Bosch Internet of Things & Services Lab

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The IoT Business Model Builder

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1 Introduction

The Internet of Things is becoming more and more important in many domains. Because in many cases it has the power to create completely new value propositions, new *business models*[1] have to be designed for new IoT solutions. In this paper we define business models according to Osterwalder and Pigneur (2010) as "the rationale of how an organization creates, delivers and captures value." While there is extensive literature available related to business model innovation (e.g., Gassmann et al., 2014) and IoT-induced business opportunities (e.g., Fleisch et al., 2014), the *IoT business model builder* outlined in this whitepaper provides a hands-on, easy-to-use procedure model for developing *business models* for IoT offerings. It is based on our experience in designing business models for IoT applications in various domains.

The paper is organized as follows: Chapter 2 explains what makes a specific approach for designing business models in the IoT context necessary and elaborates on further advantages of the approach outlined. Chapter 3 provides a short overview of the overall process, whereas Chapter 4 lists the ten process steps of the IoT business model builder that should be taken from generating *opportunity ideas* to evaluated business model scenarios. Depending on the current state of a project, one can "enter" the IoT business model builder at different stages; hence, it is possible to start with step 1 and the ideation of promising IoT *opportunity ideas* or, in case a specific *opportunity* were to be selected and elaborated already, to start with step 6 and the identification of a *stakeholder network*, etc. Chapter 5 focuses on the important aspects of following and validating the assumptions that were made throughout the process. Best practices, tools, and methods that are recommended for application within the process are explained in Chapter 6. It is up to the moderator to choose from the provided alternatives depending on the specific case. A glossary of important terms can be found in Chapter 7.

2 Why a specific business model development approach?

2.1 IoT specifics

IoT offers unique opportunities in many fields. At the same time, a complex value stack needs to be addressed in order to realize those possibilities. This induces specific requirements when it comes to designing IoT business models. As a benefit of our approach, the following IoT-specific requirements are being addressed:

1. Extend scope beyond the company level to ecosystem level	In most IoT scenarios, value creation happens within an ecosystem with multidirectional value and service streams across the various stakeholders involved (e.g., partners, customers, users). It is necessary to obtain a holistic view on all relevant stakeholders and their contributions in order to maximize value for the targeted stakeholders and establish shared values. Therefore, it is important to shift the focus from the company to the ecosystem level when defining the business logic (see Westerlund et al., 2014).

Table 1 (continued): Specific requirements for business modelling in an IoT context (own table)

[1] Important terms that are used throughout the paper, incl. *opportunity ideas* are highlighted in italics the first time they are mentioned. They are described in more detail in each section or listed in the glossary in Chapter 7.

2. Support design/visualization of complex value streams within the stakeholder network	Traditional approaches to illustrate value chains fall short of capturing the value added in the context of IoT because they assume linear value chains from suppliers to the focal company down to customers. Therefore, we need new ways of illustrating the value added in the stakeholder network that allow for identifying synergies and dependencies between the nodes.
3. Explicitly consider the value proposition for all key stakeholders (e.g., users, customers, and partners)	To foster sustainability of value creation within a stakeholder network, it is crucial that all contributing parties have incentives to participate in the network. Therefore it is crucial to explicitly consider the value proposition for key stakeholders in the early phases of business model development.
4. Consider data as an asset within and beyond the actual opportunity.	As connected devices have the potential to capture a lot of data, we recommend following a structured approach when defining how to leverage that data (either as value adding services within the same business model or in subsequent business models). This might include direct data monetization or other means of reusing information as assets in business models.

Table 1: Specific requirements for business modelling in an IoT context (own table)

Business model development usually begins with understanding customer needs and deriving a compelling value proposition. However, in many cases a specific context already exists – e.g., some companies work on questions concerning how rail cars will be connected and transmit sensor data, while in other cases the question might be how to draw more users/devices to an IoT platform. These very context-driven cases require a structured approach to eliminate blind spots. As IoT solutions contain usually both the "product" and "Internet" parts, we see two domains that need to be bridged: the machine camp and the Internet camp, associated with different mindsets and skills (see Slama et al., 2015, for more details). Common artifacts, e.g., templates or procedure models, can help to align these worlds.

2.2 Further benefits of the IoT Business Model Builder

In addition to addressing the specifics of IoT, our approach offers further advantages that we see as essential when developing business models. They are addressed in the following principles:

Align business model to overall company strategy: To ensure strategic fit, we recommend validating at an early stage whether and how the opportunity contributes to the overall company strategy. This can be done in the idea selection phase, using checklists that represent key values or strategic goals of the company.

Identify key drivers of value: We offer a user-centered approach when defining the IoT offering, starting by defining the value proposition and subsequently assessing which parts of the solution can contribute to the value proposition.

Assign tasks to stakeholders according to their capabilities: To minimize costs and efforts and maximize value, use a resource-based view to allocate resources. Determine what capabilities are required for the IoT offering and which stakeholder can best bring them in.

Future-proof business model at an early stage: Consider how to ensure economic viability of the business model as early as possible. Aspects might include property rights, technological skills, resources, or other competitive advantages.

Document and validate assumptions that have an impact on the business model: Throughout the process of business model development, many assumptions are made. They can be related to all components of the business model (target groups, market size, user acceptance, technical feasibility, costs, etc.). It is crucial to document them and to shed light on how much they affect the business model. As it is impossible to eliminate uncertainty when making predictions about the future, we recommend at least making a classification of assumptions according to the degree of their uncertainty (in categories such as high/medium/low).

3 The IoT Business Model Builder approach

Ideally, the IoT projects should be embedded in an overall enterprise IoT strategy; for further reference see Slama et al. (2015). This paper focuses on the operational level from idea to business model evaluation. For all opportunity ideas, the typical and seemingly simple question is "What is the appropriate business model for the idea?" Before a business model can be discussed, however, some questions need to be clarified. In particular, it has to be clear whose business model for which opportunity is to be designed.

Several questions need to be answered to get from ideating initial, rough opportunity ideas to a completely analyzed *business model* and *business case* as the basis for a management decision. All work packages can be seen as steps in the three phases of the generic business modeling process depicted below in Figure 1: ideation, preparation, and evaluation. It is of course important to note that the process includes iterations within the above-mentioned steps as well as between the process phases.

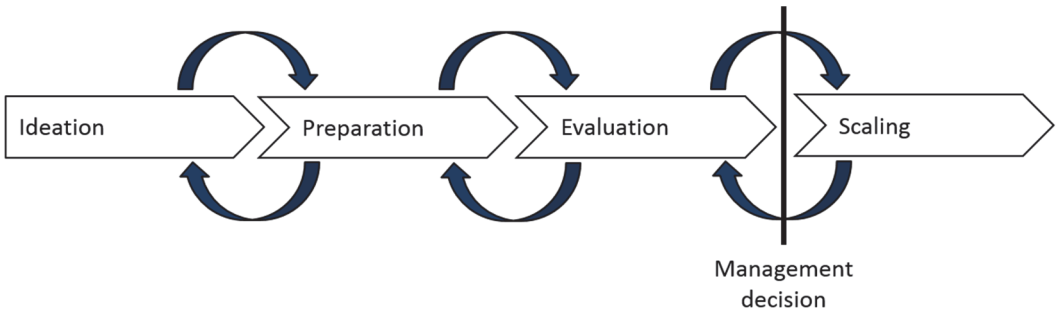


Figure 1: Phases of business modeling (adapted from Robert Bosch GmbH Corporate Department Business Models, 2015)

The document at hand aims to both help practitioners perform the challenging steps when looking for a suitable opportunity as well as enable the development of business models for a promising new IoT solution. The procedure and tools described here have been tested in previous case studies. First experiences with the methodology at hand have shown that the process usually requires several months, depending on the complexity of full execution. In addition, the procedure at hand will require the organization of certain resources (mostly time and workshop facilities) as well as ensuring the participation of diverse stakeholders within and outside the company.

4 IoT Business Model Builder

All steps below are part of a highly iterative process. Several steps might be combined into one workshop, depending on time and complexity. It might anyhow be necessary to take the results of one step home for further discussion and analysis before continuing with a next step.

Phase	Step/milestone	Input	Work to be done – content	Output	Participants	Tools
Ideation	**1. Create opportunity ideas** Workshop	IoT mission statement Generic product or service idea If applicable, strategic boundary conditions	Workshop: • Brainstorm and cluster opportunity ideas	Long list of opportunities	15–20 • Different disciplines • External views from partners or potential customers	• Creativity methods (e.g., random input, brainstorming) • 55 patterns (incl. digital component extension) • 5 value-creation layers • Assumption list (see Chapter 5)
	2. Sketch opportunities[2] Workshop	Long list of opportunities	Workshop: • Explain and discuss opportunity ideas • Ideate value drivers that increase customers´ benefits • Gain a common understanding of what is meant by each opportunity	Long list of sketched opportunities, value drivers	15–20 • Different disciplines • External views from partners or potential customers	• IoT shamrock • Mapping value drivers • Assumption list
	3. Select opportunities Workshop	Long list of (sketched) opportunities	Workshop: • Explain and discuss opportunity ideas • Agree on selection criteria • Select opportunities	Preliminary short list of 2–3 opportunities (not more than 5)	15–20 • Different disciplines • External views (partners, potential customers)	• Decision support tools • Assumption list

[2] Step 2 "sketch opportunities" and step 3 "select opportunities" might change in sequence, depending on the actual situation, complexity of the topic, and workshop participants. Sometimes it could be helpful or even necessary to have a larger group of workshop participants who came up with the ideas also specify them. When the selection of opportunities for further processing might come with strategic considerations that might not be shared with a large group of external participants → step 2, then step 3 On the other hand, it could be advantageous to first discard a number of unfeasible or unwanted opportunities to reduce the effort for specification → step 3, then step 2.

Phase	Step/milestone	Input	Work to be done – content	Output	Participants	Tools
Ideation	**4. Select opportunities** Homework	Preliminary short list of (sketched) opportunities	Homework: Depending on the results of step 3 and on the participants and their decision power, it might be necessary to re-evaluate the opportunities and make a final decision.	Final short list of (sketched) opportunities	*Core team* (see glossary in Chapter 7)	• Decision support tools • Assumption list
Preparation	**5. Detail offering from user perspective** Workshop	Final short list of opportunities	Workshop: • Detail the offering along the customer journey • Capture capabilities required to deliver the offering • Include potential users for a complete view and validation	Detailed short list of opportunities	15–20 participants (diff. disciplines) • External views (partners/ customers)	• Customer journey • Capability assessment • Assumption list
	6. Analyze stakeholder network for each opportunity Workshop	Detailed short list of opportunities	Workshop: Find suitable answers to the following questions for each opportunity:[3] • What do stakeholders contribute? • How do potential partners see their roles? • Which participants in a stakeholder network are necessary to implement the opportunity as specified? • What is the value proposition for stakeholders?	Stakeholder network diagram[4]	15–20 participants (diff. disciplines) • External views (partners/ customers)	• Stakeholder network diagram • Assumption list

[3] Stakeholder networks might look entirely different for different opportunities. For the "connected e-bike" idea, the network of the opportunity "theft protection" might include an insurance company, while bike dealers are part of a network related to a "preventive maintenance" opportunity.

[4] Note: The stakeholder network will most likely be ambiguous.

Phase	Step/milestone	Input	Work to be done – content	Output	Participants	Tools
Preparation	**7. Select a focus node / stakeholder from the stakeholder network** Decision	Stakeholder network diagram	Decision: Considering that each participant in the network has his own individual business model, it will be important to have a clear understanding of whose business model is to be analyzed. Depending on the case, it might make sense to select more than one focus node and analyze the business models and business cases for those nodes in step 8 in parallel.	Stakeholder network diagram with focus node/stakeholder	Core team	• Stakeholder network diagram • Assumption list
	8. Complete business model and business case for the focus node / stakeholder Workshop	Stakeholder network diagram with focus node / stakeholder	Workshop: The stakeholder network diagram already comprises information about customer, value proposition, partners/suppliers, and revenue model. During the workshop, the business model should be refined and completed. Based on the stakeholder network and situation, alternative business models (or alternative options for certain aspects, e.g., revenue model) could be considered. Business models and stakeholder network diagrams provide information on what the node has to deliver (relates to its cost) and what he gets in return (revenues). • Set up a tool to calculate the business case and decide which input data is necessary • Collect the required data • Calculate the business case.	Business model sketch (Osterwalder canvas or St. Gallen magic triangle) and business case for focus node / stakeholder	Core team plus experts representing internal and external sources for required data (cost, expected revenues)	• St. Gallen magic triangle • Osterwalder canvas • 55 business model patterns (incl. digital component extension) • IoT business case aspects • Assumption list

Phase	Step/milestone	Input	Work to be done – content	Output	Participants	Tools
Evaluation	**9. Aggregate results** Workshop/ homework	Artifacts from previous steps	Workshop/homework: • Validate/complete stakeholder network diagram • Consistency check of business cases • Complete assumptions validation • Agree on next steps/roadmap • Prepare management decisions	Finalized stakeholder network diagram; finalized business case for focus node/stakeholder	Core team	
	10. BM scenario planning Workshop/ homework	Stakeholder network diagram, list of assumptions, business model and business case for focus node / stakeholder	Workshop/homework: • For each assumption in the business case, determine the degree of potential impact of changes using, e.g., sensitivity analysis • Further, influencing internal and external (PEST) factors are determined and ranked according to the degree of uncertainty • Correlations are determined and several scenarios created • Further, business cases for each scenario are calculated and the ideal business model for each scenario is schemed	4 to 8 logically distinct but realistic scenarios in addition to original business model Business case with evaluation of risk and return (ROI) – enhanced decision base Actionable plan for how to counteract scenarios and alter the business model design	Core team plus • Controlling experts • Scenario-planning experts	• Business model scenario planning • Assumption list

Table 2: IoT business model builder (own table)

Together, the output documents from all the above steps, especially the business case, business model (canvas or triangle), and the network diagram, provide all necessary data for a management decision.

5 Business modeling and the importance of assumption validation

Before the tools recommended for the IoT business model builder are described in greater detail in the next section, it is essential to gain a better understanding of how business modeling ideally works. Throughout the whole process, predictions about the world are made. The underlying assumptions require testing/validation on an ongoing basis. We recognize that it is impossible to validate all assumptions; however we recommend making the degree of certainty of assumptions transparent. Uncertain assumptions with a high impact on the business case are candidates for scenario planning as outlined in step 10.

Assumptions should be tracked throughout the whole process. It is crucial for the success of the project to critically review and test assumptions at each of the remaining IoT business model builder steps.

Assumptions might be related to

- Value proposition
- Demand and customers´ willingness to pay
- User behavior, user needs
- Market conditions
- Technical feasibility
- Technical and organizational capabilities
- Motivation of network stakeholders
- Costs

The IoT business model builder with its iterative character and various tools accounts for the potential event that certain assumptions are falsified. In such a case, it might be necessary to either specify the assumption in more detail or to conduct further tests including other sources of information. If this fine-tuning is not successful, steps should be repeated and assumptions changed accordingly, resulting, for instance, in the choice of a different opportunity or an adapted definition of the value proposition.

When and how to validate assumptions

We recommend a table format to organize the required assumptions in a structured way. After each step (alternatively, also after using a specific tool), one can agree on the key assumptions underlying the step outputs. The assumptions should then be added to a list, which is maintained consecutively along the IoT business model builder steps displayed in Table 2. Apart from column one including the assumptions, the table could consist of further columns describing (1) how – i.e., based on what data (source) one intends to validate the assumption, (2) where to receive the relevant data (e.g., who needs to be contacted), (3) how long it will take to gather the relevant information, (4) whether the assumptions can finally be approved or rejected according to test/research outputs, (5) with what degree of uncertainty the questions are answered, and (6) what their overall impact on the business model is. Table 3 is an example table with two generic assumptions.

Use the time between workshops or working sessions to validate as many of the assumptions on the list as possible. To do so, it is necessary to “get outside the building” and talk to relevant stakeholders. Potential means of collecting data (cf. Punjabi, 2013) for assumption validation include

- Contacting stakeholders (e.g., consumers, potential partners, suppliers)
- Contacting experts related to assumptions (trend analysts, research institutions, etc.)
- Reviewing existing markets (i.e., competitors' offerings, existing business models, etc.)
- Looking at industry reports, statistics (incl. public online sources such as Google Trends, etc.)
- Assessing sensitivities of changes towards assumptions

Assumption	How to validate?	Potential sources	Time horizon	Check	Uncertainty	Impact
The digitally charged product is technically possible	• Gather expert opinions • Build prototype (proof of concept)	• Expert panels • Engineering team	3–4 months	☑	low	high
Customer-approved value proposition	• Interview customers for their opinions/estimations • Let customers test/use mock-ups, prototypes (observing them) • Evaluate similar solutions on the market & customer feedback	• Customer interviews • Experiments • Desk research, surveys, etc.	2–3 months	☑	high	high

Table 3: Exemplary table with two selected assumptions (own table)

As practice has shown, it is almost impossible to validate all assumptions with an ultimate degree of certainty about future developments. Aiming to develop business models in a field so innovative and new – such as the IoT environment – will always come with risks. Therefore, it is highly important to reveal sources of risks. Figure 2 provides a supplementary graph illustrating the two columns "uncertainty" and "impact" listed in Table 3 above. During the first nine steps of the IoT business model builder and the time between workshops, the assumptions still might "move across squares" (change their uncertainty and impact), especially as they become more validated and the business model gets more refined. As indicated with the color scheme, actual risks lie in the fields close to the upper right corner, where assumptions remain critical uncertainties at the end of step 9, meaning that they have a high overall impact on the business model (case) and are highly uncertain.

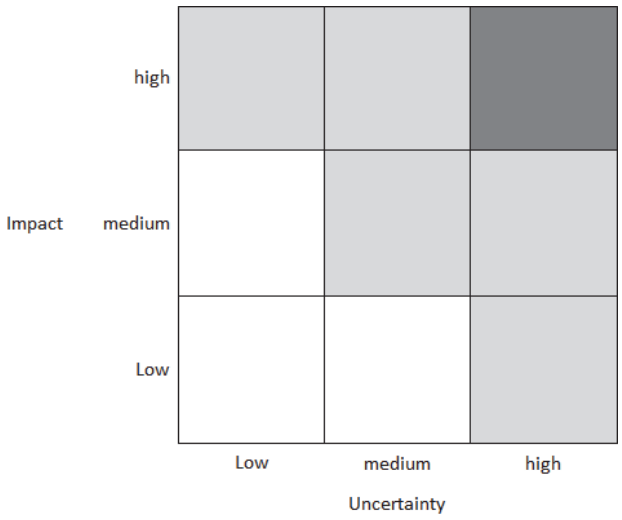


Figure 2: Impact and uncertainty of assumptions (own graph, adapted from Sharpe & Van der Heijden, 2007)

Thus, while business model validation is in general important, the validation of certain assumptions is particularly critical. Two examples are the value propositions for customers and ecosystem stakeholders, as indicated in Table 3 with high estimated uncertainty and impact. The lean-startup method offers good means to learn from customer feedback as early as possible. It is highly recommended to not only request conceptual feedback but also observe customer and stakeholder reactions based on first prototypes – i.e., minimal viable product versions (Punjabi, 2013).

Main purposes of assumption validation

- Manage risk by confronting assumptions with market reality from the start, thus increasing transparency
- Incorporate other stakeholders' views (also external), which can help to think outside the box

Sources and further in-depth literature

Punjabi (2013). *Validate or Die: Using Validation to Build the Right Product*. Accessed on July 31, 2015. http://www.mindtheproduct.com/2013/09/validate-or-die-using-validation-to-build-the-right-product/

6 Recommended tools

The following subsections describe the instruments recommended at each step in Table 2 above. These tools aim to guide practitioners through the entire process and help them at each step to focus on the critical issues, encouraging procedure participants to develop new, "out-of-the-box" ideas. Figure 3 illustrates the recommended tools to be used as part of the business model builder procedure.

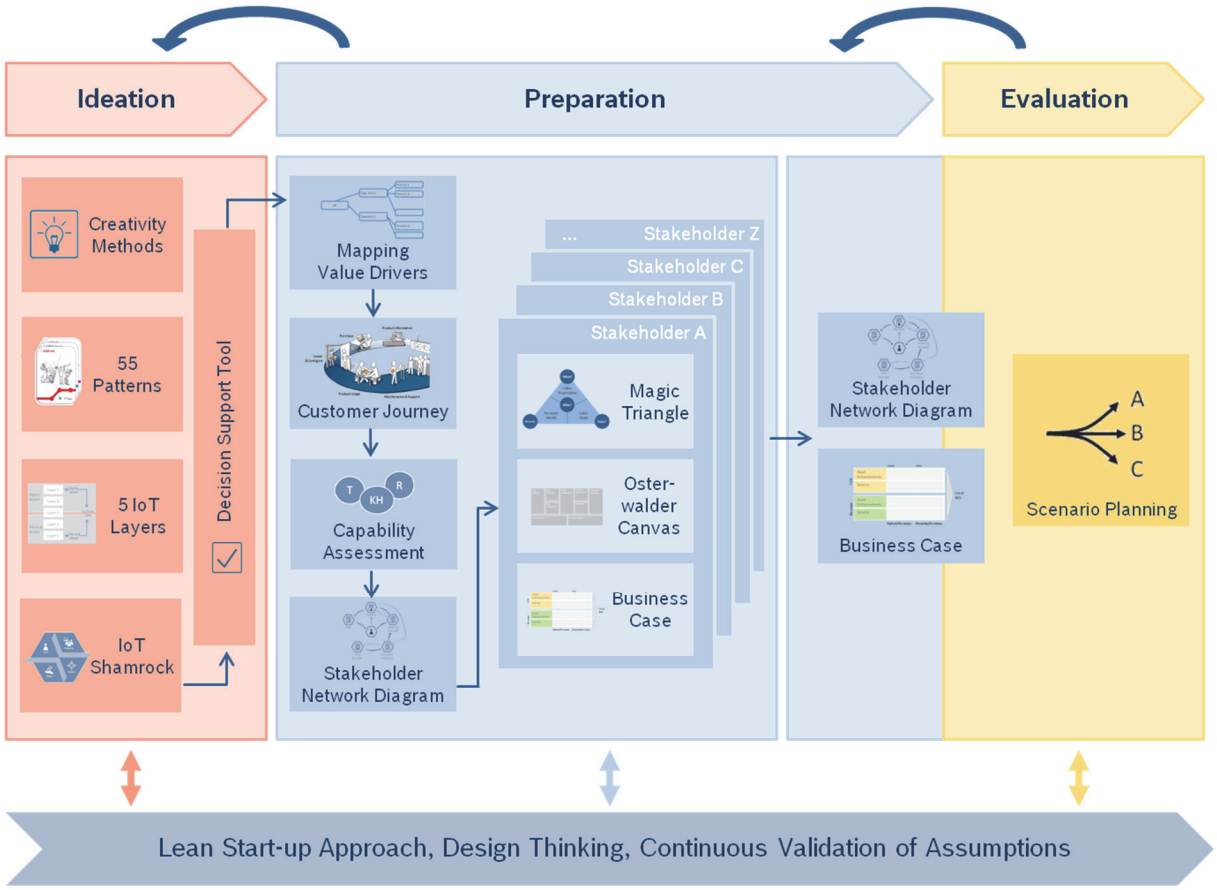


Figure 3: IoT Business model builder with recommended tools (own graph)

In order to ensure a better understanding of the tools, each of them is applied to a fictional example from the e-bike industry.

6.1 Creativity methods

To open the minds of workshop participants for new ideas and encourage thinking outside the box, creativity methods should be used. Brainstorming, for example, can help to generate new ideas, especially when people from different disciplines are involved.

In a workshop setting, it is also possible to separate all participants into working groups of up to six people and let them ideate using more structured approaches, e.g., formulating wish lists on cards and passing them to the next person, who can then suggest possible solutions that address those wishes.

Another helpful approach is to use random input: Use everyday items (e.g., umbrella, water boiler) and ask participants to generate concepts for how they could be combined with the original idea.

Sources and further in-depth literature

Vullings R. & Heleven M. (2013). *27 creativity & innovation techniques explained*. Accessed on September 20, 2015. http://de.slideshare.net/ramonvullings/27-creativity-innovation-tools-final

6.2 The 55 business model patterns

Analyzing a broad variety of companies (up to 400 cases) Gassmann et al. (2014) identify 55 business model patterns that either individually or together build the fundament of the majority of currently existing business models. A concrete pattern example is "**add-on**" – performed, e.g., by Ryanair – where customers are offered a very price competitive basic offering (What?) with additional, variable, and (generally) expensive options to book on top (Revenue?). This business model attracts price-sensitive customers, who intend to only pay for what they consume (Who?) and is based on very cost-conscious processes (How?).

Instead of reinventing the wheel, when identifying a new business model it is often sufficient to (re-)combine (i.e., transfer, combine, or repeat) these existing patterns. Hence, when using the 55 patterns, participants should discuss how, e.g., add-on might be adopted to a specific IoT opportunity. Referring to the e-bike example, inspired by the 55 Business Model Patterns,[5] several promising opportunity ideas were identified. The "smart e-bike" opportunity ideas incorporated, for instance, "theft protection," "fitness coaching," "gaming/competition," "e-bike loyalty program," "e-bike warranty/maintenance," "sale of accident data to insurance, police, etc.," "sale of data for analysis of e-bike fleets," and many more. Opportunity ideas can still be very vague and generic, requiring further elaboration. Please have a closer look at Section 6.5 "Sketching key aspects of IoT opportunities" to learn more about a tool enabling opportunity ideas to be sketched in a workshop setting.

When and how to use the tool in a workshop setting

Depending on the current process stage within the IoT business model builder, two different approaches are recommended to benefit from the 55 business model patterns. Both approaches can be repeated in several iterations to narrow down the set of selected patterns.

[5] And the "digital component" extension identified by Fleisch et al. (2014), described in Section 6.3.

In step 1 “Create opportunity ideas”: Unlike in established technologies/industries, limited business model concepts and practical experience exist for the IoT. Hence, innovative opportunity ideas are required to account for new and potentially radical product and service opportunities. The 55 business model patterns are recommended to foster creativity and allow participants to brainstorm such out-of-the-box opportunity ideas. Therefore, workshop participants are encouraged to develop new ideas based on the existing business models. One way to do so could be to select 8–10 patterns that seem particularly promising and to then develop opportunity ideas based on these patterns.

In step 8 “Complete business model and business case for the focus node/stakeholder”: At this stage, the 55 patterns can help participants to deepen their understanding of the potential revenue model underlying the business model and to identify additional revenue sources. While some patterns focus more on revenue streams than others do, all 55 patterns can facilitate valuable workshop discussions on how to monetize an opportunity. Analogous to Step 1, the procedure could be to find a selection of 8–10 patterns with promising revenue components and to subsequently rate them based on feasibility, probable success rate, alignment with the business model, etc.

Main purposes of using this tool

Depending on the current process step, the 55 patterns aim to

- foster workshop participants’ creativity to brainstorm innovative, out-of-the-box opportunity ideas and gain an initial understanding of the core elements of business models (step 1)
- deepen participants’ understanding of business models and encourage them to consider alternative business model elements, such as further revenue streams (step 8)

Sources and further in-depth literature

Gassmann, O., Frankenberger, K., & Csik, M. (2014). *The business model navigator: 55 models that will revolutionise your business*. Financial Times.

6.3 IoT-specific extension of 55 business model patterns

To account for the new opportunities offered by IoT technologies to business models and their development, Fleisch et al. (2014) identify two additional business model patterns and six components, as displayed in Table 4 below. While the two extra IoT business model patterns supplement the basic 55 patterns identified by Gassmann et al. (2014), the components allow one to reinterpret several of the existing business model patterns and redefine them through an IoT lens.

Business model patterns	Components
Digitally charged products	1. Physical freemium 2. Digital add-on 3. Digital lock-in 4. Product as point of sales 5. Object self service 6. Remote usage and condition monitoring
Sensor as a service	

Table 4: Additional business model patterns and components in the IoT (Fleisch, Weinberger & Wortmann, 2014)

The first additional business model pattern, "**digitally charged products**," can be described as an umbrella term for all the new variations of business model patterns originating through the adaptation of one of the following components.

Physical Freemium	Physical products are sold with free digital service (e.g., free apps, software updates); it is anticipated that some customers would be willing to pay extra for premium services.
Digital Add-on	Physical products are sold very inexpensively, but customers can purchase/activate various digital services at high margins (e.g., software programs, additional functionalities).
Digital Lock-in	Physical products are protected to be used with other digital services via sensor-based, digital handshake to limit compatibility, prevent counterfeits, etc.
Product as Point of Sales	Physical products offer digital sales and marketing services; the customer can consume the content either directly or via smart devices (i.e., tablets, phones). An example would be any object carrying digital advertising.
Object Self-Service	Physical products can autonomously place orders online. For example, a heating system automatically and independently orders oil to refill the tank.
Remote Usage and Condition Monitoring	Physical products can transmit data about their usage, status, or environment; An example would be Brother (computer accessories manufacturer), which started to invoice only the pages actually printed.

Table 5: IoT business model components (own chart, based on Fleisch et al., 2014)

The second additional business model pattern, "**Sensor as a Service**," emphasizes a business model pattern with completely new focus. Rather than the data-generating product and the resulting services, the data itself is the key resource and primary currency in this pattern. Hence, the measured data is no longer used for just one application but shared and traded within the IoT ecosystem, enabling completely new application and service opportunities. In our e-bike example, data from an air pollution sensor could be marketed to a wide range of further IoT opportunities.

These extensions should be used in combination with the 55 business model patterns tool described above.

Sources and further in-depth literature

Fleisch, E., Weinberger, M., Wortmann, F. (2014). *business models and the Internet of Things*, Bosch IoT Lab Whitepaper (accessible on http://www.iot-lab.ch/?page_id=10543).

6.4 The five value-creation layers in IoT solutions

In the ideation phase it might be helpful to use a meaningful illustration on IoT solution layers as a trigger to brainstorm IoT opportunity ideas. In the IoT, the boundaries between physical products and digital services intermingle. A typical IoT application consists of five general value-creation layers. The abstract IoT application displayed below illustrates (1) what these layers are and (2) how they are connected. The main aim of using the illustration is to foster creativity and allow involved stakeholders to brainstorm opportunities, which span vertically across more than one layer. Below, the five layers are described in greater detail, referring to the e-bike example.

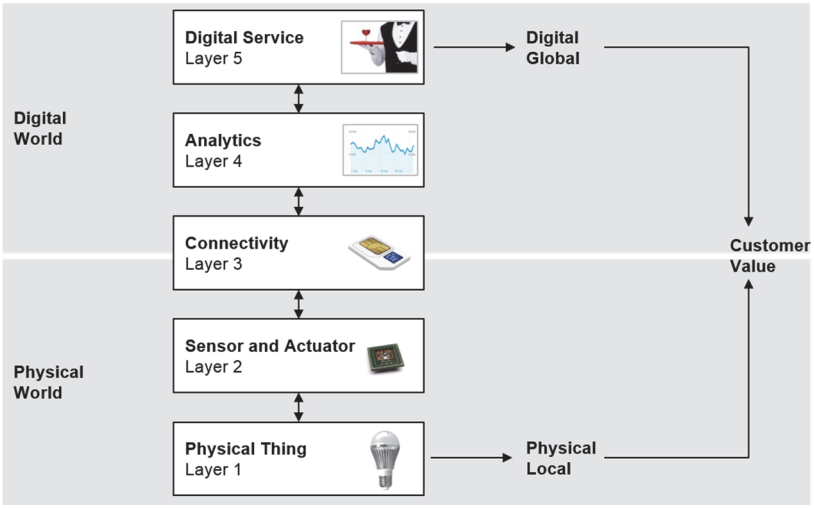


Figure 4: Value-creation layers in IoT solutions (adapted from Fleisch, Weinberger & Wortmann, 2014)

Layer 1 – Physical thing: The physical entity (in our example, the e-bike itself) supplies the first direct and physical benefit to the user. Like normal bikes, it offers a comfortable, eco-friendly, and healthy transportation method; in addition, e-bikes allow for motorized cycling support.

Layer 2 – Sensor/actuator: In this layer, the physical product further possesses a chip/minicomputer, sensors, and actuating elements. However, these elements only operate on a local level, collecting local data and generating local benefits. Referring to the widely used term "edge computing," it is important at this layer to determine how smart the device really is and to what extent computing takes place within the device vs. the cloud or a back-end (Green, McCarson & Devine, 2014). With the e-bike, potential examples could be sensors checking the battery's status and lifecycle or automatically detecting when motorization is needed.

Layer 3 – Connectivity: Adding layer 3, the sensor and actuator technologies become accessible online worldwide. Existing functions can now be leveraged (e.g., battery lifecycle state is automatically transmitted to your e-bike shop), while completely new services are also possible (e.g., theft protection, based on location tracking).

Layer 4 – Analytics: However, merely connecting devices would not generate any added value. Instead, collected and stored sensor data needs to be analyzed (i.e., checked, structured, and classified). In a next step, this data can be synchronized with other data from various sources (often in cloud-based back-end systems). This layer allows one to, for example, track movement profiles of e-bike customers, collect data about the difficulty of certain cycling routes (e.g., as a function of aggregated demand for motorized support), or detect the location of stolen e-bikes in real time.

Layer 5 – Digital service: At the last layer, the options offered by/via the other four layers are combined and structured in digital services. Customers are provided with these digital services in packaged, suitable, and location-independent formats (i.e., as mobile apps accessible via smartphone or as web tools, allowing customers to locate their bikes in case of robbery and/or to inform the police). This layer also highlights potential collaborations and business processes required to implement such company and industry spanning IoT solutions (Green, McCarson & Devine, 2014). Additionally, digital services usually require digital extensions of their traditional business model patterns, as described by Fleisch et al. (2014), and are inseparable from the smart, physical products that collect the data. Please

see Section 6.3 “Extension of the 55 business model patterns” to learn more about how digital extensions of business model patterns could look.

When and how to use the tool in a workshop setting

For participants without any prior in-depth knowledge about the IoT, it might be helpful to discuss the five layers at the beginning of step 1 to foster creativity when identifying and developing opportunity ideas. Therefore, one could briefly present Figure 4 and elaborate on the single layers as described above. It is important here to emphasize that the layers cannot exist independently of each other, which is why the arrows connecting the factors are bidirectional. An IoT solution adding value is more than a mere addition of layers; instead, it is a process of integration, extending the reach, functionality, and scope of services offered with a physical product.

Main purposes of using this tool:

- Fostering creativity relating to potential opportunity ideas across all layers of IoT solutions, beyond the focus areas (hardware, software only) of workshop participants (step 1)

Sources and further in-depth literature

Fleisch, E., Weinberger, M., Wortmann, F. (2014). *business models and the Internet of Things*, Bosch IoT Lab Whitepaper (accessible on http://www.iot-lab.ch/?page_id=10543)

Green, J., McCarson B., & Devine, M. (2014). *Building the Internet of Things*. Accessed on July 24, 2015 https://daue6ehqissah.cloudfront.net/breakouts/2014/H-ARC-01_Cisco-Intel-IBM_FINAL.pdf

6.5 Sketching key aspects of IoT opportunities (IoT shamrock)

Once several interesting opportunity ideas have been identified, it is important to gain a common understanding of what is meant for each specific idea. In this paper the aimed outcome is called “opportunity” (compared to a simple opportunity idea). The “Internet of Things shamrock” displayed below in Figure 5 can help to sketch out the main thoughts about a single opportunity.

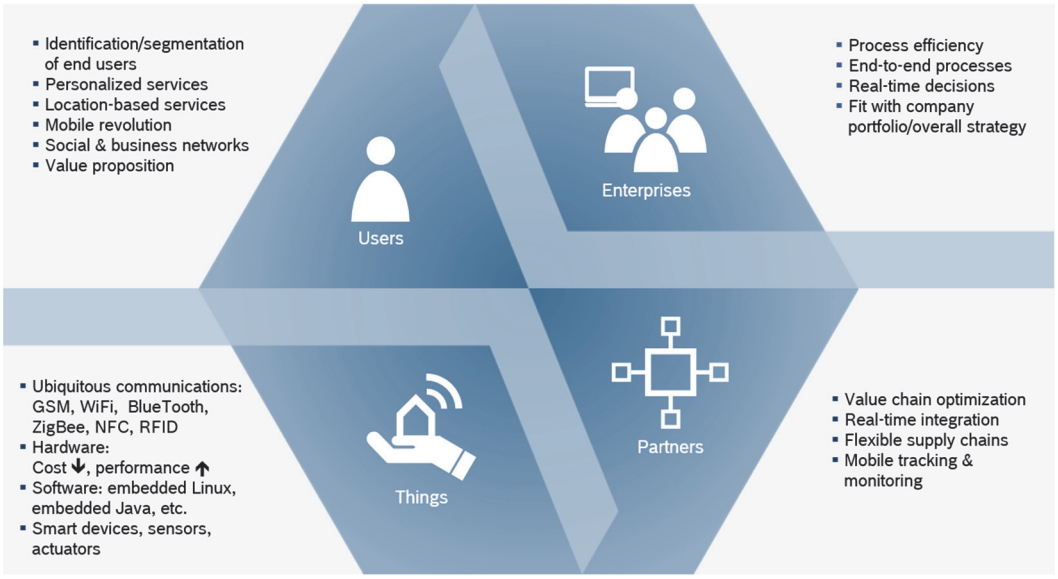


Figure 5: Internet of Things shamrock – template (adapted from Bosch Software Innovations, 2015)

The tool distinguishes four large categories: users, enterprises, things, and partners. With its open structure, the tool still allows for creative brainstorming while simultaneously helping to structure the first thoughts to specify and describe a specific opportunity idea. Figure 6 shows the IoT shamrock filled with content on the e-bike opportunity example "theft protection."

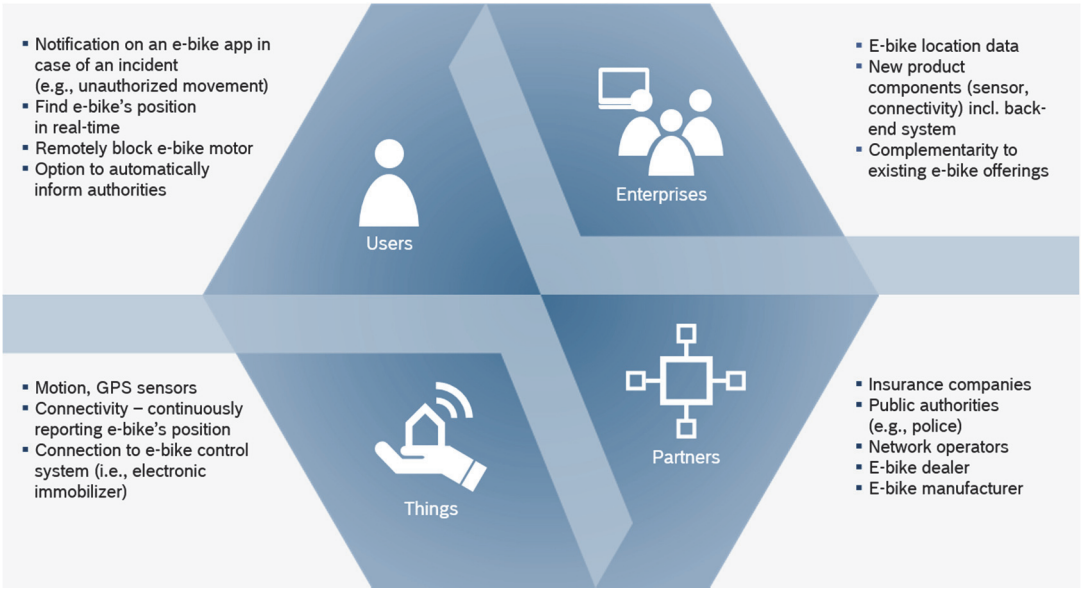


Figure 6: Internet of Things shamrock – e-bike example (adapted from Bosch Software Innovations, 2015)

When and how to use the tool in a workshop setting

The IoT shamrock should ideally be used in step 2 or 3, depending on whether one decides to first sketch or select the opportunity ideas. Once it is decided what opportunity ideas to discuss in greater detail, the moderator is asked to briefly present the concept of the IoT shamrock tool to participants as described above. They can then start to sketch opportunity ideas in detail, generating one IoT shamrock for each opportunity.

Each opportunity can either be brainstormed in plenum or first generated within smaller participant groups. For the latter approach, one preferably prepares blank IoT shamrock templates in advance to be filled in by participant groups. The cloverleaves prepared by each group could then be presented, discussed, and finalized in plenum.

Main purposes of using this tool:

- Developing a simple opportunity idea (one-liner) to a multi-layered opportunity (step 2)
- Gain a common understanding of what is meant with each opportunity idea (step 2)
- Enable clustering of efficiency-increasing versus innovative opportunities to choose the correct set of selection criteria in the next IoT business model builder step (step 3)

Sources and further in-depth literature

Bosch Software Innovations (2015). *The IoT Vision of Bosch Software Innovations*. Accessed on July 25, 2015. https://www.bosch-si.com/internet-of-things/iot-vision/iot-vision.html.

6.6 Mapping value drivers

Mapping techniques are useful when assessing which solution components can contribute to the value proposition as perceived by the key stakeholders. Inspired by tools such as “impact mapping” (cf. Adzic, 2012), we use a similar technique to work out the key value drivers.

Applied to the e-bike example, the first task is to capture the value proposition. Here, one often faces the challenge of abstracting from solution ideas and focusing instead on the needs of the users. Rather than using “theft protection for e-bike” as a starting point, one should determine whether a more generic value proposition is better, not restricting the contributing solution aspects too early. Another method that might help to assess customer needs is value proposition design where the jobs of customers are listed, pains and gains are assessed, and a corresponding value proposition is developed (Osterwalder et al. 2015).

Figure 7 below outlines how aspects of the solution (what) can contribute to the value proposition in our example. This illustrates that further aspects, such as e-bike sharing, could also deliver benefits for the user. In the next step, possible features for realizing the value drivers can be worked out (how).

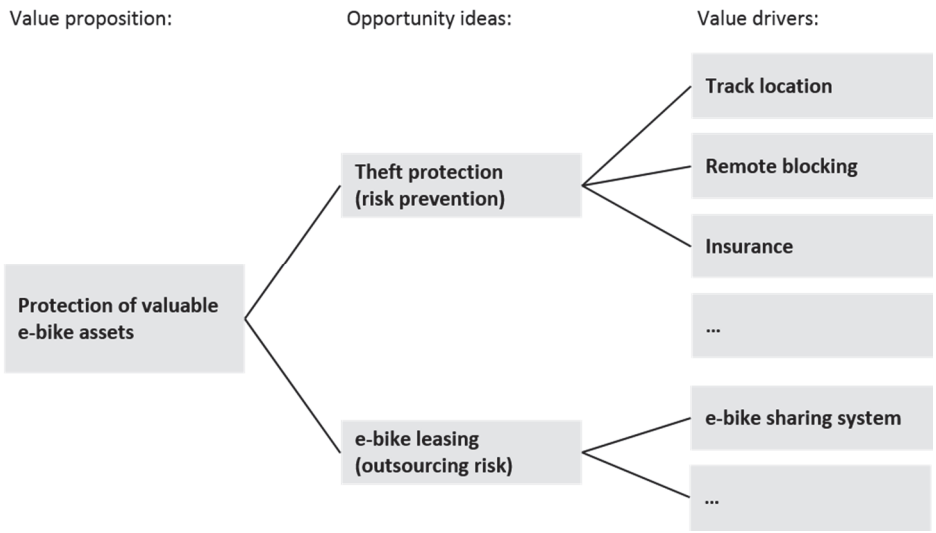


Figure 7: Mapping value drivers for e-bike example (adapted from Adzic, 2012)

The main purpose of this technique is to generate more options that contribute to the benefit perceived by the key stakeholders. However, these need to be prioritized in the next step when evaluating which solution components deliver the highest value in the most efficient way.

Sources and further in-depth literature

Adzic, G. (2012). *Impact Mapping: Making a big impact with software products and projects.* Accessed on July 29, 2015. http://impactmapping.net/site/impact_mapping_20121001_sample.pdf

Osterwalder, A., Pigneur, Y., Bernarda, G., & Smith, A. (2015). *Value Proposition Design: How to Create Products and Services Customers Want*. John Wiley & Sons.

6.7 Decision support tools

Once various opportunity ideas have been brainstormed (independent of the detail with which they are already described), it will become necessary to select the most promising ones. The IoT business model builder takes into account that company-specific decision support tools (such as scorecards, check lists, etc.) typically exist to evaluate new opportunities. To ensure that the IoT business model builder can be aligned with other company decision procedures, it explicitly encourages a combination of such tools and the approach described in this whitepaper.

The aim of the approach described below, as outlined under (a), is to offer an initial, hands-on, easy-to-use selection procedure for workshop settings as described in step 3 "Select opportunities – Workshop." In addition, further company-specific tools – as referred to under (b) – might help to (re-)evaluate IoT opportunities in greater detail in a possible fourth step: "Select opportunities – Homework."

a) Voting as a decision support tool in a workshop setting (Step 3)

A major challenge of finding adequate selection criteria is the complexity and opacity of the outcomes of a decision. Depending on the categorization of the opportunities (i.e., opportunities that improve efficiency of existing business processes versus new, radical, innovative opportunities) a different set of selection criteria is recommended to evaluate their potential. The classical means of dealing with uncertainty is building decisions upon logic of cause and effect. Such well-known KPIs recommended for opportunities that improve the efficiency of existing business processes include

- Return on investment
- Customer demand
- Time to market
- … (supplement with KPIs most important to your projects).

At the same time, we have experienced that the realm of options enabled throughout the emergence of the IoT can require quite different criteria. In contrast to traditional KPIs, applying effectuation as an entrepreneurial decision logic has been proven to be a viable means of dealing with uncertainty (Sarasvathy, 2001).

The following principles describing the effectual logic set a base to determine adequate selection criteria for new, radical, innovative opportunities (Sarasvathy, 2001; Effectuation, 2011):

- "Affordable loss" – Instead of focusing on possible profits enabled through an opportunity/business model, one should focus on possible (and at max acceptable) losses and how to minimize them.
- "Fit to our capabilities" (also known as the "Bird in hand" principle) – Instead of starting with the definition of a goal, one should focus on the given capabilities. What about the technical status quo, partner networks, existing business models, etc.? How can existing knowledge/resources be leveraged?
- "Customer demand" – Does the opportunity/business model satisfy any latent customer demand? Can new customer segments be approached?
- "Crazy quilt principle" – Does the opportunity/business model allow interesting IoT partnerships to be intensified? Are there parties to be trusted and who would limit investment risks due to their pre-commitment?

In a workshop setting, before choosing adequate selection criteria as described above, it is necessary to decide as a group whether the opportunities discussed (opportunity ideas) preliminarily improve the efficiency of existing business processes and/or should be categorized as new, innovative opportunities (opportunity ideas). It can be useful to at least roughly quantify criteria, if possible.

Next, one should choose two or three selection criteria on which the decision should be based, then draw a table with three columns on a whiteboard, with one opportunity (opportunity idea) per row in column 1. Columns 2 and 3 are named according to the chosen criteria. In a next step, workshop participants are provided with a limited number of colored stickers for each criterion and encouraged to distribute their stickers among opportunities (opportunity ideas) based on their personal assessment of the opportunities' anticipated/potential risks (depending on the chosen criteria). Finally, the results should be discussed and one to three opportunities (opportunity ideas) selected to continue with (in case of a deadlock, it is also possible for participants to vote).

The workshop selection approach outlined above can be further advanced either by making it iterative (i.e., letting participants vote several times after discussing previous outcomes) or by additionally weighting the criteria to account for potential differences regarding the importance of selection criteria.

Using this "voting" approach in step 3 will increase the awareness of participants to differentiate between new efficiency-increasing vs. very innovative, radical opportunities, thereby ensuring the selection of opportunity ideas based on the "right" set of criteria.

b) Additional decision support tools for subsequent (re-)evaluation (step 4)

After an initial workshop selection, it might be important to (re-)evaluate the opportunities subsequently in a rather quantitative, more detailed setting (step 4). Again, classical key performance indicators as well as effectuation principles, supplemented by company-specific tools such as scorecards, could be used to (re-)evaluate the selection of opportunities. Corresponding to lean startup approaches, iterative testing – i.e., in partnership with research institutions – allows for quantifying KPIs.

Sources and further in-depth literature

Effectuation (2011). Accessed on July 20, 2015. http://www.effectuation.org/.

Sarasvathy, S. D. (2001). Causation and effectuation: Toward a theoretical shift from economic inevitability to entrepreneurial contingency. *The Academy of Management Review*, 26(2), 243-263.

Slama, D., Puhlmann, F., Morrish, J. & Bhatnagar, R. (2015). *Enterprise IoT*. Accessed on July 20, 2015. http://enterprise-iot.org/book/enterprise-iot/.

6.8 Customer Journey

To illustrate the solution from the user's perspective, it is helpful to start high-level with a customer journey that ranges from awareness to after sales (it is important to focus on the key stakeholder, whether this is the customer or end user). Having sketched the journey, relevant customer touch points can be identified and prioritized according to their relevance. We recommend then "zooming in" to the most relevant touch points (e.g., product usage) and defining the necessary user stories. The

value drivers identified beforehand (see Section 6.6 “Mapping value drivers”) are helpful in accomplishing this step.

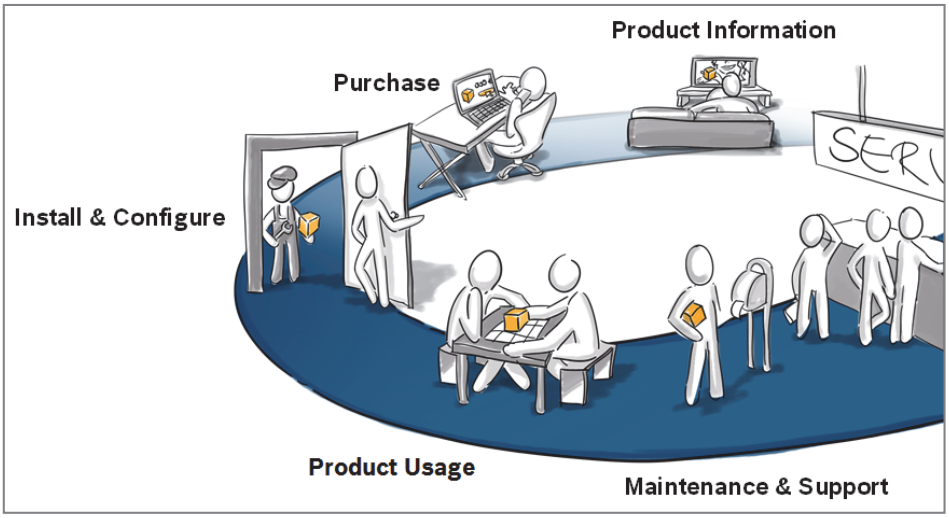


Figure 8: Example customer journey (Robert Bosch GmbH, C/UX, 2015)

By considering all touch points along the customer journey, it is more likely that a complete solution will be sketched and any relevant stakeholders that could contribute to the user value proposition will be identified early in the process. These identified stakeholders can later serve as input for the stakeholder network diagram.

6.9 Capability assessment

Having sketched a solution and having assessed what features are most relevant for the value proposition, in the next step the value added can be determined by defining how the value streams will be organized.

In some cases, the parties that will contribute to the solution are not pre-determined. Therefore, the customer journey can help to identify key touch points that are required for the solution (from the user perspective). Additionally, first illustrations of technical components can help to identify relevant parties. IoT scenarios like our e-bike example usually require both front-end and back-end development as well as reliable on premise or cloud based installations.

Having captured the main stakeholders (e.g., by listing main roles and or even named organizations), it needs to be defined how the main activities should be allocated to the stakeholders. Should the e-bike manufacturer, for example, be in charge of providing theft protection functions to the customer, or would this task be better fulfilled by a different party? A resource-based view on capabilities can help to optimally allocate tasks to the stakeholders who have the capabilities necessary for the solution.

In the document at hand, capabilities are defined as a combination of technologies [T], know-how [KH] and resources [R]. These capabilities are possessed and applied by companies to perform core functions (TechTarget, 2015). Referring to the e-bike example, a list of relevant capabilities could be structured as in the following illustrative table (only a selection of capabilities listed).

Services/activities required for solution	Capabilities needed	Relevance/impact	Partner/candidate for delivering
e-bike app	UX / Design skills, programming, analytics	High	Data service provider
e-bike supply	Supply network	Medium	e-bike retailer
Maintenance, repair service	e-bike know-how, shop, power tools,	Low	e-bike retailer
Connectivity	Telecommunication network	Medium	Telco operator
Coordination of value proposition contributions	Contract management with relevant stakeholders	High	Full service provider
Customer service	Customer relationship management, 24/7 support	High	Full service provider
Insurance service	Insurance management	Medium	Insurance company

Table 6: Illustrative list of capabilities – e-bike example (own table)

Sources and further in-depth literature

TechTarget (2015). *business capability definition*. Accessed on August 21, 2015. http://searchsoa.techtarget.com/definition/business-capability.

6.10 Stakeholder network diagram

IoT solutions are anticipated to significantly change existing "linear value chains," resulting in more complex and inter-connected ecosystems. It is important for decision makers to realize that, compared to traditional opportunities/business models, the success of IoT solutions depends to a much greater extent on the broad cooperation and participation of stakeholders within this ecosystem. Hence, a solid understanding of the respective ecosystem is paramount in order to identify one's potential position/role within the new ecosystem as well as other important collaborators, their roles, and their motivation for participating in the ecosystem.

Figure 9: Main symbols for ecosystem roles (Bosch Software Innovations, 2015)

In general, one can distinguish between suppliers for the solution and partners who are exposed to higher risk. Furthermore, the role of the business owner can be allocated to one or more nodes to indicate who is coordinating the main activities related to the customer/key stakeholders. The symbols illustrated in Figure 9 above are an example of how ecosystem roles could be visualized.

The stakeholder network diagram allows one to identify (1) potential nodes/stakeholders in the ecosystem and (2) with whom each player would be directly interacting, including the relationship types between the single players. Furthermore, it shows (3) to what extent other players are affected by the IoT opportunity and who might (for what reason) be more or less receptive towards its implementation.

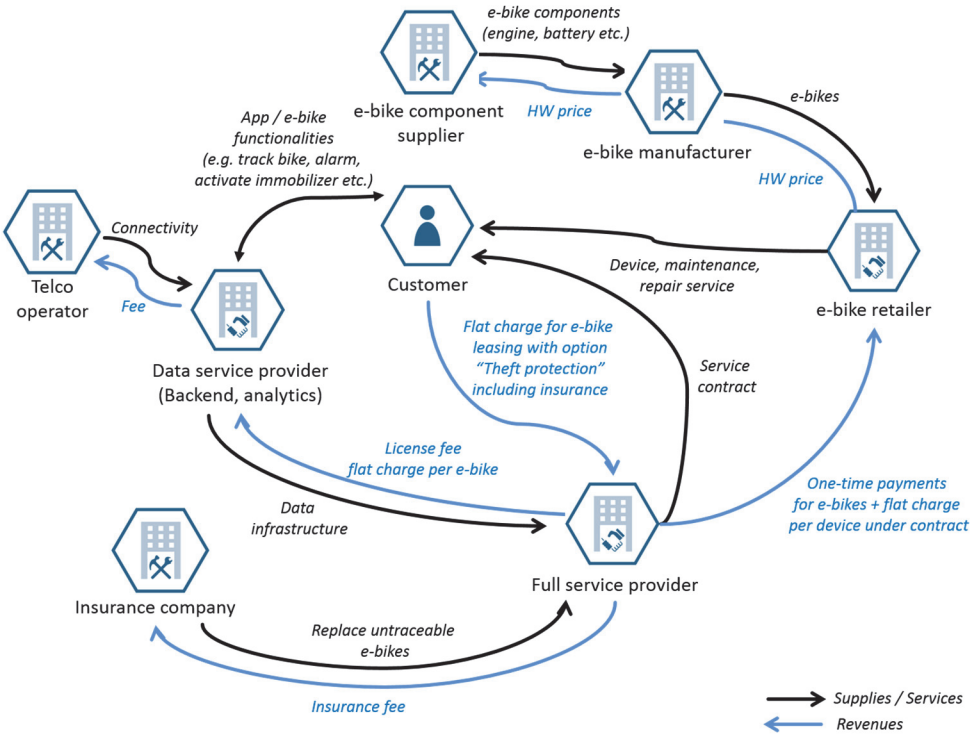


Figure 10: Stakeholder network diagram – e-bike opportunity "theft protection" (own graph)

In our stakeholder network diagram example for the e-bike opportunity "theft protection" (including e-bike leasing) displayed in Figure 10, one can see that various nodes participate as partners in the ecosystem and are thus exposed to risk. After capturing the different stakeholders, it might be necessary to identify the process owner in a next step (not yet displayed in Figure 10). In the stakeholder network diagram example illustrated above, the node "full service provider" offering an e-bike leasing contract, including new IoT-based theft protection features for the customer, could potentially take such a business owner role.

The diagram also helps to further specify the value proposition: In addition to offering more security/control to customers over their e-bikes, the "full service provider" minimizes the organizational efforts of customers and negotiates lower insurance fees, as its e-bikes are now better protected against theft.

When and how to use the tool in a workshop setting

The stakeholder network diagram helps in steps 6 and 7 to analyze the stakeholder network for each opportunity and to select a focus node/stakeholder. Ideally, it is already possible to invite stakeholders

to the workshop, providing each stakeholder with the opportunity to share information on where they see themselves in the ecosystem and how they anticipate the future relationships among stakeholders. In large corporations it could be helpful to organize two different workshops: one to identify the internal stakeholder network including all divisions involved, such as component suppliers, software developers, and sales teams, and a second workshop that also includes external stakeholders.

For both settings, the recommended way to initiate a coherent stakeholder network diagram is to start with a central consumer node. In the first step, participants should discuss in plenum all other relevant players within the stakeholder network and position them around the consumer node as displayed above. In the second step, the nodes need to be connected according to their anticipated (future) relations (based on one or more new IoT opportunities). Different arrow colors distinguishing between, e.g., supply and revenue streams and different arrow strengths indicating the relationship importance (e.g., revenue-wise) can help to add further value to the diagram. In addition, clearly naming the roles and relationships as illustrated in Figure 10 can help to gain a better common understanding of the IoT ecosystem.

Main purposes of using this tool:

- Helping participants to gain a better understanding of newly emerging IoT ecosystems
- Enabling participants to thoroughly select a focus node within the stakeholder network

Further in-depth literature

Mazhelis, O., Luoma, E., & Warma, H. (2012). Defining an internet-of-things ecosystem. In *Internet of Things, Smart Spaces, and Next Generation Networking* (pp. 1–14). Berlin Heidelberg: Springer.

6.11 St. Galler magic triangle as a business model illustration tool

Figure 11 below displays an elaborated St. Galler magic triangle example based on the e-bike opportunity "theft protection." The main ideas are next to each category, with the bullets for the customer categorization located at the right-hand side of the chart.

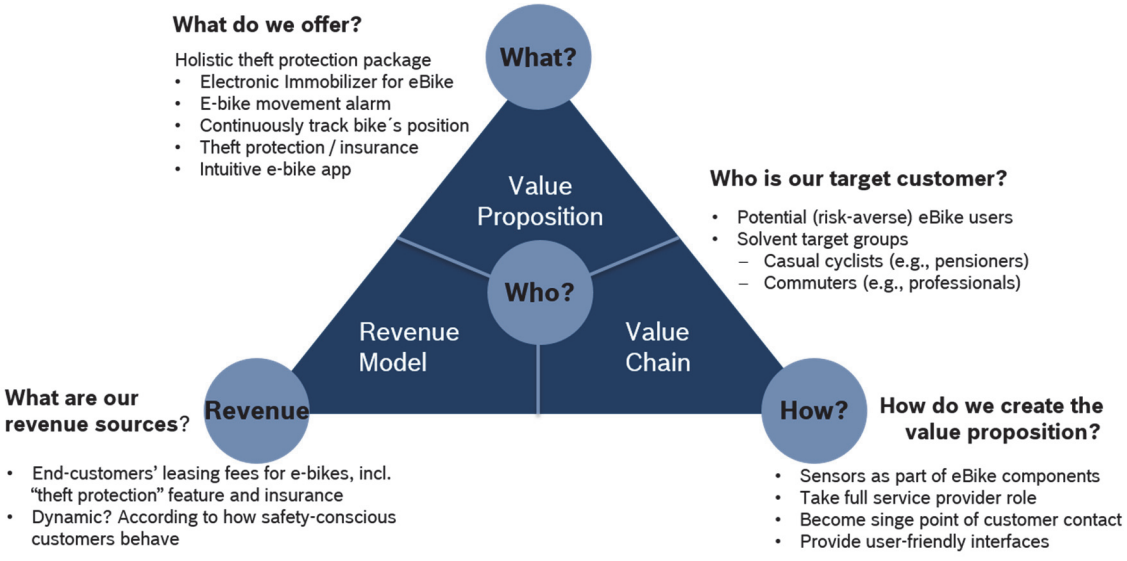


Figure 11: Magic triangle for the node "full service provider" – e-bike example (adapted from Gassmann, Frankenberger & Csik, 2014)

To sketch out an initial business model based on an opportunity, the magic triangle can be used as a substitute for the Osterwalder business model canvas. Both approaches "magic triangle" and "Osterwalder canvas" offer specific advantages and should be chosen according to personal preference and case suitability. While we see the benefit of the St. Galler magic triangle in its uncomplicated application during workshops, we describe the Osterwalder canvas as a more widely acknowledged tool, allowing for a more detailed BM description. Table 7 below presents a selection of generic questions, helping to fill the St. Galler magic triangle with relevant information.

Category	Example Questions
Who?	• Who are the customers? • (How) can customers be segmented? • What are the customers' demographics/characteristics?
What?	• What does the opportunity offer to customers? • What is the value proposition / added value to customers? • What (bundle of products and services) does the offering consist of?
How?	• How is the value proposition built, enabled, and distributed? • How will the processes and activities required to offer the products roughly look? • What resources will be required? • What ecosystem stakeholders will be required and how can they be orchestrated? (see stakeholder network diagram)
Revenue	• Is the opportunity anticipated to be financially viable? • How does the cost structure look? • What are the applied revenue mechanisms? • How can the value proposition be monetized?

Table 7: Generic St. Galler magic triangle questions (own table, based on Gassmann, Frankenberger & Csik, 2014)

When and how to use the tool in a workshop setting

In step 8 of the IoT business model builder, the triangle helps to clarify the business model of one specific ecosystem node. It is encouraged to select a promising opportunity and try to answer as many of the above-outlined questions as possible. Do not focus on quantitative analysis at this stage of the process; instead, discuss ideas that arise during group discussions.

One way of organizing this exercise could be to provide participants with stickers in four different colors. Give them time to brainstorm ideas individually and let them write one idea per piece according to the color scheme (i.e., one color per topic – e.g., green is "what?"). Draw a large-scale triangle on a corkboard and cluster ideas as displayed above, then discuss the ideas in plenum.

Make sure that the outputs of previous steps (i.e., the opportunity – IoT shamrock, five layers, etc.) are easily accessible throughout the exercise to provide participants with already-acquired information. It might be easier to answer the sections in sequence and to start with the areas "what?," "who?," and "how?" so that participants can build upon previous outputs. Finally, focus on "revenue," where participants should try to derive new thoughts on cost/revenue structure and potential revenue streams/models. The 55 business model patterns (including the digital component extension) as described in Sections 6.2 and 6.3, can help foster participants' creativity in identifying new and innovative revenue stream opportunities.

Main purposes of using this tool:

- Gaining an initial understanding about the core elements of a business model
- Developing a rough but feasible business model based on an opportunity

Sources and further in-depth literature

Gassmann, O., Frankenberger, K., & Csik, M. (2014). *The business model navigator: 55 models that will revolutionise your business*. Financial Times.

6.12 Osterwalder business model canvas

The "business model canvas" developed by Osterwalder (2010) is an alternative approach to the St. Galler magic triangle for visualizing a business model and offers a popular template for describing a business model on one page. To benefit from the canvas it is essential to familiarize oneself with and thoroughly understand the concepts described (e.g., key activities vs. key resources).

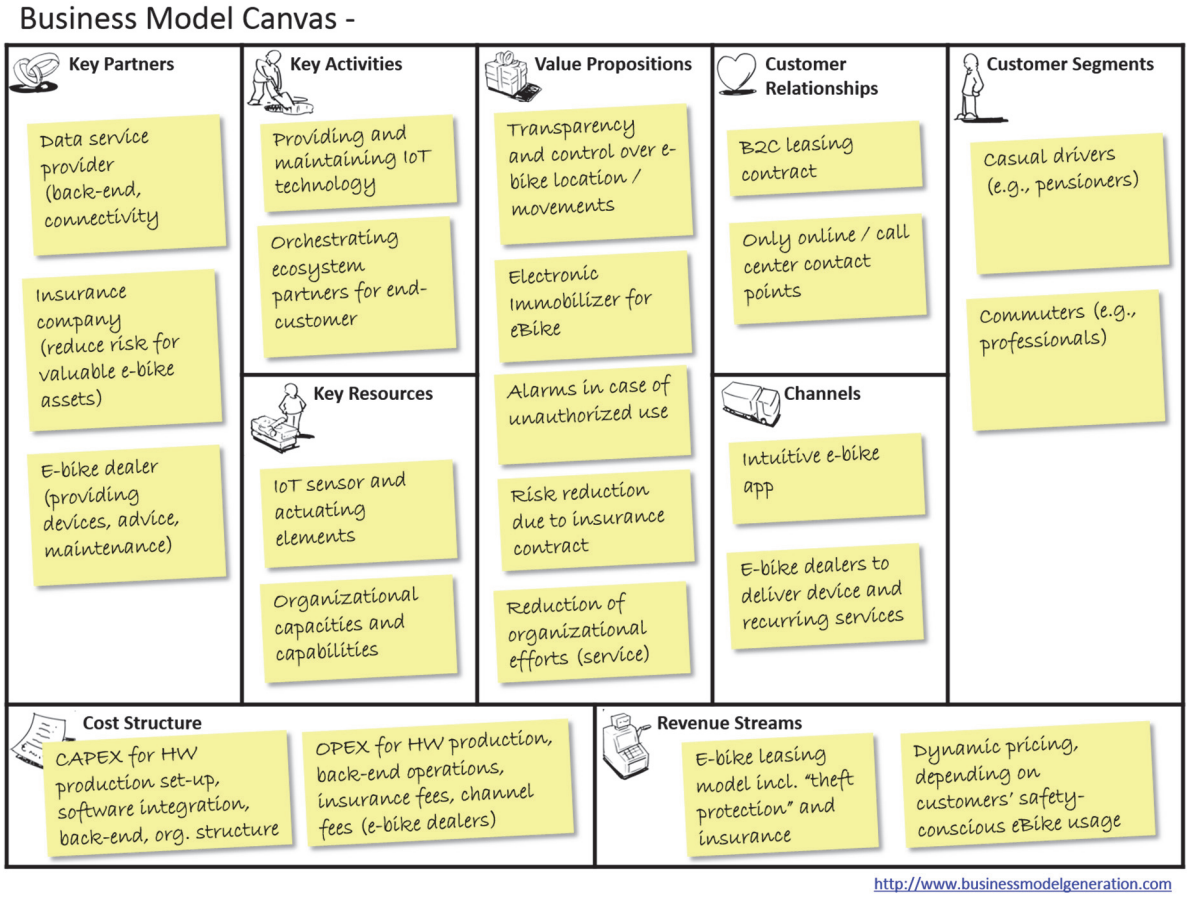


Figure 12: Osterwalder canvas for the node "full service provider" from the e-bike example (adapted from Osterwalder & Pigneur, 2010)

Figure 12 displays an illustrative business model canvas example, filled with content from the e-bike opportunity "theft protection," incorporating outputs of previous tools (e.g., St. Galler magic triangle, IoT shamrock).

When and how to use the tool in a workshop setting

Like the "magic triangle," one can use the business model canvas in step 8 of the IoT business model builder to develop a more detailed business model for one specific node/stakeholder of the ecosystem. There are plenty of online resources describing the tool (including its advantages and pitfalls) and explaining how to use it; Table 8 summarizes a selection of links with video tutorials and articles.

Short introduction	https://www.youtube.com/watch?v=QoAOzMTLP5s
Descriptions & videos	http://www.alexandercowan.com/business-model-canvas-templates/
How-to description	http://business.tutsplus.com/articles/how-to-put-the-business-model-canvas-to-good-use--fsw-40622
Videos per canvas section	http://www.firstangel.co/post/77688641763/the-business-model-canvas-and-how-to-apply-it
Top 10 pitfalls	http://www.sourcepep.com/top-10-business-model-pitfalls-and-how-can-you-avoid-them/
Official website	https://strategyzer.com/training/courses/business-models-that-work-and-value-propositions-that-sell

Table 8: Useful articles and videos describing the Osterwalder canvas[6] (own table)

Main purposes of using this tool:

- Providing participants with a more detailed understanding of the business model and its elements
- Using a business model development tool that is widely known, used, and accepted in companies
- Supplement to develop business models comparted to other frameworks (e.g., magic triangle)

Sources and further in-depth literature

Osterwalder, A., & Pigneur, Y. (2010). *Business model generation. A handbook for visionaries, game changers, and challengers*. Wiley.

6.13 IoT business case aspects

Besides developing a qualitative business model, it is essential to predict quantitative forecasts (i.e., a business case) to back investment decisions. A variety of calculation methods and templates exists. Independent from the approach actually chosen, it is important to stringently analyze different opportunities (i.e., based on the same key metrics) to ensure comparability.

Referring to Slama et al. (2015) in an IoT context, one should distinguish between the local ROI, directly generated through the IoT solution (e.g., via hardware sales, service subscriptions) and the overall impact of the new IoT product/service on the company's business case (through offering differentiation, improving operational efficiency, etc.). Thus, even with a negative local ROI, the additional funding required might be seen as the "cost to compete" from an overall company perspective.

Figures 13 and 14 below illustrate how the local ROI and the additional overall contribution for a generic IoT innovation could be structured. The example assumes that an IoT solution in general combines hardware elements (e.g., asset enhancements) and services (Slama et al., 2015), leveraging

[6] Some of the websites contain fee-based services (e.g., tutorials, lessons) alongside freely accessible content.

the new sensor as well as actuating and connectivity features of the asset (as described in more detail in Section 6.4 “The five value-creation layers in an IoT solution”).

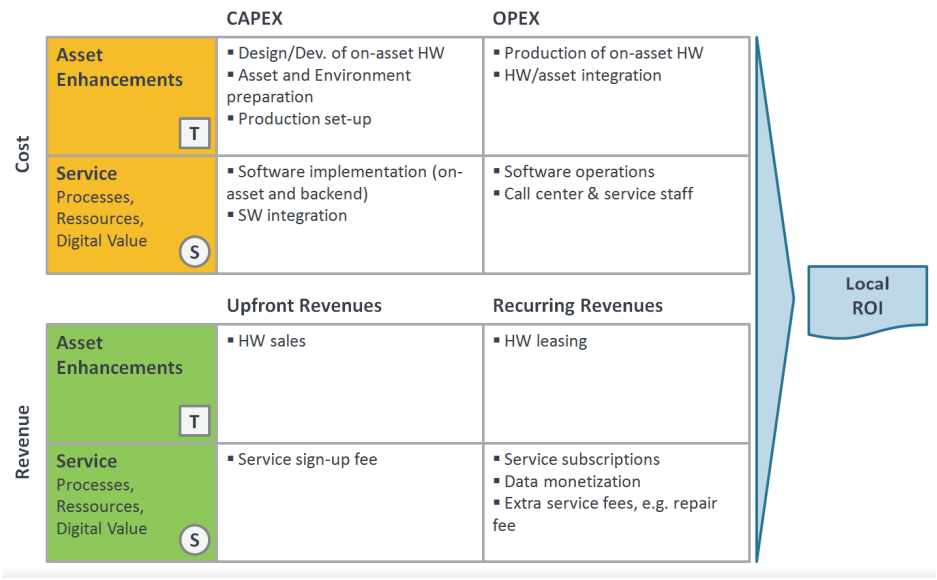


Figure 13: Local ROI for IoT business model – aspects (Slama, Puhlmann, Morrish & Bhatnagar, 2015)

As shown in Figure 13, this business case structure divides “Cost” into capital expenditure (i.e., set-up costs to develop hardware components, integrate software, set up back-end infrastructure, etc.) and operational expenditure (i.e., production costs of assets and costs to run software / back-end services). Similarly, “Revenue” is divided into upfront and recurring revenues, depending on their type and point of collection.

Calculating an IoT business case, it is important to keep in mind that IoT hardware development can be very cost intensive, and fixed costs must not be underestimated. The same holds true for operating costs, as IoT devices can require quite complex back-end systems with ongoing operating costs. Therefore, it is also important to anticipate the customer’s willingness to pay (especially with regard to recurring fees, etc.) and the extent to which (on-going operating) costs need to be incorporated within the sales price (Slama et al., 2015).

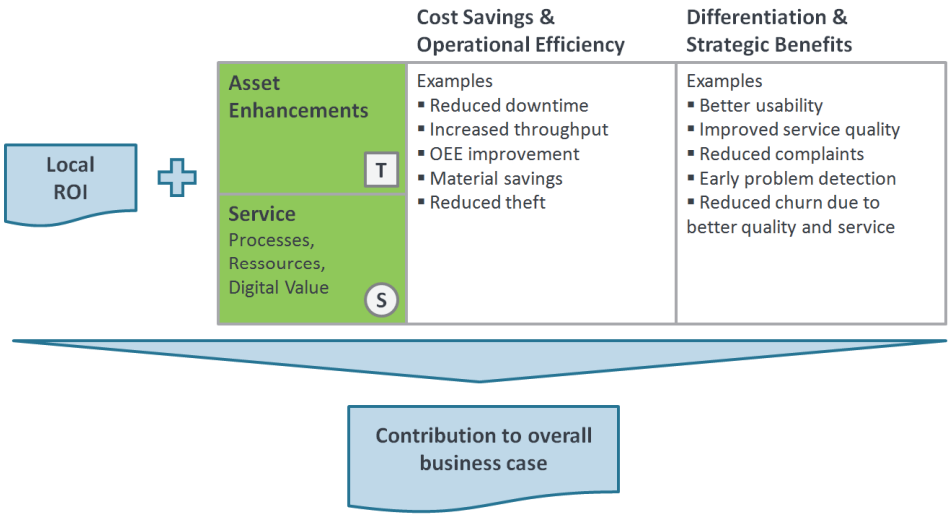


Figure 14: Business case including local ROI & additional contribution – aspects (Slama et al., 2015)

Ideally, the structure presented here can be used to create an Excel sheet, calculating a first ROI. Because such calculations will be very specific with regard to single business cases, no Excel template is provided here. While it might be difficult to calculate some of the bullets in Figures 13 and 14, the aim is to quantify as many factors as possible. Actual figures in the business case depend on assumptions from the previous steps. We recommend incorporating the relevant assumptions in the business case, allowing for sensitivity analysis.

When and how to use the tool in a workshop setting

In step 8 of the IoT business model builder "Complete business model and business case for the focus node/stakeholder," the tool described above can be used to discuss the main cost drivers and promising revenue mechanisms with participants. Two different workshop settings are possible.

First, when initiating a business case, a workshop helps to qualitatively specify the aspects described above according to the underlying business model, discussing and selecting the right metrics (cost/revenue drivers), identifying the relevant experts/colleagues to address in order to receive the required figures, etc. Depending on the type and seniority of participants, it might also be feasible to start collecting data for certain key figures. Based on the output, the core team sets up detailed Excel calculations after the workshop.

Second, in another workshop setting, a detailed business case might have already been researched and calculated. The moderator would then present a summary of the first results for cost drivers, revenue streams, ROI, etc., and ask workshop participants to comment on the findings and assumptions, discuss results, and identify potential levers and risks influencing the investment decision.

Main purposes of using this tool:

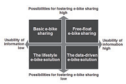
Depending on the status of the business case, a workshop can help to

- identify the main cost drivers and revenue streams in order to set up more detailed calculations.
- discuss calculations, assumptions, and risks with decision makers.

Sources and further in-depth literature

Slama, D., Puhlmann, F., Morrish, J. & Bhatnagar, R. (2015). *Enterprise IoT*. Accessed on July 20, 2015. http://enterprise-iot.org/book/enterprise-iot/

6.14 Business model scenario planning



As outlined in Section 5, ongoing assumption validation is a good means for revealing and reducing risk in business model innovation projects. However, at the end of each of the process steps, methods, and tools, there is still a set of high-impact assumptions that remain highly uncertain.

Through the years, scenario planning has been proven as a viable tool for dealing with this situation. Moreover, as history has shown, the systematic use has led to outperformance of competitors in several industries (Schoemaker, 1995). Tennent and Friend (2005) undergo the first attempt to integrate scenario planning into business model innovation attempts. In a later study, El Sawy and Pereira (2013) implement scenario planning for business model innovation in the dynamic digital

space. In the context of the IoT Business Model Builder, we applied BM scenario planning to foster further enhancement of the rather strategic business model perspective (Magretta, 2002). In steps before the management decision, business model scenario planning helps to further improve consistency and stringently streamline the business model. With all key sources of risk revealed, one can better prepare management decisions. What if analysis and the awareness of possible counteractions to unexpected events increase transparency on risk and return and thus enhance the decision base for classical portfolio management? Further post-decision benefits (in the phase "scaling") are that business model scenario planning carves out key resources to be developed by the focal firm and provides input for a subsequent implementation roadmap plan.

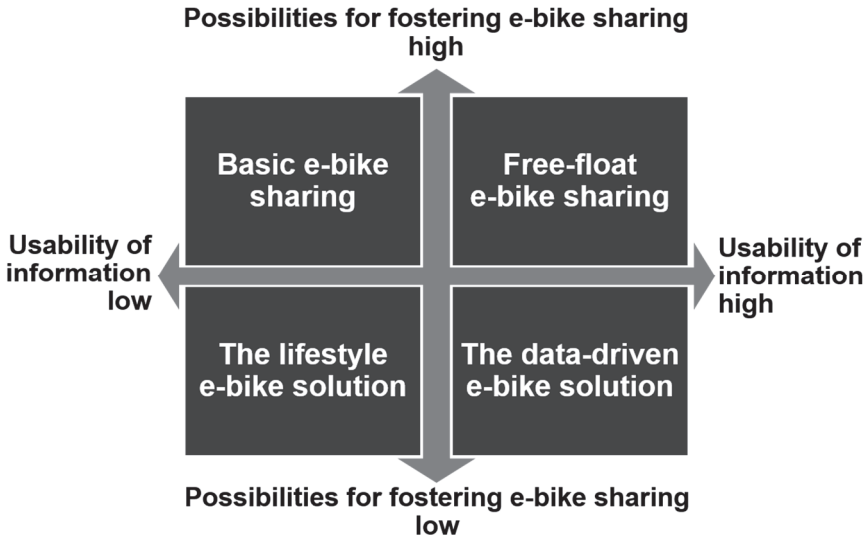


Figure 15: Scenarios for e-bike example (adapted from Tennent & Friend, 2005)

After identifying, validating, and investigating key assumptions, we applied business model scenario planning to the e-bike case. As outlined on the x- and y-axes in Figure 15 above, two mayor assumptions drive the full realm of possibilities. Following the methodology of Tennent and Friend (2005), the resulting four scenarios are realistic but represent extreme positions. Considering an appropriate business model for each scenario implies different necessary internal and external capabilities of the focal firm and thus sets a basis for determining the attractiveness in terms of risk and return towards management.

Sources and further in-depth literature

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7 Glossary

Business case

Compared to the business model, we understand the business case as detailed calculations, testing whether the logic of the business model holds financial revision. It supplements the qualitative business model outputs with quantitative cost and revenue forecasts.

Business model

Referring to Osterwalder and Pigneur (2010) “a business model describes the rationale of how an organization creates, delivers and captures value.” It is a detailed and mostly qualitative description of the value proposition, revenue mechanics, processes, customer segments, channels, stakeholders, etc., required to successfully merchandise an opportunity. Of the many tools existing to illustrate business models, two are described in this paper (St. Galler magic triangle, Osterwalder canvas).

Capabilities

In the paper at hand, capabilities are defined as a combination of know-how, resources, and technologies. These capabilities are possessed and applied by companies to perform core functions (TechTarget, 2015).

Core team

The core team is a (small) group of people supervising the entire process suggested in the IoT business model builder. As process owner, the core team is the central contact for stakeholders and is responsible for planning and organizing the workshops. Finally, the core team aggregates all documents and presents the outcome of the IoT business model builder to decision makers.

Opportunity ideas

Opportunity ideas are rather vague and generic ideas (often keywords only) about how IoT solutions could be used/sold and therefore require further elaboration. An example of an e-bike opportunity idea referred to throughout this paper is “theft protection.”

Opportunity

An opportunity is a more detailed sketch/description of a specific opportunity idea. A well-sketched opportunity allows stakeholders outside the core team to get a basic understanding of what is meant by an opportunity idea. One tool to structure and visualize opportunities is the IoT shamrock. An example of a finalized IoT shamrock for the opportunity idea “theft protection” is provided above.

Stakeholders

In the paper at hand, stakeholders are defined as all players involved in the business-modeling process. The umbrella term “stakeholders” covers diverse types of players, including internal divisions of a company as well as external suppliers, such as network operators, public authorities, customers, competitors, and universities.

Value proposition

The value proposition is a statement declaring how a product and/or service of a company adds value to customers and other stakeholders within the ecosystem. Thus, it fulfills a dual function, as it aims to convince end-customers to spend money for the product/service and ecosystem stakeholders to participate in the business model (Frow & Payne, 2011).

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