of the EU-IoT project by March 2023.

It is anticipated that the further growth of the IoT use case catalogue on the official EU-IoT / NGIoT website will be an enriching contribution that increases projection of the overall website and extends its outreach in the ecosystem.

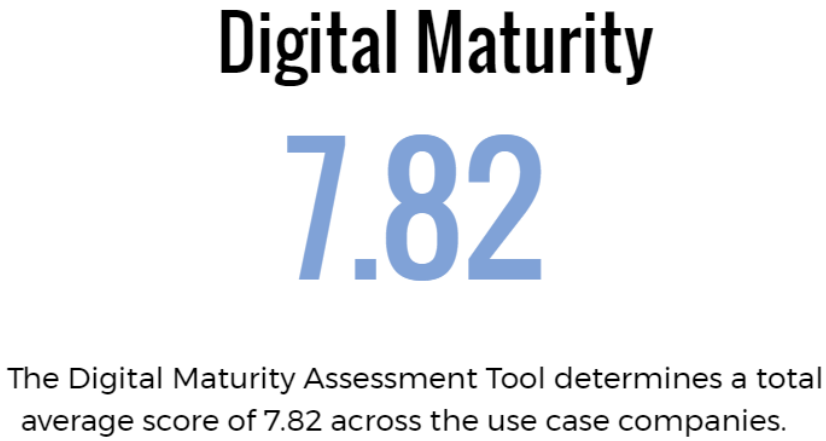
5. USE CASE STUDY

This section will provide the quantitative results of data collection and analysis conducted by the EU-IoT COACH in the scope of T4.1 under WP4. While our reporting on best practices for IoT takes departure in individual use cases, all generalising conclusions that are put forward in this report, rely on findings from a multiple case study conducted across the entire cluster of 30 use cases. Findings thereby constitute a collective exemplification of best practices that provides insight on collective factors that characterize the successful development and/or deployment of IoT solutions.

The study takes an in-depth look at business dynamics and technological dynamics of relevance to IoT success in terms of Digital Maturity, BMPs, BM configuration for innovation, Technology trends. The quantitative results presented in this section cannot be considered definitive, but rather indicative, for innovators and learners to achieve success in the IoT area.

5.1 Digital maturity

Digital maturity has been assessed to explore *how* successful IoT development and deployment interlinks with the digital maturity of a company.



The total average score assessed by the DMAT (on a scale from 1 to 10) demonstrates a high digital maturity across all the use case companies. As a whole, the case companies in the IoT use case cluster:

- are more digitally mature than the average for their respective sector
- have exceptional abilities to digitally transform and to adopt new technology

DIGITAL MATURITY SELF-ASSESSMENT

The use case cluster have assessed the digital maturity of their companies by scaling themselves (on a scale from 1 to 10) based on relevant questions as illustrated in Figure 14:

Figure 14: Digital maturity self-assessment

Best practice comparison: On a on a scale from 1 to 10, the case companies assess themselves to an average score of 7.87.

Indicates that the case companies generally consider themselves close to being perfectly digitally mature, and **close to the digital top performer(s)** in their respective sector.

(*Q: If you were to compare yourself to the perfectly digitally mature company in your industry, how close or how far are you?*)

Digital maturity of organisation: On a on a scale from 1 to 10, the case companies assess themselves to an average score of 7.70.

Indicates that the case companies generally **consider themselves to be at a high level of digital maturity**. This result is consistent with the total average digital maturity score of 7.82, which indicates that the case companies possess a great amount of self-knowledge.

(*Q: How digitally mature do you consider your organisation to be at the moment?*)

Digital maturity of BM: On a on a scale from 1 to 10, the case companies assess themselves to an average score of 7.37.

Indicates that the case companies generally consider themselves to have a digitally mature BM. This result however is lower than the self-defined digital maturity of the organisation, indicating that the case companies acknowledge **room for digital optimisation** in how value is created, delivered, and captured, in economic, social, cultural or other contexts.

(*Q: To what extent does your company have a digital BM?*)

DIMENSIONS OF DIGITAL MATURITY

The digital maturity (on a scale from 1-5) of the case companies is mapped out on the six dimensions defined by the DMAT, and the average distribution across the dimensions is illustrated in Figure 15:

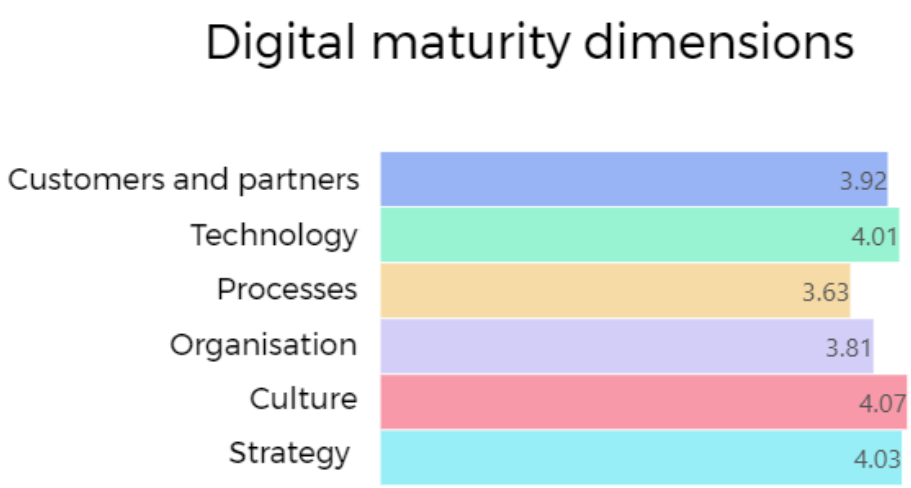
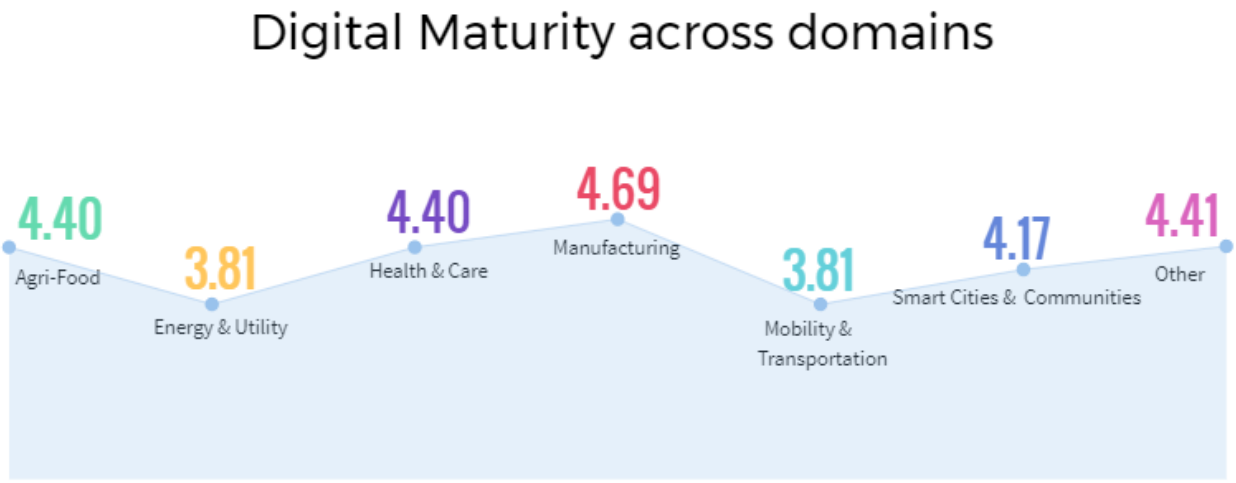


Figure 15: Digital maturity dimensions distribution

Across all case companies, Culture is the most digitally mature dimension, and therefore likely to be a driver of digital competitive advantages. Processes is the least digitally mature dimension, and therefore likely to contain digital development areas.

DIGITAL MATURITY ACROSS DOMAINS



Based on an assessment of the digital maturity (on a scale from 1 to 5) across domains, case companies in the Manufacturing domain demonstrates the highest level of digital maturity, whereas case companies in the Energy & Utility domain along with case companies in the Mobility & Transportation domain demonstrates the lowest level of digital maturity.

The digital maturity (on a scale from 1 to 5) across domains is mapped out on the six dimensions defined by the DMAT, and the average distribution across the dimensions is illustrated in the below Figure 16:

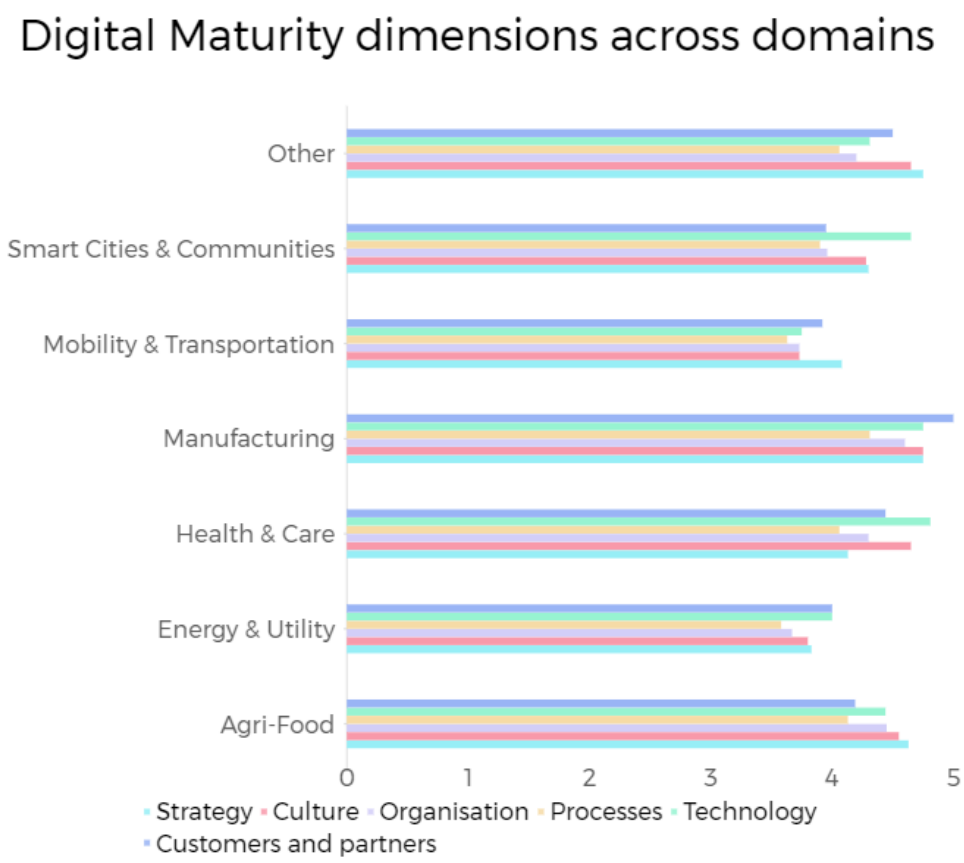


Figure 16: Digital maturity dimensions distribution across domains

All domains are *least* digitally mature on the Processes dimension.

All domains are *most* digitally mature on the Strategy, Technology and Customers & Partners dimensions:

- Strategy is likely to be the driver of digital competitive advantages for case companies in Agri-Food, Mobility & Transportation, and Other, as this is the most digitally mature dimension of these domains.
- Technology is likely to be the driver of digital competitive advantages for case companies in Health & Care and Smart Cities & Communities, as this is the most digitally mature dimension of these domains.
- Customers & Partners is likely to be the driver of digital competitive advantages for case companies in Manufacturing as this is the most digitally mature dimension of these domains. The same is true for Energy & Utility, although in combination with the Technology dimension.

Hence, although Culture appears to be the most digitally mature dimension in case companies across all domains, it does not apply to any isolated domain. This indicates that the Culture of case companies in all domains is remarkably digitally mature, however, at least one other dimension is even more mature, and therefore more likely to drive the digital competitive advantages of the case companies in the respective domain.

INSIGHTS

- The data indicates that the **digital capabilities** of the use case cluster are vastly mature, which may be explicated by the origination of many of the case companies being **born digital**.
- The data indicates that **Manufacturing is the most digitally mature domain** whereas Energy & Utility and the Mobility & Transportation are the least digitally maturity domains.
- **Processes is the least digitally mature dimension** across all domains, indicating that it is a digital development area for all companies regardless of domain.
- Culture is the most digitally mature dimension on average across all domains. However, it does not apply to any isolated domain. The most digitally mature dimension differ across domains and include **Strategy, Technology and Customers & Partners**, indicating that these are the **main drivers of digital competitive advantages**.

5.2 Business model patterns

BMPs have been surveyed to explore *how* the BMs of use cases that successfully leverage IoT technology are shaped by IoT applicable patterns.

BUSINESS MODEL SUPER PATTERNS

The below Figure 17 illustrates a distribution of the BM super patterns that have been archetypal for the IoT use case cluster:

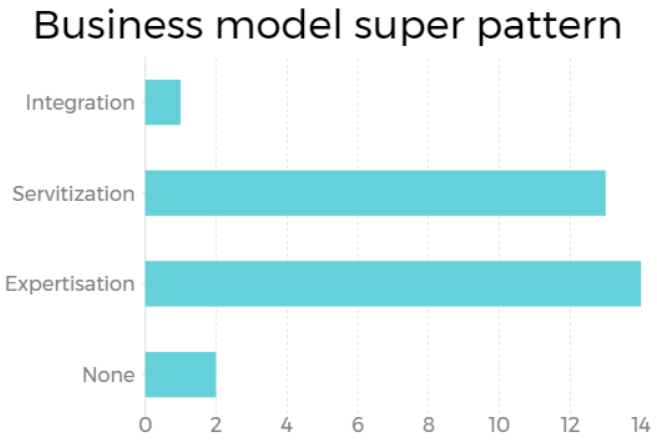


Figure 17: BM super patterns

Majority of the use cases are characterised by the BM super patterns Servitization and Expertization. Only one of the 30 cases is characterised by the super pattern Integration, and two cases cannot be characterized by any of the patterns suggested by the taxonomy

- Integration implies that innovation initiatives made by the case company typically devote to new processes. This company strives to cover more activities in the value chain rather than specialising on a single step and/or selling directly to customers via online channels
- Servitization implies that innovation initiatives made by the case company typically devote to new products or services. These companies strive to become a solution provider by offering new product support services instead of selling solely tangible products and/or integrating sensors into products.

- Expertization implies that innovation initiatives made by the case company typically devote to a combination of processes AND products or services. These companies strive to apply internally built expertise and knowhow in products, processes or as a service.

BUSINESS MODEL SUB-PATTERNS

The below Figure 18 illustrates a distribution of the BM sub-patterns (relative to the BM super pattern) that have been archetypal for the IoT use case cluster:

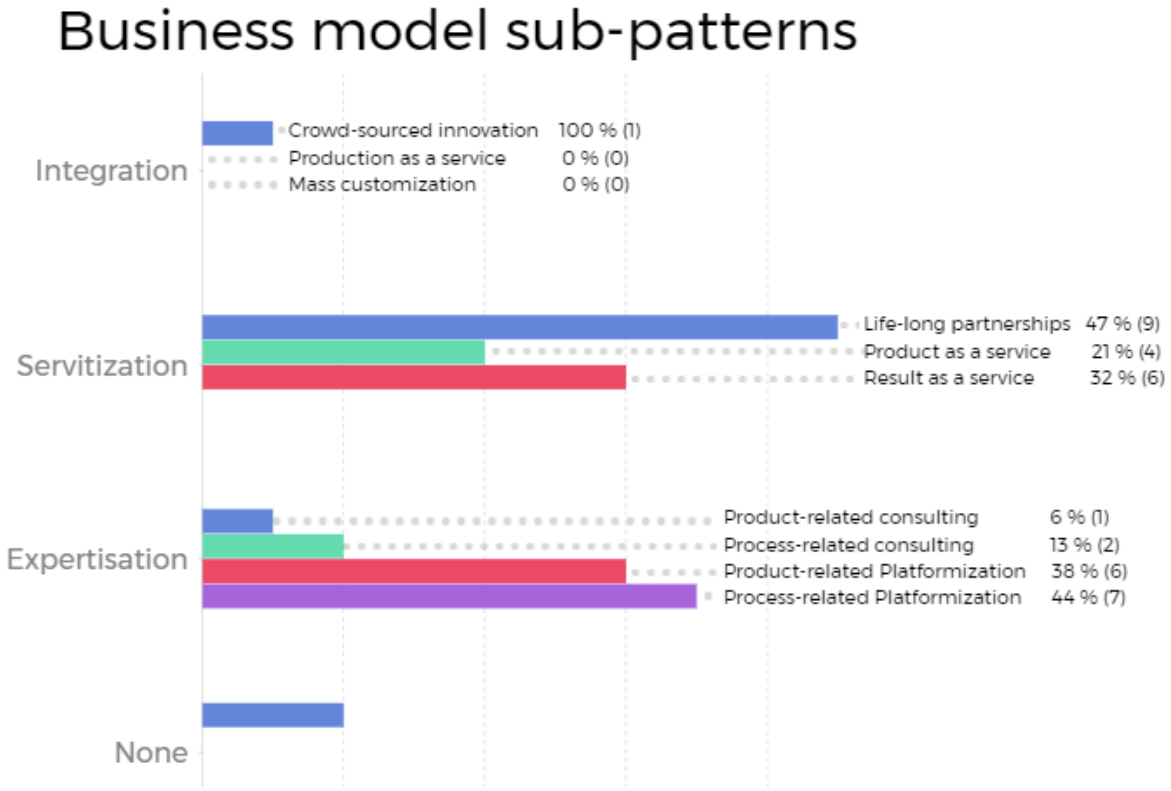


Figure 18: BM sub-patterns

**Notice that some use cases have more than one BM sub-pattern.*

TOTAL DISTRIBUTION OF BUSINESS MODEL PATTERNS

Table 2: BMP total distribution

SUPER-PATTERN	SUB-PATTERN			
Integration *3 % (1)*	Crowd-sourced innovation *4 % (1)*	Production as a service	Mass customization	
Servitization *43 % (13)*	Life-long partnerships *32 % (9)*	Product as a service *14 % (4)*	Result as a service *21 % (6)*	
Expertization *47 % (14)*	Product-related consulting *4 % (1)*	Process-related consulting *7 % (2)*	Product-related Platformization *21 % (6)*	Process-related Platformization *25 % (7)*

**Notice that two of the 30 use cases cannot be characterized by the patterns suggested by the taxonomy, and percentages are therefore calculated based on the remaining 28 cases.*

INSIGHTS

The data indicates that the BMPs that are most archetypal for the successful leverage of IoT technology are:

1. Servitization, with the sub-patterns Life-long partnerships and Result as a Service

BMs characterised by the *Life-long partnerships*-pattern typically initiate innovation initiatives with an aim to a) Provide value for customers by being a solution provider and partner throughout the entire product use phase, b) Offer preventive service throughout the product lifecycle, rather than scheduled service, and c) Add continuous revenue streams through subscription-based, life-long service contracts – however, still generate main turnover by selling tangible products.

BMs characterised by the *Result as a service*-pattern typically initiate innovation initiatives with an aim to a) Provide value for customers by offering the output or result of a product, rather than the actual product, b) Offer full-service packages and take responsibility for safe operations and compliance, and c) Generate continuous revenue streams by offering results for a use-based fee, rather than one-time product sales.

2. Expertization, with the sub-patterns Product-related and Process-related Platformization

BMs characterised by the *Platformization* pattern typically initiate innovation initiatives with an aim to a) Shift value chain focus from physical products toward digital products and related services, b) Generate continuous revenue streams through subscription fees, rather than from one-time sales, and c) Offer customers the availability, rather than for the ownership, of a product.

- *Product-related* Platformization implies that a key resource of the company is community members and a key activity is to act as an intermediary. These companies aim to turn firm experience into a digital product, and offer a cloud-based software solution that address unsolved customer problems.
- *Process-related* Platformization implies that a key resource of the company is customer data and a key activity is data analysis. These companies aim to turn firm experience into an integrated solution of a digital product and IT services, and offer a cloud-based platform with related support and facilitation.

5.3 Business model innovation and configuration

BMs have been evaluated to explore *how* successful development and deployment of IoT solutions correlate with the configuration of the four BM dimensions and BM innovation.

BUSINESS MODEL DIMENSION IMPACT

The below Figure 19 illustrates the total distribution of BM dimensions that have been subject of significant change, i.e., which specific dimension(s) in the case companies BMs that were impacted by the development and/or deployment of the IoT solution:

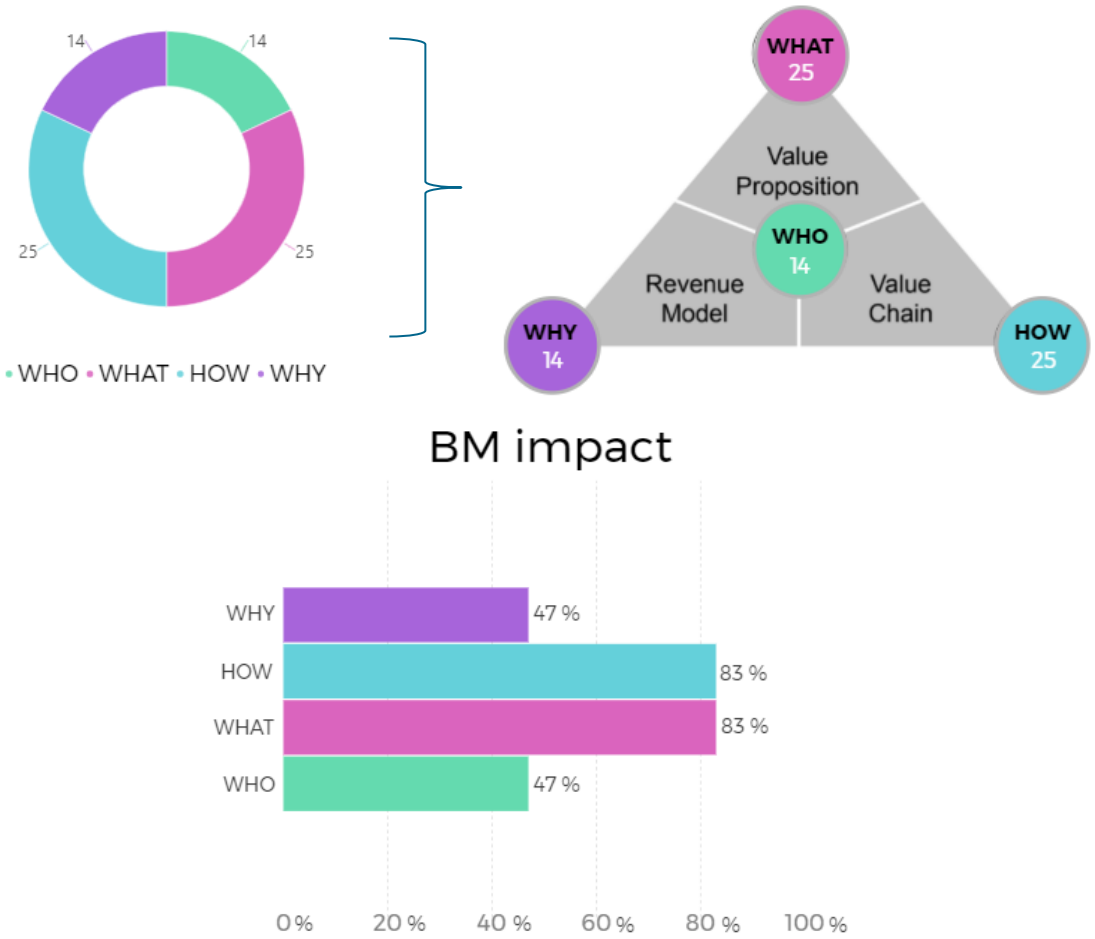


Figure 19: BM dimension impact

- The target customer was impacted in 47 % of the cases by the IoT development and/or deployment. Hence, the WHO of the BM has changed significantly for 14 of the 30 case companies.
- The value proposition was impacted in 83 % of the cases by the IoT development and/or deployment. Hence, the WHAT of the BM has changed significantly for 25 of the 30 case companies.
- The value chain was impacted in 83 % of the cases by the IoT development and/or deployment. Hence, the HOW of the BM has changed significantly for 25 of the 30 case companies.
- The revenue model was impacted in 47 % of the cases by the IoT development and/or deployment. Hence, the WHY of the BM has changed significantly for 14 of the 30 case

companies.

The below Figure 20 illustrates, per domain, the distribution of BM dimensions impacted by the development and/or deployment of the IoT solution:

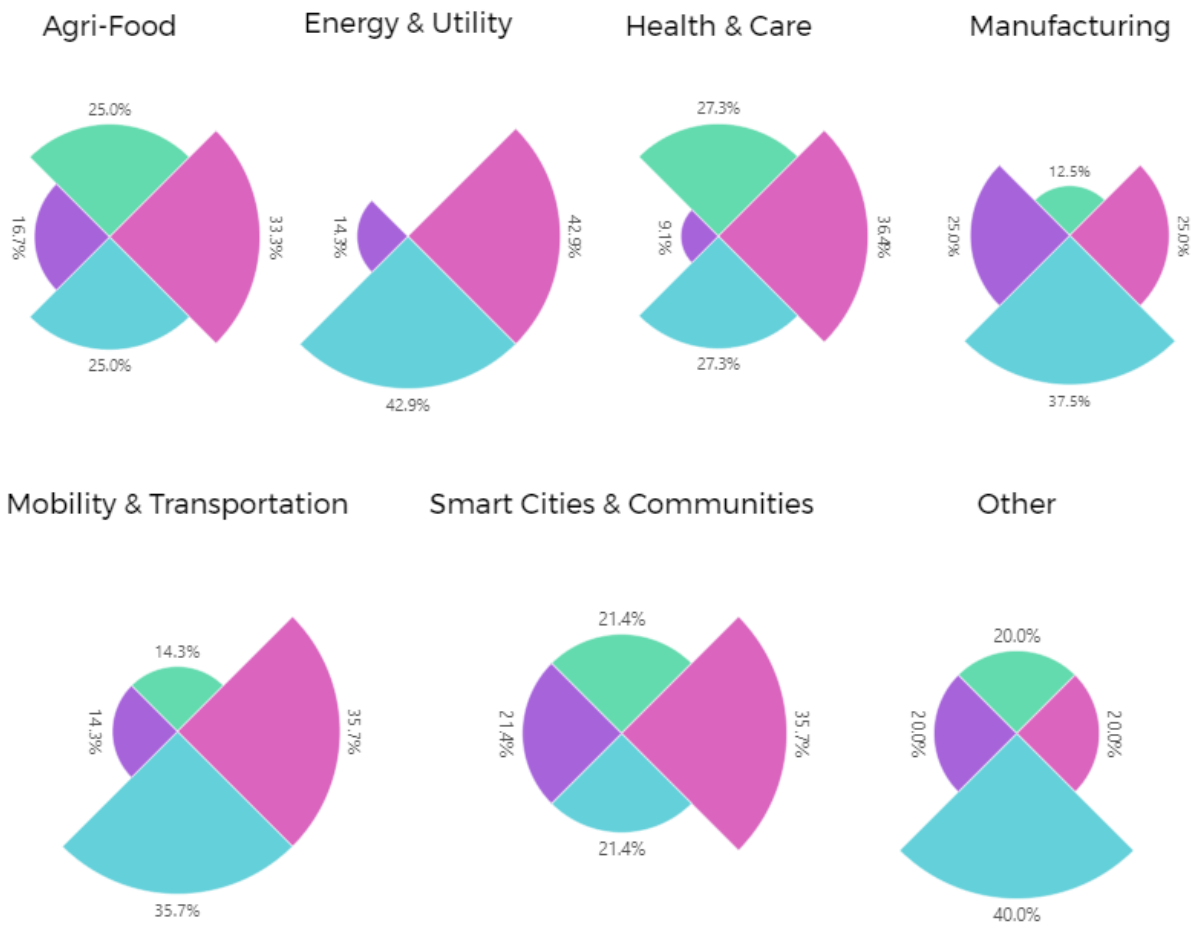


Figure 20: BM dimension impact across domains

- The value proposition is typically the dominating subject of significant change in the domains Agri-Food, Health & Care, and Smart Cities & Communities.
- The value chain is typically the dominating subject of significant change in the domains Manufacturing and Other.
- The four dimensions are never equally impacted by the development and/or deployment of the IoT empowered solution. Only one or two dimensions can be simultaneously dominating subjects of significant change.
- The WHO and WHY dimension are rarely dominating subjects of significant change. These are either equally or less impacted than the WHAT and WHY dimensions.

BUSINESS MODEL INNOVATION

To determine the correlation between BM innovation and the development and/or deployment of an IoT solution, we have explored the concept in alignment with the theory proposed by the University of St. Gallen [7], defining the occurrence of BM innovation with the occurrence of significant change in at least two of the four BM dimensions.

90 %

of the use case companies were subject to Business Model Innovation as an outcome of IoT development and/or deployment.

The below Figure 21 illustrates the number of dimensions in the BM of the case companies that are impacted by the development and/or deployment of the IoT solution:

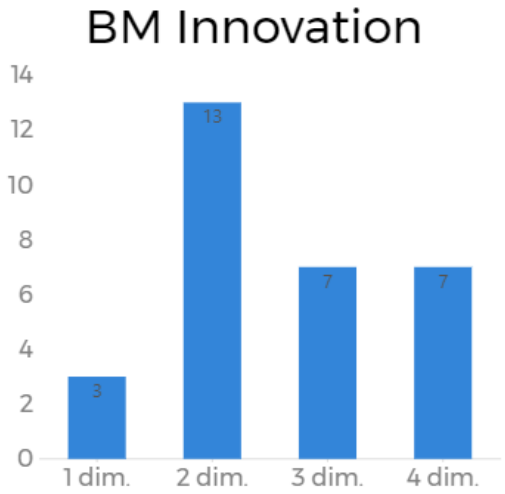


Figure 21: BM innovation – number of BM dimensions impacted per case

- Only three of the 30 case companies were impacted only on one BM dimension. Hence, the BM of these three case companies have NOT been subjects of BM Innovation.
- Almost half (43.4 %) of the case companies were impacted on two BM dimensions, and almost a fourth (23.4 %) were impacted on three BM dimensions and equivalent (23.4 %) on all four BM dimensions

The below Figure 22 illustrates the number of dimensions in the BM of the case companies that are impacted by the development and/or deployment of the IoT solution - both per case and in accumulated total of the cluster:

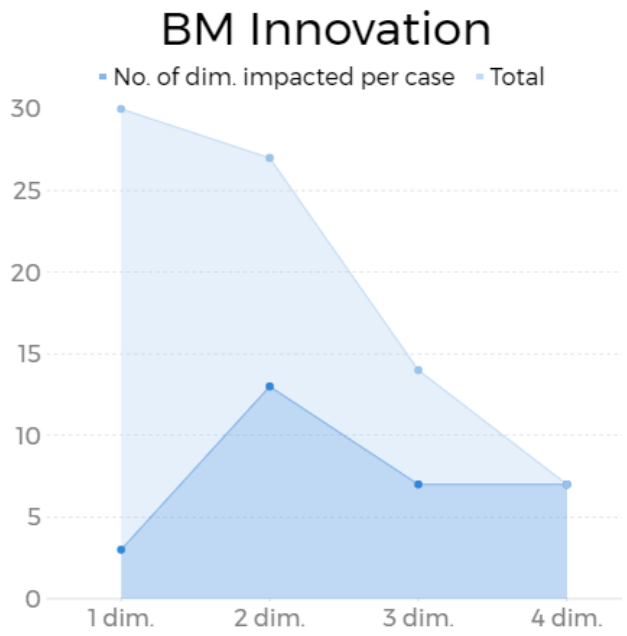


Figure 22: BM innovation – number of BM dimensions impacted accumulated

- All case companies were impacted on at least one BM dimension.
- The case companies were on average impacted on 2.65 dimensions. This indicates that best practice for IoT typically include significantly change on two or three BM dimensions.
- 90 % of the case companies were impacted on more than one BM dimension and are therefore cases of BM innovation.

The below Figure 23 illustrates the number of dimensions in the BM of the case companies that are impacted by the development and/or deployment of the IoT solution – distributed across domains:

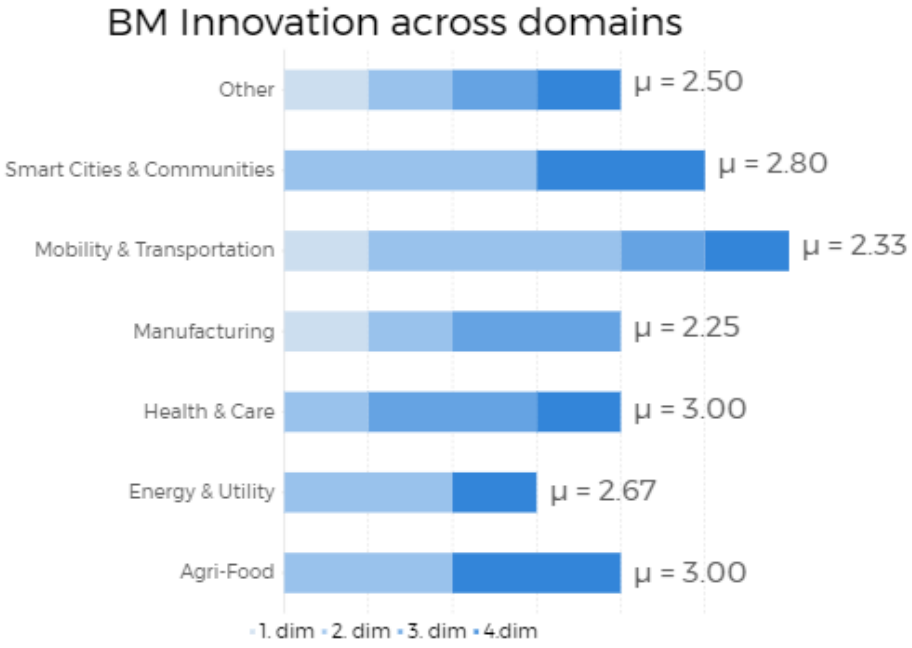


Figure 23: BM innovation – number of BM dimensions impacted across domains

- The case companies across all domains were on average impacted on 2.25-3.00 dimensions. This indicates that best practice for IoT - no matter what domain the company operates in - typically include significantly change on two or three BM dimensions.
- As outcome of development and/or deployment of the IoT empowered solution, companies in the domains Manufacturing and Mobility & Transportation are more likely to see impact on two BM dimensions, whereas companies in the domains Agri-Food and Health & Care are more likely to see impact on three BM dimensions.

BUSINESS MODEL CONFIGURATION

The below Figure 24 illustrates all the BM configurations of the case companies, i.e., the combination of BM dimensions that are impacted by the development and/or deployment of the IoT solution:

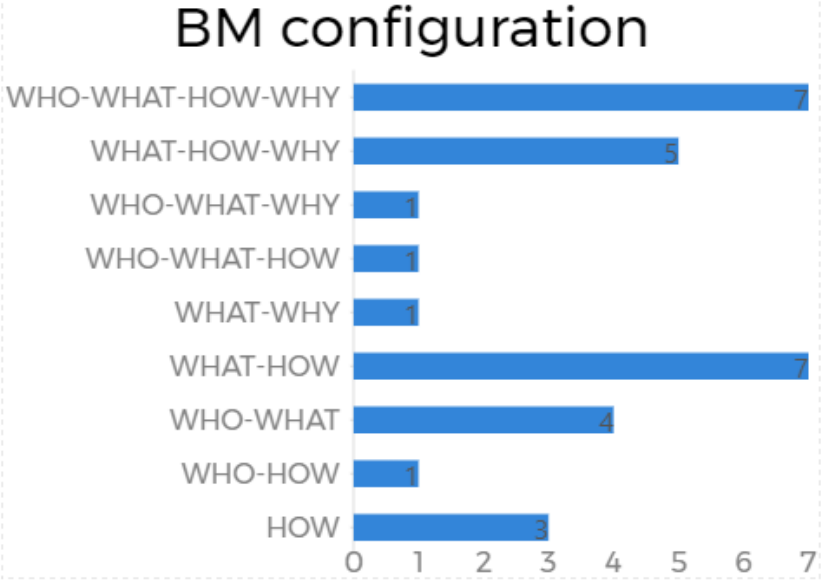


Figure 24: BM configuration – BM dimensions combination per case

The BM dimension combinations WHO-WHAT-HOW-WHY, WHAT-HOW-WHY, and WHAT-HOW are the most popular configurations that are subjected to significant change, as an outcome of the case companies' IoT development and deployment.

The below Figure 25 illustrates all the BM configurations of the case companies - both per case, the actual accumulated total of the cluster, and the potential accumulated total of the cluster:

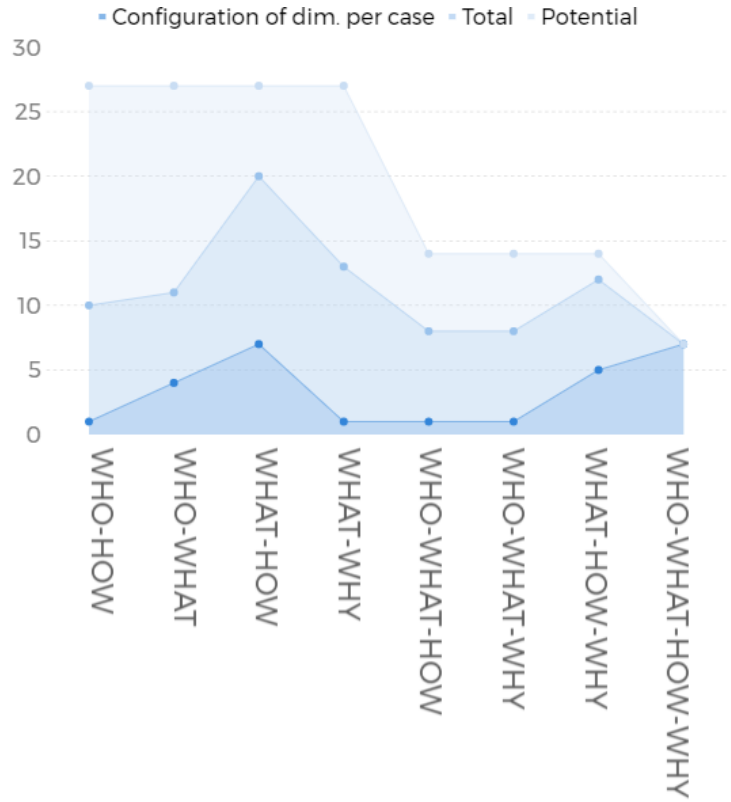


Figure 25: BM configuration – BM dimensions combination accumulated

- All illustrated 2-dimension BM configurations are applied in 37 % or more of all the potential BMI cases.
- All illustrated 3-dimension BM configurations are applied in 30 % or more of all the potential BMI cases.
- The 4-dimension BM configurations are applied in 26 % of all the potential BMI cases.

**Notice that three of the use case cluster's 30 BMs are not subjected to BMI. Potential calculations are therefore based on the remaining 27 BMI cases.*

- The BM dimension combination WHAT-HOW was among the most popular configurations for significant change (applied in 26 % of all the potential BMI cases). This specific combination was applied in 54 % of the potential 2-dimension BMI cases, and it is part of the BM configuration in 74 % of all the potential BMI cases.
- The BM dimension combination WHAT-WHY was not among the most popular configurations for significant change (applied in 4 % of all the potential BMI cases). This specific combination was applied only in 8 % of the potential 2-dimension BMI cases, but it is however part of the BM configuration in 48 % of all the potential BMI cases.
- The BM dimension combination WHAT-HOW-WHY was among the most popular configurations for significant change (applied in 19 % of all the potential BMI cases). This specific combination was applied in 36 % of the potential 3-dimension BMI cases, and it is part of the BM configuration in 44 % of all the potential BMI cases.

**Notice that configurations not mentioned constitute less than 40 % of the total accumulated BMI cases.*

INSIGHTS

- The data indicates that successful BMs in the IoT area are **impacted on their value proposition and/or value chain** by the development and deployment of IoT solutions. Hence, the single BM dimensions that are most often subject to significant change are WHAT and WHO.
- The data indicates that the combination of BM dimensions that are most often subjected to significant change include: **WHAT-HOW**, **WHAT-HOW-WHY**, and **WHAT-HOW-WHY-WHO**. These configurations seems archetypical for achieving success in the IoT area.
- The data indicates that **BM innovation** - with 90 % probability - is an **outcome of best practice IoT** development and/or deployment.

5.4 Technology trends

Technology trends that characterise IoT use cases have been explored to conclude whether the application of specific technologies is repetitive for achieving success in the IoT area.

In the setting of digital business, IT and IoT can either play a role that is constitutive, value increasing or irrelevant for the general BM of the organisation. Figure 26 illustrates the role of IT as a general phenomenon, and the role of the specific IoT solution developed and/or deployed by the case companies, across the use case cluster:

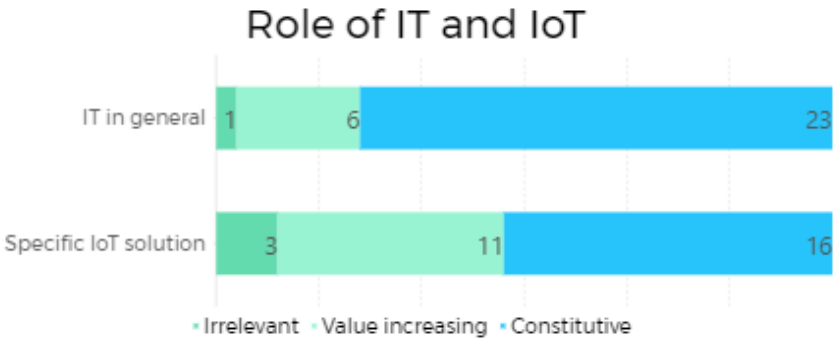


Figure 26: Role of IT and IoT

- IT as a general phenomenon is value increasing for the business of almost all the case companies explores, and constitutive to 76.7 % of them. This indicates that the value potential of business directly relies on the integration of IT driven BM patterns for three fourths of the companies.
- To 90 % of the case companies, the specific IoT solution developed and/or deployed adds value to the overall BM of the company. To more than half (53.3 %), the IoT solution even matures into having a constitutive role, causing IoT to drive the selection of patterns that depict the overall BM of the company.

The below Figure 27 illustrates the specific digital technologies that are currently applied by the case companies:

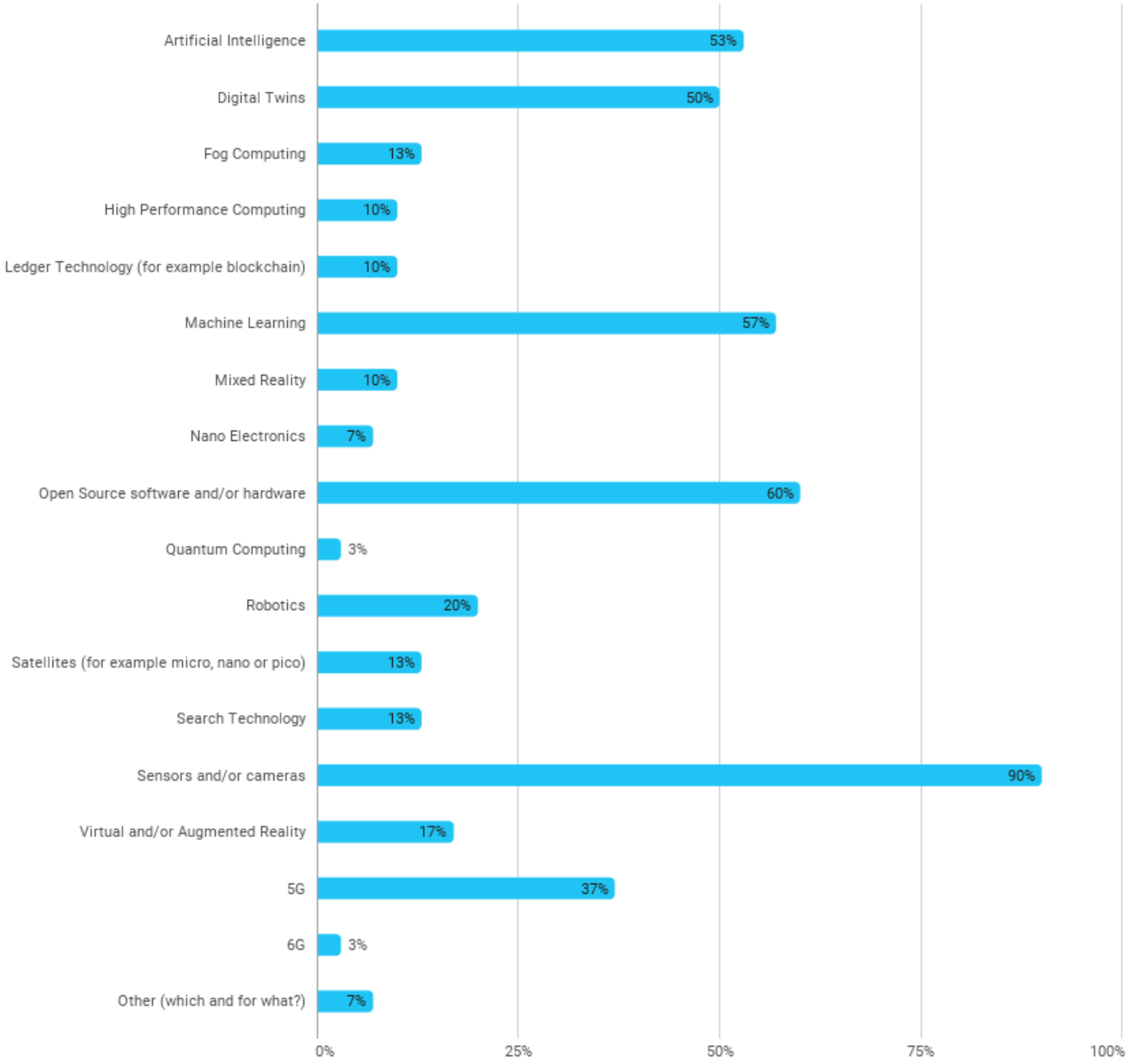


Figure 27: Technologies applied by case companies

Other technologies applied include Addictive Manufacturing, LoRa and Software-defined networking (SDN) technology.

- Sensors and/or cameras is the utmost adopted and widespread technology, with 90 % of the IoT use case cluster applying it in their case companies.
- Artificial Intelligence, Digital Twins, Machine Learning and Open Software and/or Hardware are also common technologies that are applied in half or more of the case companies.
- 6G, Quantum Computing and Nano Electronics are the technologies that are least applied in the case companies.

INSIGHTS

- The data indicates that **IT as a general phenomenon often plays a constitutive role** in the BM of companies that successfully develop and/or deploy IoT solutions. Hence, best practice seems to rest upon some digital underpinning
- The data further indicates that the **specific IoT solution** being developed and/or deployed should at least assume a **value-increasing role for the overall BM** of the company to foster future success.
- The data indicates that **key technological trends** include Sensors and/or cameras, Artificial Intelligence, Digital Twins, Machine Learning and Open Software and/or Hardware. These constitute the archetypical technologies that presently seems **repetitive for achieving success in the IoT area**

6. CONCLUSIONS AND IMPACT ASSESSMENT

This section will conclude upon the results presented throughout the report and thereby the outcome of the activities carried out by the EU-IoT COACH in the scope of T4.1 under WP4. The impact of the results will be assessed, and the potential added value it may bring to stakeholders of the European IoT ecosystem will be evaluated. Finally, some recommendations are provided as general guidelines for how industry, innovators, IoT learners and policy makers can leverage the new knowledge presented in this report.

6.1 Use case catalogue

The quantitative results presented in terms of the use case catalogue, exemplify best practices for IoT, by demonstrating how IoT frontrunners have successfully developed and/or deployed IoT solutions. The use case catalogue effectively covers a wide variety of 1) industry sectors, by means of the grouping them into time and context relevant domains, 2) geographical origins that well represents the European landscape, 3) company sizes that give a significant impetus to SMEs, and 4) timing differentiation that reflects ranges for when companies are founded, and when IoT use case are initiated. The use case catalogue furthermore covers best practice both in terms of business success and technological success, and the use cases cover IoT solutions that differ on the financial impact they have on the business, and the readiness and novelty of the technology. Hence, for industry, innovators, IoT learners and policy makers, the use case catalogue provides a collection of inspirational stories that are relevant and relatable - regardless of domain, geographical origin, company size, use case timing, IoT solutions and available technologies. For any stakeholder in the IoT ecosystem, the use case catalogue provides an exemplification of best practices for achieving success in the IoT area.

Recommendation: *the use case catalogue shall be leveraged by industry, innovators, IoT learners and policy makers to seek inspiration for how to successfully undertake their own IoT endeavours. The practitioner is able to filter the 30 success stories to identify specific use cases of relevance and relatability to their own context.*

We propose the practitioner to read through the identified use cases to gain knowledge on enabling technologies of the exemplified IoT solution and to gain insight on the partners, resources and activities needed for the exemplified IoT BMs to succeed. These dynamics are likely to apply in some form to their own context. The practitioner is also able to compare the efforts to the outcomes of the use case and use it as a foundation for developing cost-benefit analyses for own IoT endeavours. A range of best practice learnings made by the use case companies may help the practitioner to avoid facing the same challenges and making the same mistakes, and instead replicate best practices from the start. Finally, if the practitioner finds specific use cases to offer added value beyond inspiration, we recommend practitioners to reach out to the case company of interest for potential synergies.

6.2 Use case study

The qualitative results presented in terms of the use case study, reveal best practices for IoT, by providing insight on the collective factors that are archetypical in characterising successful development and/or deployment of IoT solutions. The results generated are contingent on the methodology deployed by the study, and the effectuated insights are therefore conveyed by factors in terms of Digital Maturity, BMPs, BM Innovation, Technology trends. Conclusions and impact assessment upon the qualitative results will likewise be presented one by one through these factors.

Because the results of the study are *indicative*, recommendations will address the practitioners' self-conciseness in relation to understanding own basis for achieving success in the IoT area, rather than announcing definitive objectives and conditions to fulfil. Hence, for industry, innovators, and IoT learners, the below recommendations shall serve as guidelines for practitioners to accomplish increased awareness on current basis, and the insights derived throughout the study shall serve as a guiding direction for practitioners to strive for – however, in a format that is modified to take reservations for individual context – in their IoT endeavours.

DIGITAL MATURITY

Our assessment of digital maturity has been essential to create an understanding of *how* successful IoT development and deployment interlinks with the digital maturity of a company. By exploring the level of digital maturity archetypical for successful IoT frontrunners, we have made best practices for digitalisation more transparent, and provided stakeholders in the IoT ecosystem abilities to assess and increase their own digital maturity one organisational dimension at a time.

Literature shows that businesses with high levels of digital maturity are likely to have competitive advantages along multiple performance indicators (including revenue growth, time to market, cost efficiency, product quality, and customer satisfaction), whereas businesses with low levels of digital maturity struggle to achieve these benefits [8]. Hence, being able to assess and evaluate digital maturity is a key factor for practitioners to achieve success in the IoT area. Fortunately, the application of digital maturity models is not limited to any particular domain [9] and they can be used both as an assessment, evaluation, and improvement tool [10].

Recommendation: *digital maturity assessment shall be leveraged by industry, innovators, IoT learners and policy makers as a framework to support the practitioner's adoption of technologies during IoT development and/or deployment and serve as a practice tool for the company to identify digital development focus areas before and after interventions.*

We propose practitioners to use the DMAT to evaluate the ability of the company to digitally transform and adopt new technology. The assessment enables the practitioner to measure digital maturity on six organisational dimensions and thereby provides a foundation for prioritisation, and a notice on potential dimensions in need of digital improvement. Results of the DMAT further support practitioners to become educated about the state of digital competition in their domain and enabled them to benchmark and determine the durability of their own digital capabilities. The result will point out digital development areas and digital competitive advantages at individual company level as well as at sectoral level

The DMAT provides the practitioner a score that indicates the overall level of digital maturity (cased on self-assessment on a scale from 1 to 10) – and with the insight provided by our study, revealing an average digital maturity of 7.82 as best practice, practitioners are offered a point of reference for achieving success in their own IoT endeavours. It is further found that the case companies across all domains are *least* digitally mature on the Processes dimension, and *most* digitally mature on the Strategy, Technology and Customers & Partners dimensions. Finally, practitioners cannot only benefit from assessing their digital maturity to evaluate the readiness of their existing BMs to initiate IoT development and/or deployment, but also to evaluate the effects - or success – after the IoT intervention.

BUSINESS MODEL PATTERNS

Our survey on BMPs has been essential to create an understanding of how BMs are shaped to successfully leverage IoT technology. By exploring BM patterns that are archetypical for successful IoT use cases, we have made best practices for shaping BMs more transparent and provided stakeholders in the IoT ecosystem a tool to identify and replicate the patterns, including their underlying practical factors, that characterise successful development and deployment in the IoT area, and with that, the ability to build a successful BM that empowers the use case.

BM patterns provides a structured overview of how BMs are shaped, and according to the University of St. Gallen [11], a BM pattern provides a practical template to help build new BMs from scratch and supercharge existing BMs. Hence, our exploration of the patterns applied by successful IoT use cases has derived derive well-grounded guidance, both theoretical and practical, for practitioners to build and enhance BMs for their IoT endeavours. Results of the survey have further enabled us to identify the patterns that are archetypal for successfully leveraging IoT technologies, and successfully developing and deploying IoT solutions. These patterns are available to practitioners on a level of abstraction that will facilitate their application across different industry sectors, while remaining concrete enough to be actionable for industry, innovators and IoT learners.

Recommendation: *BMPs shall be leveraged by industry, innovators, IoT learners and policy makers as a taxonomy to shape a suitable BM for their use case to successfully leverage IoT technology. The taxonomy of patterns shapes an easily replicative basis for practitioners to access best practice BMs in the IoT area.*

We propose practitioners to use the theoretical taxonomy of Weking et al. [12], to classify, describe and analyse patterns of potential in building or enhancing the BM of their own IoT use case. When a basic understanding of all potential patterns is established, the practitioner must identify the pattern(s) most suitable to characterise the BM of their IoT use case, in order to understand how specific underlying factors are influential for the successful unfolding of that pattern, and thereby the successful shaping of the BM, which is the prerequisite for successful development and deployment of IoT solutions.

The taxonomy provides the practitioner a range of BM patterns that suggests various alternatives to shape a BM for an IoT use cases – and with the insight provided by our study, revealing the patterns Servitization (with the sub-patterns Life-long partnerships and Result as a Service) and Expertization (with the sub-patterns Product-related and Process-related Platformization) as best practice, practitioners are offered a point of reference to transmit onto their own IoT endeavours.

BUSINESS MODEL INNOVATION AND CONFIGURATION

Our evaluation of BMs has been essential to creating an understanding of how successful development and deployment of IoT solutions correlate with the configuration of the four BM dimensions and BM innovation. By exploring the impact that IoT use cases have on the overall BM of a company, we have been able to detect repeatable combinations of change in the four core BM dimensions, and thereby reveal the BM innovation configurations that are archetypical for achieving success in the area.

In order to be able to determine the correlation between a company's development and/or deployment of an IoT solution, the four BM dimensions must be evaluated by considering the impact of the IoT use case in relation to each of the dimensions. BM innovation occurs if the IoT solution has significantly changed more than one dimension. The evaluation will make it visible to practitioners which dimension(s) of the BM dominates the IoT development and/or deployment, and thereby provides a foundation for prioritisation.

Recommendation: *BM evaluation shall be leveraged by industry, innovators, IoT learners and policy makers as a method for evaluating the four BM dimensions and their configuration, to innovate a BM that enables the successful development and/or deployment of their IoT solution.*

We propose practitioners to use the theoretical framework of St. Gallen University [13], by asking the following four questions while considering the potential impact of the IoT use case:

- Customer: WHO are the target customers of the IoT solution?
- Value proposition: WHAT does the company offer the customers?

- Value chain: HOW does the company, together with other partners, create this solution?
- Revenue model: WHY is this of value to the company in the form of revenue?

If the IoT solution has caused a significant change in the way the practitioner answers at least two of the four questions, the IoT solution has effectuated BM innovation.

The evaluation framework provides the practitioner a deep insight into the dimensions that configure the BM of the IoT use cases - and with the insights on best practice provided by our study, revealing that traditional BM are often impacted on their value proposition and/or value chain, that combination of BM dimensions that are most often subjected to significant change include: WHAT-HOW, WHAT-HOW-WHY, and WHAT-HOW-WHY-WHO, and that BM innovation is an outcome of successful IoT development and/or deployment with a 90 % probability - practitioners are offered a point of reference to transmit onto their own IoT endeavours. It is further found that the four dimensions never are equally impacted by the development and/or deployment of the IoT empowered solution, and that only one or two dimensions can be simultaneously dominating subjects of significant change – whereto the WHAT and WHY dimension are most often dominating subjects of significant change, as these are either more or equally impacted than the WHO and WHY dimensions.

TECHNOLOGY TRENDS

Our evaluation of technology trends has been essential to create insight on the archetypes of novel technology that defines the next generation of IoT in the European landscape. Our exploration of these trends that characterise the IoT use cases has enabled us to conclude upon the application of specific technologies, and whether these prove to be repetitive for achieving success in the IoT area.

The role of IoT has become significant as an enabler of digital transformation across many sectors and IoT seems to have a far-reaching impact on the current and forthcoming European technological dominance. Our evaluation of technology trends demonstrates that IoT reaches across the traditional sensor-network-server coupling and relies on more advanced technologies for connecting and exchanging data with devices and systems over the internet. IoT has come to be understood as a paradigm that integrates a broad set of technologies, each of which are in themselves advancing at a rapid pace. While the idea of IoT has existed for a long time, it is the combination of matured and deployable technologies that makes it practical.

Recommendation: *technology trends shall be leveraged by industry, innovators, IoT learners and policy makers, as a compass on best practice to educate themselves and potentially harness the technologies used by successful IoT frontrunners.*

We propose practitioners to proactively explore new technological trends and reflect on how specific technologies could add value to a specific IoT use case as well as to different dimensions of their company and overall BM. With the insights on technology trends provided by our study, revealing that Sensors and/or cameras, Artificial Intelligence, Digital Twins, Machine Learning and Open Software and/or Hardware seems to be repetitive technologies for achieving success in the IoT area, practitioners are offered a point of reference to transmit onto their own IoT endeavours.

However, it is important to note that the technologies proposed by this report (cf. Sec. 5.3) provide a non-exhaustive overview as the sphere of IoT expands and technology constantly evolves. Knowing from our study that IoT solutions should at least assume a value-increasing role for the overall BM of a company to foster future success, we finally want to advise practitioners to be curious, not only on IoT as phenomenon, but on the underlying technologies needed to enable physical things to share and collect data, and to facilitate the interaction between connected things.

6.3 Impact assessment

The work carried out by the EU-IoT COACH in the scope of T4.1 under WP4 has generated results that hold great potential to impact stakeholders throughout the European IoT ecosystem by providing best practices for IoT use cases.

The use case catalogue provides practical examples on successful development and/or deployment of IoT solutions – serving as inspiration towards lowering the barriers for adoption. The use case study provides insight on archetypical factors for achieving IoT success – serving as a set of recommendations that are applicable guidelines for industry, innovators, IoT learner and policy makers. In combination, the catalogue and the study insights constitute an impactful handbook for the European IoT ecosystem to leverage the success stories and harness the potential of IoT-empowered technologies and BMs.

Hence, when considering the results of T4.1 isolated, it holds great impact potential, however, when considering it in joint continuity of the remaining tasks of the EU-IoT COACH, the impact potential increases significantly. For that reason, the findings presented in this deliverable will serve as foundation for:

- **Training catalogue** (T4.2), to provide training materials and course catalogues for boosting the wider use of IoT technologies and enhancing the skills of actors inside and outside European IoT communities
- **Toolbox of methods and models for IoT BM development** (T4.3), to transfer new knowledge that support industry, innovators, IoT learners and policy makers to develop and/or enhance IoT BMs.

For the consortium to ensure the actual applicability and utilisation of best practices for IoT use cases, impact in terms of user engagement are tracked. Results will be reported on the final deliverable D4.7 by the EU-IoT COACH, along with the impact of the toolbox. All website content can be analysed based on data from activity tracking*[1] and, based on the capabilities and potential of the applied web analytics solution, the consortium focuses on the following impact indicators:

- Page views and unique page views are set up to monitor the traffic to the websites and thus interest in the individual success stories in the use case catalogue. The number of unique users is also included as a tracking parameter, serving as an indicator for the reach of the catalogue.
- Time spent on a page, in terms of event tracking, is in the process of being set up to investigate how many of the users that invest time in reading and engaging with the content. Statistically, an average user will be able to read one page (300 words) in one minute. The tracking parameter ‘60 seconds spent on a page’ will therefore be chosen to account for a positive result in assessing the number of users that engage with the cases.
- Website funnels (behaviour flows) will also be evaluated as part of obtaining insight into the preferences and interests of the readers. By monitoring the website funnels, the consortium can harvest information regarding inclination to single cases, domains, technologies etc. based on the readers’ entry point and journey through the cases.
- Pop-up question is implemented to assess the usability intention of the reader (cf. Figure 28). The pop-up is designed to capture attention quickly and call to action in an attempt to engage the reader and collect feedback upon the impact of the content. This provides

*[1] *Across the consortium websites the universal Google Analytics are currently applied. This ensures a coherent capture of data for analytics across domains, however, the project partners are planning to implement an alternative analytics solution that is better in alignment with European values - the Matomo open source web analytics have been chosen [https://matomo.org/].*

knowledge on the actual utilisation of the success story, the application intention, the application context (industry vs. academia) and insight into the groups of users.

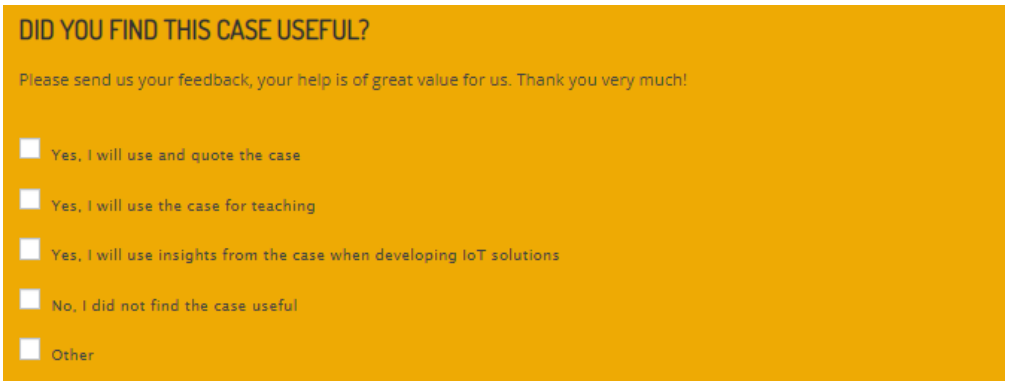


Figure 28: Case catalogue pop-up question

7. STATUS AND PLAN FOR CONTINUITY

This section will provide a status of the activities carried out by the EU-IoT COACH in the scope of T4.1 under WP4, to assess the past, current and future performance of the work effort. Also, a plan for continuity of the results presented throughout the report will be outlined to ensure its sustainability and further impact on the European IoT ecosystem.

STATUS

Impact measures have been provided by the EC to be achieved by the EU-IoT COACH in the period towards month 24 of the project and delivered by means of this deliverable. Find in Table 3 a status on the impact measures for the now finalised activities of T4.1 “Collection and Documentation of Success Stories and Best Practice Use Cases”:

Table 3: KPI measures for T4.1

	KPI measures	Target (M24)	Status (M24)	Comments
Impact 02 Impact 10	Number of success stories to be collected, consolidated and published.	>=30	30	30 success stories will be documented (based on interviews and surveys). These are selected from a backlog of identified best practice IoT use cases.
Impact 11	Number of online showcases and case studies to be documented in multimedia format	>=12	25	Minimum 12 of the 30 documented success stories shall include multimedia format.
Impact 16	Number use cases and success stories to be documented where novel and disruptive business models can be applied	>=20	24	Of the 30 documented success stories, minimum 20 shall exemplify use cases where novel and disruptive business models are applied.

30 success stories that exemplify best practices for IoT use cases have been collected and consolidated. 25 of these are currently published online, and we expect all the 30 success stories to be online prior to the finalisation of the EU-IoT project by March 2023. The intention is to make the success stories available open-source via the EU-IoT use case catalogue – and for all use cases to be showcased in a uniform format in the catalogue – we aim for all 30 to be documented in multimedia format as well.

Of the 30 documented success stories, 24 exemplify use cases where novel and disruptive BMs are applied. These are the use cases that have 1) demonstrated high digital maturity, 2) employed an IoT BMP, 3) qualified as BM innovation, and where 4) IoT has played a constitutive or value increasing role. Hence, 24 of the 30 use cases were able to meet these requirements synchronously.

As illustrated in Figure 28, all activities have been carried out in alignment with the process planned for T4.1 (cf. Sec. 1.3):

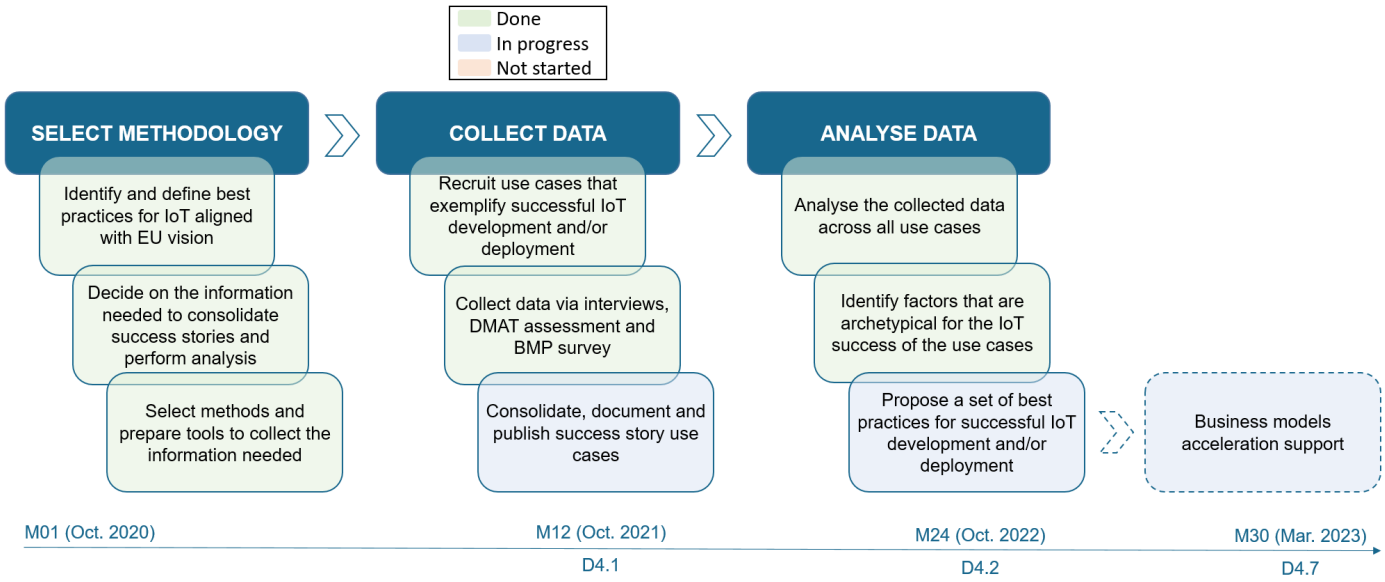


Figure 29: Status for reporting on best practices for IoT use cases

In brief, the key activities of the task have included the selection of methodology (presented in D4.1), collection of data and analysis of data, leading to the results presented in this deliverable. As indicated, the publishing of success stories for the IoT use case catalogue is still in progress, and this work will continue until meeting the KPI target measure. Also, the dissemination of analysis data, i.e., the findings of the multiple use case study, remains in progress and will be made available as a guideline on best practices for successful IoT development and deployment to help industry and innovators become IoT success stories themselves. Tools, templates and methods to support practitioners through this innovation will be developed and presented in an upcoming deliverable (D4.7). Hence, with the results presented in this report, the consortium has the foundation to provide IoT BM acceleration support.

PLAN FOR CONTINUITY

The EU-IoT COACH acknowledges the importance of ensuring the sustainability of the results presented on best practices for IoT use cases. To this end, we envision the applicability of the best practices as a handbook to manifest success throughout the European IoT ecosystem, and with that cause a self-reinforcing continuation of the results.

The key results of the work carried out under the now finalised T4.1 are the online use case catalogue and the use case study. These results represent the findings we have made from our collection and analysis of data that were presented in this report.
Although concluding T4.1 with the submission of this deliverable, the next step of the EU-IoT COACH will be to leverage the findings from our exploration in order to educate and guide stakeholders in the IoT ecosystem toward adopting the best practices for achieving IoT success and to establish tools, templates and methodologies that support and accelerate the IoT BM innovation. Hence, the work presented in this deliverable provides fundamental insight for upcoming deliverables of the EU-IoT COACH, and our reporting on training activities and programmes (D4.4 and D 4.5) and our reporting on IoT BM innovation and acceleration support activities (D4.6 and D4.7) will therefore be building on top of our findings on best practices for use cases.

The relevance of best practices for IoT use cases goes far beyond the EU-IoT project, and therefore also the sustainability of the use case catalogue and study insights. To ensure maximum continuity of the results beyond project finalisation, the following initiatives were made:

- All resources are made available to the public with open access
- All resources have double domains, which ensures an online location and point of access additional to the EU-IoT / NGIoT website
- Resources are developed under engagement and cooperation with the complementary CSAs, the ICT-56 RIA projects and IoT networks when synergies are relevant. These relations are maintained active and alive for the duration of the project to ensure wider dissemination of the results.

The activities beyond project month 24 shall focus on centralising the tasks of the EU-IoT COACH across the entire WP 4, in order to ensure that the Success stories and best practice use cases (T4.1) eventually feed into the planned Training and mentoring IoT skills development (T4.2) and Business models acceleration support (T4.3). Sustainability of the results beyond the project is the promise of the EU-IoT project for COACHing the IoT ecosystem towards success.

Finally, the EU-IoT COACH will remain committed to the ambition of the project to effectively amplify the results presented in this deliverable, and the impact of various IoT initiatives that define the Next Generation Internet. Fostering synergies in the ecosystem and supporting efforts within H2020 and beyond, these efforts will help to shape the digital future of Europe in the ongoing transition towards Horizon Europe.

APPENDIX – USE CASE INFORMATION

USE CASE RECRUITMENT SOURCE

Table 4: Use case recruitment source

Case company	Source	Source affiliation
Aguardio	Nordic IoT Center	Network
AllThingsTalk	The Things Network	Network
Aloxy	Eclipse Foundation and LoRa Alliance	Networks
Aqua Robur	IoT Next Club	Network
ASM Terni	IoT NGIN	Project: H2020, ICT-56-2020
ASTI Mobile Robotics	INGENIOUS	Project: H2020, ICT-56-2020
Awake.AI	INGENIOUS	Project: H2020, ICT-56-2020
Bielefeld University, CITEC	VEDLIoT	Project: H2020, ICT-56-2020
CERTH	IoTAC	Project: H2020, SU-ICT-02-2020
Cumucore	INGENIOUS	Project: H2020, ICT-56-2020
DunavNet - agroNET	Open DEI	Project: H2020, DT-ICT-13-2019
DunavNet - poultryNET	Open DEI	Project: H2020, DT-ICT-13-2019
Emotion	IoT NGIN	Project: H2020, ICT-56-2020
Fauna Smart Technologies	Startup3	Project: H2020, ICT-33-2019
Fivecomm	INGENIOUS	Project: H2020, ICT-56-2020
FoldAI	IoT Next Club	Network
GoodLife Technology	ACTIVAGE	Project: H2020, IoT-01-2016
Herning Vand	MEREFF and MERMISS	Project: Ministry of Environment of Denmark
HOPU	IoT Next Club	Network
MySphera	ACTIVAGE	Project: H2020, IoT-01-2016
NTT Data	IoT Next Club	Network
QiO Technologies	Alliance for Internet of Things Innovation	Network
Quadible	IoT Next Club	Network
See.Sense	IoT Next Club	Network
Synelixis	IoT NGIN	Project: H2020, ICT-56-2020

Technosens	ACTIVAGE	Project: H2020, IoT-01-2016
Tecnalia	IoTAC	Project: H2020, SU-ICT-02-2020
Terminal Link	ASSIST-IoT	Project, H2020, ICT-56-2020
Troldtekt	DIATOMIC	Project: H2020, ICT-04-2017
Veoneer	VEDLIoT	Project, H2020, ICT-56-2020

USE CASE TYPE AND LEVEL

Table 5: Case type and level

Case company	Case type	Case level
Aguardio	Business	2. Industrial
AllThingsTalk	Business	3. Industrial
Aloxy	Business	2. Industrial
Aqua Robur	Business	2. Industrial
ASM Terni	Technology	3. Pilot
ASTI Mobile Robotics	Business	3. Pilot
Awake.AI	Technology	1. Edge
Bielefeld University, CITEC	Technology	3. Pilot
CERTH	Technology	1. Edge
Cumucore	Technology	2. Industrial
DunavNet - agroNET	Business	3. Pilot
DunavNet - poultryNET	Business	3. Pilot
Emotion	Business	2. Industrial
Fauna Smart Technologies	Business	2. Industrial
Fivecomm	Technology	2. Industrial
FoldAI	Technology	1. Edge
GoodLife Technology	Business	2. Industrial
Herning Vand	Business	2. Industrial
HOPU	Business	1. Edge
MySphera	Business	2. Industrial
NTT Data	Business	3. Pilot
QiO Technologies	Business	1. Edge
Quadible	Business	2. Industrial
See.Sense	Business	2. Industrial

Synelixis	Business	2. Industrial
Technosens	Business	2. Industrial
Tecnalia	Technology	3. Pilot
Terminal Link	Technology	3. Pilot
Troldtekt	Business	2. Industrial
Veoneer	Technology	3. Pilot

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