A sustainability-oriented innovation selection method for service firms

A design process and a practice-validated prototype

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A sustainability-oriented innovation selection method for service firms
A design process and a practice-validated prototype

by

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This thesis is confidential and cannot be made public until August 2018.

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Preface

Before you lies the result of an intensive six months period of research within Royal Schiphol Group. This result, my thesis, has been written to complete my master Management of Technology of the Technical University of Delft. This thesis is not only the end of my master’s degree, it also marks the end of my time as a student. Before taking the reader by hand through my work of the past six months, I would first like to thank various persons for their help and support during this last part of my time as a student.

At first, I would like to thank Jasper Beijneveld, who left Royal Schiphol Group to chase his dream of traveling Europe by camper. Although he didn’t guide me for a long period due to this, he helped me in finding and defining a research topic that fitted my educational and personal interests. With his passion for sustainability and broad knowledge of the organisation of Schiphol, he has inspired me and brought me in contact with the right persons.

One of these persons, which I would especially like to thank, is Alfons Klaasse Bos. He has been my supervisor during my time at Schiphol and helped me to elevate the quality of my work to the level it has become. Open-minded, broadly interested and especially knowledgeable in the field of innovations, he has guided me by asking thought-provoking questions at the right time. Doing so, he has guided me in a very comfortable manner, leaving me responsible for all choices.

Continuing within Royal Schiphol Group, I want to thank all people that have helped me. Be it through interviews, user tests or informal talks in the hallway, they have helped me greatly in writing this thesis.

Then, I would like to thank Roland Ortt. Already a few months before starting my master thesis, I knew I had to have Roland as my first supervisor. His advice was not only about the thesis, but also from a personal angle, something I highly appreciate. From the beginning, he indicated that he was never a big fan of my research approach but that my way of working with it was changing his opinion. With this report, I hope to have finished this process.

Furthermore, I would like to thank Mark de Bruijne for his guidance above and beyond his role as second supervisor. I was under the impression that the second supervisor would only read the report a few times and provide some general remarks, but I couldn’t have been more wrong. Mark has meticulously read all documents I provided, giving very detailed feedback every time and has provided me with interesting alternative angles to the subject.

I consider myself lucky to have had Alfons, Roland and Mark as supervisors. They were always helpful, always in agreement and were able to motivate and guide me where possible.

Of course, I would also like to thank persons from a personal angle. I would like to thank all my friends for making my student life such a great experience. During this time, I have met amazing people and shared great experiences, which I will never forget. I want to thank my family for their support, and especially my parents and sister. Throughout all these years they have supported me in many ways, unconditionally.

R.A. Schwarze
Amsterdam, August 2018
Executive summary

Innovation is widely accepted as a source of sustained competitive advantage but is also a source of risk for a company. To obtain the most value from innovation projects and minimize the risk accompanying these, many methods for evaluating innovation ideas exist. These assess the potential value and potential risks of innovation ideas. However, most of these are tailored towards manufacturing firms, not towards service firms. For a firm such as Royal Schiphol Group, which I termed an “infrastructure-providing service firm”, this presents a first challenge.

Innovation is also seen by many as an important way to achieve sustainability for firms. There are methods for assessing the sustainability of innovation ideas, but sustainability is a different dimension than potential value and potential risk. In many firms, sustainability is still seen as a value conflicting with more traditional business values like profit. An approach that might solve this problem is Sustainability Oriented Innovation, or SOI. This approach aims to create economic value and increase sustainability, and not treat these goals as competing. Nonetheless, there are no evaluation methods for innovation ideas that adhere to this principle, evaluating both potential value and sustainability. For a firm such as Royal Schiphol Group, this presents a second challenge.

A third challenge for an organisation like Royal Schiphol Group is that it operates in a network setting. The eventual success of its innovation projects is dependent on other stakeholders within this network, as these are the adopters of innovations. It is thus invaluable to know and consider the opinions of these stakeholders on various innovation ideas. Current innovation selection methods have no solution to this challenge.

In addition, infrastructure-providing service firms often have vital processes or services. A disruption in one of the processes will have a large effect on all connected processes and will create a domino-effect. Because innovations are a source of risk, additional evaluation is necessary for innovation ideas, to minimize the risk of process disruption of the innovation.

Combining these challenges provides the research question of this research: How can a sustainable innovation idea selection method be developed for an infrastructure-providing service firm? To tackle this research question, the Design-Oriented Research approach has been followed. By doing so, a sustainable innovation idea selection method has been designed for Royal Schiphol Group. Based on this, a process with design rules has been created which other service firms can use to create their own adaptation of a sustainable innovation selection method.

First, a literature review was done on various ways of describing the innovation process and selecting innovation ideas. The field of sustainability assessment and SOI has been included as well. From the various literature streams, interesting design details or “building blocks” have been retrieved. This was done as there were no off-the-shelf innovation selection methods for the problem at hand.

Then, the current situation within the department ASM of Royal Schiphol Group has been mapped based on semi-structured expert interviews. Analysing these interviews, improvement possibilities surfaced, and a list of design goals, requirement, and assumptions was created. Following the Design-Oriented Research approach, the design must achieve the goals and fulfil the requirements, these are thus also acceptance criteria in the evaluation stage.
After that, a prototype of a sustainable innovation idea selection method has been built in an iterative process of combining requirements and building blocks. From this, a design emerged of a method consisting of three screens. The first screen is a screen in which innovation ideas are assessed by a group of people on a list of “must-meet” criteria. The second screen is a scoring model, in which criteria divided over six groups are awarded scores by the same group of people. After that, the third screen provides the group of people to discuss the outcomes and determine belief in and timing of the various innovation ideas.

This prototype of a sustainable innovation selection method has been put to the test in a first user test. From this user test, data was retrieved through three channels: Observation, a focus group, and a questionnaire. The prototype fulfilled the wishes of the department, was indicated to be clear, fair, objective, easy-to-use and differentiating enough between ideas. However, the feedback from the test indicated that some criteria and scales had to be altered. This has been done to create a second prototype of the selection method, which Royal Schiphol Group and other infrastructure-providing service firms can use and further develop.

In this sustainable innovation idea selection method, sustainability is treated as a value of an innovation, and not in a trade-off with more traditional business drivers. By doing this, the method enables a firm to assess innovation ideas on these different dimensions. This enables a service firm to select innovation ideas in accordance with the SOI principle.

For service firms, a criterion that must be used in evaluation is the expected impact on provided services, as this represents value for a service firm. Another criterion that was added for an infrastructure-providing service firm or the specific context of an airport is the ability to test the innovation on a small scale. Having the possibility to test an innovation on small scale reduces the chance of process disruption. Another criterion added for service firms is technical/process synergies. This evaluates how well an innovation fits in the current way of providing services and with the current technologies used, also reducing the risk of process disruption.

To deal with the challenge of a service firm operating in a network setting, the internal and external stakeholders must be mapped during the design process of the selection method. To include the opinion of the appropriate stakeholders in the selection process, persons of the internal stakeholders must be invited that are representative of the external stakeholders. These persons know the stance/opinion of the external stakeholders and include this in the selection process.

From this process of designing a sustainable innovation selection method for Royal Schiphol Group, design rules have been distilled for other service firms. A process is presented that other service firms can use to create their own adaptation of a selection method. In this process, design rules are included that are of importance to (infrastructure-providing) service firms. With this process, other service firms can thus create their own sustainable innovation selection method to select innovation ideas according to the SOI philosophy.
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## List of abbreviations

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<th>Description</th>
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<tbody>
<tr>
<td>AAS</td>
<td>Amsterdam Airport Schiphol</td>
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<tr>
<td>ASM</td>
<td>Department Asset Management of Royal Schiphol Group</td>
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<tr>
<td>BU</td>
<td>Business Unit</td>
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<tr>
<td>CEC</td>
<td>Closed Evaluation Criteria</td>
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<tr>
<td>DEV</td>
<td>Development</td>
</tr>
<tr>
<td>DSR</td>
<td>Design Science Research</td>
</tr>
<tr>
<td>EOH</td>
<td>Effect Op Havengelden (Effect on airport fees)</td>
</tr>
<tr>
<td>EP</td>
<td>Expertise &amp; Policies</td>
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<tr>
<td>IAM</td>
<td>Institute of Asset Management</td>
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<tr>
<td>IoT</td>
<td>Internet of Things</td>
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<tr>
<td>IS</td>
<td>Information System</td>
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<tr>
<td>IP</td>
<td>Investment Proposal</td>
</tr>
<tr>
<td>LoC</td>
<td>Level of Control</td>
</tr>
<tr>
<td>M&amp;O</td>
<td>Maintenance and Operations</td>
</tr>
<tr>
<td>MT</td>
<td>Management Team</td>
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<tr>
<td>NCV</td>
<td>Net Cash Value</td>
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<tr>
<td>NPD</td>
<td>New Product Development</td>
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<tr>
<td>NSD</td>
<td>New Service Development</td>
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<tr>
<td>OIEC</td>
<td>Open Innovation Evaluation Criteria</td>
</tr>
<tr>
<td>OPS</td>
<td>Department Operations of Royal Schiphol Group</td>
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<tr>
<td>P&amp;P</td>
<td>Planning &amp; Portfolio</td>
</tr>
<tr>
<td>PoC</td>
<td>Proof of concept</td>
</tr>
<tr>
<td>PPM</td>
<td>Project Portfolio Management</td>
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<tr>
<td>SAMP</td>
<td>Strategic Asset Management Plan</td>
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<tr>
<td>SDG</td>
<td>Sustainable Development Goals</td>
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<tr>
<td>SOI</td>
<td>Sustainability-Oriented Innovation</td>
</tr>
<tr>
<td>TCO</td>
<td>Total Cost of Ownership</td>
</tr>
<tr>
<td>TEC</td>
<td>Technical Expertise Centre</td>
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<tr>
<td>TM</td>
<td>Technical Management &amp; Strategy</td>
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1. Introduction

“Innovation is of utmost importance for achieving sustainability” (E. Hansen, Grosse-Dunker, & Reichwald, 2009, p. 2). Assuming the world population will rise to 9 billion people in 50 years and wealth per capita in developing countries will continue rising whilst looking at the current efficiency of use of resources, the efficiency of use of resources must increase by a factor of 10 to 50 in order to achieve sustainability (Tukker, Tischner, & Verkuijl, 2006). One important way of achieving this is by innovating.

*Sustainability Oriented Innovations (SOI) are innovations which are individually perceived as adding positive value to sustainable development: Creating and realizing social and environmental value in addition to economic returns (Adams, Jeanrenaud, Bessant, Denyer, & Overy, 2016).*

An innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations (OECD, 2015). In short: An invention implemented or taken to market. Rogers (2003, p. 12) gives the following definition of an innovation: “An innovation is an idea, practice or object that is perceived as new by an individual or other unit of adoption.” Innovations are thus not necessarily completely new to the world but perceived as new by a person or organisation.

Improving the sustainability of an organisation is certainly not the only goal of innovating. Firms are constantly trying to outperform competitors by innovation; Improving their processes or differentiating their products and services (Tidd, Bessant, & Pavitt, 2005). By successfully commercialising new technologies, organisations can enhance their competitiveness. Innovation lets a firm shift or react to a shift in market dynamics. Innovation can help a firm to open new markets. Innovation is not only a way of opening new markets, it can provide new manners of serving established and mature markets. Innovation is often employed to create new products or services, that help capture and retain market shares and increase profitability in those markets (Tidd et al., 2005). For service firms, innovation is an important way of offering faster, cheaper, higher quality services, a source of competitive edge (Spohrer & Maglio, 2008). Innovation is not one-off but continuous, as other firms will imitate, competing away the advantages gained by the innovation. Although innovations provide promising opportunities, they also carry risk.

“Innovation can be a primary source of sustained competitive advantage as well as a significant source of risk, competitive disruption and failure” (J. Hall & Vredenburg, 2003, p. 62).

Inherent to innovation is uncertainty, resulting in risks. There are uncertainties whether the innovation will achieve its envisioned performance, whether it is technically feasible, whether it is organisationally feasible, whether there is a market demand, and there are many more uncertainties. Much research has been done into the organisational processes that improve the success of innovation projects. Logically, a successful innovation is more valuable to a firm than a non-successful one. A successful innovation justifies the money invested in an innovation project and creates the possibility of not only earning back the investment but gaining a competitive advantage as well. To find out which factors influence innovation success, many researchers study the innovation process and innovation selection methods.

There is a plethora of ways of describing and improving the innovation process in the scientific literature, with many different focus points, but studies on innovation practices in service industries are scarce and receiving of little academic attention. Oke (2007) looks at innovation
practices in service firms and addresses the pentathlon framework. Originally developed based on extensive studies on product innovations in the UK and Germany, this generic framework addresses several soft organizational and process issues. It can be and has been adopted by Adegoke for service companies as well. The framework can be seen in Figure 1.

![Figure 1: The innovation pentathlon (Oke, 2007)](image)

This framework exists of 5 areas in which companies must perform well, to achieve successful innovation management. Here, successful is defined as having a process in place that delivers products, processes, or services that are successfully sold in the marketplace. 2 areas focus on organizational issues: Innovation strategy and human resource management. The 3 areas related to process issues are creativity/ideas management, selection, and implementation. These are the processes necessary for the carrying out or development of an innovation. The organizational areas tell how the organization is shaped, the process issues tell how it operates. Oke (2007) indicates that firms with a formal process for developing new products or processes show high performance in innovation.

The Innovation Value Chain of M. Hansen and Birkinshaw (2007) looks at the innovation process in firms, to address the aspects a firm must pay attention to for successful innovation. This value chain consists of three phases: The idea generation phase, the conversion phase and the diffusion phase. Following this model, the idea generation can happen in-house (within one business unit), cross-unit (different parts of the same company), or externally. The conversion phase consists of a selection part and a development part. Diffusion describes how “well” the selected and developed innovation ideas are spread among locations, channels and customer groups. According to M. Hansen and Birkinshaw (2007), the main question managers should ask in the selection part of the conversion phase is: “Are we good at screening and funding ideas?”, and for the development part: “Are we good at turning ideas into viable products, businesses, and best practices?”. The innovation value chain can be seen in Figure 2.

![Figure 2: The innovation value chain (Hansen and Birkinshaw, 2007)](image)

Although these 2 examples show a totally different approach to the improvement of innovation processes in a firm, it is obvious that innovation selection is an important factor in innovation
management. To increase the value of an innovation project for a firm and to increase the probability of innovation project success, there are many innovation selection methods.

Research, Development and Innovation project selection has gained large attention in the literature since the 1960s (Henriksen & Traynor, 1999), and there are many approaches, methods and models that decision makers can use to assess the value of, and select, potential innovation projects. Approaches to select projects exist in many forms, in quantitative or qualitative forms, ranging from mathematical programming to interactive approaches. According to Henriksen and Traynor (1999), project selection methods can generally be placed in the following categories: unstructured peer review; scoring; mathematical programming; economic models; decision analysis; interactive methods; artificial intelligence; portfolio optimization. These methods can be used separately, but recently, different approaches are combined to create an integrated decision support system.

It is clear there are many project selection methods. However, many of the methods are too complex for managers to use, and assistance of an expert might be necessary (Henriksen & Traynor, 1999, p. 158). Consequently, few methods are used in practice. Another problem with companies that do have a strictly formal selection method is their over-reliance on financial models and the absence of strategic criteria and criteria for Go/Kill decisions, leading to ineffective portfolio management (Ribeiro, 2015, p. 3). This makes it quite illogical to utilize a strictly formal selection method, as it will either not be used by managers due to complexity or it will be ineffective due to an over-reliance on financial models and absence of strategic criteria.

There are many ways of analysing and selecting R&D projects, innovations, and technologies. These all differ in scope, perspective, goal, criteria, and in which phase of the innovation process the method is used. However, most of these are tailored towards manufacturing firms, for screening new product innovation ideas.

*Significantly less is known about innovation selection in service organisations (De Brentani, 2001; Oke, 2007).*

**The challenge of innovation selection for service organisations**

A service organisation is a firm that operates in the service sector which comprises of the transport, government, education, healthcare, social and personal services, retail and wholesale, hotels and restaurants, telecommunication and financial sectors (Oke, 2007). A service is intangible, co-produced with customers, perishable, and production and consumption happens simultaneously (De Brentani, 2001). To summarize, a service is non-physical and can consequently not be possessed, and often has a strong component of face-to-face interaction with the client (Maister, 2012).

A product innovation within a service firm is a new development in the core offering of a service company that tends to create new revenue streams, while a service innovation within a service firm is a new development in the activities undertaken to deliver core service products. The core offering of a service firm is often referred to as a service product or as a product, although most of these are intangible (Oke, 2007). To clarify: Within a service firm, a product innovation is an innovation on the service itself, and a service innovation is an innovation in the delivery of that service.

The service innovations may influence or be influenced by innovations in the core service product. Radical service innovations have been found to result in major competitive advantages through creating new revenue streams, whereas simple augmented service offerings have the capability to impact a company’s profitability and sales through reducing
costs (Oke, 2007). So, what are examples of innovations in service companies? These could be revisions to existing products/services, service/product line extensions, adaptations of an existing product/service to meet specific customer needs or an adaptation of an existing product/service to meet or serve new markets.

Many organisations manage a portfolio of a mixture of both tangible and service products. Furthermore, the line between tangible product- and service product-based organisations are becoming blurred (Killen, Hunt, & Kleinschmidt, 2008; Slack, Chambers, & Johnston, 2010).

So, why is this focus on service firms interesting? What are the challenges in innovating within service firms? First, the scientific literature on innovations in manufacturing companies is extensive, while the topic of innovations in the service sector has received little attention and research contributions are largely fragmented (De Brentani, 2001; Droege, Hildebrand, & Heras Forcada, 2009; Oke, 2007).

Service companies often have an innovation portfolio comprising of a mixture of product and service innovation projects, which are sometimes difficult to distinguish from each other and range from radical to incremental (Droege et al., 2009). It is interesting to research how a company can compare and select between product and service innovation projects as there are different success and failure factors for service innovations than for product innovations (Droege et al., 2009). For instance, superiority of the innovation is an important success factor for product innovations but is harder to demonstrate for service innovations as services are often intangible and abstract. This intangibility and abstractness can also result in radical new services becoming hard to grasp by customers, making it hard to prove superiority over more familiar ideas, whilst for incremental new services it can be difficult to effectively demonstrate the superior facets (De Brentani, 2001).

*There is a plethora of methods to compare and select between product innovations, but virtually none for service innovations (De Brentani & Ragot, 1996).*

Another factor is that the innovation process of services is different from the innovation process of products. A pilot of a service innovation is different from a pilot of a product innovation, as testing a new service often requires more training of personnel, for instance (De Brentani, 2001).

Finally, many service firms have no formal development and evaluation process for innovations. This can possibly be due to the need for flexibility in developing service products, which may be restricted by guidelines. However, because the heterogeneity of services often leads to a highly variable quality in services, formal procedures for implementing service innovations are important to achieve a constant quality in services (Oke, 2007). A very interesting observation is that many service firms do have a formal evaluation processes for radical innovations, and not for incremental innovations (Oke, 2007). However, most service firms mainly focus more on incremental innovations, and having a formal New Service Development (NSD) evaluation process is indicated as a significant success factor in incremental innovations and not for discontinuous innovations (De Brentani, 2001; Oke, 2007).

*“Given that service company innovations are predominantly non-radical in nature … it seems surprising that management processes for managing innovations are mostly set up to foster radical innovations” (Oke, 2007, p. 582).*

**The problem owner: Royal Schiphol Group ASM**

Royal Schiphol Group coordinates the airport processes of Amsterdam Airport Schiphol. This airport is a multi-modal hub for passengers and cargo flows and is of vital importance to the Dutch economy (Rli, 2016).
Schiphol Group has the ambition to become the most sustainable airport (Royal Schiphol Group, 2018). In 2030 the company (so not the airlines) wants to achieve zero-waste, in 2040 it wants to be climate-neutral. Zero-waste means “designing and managing products and processes systematically to avoid and eliminate waste, and to recover all resources from the waste stream” (Zaman & Lehmann, 2013, p. 124), or in other words, being “circular”. Climate-neutral means the minimization of the negative impact on the climate system and the contribution to climate change (Faaij, Jager, & Kok, 2013). In this case, it is interpreted as having a net zero carbon footprint, running a CO₂-neutral operation. To achieve this, Schiphol has defined sustainability themes: A focus on people, responsible use of energy, optimum mobility, circular economy projects, and working together towards sustainability. Focal points in business operations adopted to make this possible are renewable energy and reducing energy consumption, the circular economy, optimum mobility, employment and environment, noise and air quality (Royal Schiphol Group, 2018).

Furthermore, Schiphol Group has taken the initiative to create and sign the Airports Sustainability Declaration. This declaration was signed by the aviation sector to join forces to become more socially, environmentally and economically sustainable. One of the key points mentioned in this declaration is: “Taking disruptive initiatives and new technologies into consideration and if possible use them as a means to achieve our goals” (aaae.org, 2016, p. 2). This means that airports, including Schiphol, are stimulated to consider and adopt innovations to become more sustainable.

**The department Asset Management (ASM) of Royal Schiphol Group**

The department Asset Management (ASM) of Schiphol Group not only maintains and manages the airport infrastructure, but also plans, develops and realises new assets for the airport infrastructure, with a process-driven organisation (Felten, 2017). The mission and responsibility of the department, or the strategic goal, is “Optimal and sustainable creation and management of profitable and reliable assets, with a deliberate consideration between functions, costs and risk” (Felten, 2017, p. 3). The second strategic goal is “Making assets available that optimally align with the organizational objectives of Amsterdam Airport Schiphol (AAS)” (Felten, 2017, p. 3).

To understand the scope of the work of ASM, it is useful to provide an overview of the assets that the department is responsible for:

- Ground
- Water (e.g. waterways, rainwater drainage, sewerage)
- Installations/systems (e.g. moving paths, geothermal heating systems, under- and aboveground infrastructure, runway lighting stations, electricity distribution stations, electricity delivery systems)
- Constructions (e.g. overpasses, bridges, platforms, sewers, buildings)
- Habitat (e.g. fields, parks)
- Allocation, technical documents

So, in short, the assets are items of property owned by Royal Schiphol Group that are used for supporting the airport processes. By maintaining, managing, planning, developing and realising these assets correctly, ASM supports the airport processes of Amsterdam Airport Schiphol.

ASM has the vision to achieve the goal of ‘Best in Class Asset management’, achieving the highest current performance level in the industry according to the Institute of Asset Management (IAM) systematics. To achieve this goal, the department has created a SAMP (Strategic Asset Management Plan). This plan describes the choices the department makes
to be able to facilitate its clients better in 2018, to come closer to the end-goal of achieving ‘Best in Class Asset management’. The strategic pillars that have been defined by the management of ASM to achieve this are Asset Efficiency, Organisational Excellence, Innovation & Digital, and Safety & Sustainability. ASM can employ innovations not only to work more effectively and efficiently, but also more sustainable. This results in lower maintenance costs, higher asset availability and higher predictability (and thus higher reliability).

ASM can have a large impact on how sustainable the future assets of Schiphol Group will become. Sustainable innovations can be implemented to achieve sustainable performance. However, this does not indicate that ASM is responsible for the achievement of the sustainability goals of the organisation alone. Neither is it responsible for the definition of the sustainability goals and the roadmap to achieving this. This is done by the department Corporate Responsibility, CR. But, the assets of the organisation can have a very large influence on the sustainable performance of the firm.

Currently, the department does not have a method for evaluating and selecting sustainable innovation ideas.

It has asked me to do a research into how the department can evaluate and select sustainable innovation ideas, and to create a sustainable innovation selection method. This presents various challenges.

**The challenge of innovation selection for ASM**

So, what are the challenges of innovation selection in the context of ASM, why is this context interesting?

First, Schiphol Group has a monopoly position in the Netherlands. It not only owns and runs AAS, but it also owns and runs Rotterdam The Hague Airport and Lelystad airport and holds a 51% majority stake in Eindhoven Airport. For many firms, innovating is a primary source of sustained competitive advantage by for instance creating new revenue streams or reducing costs (J. Hall & Vredenburg, 2003), but the position of Schiphol Group makes innovation for competitive advantage less necessary. Of course, there is competition with airports in other countries, but there is no real competition nationally.

Another interesting fact is that one of AAS’ main strategic goals is to be Europe’s preferred airport; it aims to deliver the best quality for a fair price (Royal Schiphol Group, 2018). Although Schiphol does not focus on being the cheapest airport in terms of airport charges for airlines, the low airport charges is one of the main competitive advantages of AAS compared to other competing airports, with a 9th position on the benchmark list (Royal Schiphol Group, 2018). Because of the monopoly position, Schiphol is legally not allowed to make a profit on the aviation part of business. Due to this, the airport charges are directly connected to the costs associated with primary airport operations, infrastructure and security. So, whilst innovating is an important way of improving the service quality for airlines, the costs associated with it are directly reflected in higher airport charges. In this respect, careful consideration is always necessary because airlines want the lowest airport charges.

An additional challenge is that the innovation projects of ASM often involve multiple (internal and external) stakeholders. The assets of ASM are often operated by external stakeholders. The external stakeholders are for instance airlines, baggage handling agents, Dutch customs, lessees, public transport providers, air traffic control, energy providers. These stakeholders have a large influence on what happens with the assets. All stakeholders have different views, priorities, interests and influence on an innovation project. It is important that the innovations are accepted by the (external) stakeholders.
The voice of the stakeholders must thus be considered while selecting sustainable innovation ideas.

This is interesting as most innovation selection methods are used by 1 selecting agent. AAS is currently operating at its absolute maximum capacity. In 2018, AAS reaches the limit of 500,000 flights, the agreed upon maximum flight movements (Royal Schiphol Group, 2018). The terminal buildings are operating over-capacity. Originally designed to handle a maximum of 45 million passengers per year, currently they handle over 60 million passengers per year. For the coming years, international air transport is forecast to grow by around 4.5% annually (Royal Schiphol Group, 2018, p. 32). This capacity shortage is currently one of the, if not most important focus points of AAS and ASM. Innovation can be seen as an important aid in solving this shortage.

Furthermore, working at maximum capacity has the effect that the processes must be performed as efficiently as possible and cannot be disturbed. The airport processes are vital, a disruption in one of the processes will have a large effect on all connected processes and will create a domino-effect. This can lead to delays, congestion or even cancelled flights, all of which are highly undesirable for AAS. Think for instance of the power failure of April 29, 2018 that led to an interruption of crucial operational processes. This ultimately resulted in cancelled flights, closed highways and chaotic scenes in the departure halls (Meindertsma & Steenhoff, 2018).

“Innovation can be a primary source of sustained competitive advantage as well as a significant source of risk, competitive disruption and failure” (J. Hall & Vredenburg, 2003, p. 62).

So, on the one hand, innovation is necessary for ASM and AAS to improve the operational processes and to achieve the strategic goals. On the other hand, innovation carries the risk of process disruption and can thus have a negative result for the airport.

This makes the challenge of selecting the right innovations of high importance.

Another interesting aspect about the context of Schiphol is that it faces conflicting demands and wishes from multiple sides. On the one hand the demand for air travel keeps growing, airlines and passengers want more capacity and more comfort. For this, Schiphol needs to grow to handle more flights and more passengers. On the other hand, Schiphol faces increasing pressure from residents, climate groups and political parties that want to halt the growth of the airport because of the climate effects of air transport. This dilemma is further complicated by the economic contribution of the airport. Schiphol (in)directly contributes €9.1 billion and 94.100 jobs to the Dutch economy (Rli, 2016). In this context, innovation can be both a main driver of growth as well as a major cause of social and environmental disruption. J. Hall and Vredenburg (2003) call this the “double-edged sword of innovation”. According to them, innovation can be an opportunity for competitive advantage as well as competitive disruption and be influenced by market forces and by public policy. This can be seen in Figure 3. This adds to the challenge for this research, to develop a method that can select innovations that contribute to the sustainable growth of AAS.

Sustainable growth in this case means growth of the airport whilst increasing the positive impact and reducing the negative impact on the 6 UN’s Sustainable Development Goals (SDGs) deemed relevant by Royal Schiphol Group:

Decent work and economic growth; Industry innovation and infrastructure; Sustainable cities and communities; Responsible consumption and production; Climate action; Partnerships for the goals (Royal Schiphol Group, 2018, p. 40; UN, 2016).
The "dartboard" of comparable organizations: Infrastructure providers

Now it is clear what the challenges are for service firms in general, and for ASM, the “dartboard” of comparable organisations must be defined. Because the context of ASM as explained previously is non-standard it is quite interesting, but this means that the results of this research cannot be generalizable to all service firms. By defining this “dartboard”, the organisations to which the results can be generalized are uncovered.

As explained before, Royal Schiphol Group is a service organisation. Service organisations are firms within transport, government, education, healthcare, social and personal services, retail and wholesale, hotels and restaurants, telecommunication and financial sectors (Oke, 2007). Royal Schiphol Group is a semi-private organisation in the transport sector.

Furthermore, Royal Schiphol Group does not provide transport services itself. It provides the infrastructure/assets which other service firms can use to provide their services with. Another important factor is that the supported processes are vital, a disruption in one of the processes will have a large effect on all connected processes, it will create a domino-effect.

Looking at this, the “dartboard” becomes visible. In Figure 4, this can be seen. Similar organisations to ASM are thus infrastructure providers within the transport sector. Keep in mind that these are not contractors or sub-contractors building the infrastructure. Organisations that...
are included in this group are airports, ports, infrastructure and water management authorities (Rijkswaterstaat), railroad providers (e.g. ProRail), electricity transmission system operators (e.g. TenneT). These are organisations that share the characteristics as explained and will for the sake of clarity be called infrastructure providers from now on, or *infrastructure-providing service firms*.

All of these operate in the public space and have a large physical asset base. Because of this, its presence and actions are publicly observable and under constant scrutiny. The influence of external stakeholders (residents, political parties, environmental organisations) is relatively high and subject to changes in political opinions.

**How to select sustainable innovations**

So, how can a firm select innovations to grow sustainably? Sustainability is in companies often seen as a goal competing with more traditional goals like performance and profit, and is consequently placed in a trade-off (Jay, Gonzalez, & Swibel, 2015). An approach that might solve this problem is SOI: Sustainability Oriented Innovation. This approach aims to create economic value and increase sustainability, and not treat these goals as competing.

“SOI is about dispelling the notion of trade-offs between what seem to be competing goals – performance versus impact, profit versus purpose, human wellbeing versus environmental protection” (Jay et al., 2015).

The notion of SOI suggests that when these goals are no longer seen as competing, it is possible to create products, services, and business models that are not fragmented, but holistic (Jay et al., 2015). This means that these creations create economic value and improve sustainable performance, instead of achieving one of these goals at the expense of the other.

**1.1 Problem definition**

The introduction presented multiple challenges. The problem owner is an infrastructure-providing service firm that wants to have a selection method to evaluate and select sustainable innovation ideas. The problem to be tackled by this research is:

*There is a lack of knowledge on how to design a selection method for sustainable innovation ideas in an infrastructure-providing service firm.*

Why is this problem interesting? Well, there is an abundance of methods for evaluating and selecting innovation ideas for manufacturing firms, less so for service firms. It is interesting to uncover which aspects are different for innovation idea selection in a service firm compared to a manufacturing firm.

On top of that, existing innovation selection methods assess the potential value of an innovation idea and/or the probability of success of an innovation idea. Add to this the fact that to follow the SOI philosophy the sustainability performance of the innovation idea must be evaluated as well, and suddenly the innovation ideas must be screened on 3 totally different dimensions. According to the notion of SOI, the possible (economic) value of an innovation must not be put in a trade-off with sustainability, innovations should contribute to both goals. This should be considered with the selection method.

*The challenge is to design a method for service firms that can compare the innovation ideas on these completely different dimensions (possible value, probability of success, sustainability) and provide the possibility to select innovation ideas that have the highest (economic) value, the highest probability of success and the greatest sustainability improvement.*
It is interesting to find out how the notion of SOI can be incorporated in the design of the selection method, this is thus the theoretical problem definition.

The context of the problem owner further creates a design constraint. Because the airport processes are vital, the possibility of process disruption of the innovation ideas must be considered in evaluating the innovation ideas. Also, the network setting with multiple stakeholders must be accounted for.

1.2 Types of innovation
What are the different types of innovations, and which of these will be included in this research? Disruptive initiatives and new technologies, as mentioned in the Airports Sustainability Agreement, are vague and awkward concepts in this context, this terminology will thus be discarded. For clarity, the focus will be put on innovations. Innovations are here defined as “a process that follows invention, being separated from invention in time. Invention is the creative act, while innovation is the first or early employment of an idea by one organization or a set of organizations with similar goals” (Becker & Whisler, 1967, p. 463). Generally, innovation is thus seen as a pilot of or the implementation of an invention, which can either be “a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method” (Eurostat, p. 31). For this research, marketing method innovations are excluded for the simple fact that ASM is not in any way involved in marketing. Product and process innovations are considered most applicable for ASM. Because these innovations can be accompanied by an organisational innovation, this set of innovations is also included. So, for the sake of clarity, innovation is further classified to product, service, process and organisational innovation. In short, a product innovation can encompasses early employment of a new or significantly improved good or service, process innovation a production or delivery method that is new or significantly improved, and organisational innovation the implementation of a new organisational method in the firm (Eurostat).

Schiphol Group is a service company. What are possible innovations in a service organisation?
- Revisions to existing products/services
- Service/product line extensions
- Adaptation of an existing product/service to meet specific customer needs
- Adaptation of an existing product/service to meet or serve new markets

ASM has different types of processes for attracting and testing new technologies before implementation. Firstly, pilots are done. Pilots are projects aimed to test how a certain technology is scalable within Schiphol. A small-scaled project is done, to evaluate feasibility, time, cost and adverse events of a certain technology. Secondly, proof of concepts are used. These (small) projects are intended to see whether a certain new concept works, a demonstration to verify the potential of a certain concept or theory. A full-fledged innovation project within ASM is a project that starts from scratch, if something new, something different is desired. For instance, the full-automatic connection (as explained in §3.3.6) is an innovation process in response to a desire of ASM to improve the docking process of aircraft. For this research, all 3 types of projects are included. From now on, innovations can either mean a pilot project, a proof of concept, or a full-fledged innovation process.

Because the definition of an innovation is dependent on the context, another important factor to consider is that for ASM, something is considered an innovation if it is perceived as new or significantly improved by Schiphol Group ASM, the unit of adoption.
1.3 Research objective

The research objective is to provide design rules for service firms that want to design a method to more effectively select innovations with sustainable characteristics. This will be done by developing and testing such a method for the department ASM of Royal Schiphol Group, and extracting general design rules afterwards. To design this method, various existing innovation idea selection methods are compared. Based on this, an adaptation is made for ASM, and the (perceived) performance in selecting sustainable innovations is tested. This selection method will be usable by other infrastructure-providing service firms, possibly with some small alterations. After this process of designing the selection method for ASM, design rules will be extracted for other service firms to use for designing their own method.

To summarize the 2 objectives: A sustainable innovation selection method for infrastructure-providing service firms (in this case ASM) will be delivered, and a process with design rules will be delivered that other service firms can use to create their own adaptation of the selection method.

This research will ultimately try to contribute towards the grand challenge of fighting climate change. To help in achieving this, companies can contribute by becoming more sustainable. This research will provide knowledge for service companies looking at innovations for improving their sustainable performance. By creating a process for other firms to follow to create their own sustainable innovation selection method, these firms will be enabled to work according to the SOI philosophy. For all companies that want to improve their sustainable performance through implementing innovations with a sustainable character, a method of selecting innovation ideas will be interesting, as it may lead to better implementation of (sustainable) innovations.

1.4 Research questions and sub-questions

The research method that will be used is the design-oriented research method. This method will be further explained in chapter 2. To research the problem and fulfil the research objective, the following research question has been formulated, accompanied by a few sub-questions:

How can a sustainable innovation idea selection method be developed for an infrastructure-providing service firm?

This question will be answered by developing such a selection method in the department Asset Management of Royal Schiphol Group. For this department, the question will effectively be: How can the department Asset Management of Schiphol Group effectively select innovation ideas to implement to improve the sustainable performance of the company? By solving this question, design rules can be created for a wide variety of service organisations, enabling them to create an innovation idea selection method independently.

To answer the main question, a couple of sub-questions have been formulated:

SQ1: Which methods for selecting innovation ideas are interesting for a service organisation?

a. What are existing methods in literature?

(1) How are these methods utilized?

(2) Is there a difference between innovation selection methods in general and sustainable innovation selection methods?

b. Which parts of various literature streams are interesting for a service organisation?
c. Which parts of various literature streams are interesting for an infrastructure-providing service firm?
d. Which parts of various literature streams are interesting for ASM?

This sub-question is formulated to get a clear overview of all the existing methods that are being used for selection of innovation ideas. By answering this sub-question, an overview is made of the existing selection methods in various scientific literature streams. The following literature streams will be addressed: “Stage-Gate”; Agile; The innovation funnel; Portfolio management; evaluation methods & criteria; New Product Screening; success/failure factors for innovations; characteristics predicting innovation adoption; sustainability assessment; Sustainability-Oriented Innovation. A distinction is made to find out whether sustainable innovation ideas are selected on other criteria than innovation ideas in general, and what these criteria are. This is to find out which innovation selection method is best applicable for selecting sustainable innovation ideas.

The literature is reflected on in respect to service firms in general, and in respect to an infrastructure-providing service firm and the problem owner. From the various literature streams, interesting aspects will be retrieved, dubbed “building blocks”. These are interesting parts or aspects to keep in mind while designing the innovation selection method.

The result of this sub-question will be an overview of all innovation idea selection methods that could potentially be relevant to a service firm, in this case being Schiphol Group ASM. How well these methods fit with the goals, requirements and assumptions of the department is assessed in a later sub-question, SQ4. This will tell which (parts of the various) methods have a good fit with ASM.

**SQ2: What does the innovation process, of which idea selection is part, look like for ASM?**

a. What are the goals that ASM aims to achieve with innovations?
b. What is the innovation process currently employed by ASM?
c. How is selection of innovation ideas currently done at ASM?
d. What is the effectiveness of the current innovation process and idea selection method as perceived by ASM?

By answering this sub-question, the innovation process and the innovation idea selection method currently employed by ASM are made explicit. Now it is unclear whether ASM does not have a formal method of selecting innovation ideas or that it does, but implicitly. This will become clear through this sub-question. Before this, it is necessary to clarify why Schiphol Group ASM wants to innovate, what the goals of the department are in terms of innovations. This will be done by interviews and studying department documents. By answering this question, an overview will be created of the current innovation process employed by ASM, the selection method currently applied, and how well the current selection method performs. Comparing the current situation with the results of SQ1, stating the 'ideal situation' from scientific literature, will give initial direction in the possibilities of solutions.

**SQ3: What are the goals, requirements and assumptions for a sustainable innovation selection method of Schiphol Group ASM?**

This sub-question will help in creating a sufficiently clear picture of what exactly it is that Schiphol Group ASM wants to achieve with the implementation of a (sustainable) innovation selection method, or the goal. The requirements indicate the functions the method should fulfil, given the goal. The assumptions state what qualities the users and context should have to
make productive use of the method. Furthermore, it defines acceptance criteria for the evaluation of the design artefact.

**SQ4: Based on the results of SQ1, SQ2 and SQ3, what are the structural specifications of the prototype of the sustainable innovation selection method for Schiphol Group ASM, and how can it be used?**

The methods investigated in SQ2 are compared to the goals, requirements and assumptions found in SQ3. By looking at which building blocks of various methods found in SQ2 best fit the goals, requirements and assumptions found in SQ3, parts of these methods can be mixed and matched to create a tailor-made method for ASM. An explanation of this process can be found in §4.2. The results of the previous sub-questions will provide enough information as input for determining the structural specifications (the design features) of the method. These are the characteristics, aspects and parts that the method must possess to be able to fully satisfy the set of requirements and assumptions (Verschuren & Hartog, 2005). Using this, realisation of the design into a prototype will be done. This results in a prototype of the method for selecting sustainable innovation ideas that suits the wishes and needs of ASM.

**SQ5: How can the prototype of the method for selecting (sustainable) innovation ideas be implemented for testing in ASM?**

Next, the prototype must be put into practice in a real-life context, as a first check. For this, a context must be realised that is compliant with the assumptions as defined in SQ3 (Verschuren & Hartog, 2005). A test protocol must be drafted, to be able to receive the necessary feedback. After this, the efficacy of the method will be tested with the next question:

**SQ6: How does the prototype perform?**

a. How well does the prototype realize the goals and meet the requirements and assumptions?

b. Which parts need to be redesigned?

This sub-question will test the method. It will evaluate the design based on acceptance criteria defined in sub-question 2. The prototype will be tested in a first user test. This step will tell if the method performs as wished and might result in some alterations to the method. For this sub-question it is important to know how the performance of the prototype can be tested based on the acceptance criteria defined in sub-question 2.

For the selection method to be incorporated in the standard working practices of ASM, a plan for implementation will have to be created. This is intentionally left out of the scope of this research due to time constraints, as this would require a whole research into implementation literature. However, my thoughts on the issue will be reflected in the recommendations.

### 1.5 Research approach

In this sub-chapter, the research approach will be explained. The research method will be explained first, explaining how the sub-questions are answered. After that, a table with an overview of the expected results is shown.

#### 1.5.1 Research method

As explained in detail in chapter 2, design-oriented research has a designing cycle of six steps. To be able to answer the research question, the sub-questions must be answered in different steps of the cycle. Here, I will explain which research sub-question will be answered in which step of this cycle, and how.
The *First hunch* part of the designing cycle has been initiated by talking to various people within the organisation, in determining a problem definition for this research. Based on this problem definition, the literature review will be executed. This step provided a first indication of the design goals, which are complemented by SQ3.

Sub-question 1 will be answered by a thorough literature review. The build-up of the literature review follows a natural path. First, the innovation process is described, based on various streams within the literature. Second, the selection methods for innovations are explained, as these are part of the innovation process described previously. After that, the criteria important to innovation selection methods are elaborated on. The literature review is done before the interviews, to acquire the knowledge to be able to ask more focused questions.

The second step of the designing cycle, *Requirements and assumptions*, will provide the answers to research sub-questions 2 and 3.

From answering sub-question 2, the current situation at ASM will become clear. The question will be answered by desk research on department documents, and face-to-face expert interviews with 7 people within the organization. These people will mainly be from the department ASM, on various layers where decisions are made about innovations (selection). It is important to interview the right persons in the organization to get a sufficiently complete view of the current situation. Getting this right will be the priority before starting with the interviews. The exploratory in-depth expert interviews will help in creating an overview of the current situation and will provide points of improvement of the current innovation process and selection method, which will be used in designing the selection method later. SQ2 will further be answered by a desk research on company documents and presentations, to verify the answers of the interviews.

SQ3 will be answered by the same interview as used for SQ2. From this interview, an overview of the goals, requirements and assumptions of the selection method will become clear. This will also result in a list of acceptance criteria for the artefact to be designed, which will be used in the evaluation of the design later. These will not only be validated by the participants of the semi-structured interviews, but also by the participants of the first user test, which will be explained later.

Sub-question 4 will be step 3 and 4 of the designing cycle as explained in §2.1, *structural specifications* and *prototype*. This is the actual design part of the cycle. It will use all the input of the previous sub-questions, and results in a prototype that can be tested. In this phase, it is important to keep in balance the effort put in constructing and evaluating the evolving design artefact (Hevner, 2007). After the *structural specifications* phase of the designing cycle, a document with a draft of the design in full detail is produced. First, a rough design is made based on the outcome of the previous sub-questions.

After that, realisation in the *prototype* phase yields a prototype. This embodies the complete design and can be used for empirical evaluation. In this phase, the first step is to compare the “building blocks” from SQ1 to the goals, requirements and assumptions of ASM found in SQ3. By doing this, a tailor-made selection method can be created, helped by the input from the interviews.

Sub-question 5 will be associated with step 5 of the designing cycle, *implementation*. For this, a context must be realised that is compliant with the assumptions. This context has previously become clear from sub-questions 1 and 3. From this, the participants that are involved with using the method will be identified. The participants, from Schiphol Group, might require some explanation to be able to use the method. To find out how to implement the selection method
and test the method and to acquire use data to answer sub-question 6, a desk research can be performed.

Sub-question 6 will be answered by a first user test, where the selection method is used in the real-life context. The participants will use and be asked to evaluate the designed selection method. During this first user test, the participants will be observed while using the prototype of the selection method. After the test, a focus group will be held to discuss the method. Finally, the participants will be asked to fill in a questionnaire concerning the prototype. Their perceived effectiveness, usability, and fit with the department of the method are among the factors that will be used to evaluate the method, but the comprehensive set of acceptance criteria will have become clear from sub-question 3.

1.5.2 Results
The research approach as explained above will provide the results of the sub-questions. In Table 1, an overview of the methods and type of results are presented per sub-question. Between brackets is the amount necessary of each source. An asterisk behind the source indicates that a source has been used for multiple sub-questions.
Table 1: Results per research question

<table>
<thead>
<tr>
<th>SQ 1</th>
<th>Sources</th>
<th>Method</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>LITERATURE</td>
<td>Books on innovation management</td>
<td>Literature review</td>
<td>“Building blocks”, taken from the overview of innovation idea selection methods that are potentially useful for service organisations, and ASM. Also taken from information on how sustainability is considered in selection of innovation ideas.</td>
</tr>
<tr>
<td>Articles on innovation process, selection methods, sustainability assessment, SOI, success/failure factors</td>
<td>Literature review</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>SQ 2</th>
<th>PEOPLE</th>
<th>DOCUMENTS</th>
<th>Method</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEOPLE</td>
<td>People from various layers and parts of ASM (7)</td>
<td>Face-to-face interviews</td>
<td>An overview of the innovation process at ASM, with the intended goal of the department. Also, an explicit description of how (sustainable) innovation ideas are currently selected within the department. The result of SQ 2 will provide improvement possibilities, which will be addressed by this research.</td>
<td></td>
</tr>
<tr>
<td>DOCUMENTS</td>
<td>Presentation ASM strategy</td>
<td>Desk research</td>
<td></td>
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<tr>
<td></td>
<td>Annual report Schiphol</td>
<td>Desk research</td>
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<td></td>
<td>Strategic ASM Plan</td>
<td>Desk research</td>
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<td></td>
<td>Project Initiation Documents</td>
<td>Desk research</td>
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<table>
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<th>SQ 3</th>
<th>PEOPLE</th>
<th>DOCUMENTS</th>
<th>Method</th>
<th>Results</th>
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<tr>
<td>PEOPLE</td>
<td>People from various layers and parts of ASM (7)</td>
<td>Face-to-face interviews</td>
<td>A document with the Goals, Requirements and Assumptions for the selection method to be designed. The requirements will also act as a list of acceptance criteria for the evaluation of the designed method in a later stage.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SQ 4</th>
<th>DOCUMENTS</th>
<th>Method</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOCUMENTS</td>
<td>Results from previous sub-questions</td>
<td>Design</td>
<td>This sub-question will provide a first prototype of the innovation selection method. The shape of this will be dependent on the results of the previous sub-questions. The building blocks taken from the literature will be combined to create a prototype that fulfils the design goals and meets the requirements.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SQ 5</th>
<th>DOCUMENTS</th>
<th>Method</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOCUMENTS</td>
<td>Written results from previous sub-questions</td>
<td>Desk research</td>
<td>A test protocol for the testing of the prototype. This includes a context that complies with the assumptions, which will be clear from SQ 3. This will determine the conditions for the field test of SQ 6.</td>
</tr>
<tr>
<td></td>
<td>Documents on how to set up a test protocol</td>
<td>Desk research</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SQ 6</th>
<th>PEOPLE</th>
<th>Method</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEOPLE</td>
<td>People from various layers and parts of ASM (5)</td>
<td>Observations during first user test</td>
<td>This first user test will act as an evaluation of the prototype. This act as input for a redesign, finally resulting in an adjusted selection method.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Focus group</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Questionnaire</td>
<td></td>
</tr>
</tbody>
</table>

1.6 Overview thesis
In the following chapters, this report presents how the research sub-questions have been answered, to ultimately answer the main research question. First, chapter 2 will present the research methodology followed during this research and the various methods of data collection applied. Next, the current situation within ASM is compared to the “ideal” situation as presented by various literature streams in chapter 3. The current situation provides the design goals, requirements and assumptions, presented in chapter 4. Furthermore, the literature review of chapter 3 provides interesting design details, which are used in chapter 4 to create a sustainable innovation selection method for ASM. How the design details are combined is explained here, resulting in a prototype. The prototype of the design as explained in chapter 4 has been tested, and the results of this test are presented in chapter 5. The design alterations
made based on the results of this test are also explained in this chapter. Chapter 6 presents the process other service firms can follow to create their version of the sustainable innovation selection method, accompanied by the design rules. Finally, chapter 7 contains the conclusions of the research, the practical and theoretical contributions, a discussion on the research approach and on the selection method design, and recommendations for future research and for Royal Schiphol Group.
2. Methodology

This chapter will explain the research strategy followed for this research. The research was performed according to the Design-Oriented Research method, which is a guideline for research aiming at solving construction or inventive problems. This method is explained first in §2.1, providing an overview of how the research is shaped. After that, the methods of data acquisition are explained in §2.2. The set-up of the semi-structured expert interviews and the first user test is explained in detail here.

2.1 Design-Oriented Research

In the field of organization and management, academic research products have a problematic relevance issue (Van Aken, 2005). Most of the research methodologies are aimed at knowledge just for knowledge (Verschuren & Hartog, 2005). “The modern research university is hampered by a belief that the discovery of new ideas is the only path” (Denning, 1997, p. 133). A possible answer to this is the Design-Science research paradigm.

Design-Science Research (DSR) has since roughly two decades been used in Information System (IS) research field, but the use of this approach is certainly not limited to IS. Design science creates and evaluates artefacts intended to solve identified organizational problems. For IT, these artefacts can be represented in the form of software, formal logic, rigorous mathematics or informal natural language descriptions. In other fields than IT, the artefact can take shape as organizations, policies, work practices, and many more. The fundamental principle of DSR is that “knowledge and understanding of a design problem and its solution are acquired in the building and application of an artefact” (Hevner, March, Park, & Ram, 2004, p. 75). In another paper, Hevner (2007) presents an IS research framework with a focus on three inherent research cycles, which must be present and clearly identifiable in a DSR project. In Figure 5, the research framework can be seen.

The relevance cycle connects the environment of the research with the design science activities. The application domain consists of the people, the organizational and technical system that all work towards achieving a goal. From studying the application domain, the problems and opportunities are identified, which provide not only the requirements of the design research, but also defines criteria for the evaluation of the research results.

The design cycle is a cycle that iterates between the build and evaluation of an artefact. This cycle will be elaborated a bit further below.

Figure 5: Research cycles a DSR project should have, according to Hevner (2007)
The rigor cycle connects the design activities with existing knowledge. The research project is informed from this base of existing knowledge, providing past knowledge to ensure innovation. This cycle is important to guarantee that the design artefact is research contribution, and not just routine design based on known processes (Hevner et al., 2004).

Verschuren and Hartog (2005) focus in their paper on Evaluation in Design-Oriented Research on research aiming at solving construction or inventive problems, or so-called design-oriented research. According to them, an artefact that is being designed should satisfy a set of design criteria, meaning that evaluation must play an important role in the design process. Research-oriented design has the primary objective of producing an artefact – material or immaterial – and in the process answering to the problems and real-world obstacles that are faced. For the design of an artefact, they follow the so-called designing cycle, as a counterpart of the intervention cycle. The designing cycle consists of 6 stages: The first hunch phase, the requirements and assumptions phase, the structural specifications phase, the prototype phase, the implementation phase, and the evaluation phase. This designing cycle will be explained below:

1. **First hunch.** This is the initiative for constructing a new artefact. From this stage, a small set of goals [G] that the artefact must realise will be the main result. In this case, the goal is to have a selection method that helps service firms in more effectively selecting sustainable innovation ideas to implement.

2. **Requirements and assumptions.** With the goals [G] from phase 1, the requirements [R] to be fulfilled must be specified. There are 3 main types of requirements. Functional requirements [R_f] are the first and indicate the functions the artefact should fulfil after realisation, given the goals [G]. The second set of requirements to be fulfilled regards the interface between the artefact and the “world outside”, or the user requirements [R_u]. The third category of requirements are prerequisites set by the social, economic, political and legal environments, or contextual requirements [R_c]. For this research, the functional requirements can include that the method must be able to discriminate between (wildly) varying innovation ideas. The user requirements are based on the department and people working with the method in the future.

   Apart from the requirements that the artefact must fulfil, the designer/researcher must also specify what qualities the context and future users should have. This is necessary to make effective use of the artefact possible. These qualities are denoted as assumptions [A]. These assumptions again may regard the functions [A_f], users [A_u] and context [A_c].

3. **Structural specifications.** This is the structure of the artefacts, derived from the design requirements [R] and assumptions [A]. To be able to satisfy these, this step derives the parts, aspects and characteristics the artefact can possess.

   After these 3 steps are completed, a first draft of the design in full detail of the artefact will be produced. This is composed of a general design (overall architecture) and a specific design. The decision making in the general design is of strategic nature, and during the specific design the decision making is of operational nature (Verschuren & Hartog, 2005). After this, the next step is performed:

4. **Prototype.** In the case of an immaterial artefact, this step is realisation of a prototype, and for a material artefact, it is materialisation of a prototype. This is the complete design and can be used for empirical evaluation.
5. **Implementation.** The prototype is in this step put into practice, to check its workings in the next stage. Preferable this is done in a real-life context, so a context must be realised that complies with the assumptions of step 2.

6. **Evaluation.** In this step, it is checked how and how well the prototype accomplishes the design goals [G], requirements and satisfies the designers’ and stakeholders’ expectations.

If it becomes clear in step 6 that the artefact does not fully meet the goals and the expectations and requirements of the stakeholders, which happens often, a second run of the designing cycle can be started. If the evaluation of step 6 is able to pinpoint the stage where the deficiencies occurred, the second designing cycle can start in that stage. Verschuren and Hartog (2005) stress the importance of evaluation during the whole designing process, even though the last 2 stages are specifically aimed at evaluating.

Although the designing cycle is written down linearly in 6 steps, it is an iterative process with constant evaluation.

The designer/researcher must go back and forth between the stages continuously, to check what the result of a decision in a certain stage is to other stages. The cycle has a few benefits. It is relatively “light-weight”: After 1 cycle through the designing process, a working and testable prototype is delivered, the evaluation of which presents the input for the second designing cycle.

2.2 Data collection

In this sub-chapter, the various methods of data acquisition are explained. In chapter 1, it has been discussed in which manner the various research (sub-) questions are answered. In the current sub-chapter, it is explained how the various methods of data acquisition are structured and executed.

2.2.1 Expert interviews

**Goal**

The goal of the expert interviews is to acquire the knowledge to answer SQ2: “What does the innovation process, of which idea selection is part, look like for ASM?” and SQ3: “What are the goals, requirements and assumptions for a sustainable innovation selection method of Schiphol Group ASM?”. By employing semi-structured interviews, a fairly holistic view of the current innovation process can be created. The exploratory in-depth interviews will help in creating a clear overview of the current situation and the problem. Furthermore, in trying to uncover all the goals, requirements and assumptions, the interviews will be better in achieving this than for instance a questionnaire.

To be able to answer the 2 sub-questions, the interview will cover multiple topics. The interviews are of a qualitative nature. Sub-question SQ2 is further split up in four parts, with every part being a topic of the interview. SQ 3 forms the fifth topic of the interview.

**Selection of interviewees and location**

The selection of interviewees is done within Schiphol Group, as the innovation idea selection method is designed for this organisation. With help from my company supervisor and various other people in the department ASM I made a list of people involved in and responsible for innovations, sustainability, innovation selection decisions and the strategy of the ASM department. As all the interviewees are people within the organisation of Schiphol Group, the interviews are face-to-face and are held in the main building of Schiphol Group. The interviewees have been approached in person or via internal e-mail.
The selected interviewees can be seen in Table 2. In appendix B, a description of all participants and why they have been selected can be found.

Table 2: Semi-structured expert interview participants

<table>
<thead>
<tr>
<th>Participant</th>
<th>Gender</th>
<th>Function</th>
<th>Department</th>
<th>Years at Schiphol</th>
<th>Education level</th>
<th>Age</th>
<th>When</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M</td>
<td>Strategic Advisor</td>
<td>A/ASM/TC/EP</td>
<td>&gt;3</td>
<td>MSc,MBA.</td>
<td>35+</td>
<td>24-4-2018</td>
</tr>
<tr>
<td>2</td>
<td>M</td>
<td>Strategic Advisor</td>
<td>A/ASM/TC/EP</td>
<td>&gt;3</td>
<td>BSc</td>
<td>30+</td>
<td>25-4-2018</td>
</tr>
<tr>
<td>3</td>
<td>F</td>
<td>Senior Manager</td>
<td>A/ASM/DV</td>
<td>&gt;5</td>
<td>MSc.</td>
<td>45+</td>
<td>25-4-2018</td>
</tr>
<tr>
<td>4</td>
<td>M</td>
<td>Strategic Advisor</td>
<td>A/OPS/PDC</td>
<td>&gt;10</td>
<td>MSc.</td>
<td>45+</td>
<td>7-5-2018</td>
</tr>
<tr>
<td>5</td>
<td>M</td>
<td>Strategic Advisor</td>
<td>A/ASM/TC/EP</td>
<td>&gt;4</td>
<td>MSc.</td>
<td>30+</td>
<td>8-5-2018</td>
</tr>
<tr>
<td>6</td>
<td>M</td>
<td>Senior Manager</td>
<td>A/ASM/TC/EP</td>
<td>&gt;17</td>
<td>BSc.</td>
<td>45+</td>
<td>8-5-2018</td>
</tr>
<tr>
<td>7</td>
<td>F</td>
<td>Business Owner</td>
<td>A/ASM/SO</td>
<td>&lt;1</td>
<td>MSc.</td>
<td>35+</td>
<td>15-5-2018</td>
</tr>
</tbody>
</table>

Interview procedure

The expert interviews had a semi-structured nature. To create an overview of the current situation and identify possible improvements, 5 main topics were prepared: Goals of innovating for ASM, current innovation process, current selection method, effectiveness of current innovation process and selection method, requirements. These topics were accompanied by a list of questions. The interview questions can be found in Appendix A. Because the interview itself is merely a part of the whole interview procedure, the procedure is explained below:

1. **Invite:** The participant, chosen in consultation with my graduation supervisor at Schiphol, was approached in person or via internal mail. An introduction of this research was provided, along with a motivation of why I found it useful to interview the participant in question.

2. **Prepare:** When the participant agreed to help with an interview, the interview was prepared with a small background study on the participant. In this phase, the interview topics were also prepared. The interview protocol, including the questions, can be found in appendix A. Note that as the interviews were semi-structured, not all questions have been asked literally and answered during all interviews.

3. **Execute 1:** The first step during the interview itself was an introductory part. In this, I gave a short introduction of myself, the research topic, the goal of the interview, the contents of the interview and asked for permission to record.

4. **Execute 2:** After that, the interview took place. I took notes in my notebook and recorded the whole interview. By taking notes and keeping track of the topics, I made sure all themes were covered. Again, not all questions were asked literally, and I adjusted my questions according to the interview.

5. **Reporting:** The interviews were reported directly after the interview was over. The reports were made based on the sound recordings and notes taken to make a more complete story. The detailed reports have the layout as seen in Table 3. In appendix C, the overview of the answers given can be found.
**Table 3: Layout interview reports**

<table>
<thead>
<tr>
<th>Text unit</th>
<th>Functions</th>
</tr>
</thead>
</table>
| **Introduction** | - Subject  
- Date of interview  
- Name interviewer  
- Name and age interviewee  
- Function in organisation, education, previous work experience  
- Duration of interview  
- Location of interview |
| **Core**      | - The course of the interview itself. The answers are transcribed from the recordings and can be found here.                               |
| **Conclusion** | - Characterisation of the interview and interviewee (atmosphere, behaviour)  
- Remarks on reliability and accuracy of information (consistency of answers)  
- Possible further agreements |

This procedure was done for every interview, to generate the necessary output. Supporting materials were a smartphone to record the conversations, a notebook and pen to write down quick reminders and a printed topic list with supporting questions. The topics, as explained before, were divided as such to be able to answer SQ2 and SQ3 based on the interviews.

**Analysis**

Due to the nature of semi-structured interviews, not all answers were given following the appropriate question. For example, when asking how the current innovation process looks like, requirements for the selection method already surfaced. To make sure the right answers were used, the results were accumulated and coded. So, with the transcribed interviews, the first step of the analysis is open coding. The transcribed interview is analysed, and codes are appointed to fragments of text, indicating the main theme of the fragment in question. The coding is done in Atlas.ti, for ease of use and visualization. With these codes, an overview was made to see what all participants had to say about all the various topics.

![Figure 6: Interview analysis](image)

In Figure 6, it is made visual what information is retrieved from the interviews, and for which chapters the information is used.
Once coding has been done, the results were analysed to determine the answers to SQ2 and SQ3. The answers given by the participants were analysed to find the aggregate opinion on the current situation. The results of the interview topics have been translated into an overview of the current situation within Schiphol Group ASM, which can be found in §3.3. Furthermore, the results of the interviews provided design goals, requirements and assumptions for §4.1. The table with an overview of all answers on the various topics can be found in appendix C.

After 7 interviews, the picture that emerged from the interviews was considered complete enough. There was enough saturation, and as the participants can be considered experts in the field of (sustainable) innovation in the department, it was determined that the gathered information painted a complete picture of the current situation, goals, requirements and assumptions.

**Validation**

Validation of the interviews was done through 4 ways. First, questions were asked twice to see if the answers are consistent. Secondly, the background and experience of all participants was checked, to see if they are knowledgeable in the field of innovation (selection) in the department ASM. Finally, after all interviews were held, a summary was sent to the participants, with a question for feedback. If the participants agree with the summary of the findings from the interview, I know I have summarized the answers completely and correctly.

Furthermore, reports, documents and presentations of the department have been used to validate the answers given by the interview respondents. These included the Annual Report of 2017 (Royal Schiphol Group, 2018), the Strategic Asset Management Plan (SAMP) (Felten, 2017), Project Initiation Documents (beslisdocument) of various innovations, and presentations given to the MT for further explanation of the Project Initiation Documents.

**Conclusion**

The interviews, as described in this subchapter, were initiated to be able to answer SQ2 and SQ3. Semi-structured interviews were chosen, to create an overview over the situation, the problems and the requirements, but to also be able to steer the conversation towards the 5 topics of interest. An interview guideline has been described, that makes it possible to obtain the required data from the interviews. With help from my thesis supervisor, one of the interviewees as well, I made a list of experts on the topics of my research. The output of the interviews is used in §3.3 and §4.1 and is an important step in the design of the (sustainable) innovation selection method. Validation of the results of the interviews has been done by summarizing answers and repeating questions, to check for consistency. The background of the participants was checked by checking LinkedIn and asking personally, to verify that the participants had the required knowledge. Furthermore, the interview participants were asked for a reaction on the results obtained. Finally, company and department documents and presentations were used to verify the answers.

**2.2.2 First user test**

**Goal**

The goal of the first user test is to get a first evaluation moment on the prototype, to receive feedback on the first designing cycle. In this evaluation stage, stage 6 of the designing cycle, the prototype (created in stage 4) is implemented in a real-life context (stage 5). In this evaluation stage, it is checked how and how well the prototype accomplishes the design goals [G], requirements and satisfies the designers’ and stakeholders’ expectations. Based on the results and feedback of this first user test, the second design cycle can be started.
By drafting the test protocol, it becomes possible to answer SQ5: “How can the prototype of the method for selecting (sustainable) innovation ideas be implemented for testing in ASM? Even more interesting perhaps, is that by performing this first user test, both sub-questions of SQ6 can be answered: “(a) How well does the prototype realize the goals and meet the requirements and assumptions? (b) Which parts need to be redesigned?” By answering these, SQ6 will be answered fully: “How does the prototype perform?”

The first user test will provide 3 sources of data: An observation during the first user test, a focus group and a questionnaire. With this triangulation of data sources, it will be able to capture all dimensions of feedback on the selection method. The observation will look at both the selection process and the criteria used in the method, the focus group will be tailored towards the selection process, and the questionnaire will be focused on the criteria and scales. Further below, a more elaborated explanation of the test set-up is provided.

Selection of participants for user test

The first user test has been performed in a group setting with 5 people of various departments of Schiphol. To meet requirement R4 of the selection method, as explained in §4.1, the group consists of 3 people from the department ASM, 1 from OPS (Operations) and 1 from CR (Corporate Responsibility). This way, the composition of the group for the test is representative of the group composition of when the selection method is put to actual use. This group composition is also in compliance with the design requirements, which state that the appropriate external stakeholders must be included in the process. In §3.3.3 and §4.3, an explanation is given as to why people of these departments are included in the selection method. In Table 4, an overview of the user test participants is given.

Table 4: First user test participants

<table>
<thead>
<tr>
<th>Participant</th>
<th>Gender</th>
<th>Function</th>
<th>Department</th>
<th>Years at Schiphol</th>
<th>Education level</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M</td>
<td>Strategic Advisor</td>
<td>A/OPS/PDC</td>
<td>&gt;10y</td>
<td>MSc.</td>
<td>45+</td>
</tr>
<tr>
<td>2</td>
<td>M</td>
<td>Sr. Specialist Civil Engineering</td>
<td>A/ASM/TC/EP</td>
<td>&gt;2y</td>
<td>MSc.</td>
<td>30+</td>
</tr>
<tr>
<td>3</td>
<td>F</td>
<td>Product Manager</td>
<td>A/ASM/SO/UT</td>
<td>&gt;1y</td>
<td>MSc.</td>
<td>25+</td>
</tr>
<tr>
<td>4</td>
<td>M</td>
<td>Manager Developer</td>
<td>A/OPS/PCD/PD CR</td>
<td>&gt;10y</td>
<td>MSc.</td>
<td>45+</td>
</tr>
<tr>
<td>5</td>
<td>M</td>
<td>Strategic Advisor</td>
<td>A/ASM/TC/PD</td>
<td>&gt;9y</td>
<td>MSc.</td>
<td>40+</td>
</tr>
</tbody>
</table>

First user test procedure

The first user test provided 3 sources of data for the evaluation of the prototype of the selection method. First, the participants were observed while using the selection method. Secondly, a focus group is held after using the selection process, to discuss the structure of the selection process, the objectivity and fairness of the process, and whether it achieves the goals and meets the requirements or not. Finally, a questionnaire is filled in, in which the criteria and the scales of the selection process are evaluated. In Figure 7, the first user test set-up can be seen.
The various steps of the first user test are explained further below:

1. **Invite:** The participants, again chosen in consultation with my graduation supervisor of Schiphol, were approached in person or through internal e-mail. For the uninitiated, an introduction of this research was given. All participants received an explanation of the goals of the first user test, and a time schedule of the test.

2. **Prepare:** In this phase, the test set-up was prepared. The questions for the focus group were formulated and the questionnaires were created. The questions for the focus group were formulated to receive feedback on the general design of the selection method, the questions for the questionnaires were formulated to receive detailed feedback on the criteria and scales used. The idea generation/collection (Figure 7) was done by me, previously to the first user test. For the sake of time, 3 innovation ideas were included in the first user test run. 2 of these innovation ideas were retrieved from employees of ASM, who filled in a standard innovation idea submission form, which can be found in appendix G. I also wanted to test whether an innovation that was brought in by a member of the group performing the selection process, in this case a test participant, would be judged differently. To achieve this, I asked the group of test participants to add 1 more innovation idea during the meeting, before commencing screen 1. The Excel sheet that is used to calculate the scores and create the visuals for round 3 was prepared, and the scoring forms were printed. The innovation ideas were printed, and the goals and requirements were printed for the focus group.

3. **Introduction/explanation:** During the first part of the meeting for the first user test, I gave a small introduction on my research, explained how the selection process looks like, and explained how the first user test was shaped. Detailed information on the design of the selection process that was tested in the first user test can be found in §4.3. To be able to test screen 1 and screen 2 of the selection process, these rounds were included in the group setting of the first user test. Normally, these rounds are not done in a group setting but individually. Because of this, the test participants were instructed to not discuss/talk during these rounds, so they could not influence each other. They were of course allowed to ask questions about screen 1 and 2 if things were unclear. During screen 1, 2 and 3, the participants were observed to see if there were any unclarities for the participants while doing the screens, or other questions arose. The summary of the observations can be found in appendix D.

4. **Adding the third innovation idea:** After the introduction, the group of participants could discuss and add 1 more innovation idea to be screened in the first user test. They
agreed to add one idea of one of the participants, who was able to explain this innovation concisely.

5. **Screen 1**: After the third innovation idea was added, the participants were asked to fill in a form for screen 1: Must-meet criteria and showstoppers. As said before, they were not allowed to discuss during this round. After this round, the forms were collected and examined by me. If more than 50% of the respondents, so in this case 3, answered a NO on one of the criteria of an innovation, the innovation was dropped out of the process and excluded from entering round 2. This was done after the differences in opinion were discussed first.

6. **Screen 2**: During this round, the participants were asked to fill in a scoring form for the innovation ideas. Again, they were not allowed to discuss, but they could ask me questions when uncertainties arose about round 2. When the forms were completed, the results were collected in an Excel sheet, in which the scoring model transformed the scores into a result overview, graphs and matrices. The results were then printed and given to all participants.

7. **Screen 3**: In this screen, the participants could discuss the outcome of round 2 based on the overview and graphs. Striking results were discussed, and the participants were able to elaborate on various scores. Based on the results, the graphs and the discussion, the participants were asked to fill in a form for screen 3, in which they could indicate an advice for which innovation idea is best in their eyes.

8. **Focus group**: After the selection process was used for a first time, I performed a focus group with the test participants, to get general feedback on the structure of the selection process. During this interactive session, I asked questions and the participants were free to discuss and answer these. I printed an overview of the goals and requirements for all participants, to enable them to answer the questions whether the selection process meets the requirements and (fully) achieved the goals. The conversation was recorded to be able to listen back the vital points. The questions and a summary of the answers of this session can be found in appendix E.

9. **Questionnaire**: After this all has been done, the test participants were given a questionnaire, which focused on the criteria used in the 3 screens. In this questionnaire, questions were asked to find out whether the criteria used are operational (easy to use), realistic (make use of available information) and differentiating (differentiate between good and mediocre projects). These three factors were asked, as these are indicators for strong decision criteria (Cooper et al., 2002a). Furthermore, the completeness of the criteria is checked and the scales. The questionnaire with a summary of the answers can be found in appendix F.

**Analysis**

The observations made during the first user test were compared to the answers given on the questions of the focus group and the questionnaires. The combination of the observations and the answers given during the focus group and in the questionnaire provide the answers for SQ6 a and b. The results provide input for design alterations and can be found in §5.1. In this chapter, an overview is given of the goals and requirements, and whether the participants believe these are achieved. Based on these results, the prototype can be adapted. This adaptation, part of the second designing cycle, can be found in §5.2.

**Validation**

Validation of the results of the first user test is done through 3 ways again. Firstly, the participants were carefully selected as to match the group composure of when the selection process is used. Secondly, the background and experience of the participants was checked to see if they have the appropriate knowledge and experience. Finally, observing the test
participants during the first user test makes it possible to see whether the answers given in the focus group and on the questionnaires are in accordance to (observed) reality.

**Conclusion**

The first user test, as described in this sub-chapter, will provide the answers to SQ5 and SQ6. By doing so, the first designing cycle is finished. Based on the results of the test, the selection process can be redesigned in designing cycle 2. The first user test, consisting of a focus group, questionnaire and observations, provide answers to the question whether design goals and requirements are achieved, and whether the users are satisfied. The test procedure is described, in which an explanation is given of the parts of the selection process that are tested. The results of this first user test provide input for §5.1 and §5.2.
3. Comparison of literature and current situation

The first step in this research is to compare the current situation within ASM with the ‘ideal situation’ as dictated by scientific literature. The analysis of the current situation provides “problems” or improvement possibilities, the scientific literature can provide solutions. In this chapter, the literature review is discussed first in §3.1. After that, the literature is reflected in §3.2. This is done in respect to service firms and in respect to ASM. Also, the building blocks retrieved from the literature streams are presented. Then, §3.3 describes the current situation within the department ASM in terms of innovation management. Finally, a small conclusion is presented in §3.4. In each sub-chapter, a more detailed description is given of the contents and possible further sub-division of the sub-chapters.

3.1 Literature review

The first step in the research of developing an innovation selection method for the department Asset Management (ASM) of Royal Schiphol Group is a literature review. Because it is used as part of the designing cycle, it is done after the methodology chapter. This was done to create an overview of which methods exist and how these are used, to gather knowledge on which (parts) could be applicable for a service organisation, and ASM. In this chapter, the literature that has been reviewed will be presented. For this research, I determined it was useful to do a literature review on various fields, explained below. Where possible, the various literature streams were reviewed with a focus on service firms, but this was not possible in every field as services have received significantly less attention in the innovation literature.

Because innovation selection is merely one part of the innovation process, I first looked at the innovation development process. There are various ways of describing and guiding the innovation process. These descriptions cover different facets of the innovation process. One of the largest streams in the innovation development process literature is the “Stage-Gate” method, which can be found in §3.1.1. Originally intended for managing new products, it has been altered to manage new service development as well. When searching for innovation process, the “Stage-Gate” literature is the first and largest stream emerging, hence the inclusion in this literature review.

Agile, originally for software development, is currently also one of the largest (innovation) project development methods. This is explained in §3.1.2. It is the largest “contestant” of “Stage-Gate” and is subsequently included in the literature review. Whereas “Stage-Gate” is a project management model for managers, Agile is a bottom-up approach focusing on simplifying the development process and focusing on the wishes of the client.

Another one of the most well-known ways of describing and structuring the innovation process, the innovation funnel, was researched after that and can be found in §3.1.3. As “Stage-Gate” looks towards innovation development on the project level, it might not be useful for selecting innovation ideas. The funnel looks at the “group-level”, making it possible to compare various innovation ideas and select accordingly. Due to this, this literature field has been included in the literature review. Recently new in the field is the open innovation “Stage-Gate” model, a combination between a funnel and “Stage-Gate”. This is also addressed in the literature review, as many service firms are involved with open innovation.

As many firms have evolved from a “Stage-Gate” approach towards a portfolio management approach, this field of knowledge has also been studied and is explained in §3.1.4. Portfolio
management encompasses the selection and managing of a portfolio of (innovation) projects. It is “A dynamic decision process, whereby a business’s list of active new product and R&D projects is constantly updated and revised” (Cooper, Edgett, & Kleinschmidt, 2006, p. 4). Because this approaches the reality of a firm, in which a selected innovation project is constantly re-evaluated, this field of literature is included. Again, the link with open innovation is clearly made and researched.

From all the researched literature as discussed, it became clear that there are many methods of screening/evaluating/selecting innovation ideas, and that idea selection is an important part of the innovation process. So, which are interesting for an infrastructure-providing service firm, and are included in the literature research?

Henriksen and Traynor (1999) provide a list of categories of selection methods: Unstructured peer reviews; scoring; mathematical programming; economic models; decision analysis; interactive methods; artificial intelligence; portfolio optimization. In the literature, there is discussion on whether it is better to have a formal or informal evaluation method, which is addressed in §3.1.5. Here, the criteria on which project/innovations are evaluated in various evaluation methods is explained. An overview is given of various quantitative and qualitative selection methods, and their evaluation criteria. A distinction is made between selection on project level and on group level, as selection happens differently on these two levels.

The field of New Product Screening methods is addressed in §3.1.6. This field has been included as it is advanced field of knowledge on screening new product ideas, providing valuable knowledge for innovation idea screening within service firms. New Product Screening models are widely used to predict the success or failure of a variety of product concepts. Different screening models are explained.

There is a large body of literature on success and failure factors for innovations. These are also used in screening innovation ideas and can be read in §3.1.7. As explained previously, screening models are used to assess the probability of success or failure of ideas. To do this, success and failure factors are necessary to be included in the literature review. Most literature on success/failure factors is tailored towards product innovations, but a research on success/failure factors for service innovations is also presented.

Because many of the success/failure factors are external and cannot be directly influenced by a firm, more attention is given to factors influencing the adoption of an innovation in §3.1.8. A summary of the 11 factors that have shown to have the most influence on innovation adoption is given, as presented by Klaasse Bos (2007). These factors have been included in the literature review because many infrastructure-providing service firms operate in a network setting, as explained previously. Because of this, external stakeholders must be willing to accept/adopt innovations, and increased adoption means a more successful innovation idea.

After that, §3.1.9 discusses the field of Sustainability-Oriented Innovation. The previously discussed literature is about the screening/selection of innovation ideas to select the most profitable/successful innovation projects. However, this is currently not the only concern for many firms, as they want to become more sustainable as well. A philosophy that can be followed to achieve this is the Sustainability-Oriented Innovation philosophy, hence the inclusion in the literature review.

Finally, the field of sustainability assessment can be found in §3.1.10, as this describes how the sustainability of innovation ideas can be assessed. This will give an indication of which methods exist to assess the sustainable performance of innovation ideas, one of the three dimensions for SOI.
I have looked at the innovation and selection process at both the project level and the group level. In the text, I have clearly indicated/divided these two areas. I started on project-level, with the "Stage-Gate" model, and moved to a more group-level view.

3.1.1 “Stage-Gate”
First, I have looked to the innovation development and selection process on the project-level. A structured manner of moving a new product from idea to launch is the “Stage-gate” model. In manufacturing as well as services industries, successful innovators follow a “Stage-gate” approach as a structured way of developing ideas to bring to the market (Cooper, 2008; Cooper, Edgett, & Kleinschmidt, 2004; Griffin, 1997).

*Originally developed for organisations in the business of developing New Products but currently also used for New Service Development, the “stage-gate” model is a success factor in firms (Oke, 2007).*

In a service firm, a portfolio of product and service innovation projects is present, which all have a different degree of innovativeness (Oke, 2007). So, for organisations, both product and service innovations are considered. A product innovation in a service company is defined as “New developments in the core offering of service companies that tend to create new revenue streams” (Oke, 2007, p. 572), and service innovation in a service company defined as “New developments in activities undertaken to deliver core service products” (Oke, 2007, p. 572). Service innovations may influence or be influenced by innovations in the core service product (Oke, 2007).

Especially at the front end and during the design stage of the development process, installing a “stage-gate” model enhances the performance of innovation projects, in NPD as well as NSD (De Brentani, 2001). A formal stage-gate system can provide important benefits in a service firm, especially when developing incremental new service offerings, as firms that achieved best performance for low innovation-type projects tended to implement a formal (stage-gate) system (De Brentani, 2001). But, the implementation of a “stage-gate” model is a success factor for both radical and incremental innovations, resulting in more successful outcomes for innovation projects, improving corporate performance (De Brentani, 2001).

The stage gate model is used for moving a new product from idea to launch, and is both a conceptual and an operational model (Cooper, 1990). At every gate the ideas, concepts, products and processes are selected. These gates are not merely status reports, these are points where tough Go/kill decisions or prioritization choices are made. In Figure 8, the “Stage-Gate” model can be seen.

![Figure 8: The most current “Stage-Gate” model with five stages and gates, with a discovery and post-launch review phase, from (Cooper, Edgett, & Kleinschmidt, 2002a)](image-url)
Many companies have too many projects, and too few resources to execute them properly (Cooper et al., 2002a). This results in resources (time, people, money) being spread too thin over the projects. Why is this? According to Cooper et al. (2002a), there are no formal, serious, Go/kill decision points built in the projects and following this, no criteria have been established to compare projects and make prioritizing decisions.

To make Go/kill and prioritization decisions, clear and visible criteria are necessary. Furthermore, these criteria need to be effective (easy to use by person making the decision), realistic (there should be enough information to make the decisions) and differentiating. Often, the criteria are checked by means of a scorecard. The criteria can either be “must meet” or “should meet”. In Table 5, criteria for new product development gates are shown, many of these criteria show strong correlation with new product profits and success (Cooper et al., 2002a).

The stage-gate process is a risk management model. Larger projects that carry higher risk often adhere to the standard 5-stage 5-gate model, while smaller projects that carry lower risk can take detours and use less stages and gates.

Table 5: Gate criteria according to Cooper, Edgett & Kleinschmidt (2002a)

<table>
<thead>
<tr>
<th>“Must Meet” Criteria (Checklist-Yes/No)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Strategic alignment (fits BU’s strategy)</td>
</tr>
<tr>
<td>- Reasonable likelihood of technical feasibility</td>
</tr>
<tr>
<td>- Meets Environmental Health &amp; Safety and legal policies</td>
</tr>
<tr>
<td>- Positive return vs. risk</td>
</tr>
<tr>
<td>- No show-stoppers (killer variables)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>“Should Meet” Criteria (Scored on 0-10 scales)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Strategic:</td>
</tr>
<tr>
<td>- Degree to which project aligns with Business Unit’s (BU’s) strategy</td>
</tr>
<tr>
<td>- Strategic importance</td>
</tr>
<tr>
<td>2. Product advantage:</td>
</tr>
<tr>
<td>- Unique benefits</td>
</tr>
<tr>
<td>- Meets customer needs better</td>
</tr>
<tr>
<td>- Value of money</td>
</tr>
<tr>
<td>3. Market attractiveness:</td>
</tr>
<tr>
<td>- Market size</td>
</tr>
<tr>
<td>- Market growth</td>
</tr>
<tr>
<td>- Competitive situation</td>
</tr>
<tr>
<td>4. Synergies (Leverages core competencies):</td>
</tr>
<tr>
<td>- Marketing synergies</td>
</tr>
<tr>
<td>- Technological synergies</td>
</tr>
<tr>
<td>- Manufacturing/processing synergies</td>
</tr>
<tr>
<td>5. Technical feasibility:</td>
</tr>
<tr>
<td>- Technical gap</td>
</tr>
<tr>
<td>- Complexity</td>
</tr>
<tr>
<td>- Technical uncertainty</td>
</tr>
<tr>
<td>6. Risk vs. return:</td>
</tr>
<tr>
<td>- Expected profitability (magnitude: e.g., NPV)</td>
</tr>
<tr>
<td>- Return (e.g., IRR)</td>
</tr>
<tr>
<td>- Payback period</td>
</tr>
<tr>
<td>- Certainty of return/profit estimates</td>
</tr>
</tbody>
</table>

The idea screen is an important part of the “Stage-Gate” model. According to Cooper (1999), as much as 88% of the projects investigated have a deficient idea screen, meaning the ideas are not subjected to serious scrutiny. This can result in marginal projects being developed for too long without any serious scrutiny.

Of course, there are also negative sides to employing strictly enforced evaluation criteria. Repeated application for improved control makes projects more inflexible, leading to learning failure (reduced ability to process acquired information into the project). This has negative effect on the market performance of novel products (Sethi & Iqbal, 2008). When gate review criteria are not open to interpretation or allowed to vary when the project requires, these increase the inflexibility of the new project. However, the research by Sethi and Iqbal (2008) only focused on market performance as the outcome, and not on cycle time and efficiency.
While recent work in the “Stage-Gate” literature indicates the importance of open innovation activities, it doesn’t provide guidelines on how to incorporate such activities (Grönlund et al., 2010). According to Grönlund et al. (2010), incorporating principles of open innovation (leveraging external sources of knowledge to drive internal growth) can overcome the inherent limitations of the “Stage-Gate” model. In their paper, an Open “Stage-Gate” model is presented, consisting of a Define phase, Design phase and a Validate phase.

As can be seen from Figure 9, the open “Stage-Gate” model is a combination of the development funnel (which will be explained in the next sub-chapter) and the “Stage-gate” model. The arrows indicate the openness of the model, with incoming and outgoing know-how and technology streams. Some key inbound and outbound open innovation activities have been identified by Grönlund et al. (2010). The inbound open innovation activities are spin-in of ideas, knowledge, product concepts, external inventions or already commercialized products and joint development, application or collaboration with other firms. The outbound open innovation activities include spin-out of internally generated ideas, evaluating different commercialization modes and out-licensing or selling of products and technologies. Inbound open innovation activities are mainly make-or-buy decisions, and mainly occur in the earlier stages of the process, whilst outbound open innovation activities are generally conducted in the later stages.

An open “Stage-Gate” model needs the addition of a new set of Open Innovation Evaluation Criteria (OIEC), on top of the normal Closed Evaluation Criteria (CEC). These make it possible to explore the spin-in and spin-out alternatives for each NPD project in each gate.

Apart from allowing firms to increase their competences in outbound open innovation activities, the open “Stage-Gate” model presents an initial step towards systematically integrating the principles of inbound open innovation with existing “Stage-Gate” processes. Furthermore, the open “Stage-Gate” model helps managers to constantly review and adjust the core capabilities and business model of the firm. This enables business model innovation, essential to sustained business performance (Grönlund et al., 2010).

3.1.2 Agile
The biggest “counterpart” of “Stage-Gate” is Agile. Originally intended for software development, it is also well suited for new product development and R&D development (Karlesky & Vander Voord, 2008). Agile project management sees project failure as the most expensive aspect of development, whereas traditional project management views change and rework as the most expensive aspects of software development (Karlesky & Vander Voord, 2008). Agile can reduce the cost of changes and rework, by promoting several engineering practices that enable cost effective change (Szalvay, 2004). It focuses on delivering working features as soon as possible, building supporting subsystems along the way. It is thus iterative, rather than sequential.
Because it is iterative, it is very much usable for development projects that have requirements that are unknown up-front. An example of such a project is an innovation project, making Agile interesting for innovation projects. Agile methods are designed to facilitate flexibility and responsiveness to changing conditions.

Agile methods try to minimize risks by developing software in short, clear timeboxes called iterations or sprints. After each iteration, a working feature is delivered that can be tested. By producing small increments of functional code, a lot of effort on big up-front design analysis is saved. Furthermore, the final product will better match the customer’s wishes. At the end of each iteration, the delivered product as well as the development process is evaluated, to learn and improve continuously. In Figure 10, a visual representation of the agile methodology can be seen.

![Visual representation of Agile](image)

**Figure 10: Visual representation of Agile**

Some Agile development methods and frameworks are:

- Kanban
- Scrum
- Dynamic systems development method (DSDM)
- Extreme programming (XP)
- Crystal clear
- Agile modelling
- Adaptive Software Development (ASD)
- Feature Driven Development (FDD)
- Lean software development
- Agile Unified Process (AUP)
- Continuous integration
- Evolutionary Project Management (EVO)

Karlstrom and Runeson (2005) studied the feasibility of applying agile methods in the context of large software development projects using stage-gate project management models. They found that it is feasible to integrate agile software development with stage-gate project management. Furthermore, by doing so, companies can improve cost control, product functionality, and on-time delivery. Serrador and Pinto (2015) found that the greater the Agile approach reported, the higher the reported project success was in firms. Success was here split up in 3 dimensions: Overall project success, project efficiency (meeting cost, time and scope goals), and stakeholder success (satisfying the expectations of project stakeholders).

### 3.1.3 The innovation funnel

After looking at the innovation process on the project-level with the “Stage-Gate” model, I have looked at the situation where various innovation projects happen parallel, bringing me to the development funnel. This looks at innovations from a group-level perspective.
The innovation funnel, as presented by Wheelwright and Clark (1992), is a visual representation of the process of generation and screening of alternative development options, and combining a subset of these into a product (or process) concept. It can be seen in Figure 11. Various ideas enter the funnel for investigation, but only a fraction will be fully developed. How the funnel is shaped is determined by how an organization identifies, screens, reviews, and converges on the elements of a process or product development project. In short, it is the overall framework for development. It creates an overview of which development steps are necessary for a successful development project.

According to Wheelwright and Clark (1992), the management of the development funnel is accompanied by 3 challenges. The first is to widen its mouth. The second is to narrow the funnel’s neck. The third challenge is ensuring that the selected projects deliver on the objectives that were set when approving the project. For now, I will focus on the second challenge, as innovation idea selection is essentially the neck. The challenge is to narrow the neck of the funnel, while at the same time assuring that a constant stream of good projects passes through it. The narrowing is done by a set of screening criteria, which fit the organization’s technological opportunities. The screening can be viewed as a resource allocation problem, with the issues of determining what data are relevant, how to weigh them, and what they tell us about their eventual success.

The focus should not only be on which projects generate the highest payoff, but to create a project portfolio that meets the firm’s objectives and enhances the firm’s strategic capability to execute future projects (Wheelwright & Clark, 1992).

There are two dominant shapes of the Development Funnel. One is the “R&D Driven, Survival of the Fittest” model or Model 1. This model is more common in large, technology-intensive firms. Model 1 uses a series of screens, starting with a technical feasibility screening and moving towards screens necessary before commercial introduction. “The essence of the Model 1 funnel is a technology-driven survival of the fittest” (Wheelwright & Clark, 1992, p. 118). With this model, a larger number of advanced development projects may find its way to commercial development. A problem with this is that many firms lack mechanisms and discipline to kill some of these projects, while not having the funds to carry out all of them. This can result in marginal projects being developed for too long, delivering too less value and costing too much development resources. This problem is also addressed with the “Stage-Gate” method, as discussed earlier.
Model 2, the “A Few Big Bets” model, is characterized by a very quick collapse, screen and combination of a variety of ideas into a single project aimed at meeting the market needs and can be seen in Figure 13. This model is more common in small, entrepreneurial start-ups. Fewer projects find its way through the funnel, and the ones that do are corrected and adjusted more during the course, as efforts are more concentrated due to less projects requiring attention. A problem with this type of funnel is that high level of knowledge must be accessible for and be present in the development team. Another problem is that disbanding projects becomes harder because more effort is put in the individual projects.

Because of the problems discussed above, Wheelwright and Clark (1992) present a third development funnel, one which combines the best features of model 1 and 2. This model shows an expanded mouth and 2 screening moments. The first screening is not a go/no-go decision, but a review by cross-functional peers to determine what additional information is needed before screen 2. It is meant to periodically assess the status of the ideas in the concept development stage, along with a check for fit with strategies. Another function of the first screen is to identify competing concepts, that might become part of a platform development project, or embedded in enhancement or derivative projects. At screen 2, senior managers review the options and select those that will become development projects. Screen 2 is thus a go/no-go decision, at which senior management decides on projects that are expected to be fully carried through to market introduction. Of these, the entire development efforts will be funded. Proposed projects are evaluated against competing and complementary projects under consideration, the functional strategy maps, the aggregate project plan, and the available development resources.

The power of the Model 3 development funnel is that it avoids the problems of Model 1 and 2, combines a creative set of innovative ideas into a logical set of development projects, and ensures that the projects are in line with the business strategies (Wheelwright & Clark, 1992). As well as in the “Stage-Gate” literature, the screens are important parts of the development process.
3.1.4 Portfolio management

Leading firms are moving beyond a “Stage-Gate” approach and are integrating portfolio management into their new product or new service process. Project Portfolio Management (PPM) focuses on resource allocation through selecting the right set and amount of development projects. Portfolio management is “a dynamic decision process, whereby a business’s list of active new product and R&D projects is constantly up-dated and revised” (Cooper et al., 2006, p. 4). It has four main goals (Cooper, 1990):

- Selecting high-value projects
- Achieving the right balance of projects
- Selecting the right number of projects
- Strategic alignment

It is possible to add effective portfolio management on top of the gating process from “Stage-Gate” (Cooper et al., 2006). To do this, the gates become two-part meetings, where the first part is the traditional gate meeting where the project is assessed on an absolute set of standards. A positive outcome of this part means a pass, not a Go. Then, the projects are assessed in a relative sense in the second part. A positive assessment of this part results in a Go, a negative assessment results in a hold. In this case, additional work needs to be done to achieve a Go. This results in a method that evaluates both on project and on group level.

Portfolio management is a dynamic decision process, whereby a business’s list of active new product (and R&D) projects is constantly up-dated and revised (Cooper et al., 2006). Portfolio management aims to enhance the success ratio of innovations by strategically aligning projects (Killen et al., 2008).

A lack of portfolio management is expressed through a reluctance to kill projects, weak decision points, no rigorous selection criteria and no strategic criteria for project selection which in turn results in increased time to market, higher failure rates and products that do not support the firm’s strategy (Cooper, Edgett, & Kleinschmidt, 2000; Cooper et al., 2006).

In Figure 15, a standard risk-reward project portfolio matrix can be seen. This is a mapping technique to rank innovation projects. Innovation projects are put in a matrix with four quadrants:

- Pearls: High pay-off with a high probability of success.
- Oysters: High pay-off but require some more effort to make it a success. If the technical feasibility is improved, it may become a pearl.
- Bread & butter: Low-risk projects with low rewards. “Safe bets”.

![Figure 15: Risk-reward project portfolio matrix](image-url)
- White elephant: Projects that have a low pay-off and low probability of success. Not worth spending resources on.

The project portfolio of a company can consist of projects that belong in the first 3 quadrants. Bread & butter projects are good for continuity, pearl projects are a "no-brainer", oyster projects can become very valuable with the right efforts, and it makes no sense to go for white elephant projects.

**Portfolio management in open innovation projects**

The integration of portfolio management in an open innovation environment is necessary to make projects manageable, minimize risks and control correctly (Bingham & Spradlin, 2011; Griffin, Noble, & Durmusoglu, 2014). Groenewegen (2018) investigated the influence of portfolio management on the success of open innovation projects, with success being defined as the realization of the expected project goals (Groenewegen, 2018; Manoochehri, 2010; Müller & Jugdev, 2012). This definition of success has been chosen due to the fact that no innovation project is the same; there are no standard projects (Hedeman & Seegers, 2009). The success was measured based on 3 concepts: Value maximization (retrieving maximum value from a project), strategic fit (project’s match with company strategy) and decision-making process (is the project part of integrated and systematic decision-making process) (Groenewegen, 2018). An interesting result of this research is that successful open innovation projects show a clearly defined decision-making process with clearly defined criteria and clear decision moments (Groenewegen, 2018).

*Because the innovation projects undertaken at Schiphol are non-standard (varying outcomes, explained in §3.3.6), innovation success is in this research also defined as an innovation project that realizes the expected project goals.*

**Importance of Go/No-go in portfolio management**

In order to align the projects with strategy and maximize value, screening of alternative ideas has an important role in portfolio management (Cooper, Edgett, & Kleinschmidt, 1997; Englund & Graham, 1999). In the projects, the correct Go/No-Go decisions must be made to maximize value (Cooper & Edgett, 2008). To do this, scoring models are used. A scoring model assesses projects, often by ranking projects based on desired goals, and uses weighing factors.

*There is a strong correlation between portfolio management tools like scoring models and the creation of higher value (Killen et al., 2008).*

For this, it is important to determine evaluation criteria for the project in advance, to create the most value (Blichfeld & Eskerod, 2008; Groenewegen, 2018). By using scoring models instead of only looking at the financial value of the project, firms avoid missing strategic opportunities (Martinsuo & Killen, 2014). In non-successful innovation projects, weighing factors were not clearly defined, resulting in ambiguous outcomes (Groenewegen, 2018).

The decision-making process or the Go/Kill-process within portfolio management is defined as a process to preserve profitable projects, avoid risks and create a balance in the resources (Cooper, Edgett, & Kleinschmidt, 2002b). Employing a Go/Kill-process makes a project measurable and controllable, which results in making better funded decisions and thus in a higher chance of success (Stosic & Milutinovic, 2014).

*The importance of a Go/Kill-process is even higher in open innovation projects, as these projects are bigger and have higher coordination costs than closed innovation projects, making a bad decision have more negative impact (Coras & Tantau, 2014; Gerybadze, Hommel, Reiners, & Thomaschewski, 2010).*
3.1.5 Evaluation methods & criteria
In all literature previously discussed, evaluation criteria play an important role. In this piece of the literature review, I will go through which evaluation criteria are most used, how and why.

An important part of evaluation criteria for open innovation projects concerns strategic fit, or the degree to which an idea matches the strategy, resources and capabilities of a firm (Grönlund et al., 2010).

Clearly defined indicators in a Go/Kill-process show a positive influence on the success of open innovation projects (Groenewegen, 2018). Evaluation criteria play an important role in improving the competitive and business potential in the front end of innovation (Martinsuo & Poskela, 2011). According to them, market and technical criteria are especially important for competitive potential, and the use of strategic criteria is associated with future business potential. Their findings indicate that holistic but informal assessment systems must be developed, and the evaluation criteria used in these must be adapted in line with the development objectives of the company. Effective screening in the front end of innovation (before development project starts) can prevent the risk of investing company resources in poor concepts (Martinsuo & Poskela, 2011). On project level, a Go/Kill-process with clearly defined criteria is seen as an important indicator for innovation project success (Duin, 2006).

Although various companies have adopted various sets of evaluation criteria, the literature is not undivided on the benefits of selection criteria for ideas and concepts. Hart, Hultink, Tzokas, and Commandeur (2003) indicate that different evaluation criteria may be linked with different kind of performance measures. Another point of debate is whether concept evaluation should be more formal or informal. Formal evaluation is favoured because it provides a fair evaluation process and supplies consistent information to idea generators and decision makers (Calantone, Di Benedetto, & Schmidt, 1999; Koen et al., 2002; Montoya-Weiss & O’Driscoll, 2000). Conversely, informal methods are suggested to enable creativity, negotiation, and prioritization of various viewpoints in preparing the project (Henriksen & Traynor, 1999).

Koen et al. (2002) suggest that idea evaluation and selection in the front end of innovation should be more informal, whilst during the development project itself it should be more formal.

Martinsuo and Poskela (2011) indicate that assessment formality may be detrimental to competitive and future business potential.

Some formal, quantitative, methods presented in the literature are so mathematically complex, that little use of these have been made by managers (Higgins & Watts, 1986; Lee, Lee, & Bae, 1986; Maher & Rubenstein, 1974). Instead, managers need flexible methods that can be used without extra competence needs (Henriksen & Traynor, 1999) and fit the organization’s characteristics (Liberatore & Stylianou, 1995). The general consensus is that NPD evaluation systems should include both qualitative and quantitative criteria (Liberatore & Stylianou, 1995). Henriksen and Traynor (1999) indicate that an informal scoring technique for R&D projects based on subjective assessment promotes cost effectiveness and maximum utility in R&D activities.

Typically, methods for evaluating and screening ideas and concepts exist of a set of criteria to compare the projects between themselves and to the company strategy (Hart et al., 2003). These criteria might encompass aspects of strategy, technology, markets, resources and risks (Englund & Graham, 1999). At different screening gates, different criteria are used. In the early-screening gates of the NPD process criteria such as technical feasibility, intuition and market potential are stressed, while a focus on product performance, quality, and staying within the development budget is kept in later phases of the process (Hart et al., 2003).
Carbonell et al. (2004) researched the use and importance of decision criteria and the success of a product innovation project. In this research, 5 dimensions of criteria and their use have been described: Criteria for strategic fit, technical criteria, market opportunity criteria, financial criteria and customer acceptance criteria are all positively related to project success in different phases of the development process. Furthermore, employing evaluation based only financial criteria in the initial screening shows a negative effect on the success of innovation projects (Carbonell et al., 2004). In Figure 16, the criteria of importance are found next to their respective screens.

![Figure 16: Important decision criteria in different phases (Carbonell, Escudero, & Aleman, 2004)](image_url)

Koen et al. (2002) indicate that idea selection should be done in a formal process and should be based on technical success probability, commercial success probability, reward, strategic fit and strategic leverage. However, the findings of Martinsuo and Poskela (2011, p. 910) question the use of formal assessment systems, saying that a more informal system could be beneficial when pursuing strategic opportunities. Also, they indicate that idea and concept evaluation systems should include criteria that promote strategic opportunities and not only be focused on short term innovation performance measures. Furthermore, a holistic (flexible) evaluation method may be needed to cover multiple competing interests.

The literature thus mostly addresses evaluation criteria of product innovations. Service innovations must also be considered and are addressed now. Oke (2007) indicates that firms with a formal process for developing new products or processes show high performance in innovation. Innovation performance was in his study evaluated on the following non-financial measures: Whether the company is often first to market with innovations; whether the company is more effective than competitors at taking existing ideas and making them into something better; whether the company is better than competitors at developing products and services to meet customer needs; whether the company is perceived by customers to be more innovative than competitors; whether the company is perceived as being at the leading edge of innovation. However, he indicates most of the studies on this have been performed on
manufacturing companies and indicates that in service companies, formal processes for innovation are less common.

Despite this, Oke (2007, p. 581) found that innovation idea selection is an important factor in the service innovation process as well, not only in the product innovation process.

Service organizations often have formal procedures for the development of radical innovations, and informal screening procedures for incremental services (Easingwood, 1986; Oke, 2007; Scott, 1993). Given that innovations in service organizations are mostly non-radical, this is a surprising find. Why have a formal procedure in place for radical innovations, while most innovations are incremental?

Following this, Oke (2007) suggests that service companies must define formal practices for selecting and implementing incremental innovations as well.

3.1.6 New Product Screening
Continuing the evaluation/screening of innovation ideas, the field of New Product Screening has also been included, as it is one of the most extensive literature streams on evaluating innovation ideas (Calantone et al., 1999, p. 65). The initial screening of a new product idea is critically important. New product screening decisions are made on a daily basis in companies, albeit with varying degrees of thoroughness (Baker & Albaum, 1986). The goal of screening new product ideas is to decide if any of the ideas have any merit, quickly, inexpensively and efficiently without much information. According to Baker and Albaum (1986), the primary focus should be to identify failures, or products that will be unsuccessful, as soon as possible in order to minimize non-productive investments.

As discussed in the previous subchapter, evaluation is preferably done with a mix of quantitative and qualitative assessment. To achieve this, scoring seems like a useful solution.

“It is quantitative enough to possess a certain degree of rigor, yet not so complex as to mystify and hence discourage potential users” (Henriksen & Traynor, 1999, p. 162).

Scoring models are widely used for new product screening. Although these have various flaws, like potential inconsistent applications of criteria and problems in interpretation of scores (Shocker, Gensch, & Simon, 1969), they are widely used (Baker & Albaum, 1986). In their paper, Baker and Albaum (1986) evaluated alternative types and structures of decision models which can be used for screening potential new products. The conjunctive, disjunctive, lexicographic, and linear compensatory approaches are analysed. These models are explained briefly in Table 6, taken from (Baker & Albaum, 1986).

<table>
<thead>
<tr>
<th>Table 6: Scoring models for screening potential new products</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Conjunctive model</strong></td>
</tr>
<tr>
<td><strong>Disjunctive model</strong></td>
</tr>
<tr>
<td><strong>Lexicographic model</strong></td>
</tr>
<tr>
<td><strong>Linear compensatory model</strong></td>
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</table>
The models as seen in Table 6 have been evaluated to see if all types of model are equally accurate in their ability to correctly screen out unsuccessful products, and whether the accuracy of the models would change when different number of evaluation criteria or weighting scales are used. The checklist consisted of 33 evaluative criteria, which can be seen in Table 7.

Baker and Albaum (1986) found that the lexicographic model and linear compensatory model correctly classified the highest percentage of products as either a success (innovation succeeded in marketplace by meeting company’s objective) or a failure (don’t meet company objectives), compared to the conjunctive and disjunctive models. Another interesting finding is that the models perform almost equally as good when using 5 critical criteria instead of all 33 criteria. Especially the linear compensatory model performed nearly identical using 5 criteria instead of 33. When considering the 33 criteria, this model correctly classified 72.7% of the successful products and 63.6% of the failed products. When considering only the 5 critical criteria, it correctly classified 72.7% and 61.4% of the successful and failed products, respectively. The 5 critical criteria were: Functional feasibility, profitability, potential sales, need and price.

Table 7: Evaluative criteria retrieved from Baker & Albaum (1986)

<table>
<thead>
<tr>
<th>Societal factor</th>
<th>Market acceptance factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Legality: Product liability</td>
<td>Compatibility: Existing attitude compatibility</td>
</tr>
<tr>
<td>Safety: Usage hazards</td>
<td>Learning: Degree of learning for proper usage</td>
</tr>
<tr>
<td>Environmental impact: Pollution potential</td>
<td>Need: Level of need/utility provided</td>
</tr>
<tr>
<td>Societal impact: Benefit to society</td>
<td>Dependence: Dependence on other products</td>
</tr>
<tr>
<td><strong>Competitive factor</strong></td>
<td></td>
</tr>
<tr>
<td>Appearance: Perceived competitive superiority</td>
<td>Visibility: Difficulty in communicating benefits</td>
</tr>
<tr>
<td>Function: Perceived usage relative to competition</td>
<td>Promotion: Cost to communicate benefits</td>
</tr>
<tr>
<td>Durability: Perceived durability relative to competition</td>
<td>Distribution: Cost of distribution channels</td>
</tr>
<tr>
<td>Price: Selling price relative to competition</td>
<td>Service: Cost to provide after sale service</td>
</tr>
<tr>
<td><strong>Demand analysis</strong></td>
<td></td>
</tr>
<tr>
<td>Existing competition: Level of existing competition</td>
<td>Functional feasibility: Work as intended</td>
</tr>
<tr>
<td>New competition: potential level of new competition</td>
<td>Production feasibility: Technically feasible</td>
</tr>
<tr>
<td>Protection: Patentability or secrecy protection</td>
<td>Stage of development: Prototype development</td>
</tr>
<tr>
<td><strong>Business risk factor</strong></td>
<td></td>
</tr>
<tr>
<td>Investment costs: Development costs</td>
<td>Payback period: Time to recover investment</td>
</tr>
<tr>
<td>Trend of demand: Growth of demand</td>
<td>Profitability: Profit potential</td>
</tr>
<tr>
<td>Stability of demand: Demand fluctuation</td>
<td>Marketing research: Necessary market information</td>
</tr>
<tr>
<td>Product life cycle: expected length of cycle</td>
<td>Research and Development: Production development</td>
</tr>
<tr>
<td>Product line potential</td>
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</table>

3.1.7 Success/failure factors for innovations

To determine the criteria used for evaluating the various innovation ideas, it makes sense to look at success and failure factors for innovations as well. These can tell something about the likely success of an innovation or the risk of failure.

There have been many studies looking at success/failure factors for innovations. Most have been performed on New Product Design (NPD) success factors. De Brentani (2001) divides success and failure factors of NPD projects over 4 groups: Product-related (product superiority, complexity, newness, degree of customization), market-related (market attractiveness, competition, specialized or mass market, customer need fit), company-related (strategies, capabilities and resources of the firm, competitive advantage, and innovation environment), and process-related (complexity and formality of NPD process, extent of actual use, NPD process-management, application of NPD tools).
Kumar, Persaud, and Kumar (1996) provide a summary of findings from previous project success and failure studies. Although it must be noted that these studies sometimes use a different nominal definition of success (e.g. technical and commercial success, profitability, financial break even, market share), the summary gives a nice starting point. An interesting feat from their research is that factors which determine the outcome of a project vary according to the stage of innovation process, meaning other success and failure factors need to be observed in different stages. In their paper, they present the various criteria that should be used in different stages of the innovation process. For instance, they indicate the most significant variable in the first decision stage is the extent to which the project objectives fit into the organization’s corporate philosophy and strategy. For the second decision stage the available technology, support within the organisation and the technical capability are important variables.

De Brentani (2001) provides success factors for service innovations. Just like in NPD, product superiority or distinctiveness is an essential success criterion. However, it is harder for a service company to prove product superiority as services are often intangible and abstract (De Brentani, 2001). Product complexity has a negative performance impact, even more than is the case with product innovations, due to intangibility of services (De Brentani, 2001). She looked at the differential in impact of success/failure factors for incremental and discontinuous service innovations. All four dimensions described in the literature were covered: Product related factors, market-related factors, company-related factors, and NSD process factors. For both incremental and discontinuous new business-to-business services, a ranking is presented of the importance of the factors. According to De Brentani (2001), the ranking of success/failure factors for incremental innovations is, from most to least important:

1. Client need/fit
2. Strategy and resource fit
3. Front line expertise
4. Formal testing & launch
5. Service complexity/cost
6. Innovation culture & management
7. Formal evaluation & design

For radical innovations, the ranking is as follows:

1. Innovation culture & management
2. Client need/fit
3. Front line expertise
4. Formal testing & launch
5. Service quality evidence
6. Market potential
7. Strategy and resource fit

From her research, De Brentani (2001) gives a few keys to NSD success, of which the most interesting is: “A well-planned NSD process can provide important benefits, particularly when developing incremental new service offerings” (De Brentani, 2001, p. 182).

3.1.8 Characteristics of innovations predicting innovation adoption

As said before, not all success/failure factors are applicable and interesting, as some are not innovation-specific, are static and not distinctive. If ASM decides to innovate, the innovation is often used by other stakeholders on the airport. Other parties must adopt and use the innovations. Because of this, it makes sense to look at which factors predict innovation
adoption by the stakeholders. A service firm would be smart to select innovations that have a higher chance of being adopted by the parties that have to implement the innovation. Adoption is the decision of any individual or organization to make use of an innovation (Rogers, 2003). Furthermore, as adoption of an innovation often leads to innovation success, it makes sense to compare innovation ideas on characteristics that influence the extent to which an innovation is adopted.

Innovation characteristics, organizational characteristics, information processing characteristics, characteristics of the environment (the surroundings) and the decision-making process are all factors influencing the adoption rate of innovations. For this research, the innovation characteristics are of importance, as these are innovation-specific. The organizational characteristics, information processing characteristics and characteristics of the environment (the surroundings) are assumed to be given and static within the department for the duration of the research and fall outside of the scope of this research. The decision-making process will ultimately be changed after this research.

In the literature, a plethora of variables are found that affect the adoption process. Because of this, only the most influential variables found in empirical studies are discussed by Klaasse Bos (2007). In his thesis, he describes 11 innovation characteristics that influence the adoption and diffusion process of innovations. These were retrieved by studying various researches on the subject to find the most important innovation characteristics. These characteristics are divided in a group of characteristics that are directly observable from the innovation itself, and a group of characteristics that are indirectly related to the innovation. 5 characteristics from Rogers (2003) are used, 3 from G. C. Moore and Benbasat (1991), 2 from Nooteboom (1989), and 1 from Fidler (1997) and Lichtenberg (2003). From this, the directly observable innovation characteristics are found in Table 8.

Frambach, Barkema, Nooteboom, and Wedel (1998) found that supply-side factors as perceived by adopters are important determinants of innovation adoption in addition to adopter-side variables, especially for a service product. Furthermore, adoption was found to be positively influenced by the perceived relative advantage of the innovation and negatively influenced by perceived complexity of the innovation. The factors are not only of importance to the adoption of product innovations, but also service innovations.

<table>
<thead>
<tr>
<th>Directly observable innovation characteristics</th>
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<tbody>
<tr>
<td>Relative advantage</td>
<td>The extent to which potential adopters think an innovation is better or superior compared to alternatives (Rogers, 2003, p. 229). Not only in terms of financial advantage, but also perceptual values. It is one of the most reliable indicators of the extent to which an innovation is adopted, and is positively related to the extent to which an innovation is adopted (Onkvisit &amp; Shaw, 1989; Rogers, 2003). The decision to adopt within industrial adopters is determined by the relative advantage (B. H. Hall, 2004; Webster Jr, 1969).</td>
</tr>
<tr>
<td>Compatibility</td>
<td>The extent to which an innovation connects with the existing company culture, needs, processes, habits, techniques etc. (Rogers, 2003). A higher compatibility lowers the transition risks, transition costs and transition thresholds, lowering the uncertainty. The effect of this variable is lower than that of relative advantage (Robinson, 1990).</td>
</tr>
<tr>
<td>Complexity</td>
<td>The degree to which a (potential) adopter experiences the innovation as simple or complex. When an innovation is seen as relatively complex, it has a negative influence on the adoption and diffusion process (Rogers, 2003).</td>
</tr>
<tr>
<td>Trialability</td>
<td>How well the potential adopter is enabled to test the innovation on a smaller scale (Rogers, 2003). Being able to test the innovation on a small-scale increases knowledge which reduces uncertainty.</td>
</tr>
<tr>
<td>Visibility</td>
<td>The extent to which an innovation is visible to others (Rogers, 2003). A potential adopter will include the (perceptual) visibility in the decision to adopt. A visible innovation can be seen by</td>
</tr>
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</table>
clients of the adopter, which can have the positive effect that the adopter is regarded as innovative.

<table>
<thead>
<tr>
<th>Indirectly related characteristics</th>
<th>Description</th>
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<tbody>
<tr>
<td>Voluntariness</td>
<td>The extent to which a potential adopter is obligated to adopt an innovation. Voluntariness increases the chance of successful adoption. Conversely, when a potential adopter is obligated to adopt an innovation, the chance of discontinuity increases (G. C. Moore &amp; Benbasat, 1991).</td>
</tr>
<tr>
<td>Image</td>
<td>The improvement of the image of the adopter by adopting an innovation. The chance of adoption increases when the image of the adopter is improved by adopting the innovation (G. C. Moore &amp; Benbasat, 1991).</td>
</tr>
<tr>
<td>Result demonstrability</td>
<td>The ability of the adopter to explain, prior to adoption, what the result of adopting an innovation will be. Positively contributes to the adoption process (G. C. Moore &amp; Benbasat, 1991).</td>
</tr>
<tr>
<td>Uncertainty</td>
<td>Not only caused by compatibility and complexity. Also caused by lack of full insight in the consequences of an innovation prior to adoption. The bigger the uncertainty, the smaller the chance of adoption. According to Nooteboom (1989), uncertainty correlates with perceived risk, technical risk, financial risk, social risk.</td>
</tr>
<tr>
<td>Obstruction of diffusion</td>
<td>Fast technological developments can negatively influence the diffusion process of an innovation. When a potential adopter expects fast technological developments, the adoption decision can be postponed. Here, these expectations act as an obstruction of adoption.</td>
</tr>
<tr>
<td>Trust</td>
<td>Trust towards the supplier of an innovation. According to Fidler (1997), this variable is just as important as the other variables, except for relative advantage. Lichtenberg (2003) notes that that larger companies with a trustworthy reputation encounter less trouble with market diffusion of their innovations.</td>
</tr>
</tbody>
</table>

3.1.9 Sustainability-Oriented Innovation

Firms increasingly face the challenge of successfully competing in changing markets while contributing to sustainable development (Klewitz & Hansen, 2014; S. Moore & Manring, 2009). Innovation for sustainability received wide attention after the Brundtland report in 1987, and since then eco-innovation practices found their way into firms.

*Sustainability-Oriented Innovation (SOI) is the integration of ecological and social aspects into products, processes, and organizational structures. It is more than eco-innovation which solely focuses on environmental sustainability, as it is innovation from a triple bottom line perspective: The economic, social, and environmental dimension (Jay et al., 2015; Klewitz & Hansen, 2014).*

It builds on the idea that innovation for sustainability is about a relative improvement compared to a prior or other entity. The name, sustainability-oriented innovation comes forward from this fact, as it is a process or direction toward sustainability (E. Hansen et al., 2009; Klewitz & Hansen, 2014). SOI does not treat sustainability dichotomously (sustainable/not sustainable), but as a dynamic, unfolding process (Adams et al., 2016). SOIs create more sustainable production methods, market structures and consumption patterns by becoming successful in the (niche or mass) marketplaces (Schaltegger & Wagner, 2011).

“Sustainability-oriented innovation involves making intentional changes to an organization’s philosophy and values, as well as to its products, processes or practices to serve the specific purpose of creating and realizing social and environmental value in addition to economic returns” (Adams et al., 2016).

To summarize, sustainability is no longer treated as being in a trade-off with traditional business values. In Figure 17, a visual representation of SOI can be seen. From here, it can be seen that SOI is good for business, customer, and the system (environment), and not a trade-off between these values.

S. Moore and Manring (2009) argue that SMEs that follow the SOI principle, thus successfully integrating social and environmental issues into core business strategies, expand their opportunities for innovation by increased opportunities for rapid learning. So, it is more beneficial to a firm than merely improving its sustainability.
Klewitz and Hansen (2014) argue that SMEs changing their innovation process for SOIs not only improve their sustainability performance but are also likely to lead to more radical product, process and organizational innovations. Furthermore, their interaction with external stakeholders will be more extensive. Following this, these SMEs might even be able to successfully unlock dominant technologies and institutional structures to effect change on an industry level.

Adams et al. (2016) present a model with 3 contexts of SOI activity. The first context, operational optimization, has the innovation outcome of reducing harm. The second context, organizational transformation, creates shared value. The final context, systems building, creates net positive impact. See Figure 18. In this, the SOI activities of firms can be seen, presenting sustainability as a journey.

**Figure 17: Visual representation of SOI**

**Figure 18: SOI as a "journey"**

### 3.1.10 Sustainability assessment

Sustainability and “green” not only poses a challenge for companies, it also presents options. These options include the creation of cost reduction or a basis towards customer value (Ginsberg & Bloom, 2004). For airports, the quality of service and range of facilities present the increase of value (Graham, 2012). Furthermore, as airports face major environmental operational limitations, sustainability can also act as an indirect source of capacity increase, resulting in a revenue increase (Bergsma, den Boer, Faber, Verbraak, & Wielders, 2009).
The assessment of innovations with respect to sustainability is considered highly complex, due to multi-dimensionality of sustainability targets and dispersion of sustainability effects (E. Hansen et al., 2009). This is reinforced by the inherent uncertainty in the success/failure of an innovation. In the field of sustainability assessment, there are a plethora of methods of assessing the sustainability of policy measures, corporate performance, and products. In Figure 19, an overview of product-related sustainability assessment methods can be found, from Singh, Murty, Gupta, and Dikshit (2009). However, these methods are comprehensive and elaborate to use within an innovation screening process.

![Figure 19: Product-related sustainability assessment methods (Singh, Murty, Gupta, & Dikshit, 2009)](image)

Curran, Knoester, and Bavelaar (2017) present a Value Operations Methodology approach to the ranking of sustainable improvements on airports specifically. This framework acts as a first filter to identify preferred innovations towards sustainable operations. A set of criteria is presented to trade off and select sustainable innovations. It does so according to three directions of strategic benefits of sustainability towards the airport product. A multi attribute value approach is used (Curran et al., 2010). It presents an easy to use method for quickly assessing the sustainability of innovation options.

A sustainable score function is presented, being:

\[
\text{Sustainable score} = \text{LOC} \cdot w_1 + \text{Investment} \cdot w_2 + \text{PBT} \cdot w_3 + \text{Image} \cdot w_4 + \text{Quality} \cdot w_5 + \text{CO}_2 \cdot w_6
\]

This score function only looks at the relative advantage characteristics of an innovation. So, although it gives a ranking of how “good” an innovation is, it does not look at how well it for instance fits within a company, how complex it is etc. However, it does provide a good starting point for the Relative advantage criteria.

For sustainability, Curran et al. (2017) use the criterion CO\(_2\) reduction by looking at the carbon footprint. Although CO\(_2\) reduction is sustainable, there are other criteria that are important when looking at sustainability. Because corporations increasingly subscribe to the principles of corporate sustainability, more sustainability-oriented innovations are considered and implemented. Because these innovations are very risky in terms of market success and direction of sustainability effect, E. Hansen et al. (2009) present a model termed the
‘Sustainability Innovation Cube’. With this model, it is possible to structure innovations’ sustainability effects, minimizing the ‘directional risk’ of sustainability-oriented innovations. The paper provides an insight in what are the main dimensions for assessing sustainability effects of product innovations. In their article, E. Hansen et al. (2009) define 27 areas in which sustainability effects may occur, and provide a list of applicable assessment methods for every area. However, a holistic evaluation method for defining sustainability-related innovations does currently not exist due to the multidimensionality of sustainability.

3.2 Reflection on literature study

In this sub-chapter, my reflection on the literature review is presented. First, I reflect on the literature in respect to service firms. What are potentially interesting finds for service firms in the various literature streams? This reflection is found in §3.2.1. After that, I reflect on the literature review in respect to infrastructure-providing service firms and the context of the assignment within ASM. What are potentially interesting observations for these firms, and for ASM in the literature streams? This is presented in §3.2.2. Finally, as I follow the design-oriented research approach, I have decided to retrieve building blocks from the various literature streams. These are parts of various selection methods/processes I deemed useful for service firms in general, for infrastructure-providing service firms and for ASM. These building blocks are presented in §3.2.3, §3.2.4, and §3.2.5 respectively.

3.2.1 Reflection in respect to service firms in general

An important find is that for both product and service innovations, it makes sense to follow a formal “Stage-Gate” development process to make innovation processes more successful.

*It became clear that the “Stage-Gate” model results in more successful innovation projects (Cooper, 2008; Cooper et al., 2004; De Brentani, 2001; Griffin, 1997; Oke, 2007).*

Not only is this beneficial for radical innovations, it is also beneficial for incremental innovations as it improves the innovation project success rate (Oke, 2007). Currently, not many firms use formal methods for developing low-innovation type projects. But, it is originally tailored towards firms that want a better NPD process.

*And, is a better NPD (or NSD) process always necessary? There are many firms in which New Product or New Service Development does not play an important strategic role, as these do not focus on achieving a high output of new products or services.*

Especially for service firms from for instance the transport or airport sector, a higher output of new products or services is not important. For firms that do not have a strategic focus on internally developing innovations, open innovation is an important way of still attracting new technologies and/or services. However, the literature on “Stage-Gate” models dealing with open innovation is still rather undeveloped. Even though the innovation selection method designed in this research is an initial screen, it does not mean the selected innovations do not need further evaluation at later stages. One lesson from the “Stage-Gate” literature is that innovation projects need to be evaluated all the way through development.

But, the issue with “Stage-Gate” is that it looks at development projects separately. The innovation funnel compares various innovation development ideas with each other.

Although the funnel provides a visual representation of the process of generation and screening of alternative development options and combining a subset of these into a product (or process) concept, and thus gives a nice indication of how the innovation process with parallel projects can look like, a few remarks must be made. Firstly, the same remark made
about the “Stage-Gate” model can be made. The model is meant to increase the output of successful innovation projects. For a service company such as Schiphol, it is not necessary to produce as much successful development projects as possible, New Product Development does not play an important strategic role. Innovation is used to accomplish other strategic goals.

An interesting method combining the “Stage-Gate” and the development funnel is the Open “Stage-Gate” model by Grönlund et al. (2010). This method is also capable of dealing with open innovation, due to the addition of extra screening criteria. It presents an initial step towards systematically integrating the principles of inbound open innovation with existing “Stage-Gate” processes, perhaps interesting for service firms that employ a “Stage-Gate” process.

The interesting thing of a portfolio management tool is that it looks at both the initial screen and evaluation of current innovation projects. Both the innovation funnel and “Stage-Gate”, as discussed before, can actually be part of a portfolio management approach. Overall, Project Portfolio Management (PPM) shows many advantages for both firms developing new products and firms developing new services. One of the most important advantages is a better alignment of development projects with the strategy of a company, which is a major success factor in innovation projects. Furthermore, it reduces time-to-market, failure rates, and products that do not support the firm’s strategy. A PPM approach increases the success of open innovation projects. However, decision-making processes using portfolio maps are more common in product-based organisations than in service firms. PPM methods are longer-established and more mature in product-based organisations. Although there is scientific evidence that PPM methods are beneficial to both product and service innovations, there is no literature on a method which compares products and services.

From the literature on evaluation criteria it has been confirmed that evaluation methods improve the outcome of innovation projects, and prevents the risk of investing company resources in poor concepts (Martinsuo & Poskela, 2011). This is the case for both manufacturing and service organizations. Despite this, formal processes for innovation evaluation are less common amongst service firms.

Even more striking is that the service firms that do have formal evaluation methods tailor these methods towards radical innovations, and not towards incremental innovation. This is especially surprising since innovations in service organizations are mostly non-radical in nature.

Why have a procedure in place for radical innovations while most innovations are non-radical? This is an interesting find for service organisations, suggesting it is beneficial to instate a formal process for incremental innovations as well.

Although New Product Screening decisions focus mainly on new products in manufacturing firms, it does give a good indication of methods used for assessing various ideas. Scoring models give a nice mix between qualitative and quantitative assessment and are very useful to assess innovations on group-level. Scoring models can be altered to include evaluation criteria for service innovations, providing a useful starting point for screening service innovations.

Although it can be useful to compare various innovation ideas on possible success/failure factors, they are not the only important factors to compare innovations on. Most studies on success/failure factors are retrospective. This makes it questionable if these factors can be used to predict innovation project success, and this is complicated by the fact that the innovation-specific characteristics are often unknown up front with innovations. From this
literature it became clear that there can be differences in success/failure factors for product and service innovations, useful knowledge for service firms.

For both manufacturing and service firms, looking at the characteristics predicting innovation adoption can be beneficial. An innovation that is more likely to be adopted presents more certainty of putting effort into the development of that innovation not going to waste. The characteristics as presented say something about the adoption of both service and product innovations. For service firms that want to improve the adoption rate of innovations, it is useful to look at these characteristics.

Due to the multi-dimensionality of sustainability, many sustainability assessment methods are too complex for service firms. This is reinforced by the fact that the future performance of innovations is highly uncertain, also in terms of sustainable performance. The fact that the future performance of service innovations is even harder to predict than that of product innovations adds even more to this. However, the sustainability score function as presented in the literature review provides a good starting point.

To wrap-up: Although there is discussion on how screening/evaluation must be done, the literature is undivided over the fact that screening/evaluating innovation projects is beneficial to innovation project success. There are many screening/selection methods in the literature, ranging from formal to informal, quantitative to qualitative. From the literature it has emerged that quantitative, complicated methods are often not used as they are time consuming and confusing to use.

"Often, a more informal and qualitative way of assessing innovation ideas is preferred, especially in the early stages of innovation."

The criteria as found in the various literature streams often show a large overlap.

3.2.2 Reflection in respect to infrastructure-providing service firms and ASM

Although idea screen is part of the model, the “Stage-Gate” model is an innovation process rather than a selection process. The problem owner has clearly indicated it wants a selection process, not an innovation process. Also, in the “Stage-Gate” model the party that innovates is also the party that selects. This is not the case in ASM, where often other parties innovate and ASM wants to select. Furthermore, the “Stage-Gate” model is a “Project-level” innovation development process, in which 1 project is constantly evaluated. It does not look at the “Group-level”. ASM is especially interested in being able to compare and select among various innovations, not completely tracking 1 innovation project.

Because it is intended for moving a new product from idea to launch, it might not be applicable for Schiphol Group, where innovations enter the company in various stages of development. This is addressed with the open “Stage-Gate” model. But, “Stage-Gate” focuses mainly on process factors (Oke, 2007), whereas ASM wants to focus on the innovation factors.

"A major absence in the “Stage-Gate” literature is that there is no mention of comparing innovation ideas on sustainability. Innovations are compared on various performance indicators, but not on their performance sustainability-wise."

The innovation funnel as discussed, assumes that all the development options under consideration are in the same pre-development stage, the idea phase. Within ASM, innovations reach the department in different phases of development. Furthermore, when looking at Model 3, projects that make it through screen 2 will be fully carried out to market introduction. This can be a very risky approach, considering the uncertainty associated with innovations. During further development, an innovation can change significantly, possibly
making it undesirable. To combat this, further screens or evaluation moments are necessary. This was done better in the “Stage-Gate” model, although that did not look at the “group-level”.

For the context of the problem owner, Project Portfolio Management (PPM) is interesting as it is a “group-level” method, very useful in comparing various innovation projects on multiple variables and visualizing the outcome. The development of an innovation portfolio management tool is a bridge too far for this assignment.

However, the development of a selection process for innovations can be a very good first step towards creating a portfolio management tool for innovations.

After all, the selection process is an important part of a PPM method. For this to be able, the selection process must be able to fit in a PPM method in a later stage.

From the literature, it became clear evaluation criteria for product innovations and service innovations are different. However, there is no mention of a set of evaluation criteria that can be used to compare both product and service innovations. It is interesting to find out if it is possible to create a list that can be used for evaluation both types of innovations.

For my research, innovations in different stages of development must be evaluated, and on top of that, compared to each other. Because of this, it could be problematic to use fixed screens, as these are used for fixed stages of development. The innovations in ASM are in different stages of development, so it might be useless to use screens with fixed evaluation criteria.

Furthermore, evaluation on sustainability performance is not included in the evaluation methods & criteria stream. However, it can be argued to be part of the strategic fit criteria or technical criteria. But, sustainability would get too little influence in this role.

Looking at the new product screening literature provided useful insights for the context of the assignment. For ASM, scoring models are a useful and promising tool.

Screening methods promise a quick, inexpensive and efficient evaluation of the merit of various innovation ideas compared to each other.

Although there is no explicit mention of evaluation on sustainable criteria, scoring models can be easily adapted to include these, as scoring models can include all desired criteria.

Looking at the success/failure factors can give an idea of which innovations can become a success. However, many factors are not innovation-specific. For instance, when comparing different innovations within the department ASM of Schiphol group, it makes no sense to look at the factor innovation culture and management, as this factor is not different for innovation A than it is for innovation B. This is, at a certain point in time, given and not distinctive. It is not innovation-dependent and is thus assumed constant. However, the non-innovation-specific criteria might not be used to select innovations on but can be useful as design rules for the selection method. For instance, increased complexity and formality of the NPD process is bad for innovation success (De Brentani, 2001). From this, a design constraint for the innovation selection method is to not make it too complex and formal.

Although these factors as explained above say something about innovation diffusion, or adoption, they are interesting factors to compare ideas on in the front end of innovation. There are many more interesting drivers and barriers for innovation adoption but researching these would make the scope too big. This is because many of these factors are organisational, regulatory, competitive, or societal. These are not innovation-specific and are assumed to be constant during the time of my research. Only innovation-specific criteria are considered.
Because of this, I have decided to only focus on attributes of innovations and their influence on the rate of adoption. The attributes predicting innovation adoption might be useful to look at since Schiphol has many stakeholders that will have to use innovations. An innovation that has a larger chance of being adopted provides a higher certainty that investments in the innovation project will be recouped.

For infrastructure-providing service organisations, an interesting find from the SOI literature is that interaction with external actors (e.g. customers, authorities, research institutes) can ultimately increase the innovative capacity of SMEs for SOIs.

Although the infrastructure providers are often not SMEs, I deem it likely that this finding stands firm for larger companies as well. After all, a department of an infrastructure provider, in this case ASM, is comparable in size to a SME. It can be expected that for infrastructure-providing service firms such as ASM, which operate in network settings with many stakeholders, this effect can be even larger.

Very useful to the context of ASM is the sustainability scoring model as presented by Curran et al. (2017), in which various sustainable airport innovations are ranked based on multiple criteria, of which sustainability is one. This is interesting to ASM as sustainability is not the only criteria on which innovations will have to be evaluated and compared.

3.2.3 Building blocks for service firms
It has come to light that there is a plethora of ways for assessing, evaluating, screening and selecting innovation ideas. Because the requirements of a service firm will not be fulfilled by using one of the standard methods, a method can be composed of interesting parts of the various literature streams. Here, I will discuss parts of the various literature streams that are interesting or useful in the design process of the selection method for a service firm. These parts I have called building blocks.

An interesting building block from the “Stage-Gate” literature is that further in the process of developing an innovation, go/no-go decisions are made. It is thus not the case that once an idea has been chosen for development, it is carried out no matter what. It is good to be able to evaluate and cancel a project if it is not successful. Having a formal process for doing this is required, as people find it hard to cancel projects they have invested in. So, rather than having a screen to evaluate innovations once, a process with multiple screens is a building block I will keep in mind.

Although the innovation funnel is an innovation process rather than a selection process, it presents useful parts for service firms wanting to create a selection process. Useful parts, or “building blocks” are the 2 screens of model 3. In here, the check for fit with strategies plays an important role. Strategic fit has proven to be a success factor for innovations from the literature. Another interesting idea I took from this is that the funnel allows for combining a creative set of innovative ideas into a logical set of development projects. It might be very beneficial for a firm to combine various innovation ideas into 1 development project, to avoid unnecessary double work.

A building block I take from the Portfolio Management literature is the visualization of the ranking of innovations. Visualization of the ranking helps decision-making in groups by providing an overview of projects in respect to factors that need to be balanced.

Generally, this is a matrix showing technical feasibility vs commercial potential, but this could also be sustainable performance vs costs, or service improvement vs risks, virtually any factors that are interesting and necessary to balance. The final building block I take from this part is the constant updating and revising of the active list of projects. This means the selected
projects are not selected at one point in time but are revised in later stages as well. Also, this creates a clear overview of which innovation projects are undertaken, and which ideas are further present in the department.

An interesting building block I take away from the evaluation methods & criteria literature is that informal evaluation methods are in many cases more effective than formal evaluation methods.

*Formal, elaborate screening methods are often too complex and consequently are not used.*

What is also interesting to see is that various researchers present different sets of evaluation criteria, but most do share large commonalities. Market, technical and strategic criteria are mentioned by virtually all the authors. This gives me an indication of which factors must most certainly be included in the design of a selection process.

Another interesting building block for all service firms is that evaluation at the front end of innovation must be more informal and on group-level, whilst it should be more formal and on project-level in later stages of development. A combination of formal and informal evaluation criteria is thus ideal, spanning multiple selection moments. In other words, different evaluation criteria are needed in different phases of innovation selection.

Furthermore, it appeared managers need flexible methods that can be used without extra competence needs, or else the methods will most probably not used. This is an important building block to remember for all service firms alike, to design an effective selection process.

The building block I take from the New Product Screening literature is that a lexicographic model or a linear compensatory model might be useful for service firms, as these show a high percentage of correctly classified successful and unsuccessful projects. Furthermore, it gives an indication of which criteria are important in screening decisions.

*From the New Product Screening literature, an even more important building block for service firms that want an (informal) selection method with scoring is that the selection process can consist of multiple scoring models consecutively.*

For instance, the selection process can start with a disjunctive scoring model looking at certain “must-pass” criteria, reducing the number of innovations for further screening. After that, a lexicographic or linear compensatory model can be used to further determine a “winning” innovation idea.

A final interesting building block from this literature stream is the use of weights for various evaluation criteria. With this, it is easy to appoint strategic importance to one or more criteria. For instance, management can decide that the focus should be put on innovations aimed at increasing energy efficiency, so they can give that criteria a higher weight.

A building block from the success/failure factors literature stream is a list of success/failure factors which are important for service firms. The success/failure factors can be used to determine the risk of the various innovation ideas that will be compared. With this comes the added advantage that the importance of these factors is known for both incremental and discontinuous innovations. This can be considered in determining the criteria of the selection method.

An interesting building block from the SOI literature (perhaps from an unexpected angle) is that interaction with external stakeholders improves the innovative capacity of a firm. Apart from
this, a major building block is that sustainability should not be treated as competing with the other values of an innovation.

3.2.4 Building blocks for infrastructure-providing service firms
In this sub-chapter, I have defined building blocks for infrastructure-providing service firms. In general, most building blocks for service firms can be used, but infrastructure-providing service firms might require additional building blocks. Building blocks that are different for infrastructure-providing service firms can be added on to the building blocks for service firms and are presented here.

An interesting building block for infrastructure-providing service firms is the open “Stage-Gate” model, as many of these firms must deal with evaluating incoming innovation activities. Because of the criticality of the provided services, these companies often do not have an internal R&D department and rely on outside parties for innovations. This open “Stage-Gate” model indicates that for innovations coming from outside, different evaluation criteria are necessary.

A building block for infrastructure-providing service firms I retrieved from the Portfolio Management literature is that it pays much attention to the strategic alignment of an innovation with the firm, an important success factor. Also, the fact that having a PPM method is even more important for open innovation is interesting, as many infrastructure-providing service firms deal with many open innovation projects.

An interesting (perhaps expected) thing to see is that the innovation characteristic predicting innovation adoption show a large overlap with criteria used in evaluation and screening of innovations, and with success/failure factors discussed earlier in this chapter. The building block taken from this piece of literature review is thus an addition to the criteria that can be used. Especially since the innovations of an infrastructure-providing service firm often must be adopted by other stakeholders, the characteristics are very interesting. An innovation that exhibits the characteristics that predict better adoption is more likely to be a success. A successful innovation justifies the investment made, making it easier for the decision maker to choose the innovation.

The scoring function of Curran et al. (2017) as discussed in the sustainability assessment part of the literature review gives a good example which I could use for further work for infrastructure-providing service firms. Especially interesting of this is that sustainability can be scored on the same level of importance as other criteria.

3.2.5 Additional building blocks for ASM
In general, the building blocks as explained for service firms in general and for infrastructure-providing service firms are usable in the context of ASM as well. However, some additional building blocks are required for ASM that might not be useful for other infrastructure-providing service firms. In this sub-chapter, I will discuss additional building blocks that are specifically for the context of ASM.

As said before, ASM does not want an innovation process but a selection process. However, the literature of the innovation funnel has useful parts. Useful parts, or “building blocks” ASM are the 2 screens of model 3. In here, the check for strategic fit plays an important role, something deemed very important in Schiphol ASM. Furthermore, it is a model that looks at the group-level of innovation, something that is desired by ASM, as the department ultimately wants to work toward a portfolio management tool.

A building block from the new product screening literature for ASM is that a lexicographic or a linear compensatory model might be useful as these perform well in classifying ideas. An even
more important building block is that the selection process can consist of multiple scoring models after each other. These models are relatively qualitative, fitting the company culture of ASM as explained in §3.3.

The final building block is taken from the SOI literature. The interaction with external stakeholders improves the innovative capacity of a firm. This gives a second reason to include the voice of the stakeholders in the selection process of sustainable innovations as well. Not only will innovations be adopted more easily by the other stakeholders, the internal innovative capacity can be increased.

3.3 Current situation at ASM

After the literature review gives a good view of what the various literature streams tell an organisation should do in terms of innovation management and selection, this sub-chapter will present an overview of the current situation in the department ASM of Royal Schiphol Group.

The current situation has been analysed by unstructured and semi-structured expert interviews. The information presented in this chapter is mostly retrieved from 7 semi-structured expert interviews held within Schiphol Group ASM between 24-4-2018 and 15-5-2018. The set-up of the expert interviews can be found in §2.2.2, the interview questions in appendix A and the interview results in appendix C. Company presentations, reports and documents have been analysed to verify the findings of the semi-structured interviews. First, the goals Schiphol Group ASM wants to achieve by innovating are presented in §3.3.1. Then, the innovation process currently employed is explained in §3.3.2. After that, the innovation stakeholders are presented in §3.3.3. Part of the innovation process is the selection of innovation ideas, and the way that is currently done is explained after the stakeholder overview in §3.3.4. The effectiveness of the current innovation process and innovation selection method as perceived by the interview participants is explained in §3.3.5, before the sub-chapter is completed with an overview of previous innovation projects presented in §3.3.6.

3.3.1 Goals of innovating

According to the interview participants, innovating serves several goals within Schiphol Group ASM. Firstly, innovation helps in achieving the mission and the strategic goals of the department. The mission of the department is “Sustainable creation and management of profitable and reliable assets” (Felten, 2017, p. 3), and the strategic goals connected to this are “Optimal and sustainable creation and management of profitable and reliable assets, with a deliberate consideration between functions, costs and risk” (Felten, 2017, p. 3) and “Making assets available that optimally align with the organizational objectives of Amsterdam Airport Schiphol (AAS)” (Felten, 2017, p. 3). Comparing the goals of innovation of ASM with the “standard” innovation goals as explained in the introduction (e.g. gaining competitive advantage) shows a striking difference but also a similarity between the goals. It is clear ASM does not innovate with the goal of opening new markets or helping to capture and retain market shares, partly because of the pricing structure of Schiphol. However, it does serve the goal of improving business processes and delivering faster, cheaper, and higher quality services. Many innovation evaluation methods pay a large amount of attention to market (attractiveness) factors of an innovation, but this is thus not as necessary for ASM as it does not innovate with the goal to create a new best-seller innovation.

The assets managed by ASM support the operational processes of AAS. So, one of the tasks of ASM is to keep these assets running and optimally available for the airport processes that are vital to the functioning of the airport.
According to the interview participants, one of the most important goals of innovating is contributing towards achievement of the strategic goals, by improving the current situation in terms of business processes and asset base.

However, the airport processes performed in “running the business” are very critical. Due to this, innovations that improve the business are may not carry the risk of disrupting the airport processes.

Improvements to the business processes, or to the assets, can be done in a couple of ways. Firstly, the current asset base can be improved, or the current asset can be used in a different manner. Secondly, new assets with improved performance can be employed. So, what are improvements that are possible to be achieved by innovating, as indicated by interview participants?

- Increasing operational capacity
- Increasing asset reliability
- Increasing asset availability
- Reducing Total Cost of Ownership during the whole lifecycle of assets
- Increasing asset efficiency
- Increasing asset safety
- Increasing asset sustainability
- Improving asset quality
- Meeting (new) laws and regulations

By doing this, ultimately new revenue streams might be created, or the profitability can be increased by lowering the costs. By improving the sustainability of the assets, ASM can help in achieving the sustainability goals set by Schiphol Group. Furthermore, the service delivered to the airlines, ground handlers, and passengers can be improved. In short, innovating is necessary to improve the business processes and achieve the strategic goals set by the company and department. This is necessary to react to a constantly changing world/environment, to remain an up-to-date airport and Europe’s preferred airport (Royal Schiphol Group, 2018, p. 34).

As mentioned previously, innovating is further seen as a method for achieving the sustainability goals of the company/department. This is indicated by both the interview participants and the mission statement of Royal Schiphol Group (Royal Schiphol Group, 2018). To repeat, the sustainability goals of Schiphol are to achieve zero-waste in 2030 and be climate-neutral in 2040. Some interview participants indicated that innovating is one of the most important methods for achieving the sustainability goals, as the focus on sustainability is relatively new and the fact that almost all innovation ideas have a sustainable component nowadays.
3.3.2 Innovation process

To be able to illustrate the current innovation process of ASM, first an overview of the department structure is given. In Figure 20, the department structure can be seen. In Figure 21, it can be seen how the department operates, how the projects are being handled through the organisation. Finally, a short description of the various sub-departments is given in Figure 22.

The main sources of innovations within ASM are TEC, DEV and SO. TEC writes the asset policies and policy agendas of the department, based on the company strategy and trends in the external environment. One of the functions of TEC is identifying technical developments and translating these into strategic opportunities. Because of this, the department performs pilots, proof of concepts and innovations to determine if a new technology or way of working can be included in the department policy. Ideas for innovations can either come from within ASM, or from outside. Innovations by TEC are not directly applied in projects but are mostly tests to find out if a technology works and how it is applicable within Schiphol. TEC has a dedicated innovation budget to perform innovation projects. In total, a handful of innovation projects are done simultaneously, to give an idea of the scale.

Figure 20: Department structure ASM

Figure 21: Project process of ASM

Figure 22: Department overview
Within DEV, innovation happens on a different scale. DEV is the developer of all the asset-related projects. These projects, with a separate project board, have a fixed budget and are given room to do innovations on own discretion, albeit with approval of the project board and under the condition that the budget is not exceeded. Innovations in DEV are thus smaller in scale than in TEC. However, as TEC often does a pilot or proof of concept, DEV is responsible for the implementation of the innovations. If a pilot done within TEC is successful, TEC can decide to implement an innovation on a larger scale and communicate to DEV to incorporate the innovation in development projects. DEV is thus often involved in a different stage of innovations, and the innovations are mostly known already.

SO only focuses on digital innovations, innovations that are based on using data. Examples of this are IoT (internet of things), smart assets, predictive maintenance, sensing, condition-based maintenance etc. These are very interesting innovation processes, as these are promising in reducing maintenance costs, increasing availability and safety.

Although the current way of working results in quite a few appealing, successful innovation projects (see §3.3.6), there is room for improvement. Success is here defined as an innovation project that realizes the expected project goals. From the expert interviews, a clear picture could be sketched of the current innovation process, or the lack of a structured, clearly described innovation process.

Most of the interview participants indicated that there is no structured, formal innovation process. “Currently, I am not aware of any formal process being followed in the department”. The process is perceived as very ad-hoc: Unstructured and non-generalizable. It does not follow a described, unambiguous method (think of a funnel or something comparable) in any way in the department. Some participants even go as far as saying that the innovations are based on coincidences. All sub-departments have a different way of working with and selecting innovations, which is not bad. But, it results in ambiguity. This is not to say that the current innovation projects undertaken are bad. The innovations done in the department are generally rather successful, but the road towards a successful innovation is quite chaotic, the process is rather unstructured. An example of this is the Flightflex asphalt innovation. The new asphalt performs better than the old asphalt in almost all aspects, but it has taken more than 10 years to come to a large-scale pilot project.

ASM is a department that works with (capital-intensive) assets that have a long lifetime, so a long-term vision is generally present and well-represented. Generally, the selected innovations match well with this long-term vision. Good examples of this are the full-automatic connection bridges and the CEDD project, as explained in §3.3.6. These innovation projects serve the goal of improving the situation and processes of Schiphol on the long-term. However, some interview participants indicated that sometimes this long-term vision is lacking, and innovations are selected to solve pressing operational problems rather than long-term issues.

Interview participants indicated that the current innovation process, which is unstructured, results in a lack of clarity for employees. It is sometimes unclear which focal area for innovations is deemed important by management. Furthermore, it is sometimes unclear for employees which factors were decisive in the selection of an innovation project. This creates ambiguity and demotivates employees to provide innovation ideas. More on the current selection of innovations in the next sub-chapter.

Because there is no unambiguous innovation process in the various sub-departments, and there is no registration of all innovation projects undertaken, an overview of which innovation projects are undertaken or considered in the department is lacking. For instance, some people in TEC have had an innovation idea for a couple of months, only to discover that that idea was
already executed in DEV. There is no portfolio oversight of all innovations happening (or considered previously) in the various layers of the department. Another effect of the ambiguous innovation process in the various sub-departments is that innovation projects undertaken are sometimes not on the same line. As explained earlier, developers in DEV have room to undertake innovations. Since these do not have to be checked by the MT, sometimes the developers can “freewheel” and select innovations they like. Sometimes these are gimmicks, that do not fit in the vision of the department and are even incompatible with the current asset base.

*Overall, the current innovation process can result in successful innovations, but that a more structured way of working could have some advantages.*

In general, the long-term vision is well-represented in ASM, but is sometimes forgotten when short-term operational issues emerge. Furthermore, being able to define a focal point in strategic goals could be beneficial to the department, as interview participants indicated that they think it is beneficial to have a prioritization of innovations tailored towards certain strategic goals.

### 3.3.3 Innovation stakeholders & idea acquisition

To get a good view of how innovations are undertaken in ASM, it is necessary to create an overview of the stakeholders involved in innovations. In this overview, only the stakeholders that are affected by innovations and stakeholders that can bring in innovation into the department are included. This is important to map, as many innovations, especially at Schiphol, require the collaboration of multiple stakeholders. So, the purpose of this sub-chapter is two-folded: It maps how innovation (idea)s arrive at ASM through which stakeholders, and it maps which internal and external stakeholders must be considered when executing various innovation projects. Keep in mind that this will not be a comprehensive list of all stakeholders of Schiphol, but that it will be limited to stakeholders involved in innovation projects of ASM.

A traditional stakeholder analysis, in which the power, influence and interests of the stakeholders are indicated is not performed. The power and influence of the stakeholders in respect to innovations is not the focus of this research. It might be more interesting to look at these factors when for instance researching the adoption of innovations by stakeholders.

In Figure 23, a visual representation of the innovation stakeholders of ASM can be seen. In this research, a distinction is made between internal and external stakeholders. Here, internal stakeholders are other departments of Royal Schiphol Group and the external stakeholders are stakeholders external of the company. Logically, not all external stakeholders have contacts with the same departments of Schiphol. Figure 23 shows how the external stakeholders are connected with the internal stakeholders.

For this research, the department OPS (Operations) and CR (Corporate Responsibility) are the most important departments apart from ASM. Virtually all innovation projects ASM performs need the cooperation of OPS. OPS is the department responsible for the primary operational processes of the airport and providing services to passengers. The operational processes of the airport are undertaken by different stakeholders like airlines and handling agents. Because of this, OPS has intensive contact with these stakeholders. The assets ASM provides support the airport processes and are thus often operated by external stakeholders. CR is responsible for determining and achieving the sustainability strategy of Schiphol and is involved in decision making in investments, tenders and operational processes to ensure sustainability is an integrated factor in all actions undertaken by Schiphol.
There are various ways in which an innovation idea can reach ASM. Below, the most prevalent scenarios in which innovation ideas reach ASM are presented:

1. ASM is confronted with a strategic goal or problem from the company strategy, for instance achieving climate neutrality or zero waste. It is asked to find innovations to contribute towards the achievement of these goals.

2. A (broad) strategic problem or challenge (security lane improvement, air quality improvement) is presented to ASM, and ASM is asked to provide a solution. To provide a solution, multiple innovation ideas can be compared alongside existing technologies.

3. An improvement is necessary in the operational processes, as indicated by OPS or another department. A problem is indicated by the stakeholders. A decision must be made to improve the situation using existing technology or by an innovation.

4. An employee of ASM observes an innovation in the market (external environment) and he/she sees opportunities for ASM.

5. ASM is approached by another stakeholder with an innovation, and asked to co-develop, test or invest in the innovation.

3.3.4 Innovation selection
As with the current innovation process, the current innovation selection method is informal and unstructured, there is no described selection method. The innovation ideas are currently selected based on a business case document, or a Project Initiation Document (beslisdocument). In this document, a qualitative and a quantitative (financial) business case must be presented. The senior manager of the department determines if he sees merit in the innovation idea based on this document and decides to allocate budget to the innovation project or not. Of course, this only happens when innovation budget is (still) available.

Although there is a sub-heading in the Project Initiation Document where considered alternatives are discussed, innovation ideas are not compared to each other, they are tested monadically (one at a time), on a first come, first serve basis. Logically, there is the danger of
making sub-optimal choices. By selecting monadically, the performance of various innovations is not compared, and the respective contribution towards the strategic goals is neither.

Although the selection is thus done based on a Project Initiation Document, interview participants indicated they felt that the selection of innovation ideas is ad-hoc. Also, they indicated that they sometimes felt that the contribution of the innovation ideas towards all the strategic goals is not considered enough. Furthermore, they indicated it would be beneficial if it would be possible to indicate focus areas for innovation.

As said before, the selection is done based on the underlying business case. Interview participants indicated that sometimes, the selection was done with a too large focus on the financial business case. For many innovations, the financial business case is still very uncertain although the innovation is quite promising, but it is then not selected on financial grounds.

Although the innovation selection is done by evaluating the Project Initiation Document which includes various qualitative and quantitative aspects, there is no comprehensive and easy-to-use list of evaluation criteria. This has the possibility it results in ambiguity, employees do not know which criteria are important to look for in innovation ideas.

There is thus no formal selection method, and the selection of innovation ideas is not done on fixed moments of the year. Furthermore, every sub-department of ASM has its own way of selecting innovations. There is no structured method, no fixed list of criteria that is used throughout the whole department. This adds to the perceived ad-hocness.

As indicated earlier, in the description of the current innovation process, there is sometimes a perceived lack of focus on the long-term. Interview participants indicated that they felt selection is done based on the issues of the day, and priority of which innovation project is pursued is often forced by operational (short term) issues. Some even describe it as: It is purely following facts. An identifiable line cannot be observed in the choices made.

3.3.5 Effectiveness of current innovation and selection process

After asking about the current innovation process and selection method, the interview participants were asked about their opinion of the effectiveness of the current way of working. In this subchapter, these answers are treated. In general, the selection that is done currently is not perceived as wrong but may be improved.

First, the current way of working results in a perceived lack of oversight and ambiguity for employees. Oversight over what is happening in the department in terms of innovation, current and future innovation projects is not always present. Another disadvantage of this is that innovation ideas that have been considered but not chosen before are not saved and are sometimes thus forgotten. Why is this bad? Well, an innovation idea might not be the best solution currently but might prove to be ideal for instance a year later. The ambiguity of the innovation process can make it hard to start innovation projects, as indicated by some participants. Because the process is unclear, innovation projects can be a hassle, which is a barrier for starting these projects in the first place, as indicated by an interview participant.

The selection of innovation ideas in its current form can result in choices that are not bad but “could be better”. The focus in innovation selection is largely on the business case, innovations
are not compared on their respective contribution towards strategic goals. Due to this, it is unclear whether the innovation budget is being spent on the innovations with the most impact. Also, projects might be started that later prove to be a bad choice, as they die because they do not fit in the current business processes, or people not having enough time to work on them.

Because there is no comparison between and oversight over innovations, some promising innovations might be skipped or missed. The potential added value of innovation ideas under consideration is unclear, as these ideas are not checked on a fixed list of criteria. There is no document describing the potential value of innovations on various aspects. The selection purely on business case puts too much focus on the financial aspects, innovations that are promising in all other aspects might be missed out on. This is further reinforced by the fact that innovation ideas are evaluated one-by-one, and not in comparison with other ideas.

The fact that there is no pre-determined, agreed way of working with innovations, can result in innovation projects being scrapped easily. As example, innovations that are not in the core business are scrapped when there is a budget squeeze. Think for instance about sustainable innovations, which are not directly in the core business, being scrapped for the year 2018. According to some interview participants, this is an indication of the focus on short-term, problem-oriented project selection. These participants further indicate that “Running the business” gets the most attention, and not enough attention is given to “changing the business”. The 80-20% rule is not in place, further strengthening this effect.

3.3.6 Previous innovations

In this sub-chapter, I will provide a table of previous (or ongoing) innovation projects, with a condensed explanation. In this table, an indication will be given of the type of innovations and their reasons for success or failure. Success is here defined as an innovation project that realized the expected goals. An innovation project that achieves the expected goal can be implemented on a larger scale. Table 9 on the next page contains the overview of previous innovation projects.

From previous innovation projects, it becomes clear that the most successful innovation projects showed a clear match with the strategic goals. This is also given as a success factor in the literature (De Brentani, 2001). It would thus make sense to perform a thorough evaluation on an innovation idea’s match with the strategic goals.

A clear contribution to the improvement of the operational processes, in itself a strategic goal, is also observed in the innovations that have proven to be successful. This could also be called (service) product superiority, a success factor in the literature as well. Most successful innovations had a clear advantage over current services or products.

A failure factor seen in 3 of the 4 examples is the lack of technological readiness, meaning the necessary technology is not available yet or not developed enough. This results in an innovation becoming unfeasible, ultimately resulting in the innovation project not realizing the expected goals. For instance, the Smart-VOP project did not realize the expected goals as the technology was not ready for this application. A possible explanation for this is over-confidence in the technological readiness before the project, or a sub-optimal evaluation of the technological readiness.

What this shows is that the success/failure factors found in the literature review can be observable in a service firm, and to the context of ASM. This confirms that it makes sense to include these factors in the selection method.
Table 9: Previous innovation projects

<table>
<thead>
<tr>
<th>Innovation</th>
<th>Type of innovation</th>
<th>Description</th>
<th>Reason for success/failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Security lanes</td>
<td>Service innovation</td>
<td>Centralised checkpoints where passport, cabin luggage and body of passengers are checked in one go, instead of having a security lane for each gate.</td>
<td>High strategic importance/necessity, clear improvement in service, good ability to test on small scale.</td>
</tr>
<tr>
<td>CEDD (Contactless Energy and Data Distribution)</td>
<td>Technical product and process innovation</td>
<td>New connection technology for distribution of energy and data. Enables easy installation and replacement of runway lights without having to be in contact with a power or data cable.</td>
<td>Good fit with current processes, technology, and strategic goals. Good ability to test on small scale</td>
</tr>
<tr>
<td>Full-automatic connection</td>
<td>Technical product innovation</td>
<td>Automated connection of passenger bridges to aircraft, making human controllers redundant.</td>
<td>Clear strategic contribution, clear improvement in operational processes; less turn-around-time, less room for errors, good trialability.</td>
</tr>
<tr>
<td>Smart baggage tractors</td>
<td>Technical product innovation</td>
<td>Installing sensors to track mileage of baggage tractors, providing insight in when maintenance is necessary.</td>
<td>Clear decrease in maintenance costs, good fit with current processes and technology</td>
</tr>
<tr>
<td>Flightflex</td>
<td>Technical product innovation</td>
<td>A new type of concrete that renders it unnecessary to install an extra anti-skid layer on runways.</td>
<td>Clear improvement in TCO, good trialability with small-scale tests</td>
</tr>
<tr>
<td>e-GPU</td>
<td>Technical product innovation</td>
<td>A Ground Power Unit providing aircraft power from a battery instead of a diesel generator.</td>
<td>Clear improvement in air quality, good fit in current processes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unsuccessful innovation projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smart-VOP</td>
</tr>
<tr>
<td>Hydrogen test</td>
</tr>
<tr>
<td>Biometric boarding process</td>
</tr>
<tr>
<td>FLEET AGV for baggage transportation</td>
</tr>
</tbody>
</table>

### 3.4 Conclusion

This chapter presents the work done for answering research sub-questions 1, 2 and 3. First, a literature review is presented. In this review, various ways of managing the innovation process within a firm and various manners of evaluating, screening, and selecting innovation ideas are presented. Wherever possible, this is done with a focus on service firms. The subject of selection criteria for innovation ideas has been covered, as well as the field of sustainability assessment.

After this, the reviewed literature has been reflected on. This is done in respect to service firms, and in respect to the context of ASM. In this reflection, the building blocks retrieved from the various literature streams are presented. The literature review and reflection provide the answers for SQ1: *Which methods for selecting innovation ideas are interesting for a service organisation?* The conclusions to this are presented in §7.1. In short, there are various ways of describing and shaping the innovation process within a firm. In all of these, innovation
screening/evaluation/selection is an important part. There is a plethora of methods, tools, and processes of evaluating innovation ideas, varying from strictly formal to informal and from qualitative to purely quantitative. The various methods have presented useful insights, which are taken forward in the shape of building blocks. Some methods use different selection criteria, but many similarities can be found in different methods. How the sustainability of innovation ideas can be assessed has finally been uncovered.

After this, the current situation at ASM is presented as answer to SQ2: What does the innovation process, of which idea selection is part, look like for ASM? This has been uncovered by semi-structured expert interviews and investigation into company documents. In general, the innovation projects done by ASM are quite successful and serve the goal of achieving strategic goals of the department. However, the innovation (selection) process is unstructured and informal. The interview participants perceived this as opportunities for improvement. The innovation stakeholders have been presented, and an overview of previous innovation projects is given.

Some interview participants indicated they would prefer a portfolio management tool for innovations within ASM. Although it is too ambitious to create a complete portfolio management tool for ASM during this research, it must be kept in mind that the selection method could become one of the parts of a portfolio management tool in the future.

The interviews served a second goal of finding the answers to SQ3: What are the goals, requirements and assumptions for a sustainable innovation selection method of Schiphol Group ASM? The answers to this are presented in §4.1.
4. Selection method building

In this chapter, the building/designing process of the selection method is explained. The goals, requirements and assumptions as presented in §4.1 have been uncovered by the semi-structured expert interviews done within the ASM department. Based on these, the selection method has been shaped. How this is done is explained in §4.2, and the structural specifications (how the method looks like and operates) of the prototype of the selection method are presented in §4.3. The answers of the expert interviews used for this chapter can be found in appendix C.

4.1 Design goals, Requirements, Assumptions

4.1.1 Goals

The goals the selection method must fulfil has been uncovered by the semi-structured expert interviews. The goals are determined based on the problems/issues perceived by the employees of ASM, and discussions within the department. Based on these goals and responses of the interview participants, the requirements as presented in the next sub-chapter are determined.

Below, the goals the innovation selection method must fulfil are presented, not ranked according to importance:

[G1]: Making better founded choices and making these choices easier (for MT). Manage risks by making well considered choices. By making choices easier, and better founded, it is easier to obtain the most value from innovation projects and select innovations that better match the strategic goals of the department. This makes sure the innovation budget is optimally utilized.

[G2]: Create a pre-determined, structured and unambiguous innovation management process, a guaranteed process for all employees. By using an integral method, it creates clarity of which process is followed, which selection method, based on which criteria, and by doing so reducing ambiguity. This partially eliminates subjectivity from the selection process, to avoid the possibility of people pushing their own preferred innovation projects. This makes it easier to communicate towards employees why certain innovation ideas are (not) chosen. It works the other way around as well, as it is easier to communicate towards higher management as to why certain innovation ideas are suggested.

[G3]: Create (portfolio) overview of which innovation ideas are present in the department, and which have been considered previously. In this overview, it must be made clear what the intended goals of the innovations are, what their status is and how much financing is required until completion. This overview makes it possible to transfer innovations from one sub-department to the other, avoiding the “re-invention of the wheel”. Furthermore, it makes the innovations of ASM visible in the organisation.

[G4]: Enable ASM to select innovations according to the SOI philosophy, in which sustainability is not treated as a competing goal of traditional business values. It must not follow the “sustainability trade-off” view of the world which dictates that positive environmental and social impact must exist as a trade-off with more traditional business drivers.
4.1.2 Requirements

To develop the selection method for sustainable innovations, a list of requirements is needed to be able to start designing. It is important to focus on specifying the requirements, and not design solutions. The focus should be on what is required, not on how it is achieved. Another thing to keep in mind is that the requirements should be testable. To be able to easily check whether the requirements have been met, the requirements must be uniquely numbered.

There are 3 types of requirements: Functional, user, and contextual requirements. Functional requirements are the functions that the selection method should fulfil or enable to perform once realised, to achieve the goal. User requirements are demands of the user of the selection method. Contextual requirements are prerequisites set by political, economic, legal, and/or social environments.

The requirements are retrieved directly from the answers of the semi-structured expert interviews, and a more thorough analysis and interpretation of the answers given. For instance, some interviewees indicated they wanted to have a selection method in which it is possible to adjust the focus in strategic goals for innovations, to be able to select innovations that solve the most pressing strategic challenges. One participant indicated he would rather have a selection method solely for sustainable innovations. A requirement that covers both these requests is the possibility to change the weights which are used in ranking the importance of the selection criteria.

Apart from the functional, user, and contextual requirements for the selection method, a list of criteria requirements is added. This list is retrieved from the same semi-structured expert interviews and is presented separately as these relate to the actual content of the selection method.

To uncover all requirements and assumptions from the semi-structured interviews systematically, the answers given for the process requirements and criteria requirements, as found in appendix C were first labelled with 7 labels: R_f, R_u, R_c, R_crit, A_f, A_u, and A_c. Then, all requirements or assumptions with the same label were grouped, and double entries were deleted. Similar entries were compared and, where possible, merged into 1 requirement or assumption.

Table 10: Functional, user, contextual requirements

| Id | Functional requirements | | User requirements |
|----|------------------------| |-------------------|
| R_f 1 | The selection method should have a clearly defined decision-making process with clearly defined criteria and clear decision moments. | | The selection method must be qualitative in nature. |
| R_f 2 | The selection method must compare and provide a ranking of innovation ideas based on standard criteria and weighing factors. | | The selection method must be perceived as easy to use, using it should require only a small investment of time and effort. |
| R_f 3 | The weighing factors must be customizable, to be able to apply focus towards a certain strategic goal. | | The selection method must be used in meetings with people of relevant departments with appropriate knowledge. This will ensure that the appropriate external stakeholders are represented. |
| R_f 4 | The selection method must be able to compare innovation ideas that are in different stages of development. | | The selection method must be able to make a distinction between long- and short-term projects |
| R_f 5 | The selection method must be able to be used 4 times a year, once every quarter. | | The selection method must be able to make a distinction between Schiphol-specific and product-specific innovations. |
| R_f 6 | Innovations must not be selected in one decision moment, but in multiple phases in which the choices are re-evaluated. | | It must be able to create ‘strategic buckets’, based on which innovations are selected. * |
| R_f 7 | The selection method must result in innovation choices that better match the strategic goals of Schiphol/ASM. | | The selection method must use a mix of quantitative/qualitative, and objective/subjective criteria. |
In Table 10, the functional, user, and contextual requirements can be found. The criteria requirements can be found in Table 11.

**Table 11: Criteria requirements**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial business case</td>
<td>Project budget, impact on EOH or NCV* from TCO, potential subsidy.</td>
</tr>
<tr>
<td>Potential value for the organisation</td>
<td>All potential benefits of the innovation. Think for instance about operational capacity, asset reliability, asset availability, asset efficiency, asset safety, asset quality, improvement of service for traveller and airlines. Also, further qualitative benefits.</td>
</tr>
<tr>
<td>Sustainability</td>
<td>Emissions and waste reduction, energy efficiency.</td>
</tr>
<tr>
<td>Match with strategic goals</td>
<td>The fit of a certain innovation with the strategic goals of ASM.</td>
</tr>
<tr>
<td>Risk</td>
<td>Safety risks, time risks, quality risks, financial risks, risk of process disruption, uncertainty.</td>
</tr>
<tr>
<td>Technical feasibility/technological readiness</td>
<td>Is the innovation technically feasible? What are the success/failure factors? Complexity, technical risk, uncertainty.</td>
</tr>
<tr>
<td>Belief</td>
<td>Belief of employees in the success of an innovation.</td>
</tr>
<tr>
<td>Lead time</td>
<td>Time necessary to complete the innovation project.</td>
</tr>
<tr>
<td>Necessity</td>
<td>Not only the necessity of the innovation, but also the question whether Schiphol or the market should do the innovation.</td>
</tr>
<tr>
<td>Level of Control (LoC)</td>
<td>How much control does ASM have? What are other stakeholders and their opinions, influence, LoC.</td>
</tr>
<tr>
<td>Organisational feasibility</td>
<td>Does the department have the right people, capabilities and commitment to do the project? What is the match with the department: What are relations and dependencies with other projects?</td>
</tr>
<tr>
<td>Demand</td>
<td>Is there a demand/request from customers? Or is there a demand stemming from laws and regulations?</td>
</tr>
<tr>
<td>Timing</td>
<td>Is now the right time to do this innovation?</td>
</tr>
</tbody>
</table>

*: NCV is only applicable if an investment generates cash flows.

### 4.1.3 Assumptions

When defining the requirements, assumptions will also have to be made about the qualities that the users and context should possess to make fruitful use of the selection method possible. The functional assumptions ($A_f$) are related to the problem, which the selection method solves. To find the user assumptions ($A_u$), ask: What qualities should the users possess to turn the selection method into a success? The contextual assumptions ($A_c$) indicate what the political, economic, legal and social environment looks like. In Table 12, the assumptions can be found.
4.1.4 Goals and requirements verification

The design goals \([G]\) and requirements \([R]\) as explained in this sub-chapter have been derived from the semi-structured expert interviews. These were validated in 2 ways: First, the interview participants were asked to validate the interview results. This ensured that the goals and requirements are correctly derived in the eyes of the interviewed experts. Furthermore, the goals and requirements were presented in the first user test, in which the participants were asked to validate the goals and requirements. This was done to make sure the goals and requirements were not only validated by the interview participants, but also by other people within Schiphol.

4.2 Building/designing process

With the goals, requirements and the assumptions of the department uncovered from the interviews, the actual design of the selection method could be initiated. In this sub-chapter, the designing process of the selection method will be explained. By combining the requirements and assumptions with the building blocks retrieved from the literature, it is possible to create a selection process that meets the requirements of the department by using the appropriate pieces of useful literature. As seen in Figure 24, the rigor cycle has been done by the literature review, whilst the relevance cycle has been done by the interviews as presented earlier. The knowledge of these cycles is combined, to perform the design cycle, which is explained in this chapter.

In this sub-chapter, the requirements as presented earlier are compared to the building blocks retrieved from the literature. The appropriate building blocks from various literature streams are combined to create a selection process that fulfills all functional, user, and contextual requirements. By finding the right building blocks for these requirements, the structural specifications (how the selection process looks like) of the selection method will be determined. After all, the selection process will only be used and accepted if it meets all requirements.

---

**Table 12: Assumptions**

<table>
<thead>
<tr>
<th>Id</th>
<th>Functional assumptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>Unstructured innovation selection leads to sub-optimal choices</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Id</th>
<th>User assumptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>Users must be knowledgeable in the field of innovations</td>
</tr>
<tr>
<td>A2</td>
<td>Users must understand the selection method and criteria</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Id</th>
<th>Contextual assumptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>Innovation is necessary for sustainable growth of AAS</td>
</tr>
<tr>
<td>A2</td>
<td>Regulations and airport policy are key drivers for implementation of sustainability</td>
</tr>
<tr>
<td>A3</td>
<td>Funding is a main barrier for implementation of sustainability practices</td>
</tr>
</tbody>
</table>

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*Figure 24: Research cycles, Hevner (2007)*
The criteria requirements, as presented earlier, are also compared to the evaluation/selection criteria brought forward by the various literature streams. By comparing and combining these, a complete list of criteria will be presented that provides the content of the selection method. Below, an example is given of the process of combining requirements with the building blocks from the literature review:

The first decision that was made was to design a selection method consisting of multiple phases or screens, to fulfill requirement $R_1$. For this, the building block from the “Stage-Gate” literature is used, in which various screens are applied consecutively. Then, requirement $R_2$ is consulted. This dictates that a ranking of innovation ideas must be made, with standard criteria and weighing factors. For this, the building blocks from the New Product Screening literature are useful. Multiple screens can be applied consecutively, with different shapes.

In this example it can be seen how multiple criteria are combined with multiple building blocks. This is an iterative process. When a requirement is coupled with a building block, this combination is checked with the other requirements to find out whether it complies. If it complies, the building block is adopted. If it does not comply, the building block can be removed, changed or combined with another building block. Figure 25 gives a visualization of this process.

In a similar fashion, design choices are made by combining requirements and building blocks. The thought process behind all design choices is elaborate and will not be explained here. Instead, an overview in the shape of a table is given of which building blocks are used for which requirements. See Table 13 for this overview.
The linear compensatory model from the New Product Screening literature can be used in the selection process. For this requirement, no building block is necessary. This requirement states that the selection method should be clear on various aspects. This requirement is kept in mind with designing and describing the selection method.

The selection method must compare and provide a ranking of innovation ideas based on standard criteria and weighing factors.

To achieve this, the linear compensatory model from the New Product Screening literature can be used. This gives a ranking based on standard criteria and weighing factors.

The weighing factors must be customizable, to be able to apply focus towards a certain strategic goal.

Again, the scoring models from the New Product Screening literature are building blocks that fulfill this requirement. In these models, the weighing factors of the evaluation criteria are customizable, to indicate a focus towards a certain strategic goal.

The selection method must be able to compare innovation ideas that are in different stages of development.

This can be achieved by comparing innovations not only on their value to the organization, but also on technical feasibility/technological readiness. From both the New Product Screening and success/failure literature, this criterion was indicated to be an important building block.

The selection method must be able to be used 4 times a year, once every quarter.

To fulfill this requirement, the selection method must be reusable. Important for this is that the innovation ideas that have been evaluated are saved in a database. In the next meetings, the "old" innovation ideas can always be retrieved to see if they are desirable now. This is an important building block from the Portfolio management literature stream.

Innovations must not be selected in one decision moment, but in multiple phases in which the choices are re-evaluated.

The building block of the "Stage-Gate" literature can be used for this, where multiple screens can be used. This, combined with the building block for R2, makes that at least one of the phases is a scoring model with standard criteria and weights. Another building block from the New Product Screening literature is that multiple screening methods can be used consecutively. The Model 3 funnel from the innovation funnel literature is another building block for this requirement.

The building block of the success/failure factors of innovation indicates that match with strategy and resources is a success factor for innovations. To fulfill this requirement, all innovation ideas must be evaluated on their match with strategic goals and resources. This will become part of one of the screens.

The selection method must result in innovation choices that better match the strategic goals of Schiphol/ASM.

The building block of the success/failure factors of innovation indicates that match with strategy and resources is a success factor for innovations. To fulfill this requirement, all innovation ideas must be evaluated on their match with strategic goals and resources. This will become part of one of the screens.

The selection method must be able to make a distinction between long- and short-term projects

Table 13: Requirement and building block combination

<table>
<thead>
<tr>
<th>Id</th>
<th>Functional requirements</th>
<th>User requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>The selection method should have a clearly defined decision-making process with clearly defined criteria and clear decision moments.</td>
<td>A building block is again the scoring model as discussed in §3.1.6. Scoring is qualitative.</td>
</tr>
<tr>
<td>Building block(s)</td>
<td>For this requirement, no building block is necessary. This requirement states that the selection method should be clear on various aspects. This requirement is kept in mind with designing and describing the selection method.</td>
<td>The selection method must be perceived as easy to use, using it should require only a small investment of time and effort.</td>
</tr>
<tr>
<td>R2</td>
<td>The selection method must compare and provide a ranking of innovation ideas based on standard criteria and weighing factors.</td>
<td>From the literature of Evaluation methods &amp; criteria, a building block is that an informal way of evaluating innovations is less complicated, making actual use more probable. By keeping the screens flexible, the selection method can be adjusted to the competences of people using the method, making it even more easy to use. Scoring models are easy-to-use, informal evaluation methods. Looking at the building block for R6, the selection method will consist of multiple phases/screens. One of these screens is a scoring model. To keep it easy to use with a small investment of time, a more simplified screen must be implemented before the scoring model. This will be a screen with must-meet criteria and showstoppers.</td>
</tr>
<tr>
<td>Building block(s)</td>
<td>To achieve this, the linear compensatory model from the New Product Screening literature can be used. This gives a ranking based on standard criteria and weighing factors.</td>
<td>The selection method must be used in meetings with people of relevant departments with appropriate knowledge. This will ensure that the appropriate external stakeholders are represented.</td>
</tr>
<tr>
<td>R3</td>
<td>The weighing factors must be customizable, to be able to apply focus towards a certain strategic goal.</td>
<td>For this requirement, there is no building block from the literature. However, §3.3.3 provides an overview of stakeholders that can possibly be involved with innovation. From here, it is clear to see which people from which department must be included in the selection process. 1 person from a department representing the involved stakeholders is enough.</td>
</tr>
<tr>
<td>Building block(s)</td>
<td>Again, the scoring models from the New Product Screening literature are building blocks that fulfill this requirement. In these models, the weighing factors of the evaluation criteria are customizable, to indicate a focus towards a certain strategic goal.</td>
<td>The selection method must be able to make a distinction between long- and short-term projects</td>
</tr>
<tr>
<td>R4</td>
<td>The selection method must be able to compare innovation ideas that are in different stages of development.</td>
<td>To be able to do this, the selection process must include a check on lead times of innovation ideas, and a check to find out whether the timing for a certain innovation is optimal. These are not acquired from building blocks from the literature, but from the criteria requirements.</td>
</tr>
<tr>
<td>Building block(s)</td>
<td>This can be achieved by comparing innovations not only on their value to the organization, but also on technical feasibility/technological readiness. From both the New Product Screening and success/failure literature, this criterion was indicated to be an important building block.</td>
<td>The selection method must be able to make a distinction between Schiphol-specific and product-specific innovations.</td>
</tr>
<tr>
<td>R5</td>
<td>The selection method must be able to be used 4 times a year, once every quarter.</td>
<td>The building block of the success/failure factors of innovation indicates that match with strategy and resources is a success factor for innovations. To fulfill this requirement, all innovation ideas must be evaluated on their match with strategic goals and resources. This will become part of one of the screens.</td>
</tr>
<tr>
<td>Building block(s)</td>
<td>To fulfill this requirement, the selection method must be reusable. Important for this is that the innovation ideas that have been evaluated are saved in a database. In the next meetings, the &quot;old&quot; innovation ideas can always be retrieved to see if they are desirable now. This is an important building block from the Portfolio management literature stream.</td>
<td>The selection method must be used in meetings with people of relevant departments with appropriate knowledge. This will ensure that the appropriate external stakeholders are represented.</td>
</tr>
<tr>
<td>R6</td>
<td>Innovations must not be selected in one decision moment, but in multiple phases in which the choices are re-evaluated.</td>
<td>From the literature of Evaluation methods &amp; criteria, a building block is that an informal way of evaluating innovations is less complicated, making actual use more probable. By keeping the screens flexible, the selection method can be adjusted to the competences of people using the method, making it even more easy to use. Scoring models are easy-to-use, informal evaluation methods. Looking at the building block for R6, the selection method will consist of multiple phases/screens. One of these screens is a scoring model. To keep it easy to use with a small investment of time, a more simplified screen must be implemented before the scoring model. This will be a screen with must-meet criteria and showstoppers.</td>
</tr>
<tr>
<td>Building block(s)</td>
<td>The building block of the &quot;Stage-Gate&quot; literature can be used for this, where multiple screens can be used. This, combined with the building block for R2, makes that at least one of the phases is a scoring model with standard criteria and weights. Another building block from the New Product Screening literature is that multiple screening methods can be used consecutively. The Model 3 funnel from the innovation funnel literature is another building block for this requirement.</td>
<td>For this requirement, there is no building block from the literature. However, §3.3.3 provides an overview of stakeholders that can possibly be involved with innovation. From here, it is clear to see which people from which department must be included in the selection process. 1 person from a department representing the involved stakeholders is enough.</td>
</tr>
<tr>
<td>R7</td>
<td>The selection method must result in innovation choices that better match the strategic goals of Schiphol/ASM.</td>
<td>The building block of the success/failure factors of innovation indicates that match with strategy and resources is a success factor for innovations. To fulfill this requirement, all innovation ideas must be evaluated on their match with strategic goals and resources. This will become part of one of the screens.</td>
</tr>
<tr>
<td>Building block(s)</td>
<td>The building block of the success/failure factors of innovation indicates that match with strategy and resources is a success factor for innovations. To fulfill this requirement, all innovation ideas must be evaluated on their match with strategic goals and resources. This will become part of one of the screens.</td>
<td>The selection method must be used in meetings with people of relevant departments with appropriate knowledge. This will ensure that the appropriate external stakeholders are represented.</td>
</tr>
<tr>
<td>R8</td>
<td>The selection method must be able to make a distinction between long- and short-term projects</td>
<td>For this requirement, there is no building block from the literature. However, §3.3.3 provides an overview of stakeholders that can possibly be involved with innovation. From here, it is clear to see which people from which department must be included in the selection process. 1 person from a department representing the involved stakeholders is enough.</td>
</tr>
<tr>
<td>Building block(s)</td>
<td>To be able to do this, the selection process must include a check on lead times of innovation ideas, and a check to find out whether the timing for a certain innovation is optimal. These are not acquired from building blocks from the literature, but from the criteria requirements.</td>
<td>The selection method must be used in meetings with people of relevant departments with appropriate knowledge. This will ensure that the appropriate external stakeholders are represented.</td>
</tr>
<tr>
<td>R9</td>
<td>The selection method must be able to make a distinction between long- and short-term projects</td>
<td>For this requirement, there is no building block from the literature. However, §3.3.3 provides an overview of stakeholders that can possibly be involved with innovation. From here, it is clear to see which people from which department must be included in the selection process. 1 person from a department representing the involved stakeholders is enough.</td>
</tr>
<tr>
<td>Building block(s)</td>
<td>To be able to do this, the selection process must include a check on lead times of innovation ideas, and a check to find out whether the timing for a certain innovation is optimal. These are not acquired from building blocks from the literature, but from the criteria requirements.</td>
<td>The selection method must be used in meetings with people of relevant departments with appropriate knowledge. This will ensure that the appropriate external stakeholders are represented.</td>
</tr>
<tr>
<td>R10</td>
<td>The selection method must be able to make a distinction between long- and short-term projects</td>
<td>For this requirement, there is no building block from the literature. However, §3.3.3 provides an overview of stakeholders that can possibly be involved with innovation. From here, it is clear to see which people from which department must be included in the selection process. 1 person from a department representing the involved stakeholders is enough.</td>
</tr>
<tr>
<td>Building block(s)</td>
<td>To be able to do this, the selection process must include a check on lead times of innovation ideas, and a check to find out whether the timing for a certain innovation is optimal. These are not acquired from building blocks from the literature, but from the criteria requirements.</td>
<td>The selection method must be used in meetings with people of relevant departments with appropriate knowledge. This will ensure that the appropriate external stakeholders are represented.</td>
</tr>
<tr>
<td>R11</td>
<td>The selection method must be able to make a distinction between long- and short-term projects</td>
<td>For this requirement, there is no building block from the literature. However, §3.3.3 provides an overview of stakeholders that can possibly be involved with innovation. From here, it is clear to see which people from which department must be included in the selection process. 1 person from a department representing the involved stakeholders is enough.</td>
</tr>
<tr>
<td>Building block(s)</td>
<td>To be able to do this, the selection process must include a check on lead times of innovation ideas, and a check to find out whether the timing for a certain innovation is optimal. These are not acquired from building blocks from the literature, but from the criteria requirements.</td>
<td>The selection method must be used in meetings with people of relevant departments with appropriate knowledge. This will ensure that the appropriate external stakeholders are represented.</td>
</tr>
</tbody>
</table>
By combining the requirements from the department ASM with the building blocks from the literature, the structure of the selection method was determined. The selection method/process consists of 3 screens. The first screen is a “must-meet” criteria and showstopper screen, compact with only a few criteria. Innovation ideas that pass this screen, continue towards the second screen, a scoring model. In this screen, more criteria are scored to determine one or more “winning” ideas by multiplying the scores with weights. Because this screen is more elaborate, the first screen is used to reduce the number of innovation ideas considered in this screen. After this screen, an overview is given of the scores of innovation ideas, with graphs showing the composition of these scores. Based on these results, a third screen is applied, in which the “belief” in the innovation ideas is determined. This belief was found to be an important success factor for innovations. Further details on how the method looks, or the structural specifications, can be found in the next sub-chapter.

When the rough structure of the selection method was determined, the next step was to determine which criteria were included in the various screens of the selection method. This was done while keeping in mind that the criteria should be operational, meaning they must be easy to use. Furthermore, the criteria must be realistic, making use of available information. Finally, the criteria must be differentiating, meaning they must be able to differentiate between good and mediocre projects (Cooper et al., 2002a). The criteria as found by the interviews were compared with the criteria used in the various literature streams. To assemble a comprehensive and useful list of criteria, the first step was to put together all criteria found in the literature review and the semi-structured interviews. First, all non-innovation-specific evaluation criteria and success/failure factors were deleted. For instance, process-related
factors such as the complexity and formality of the NPD process and the innovation environment were deleted. A final important factor in determining the selection criteria is that these should be applicable to both product and service innovations. In §4.3, a more elaborate explanation of the criteria used in the screens is given.

This selection method will be used in quarterly meetings. Screen 1 and 2 can be done individually, from behind a computer for instance. Screen 3 is done in a group, where knowledgeable people representing the applicable stakeholders can discuss and influence each other. The criteria in screen 2 have a weight appointed up front by the senior manager. The attribute weighting is done with direct weighting: The senior manager is asked to divide for instance 100 points among the attributes. Further details on the selection method will be explained in the next sub-chapter.

4.3 Structural specifications

In this sub-chapter, the first design of the selection process is presented. This is the prototype that is used for the first user test, which is explained in §2.2.2 and §5.1. First, a figure is shown in which the general lay-out of the selection process can be seen. Then, an explanation is given of the composure of the group necessary for the use of the selection method. After that, a detailed description is given of the various phases of the selection method, accompanied by an explanation. The various forms used in the first design of the prototype are found in appendices G to J. Figure 26 shows the prototype of the design visually.

4.3.1 Group composure

Since the innovations of ASM often need the involvement of various stakeholders, the voices of these stakeholders must be included in the selection process. One option to achieve this is to invite a representative of each stakeholder involved with any of the innovation ideas. But, the process of identifying all the stakeholders, contacting those, and getting them to send a representative to a meeting is too much effort for a quick screening process.

To make sure the voice/opinion of external stakeholders is included in the selection process anyways, a person is invited from the department of Schiphol that has contact with the external stakeholder.
For instance, when an innovation idea is screened that needs the cooperation of the airlines, a representative of OPS is invited. It is assumed that these representatives have a good view of the interests of the external stakeholders. See §3.3.3 for an overview of the stakeholders.

Keeping this in mind, the group should be composed of at least 5 people. 3 of ASM, to make sure the broad knowledge and various interests of the department are guarded. 1 from OPS, since this department is often involved with the innovations of ASM, and because this department has contact with the airlines, passengers, and handling agents. 1 from CR, to make sure the innovations are in line with the sustainability strategy of Schiphol. A group of 5 or 6 people is considered optimal. A larger group will slow down the decision process, a smaller group will provide too little input.

4.3.2 Idea generation/collection phase
Prior to this phase, when the MT of ASM has determined it wants to execute innovation projects and there is budget for innovation projects, a message is sent to all employees of ASM and possibly OPS, SRE and CR. In this message, the strategic focus for innovations is indicated, and an innovation idea submission form is included. With this form, employees are given some time to suggest innovation ideas. This form, which can be found in appendix G, consists of 8 questions about the innovation concerning the following topics:

1. Innovation description + goals of innovation
2. Project goals
3. Strategic alignment
4. Feasibility
5. Technical advantage
6. Technical maturity
7. Internal and external stakeholders
8. Business case estimation

The answers to these questions should provide enough information to make use of the selection method possible. Filling in this form should not require a large amount of time, as this selection method is meant to select innovation ideas which will be researched further. Rough estimates can be given, keeping the barrier of filling in the form low. When an innovation idea is indicated to have merit after the selection process, more effort can be put in writing a detailed BD (beslisdocument). This is not necessary before this process.

The process of screening is started when enough innovation ideas are delivered.

Although the process can be used for 1 innovation idea at the time, the goal is to evaluate innovation ideas relative to each other.

Looking at screen 2, which is explained further below, having circa 5 innovation ideas in the screening process will provide a good comparison while not requiring too much time.

4.3.3 Screen 1: “Must-meet” criteria and showstoppers
In this screen, the first filter, the innovation ideas are evaluated on various “must-meet” criteria and potential showstoppers. A simple YES or NO is required for these criteria. If an innovation idea is indicated to not possess one of the “must-meet” criteria or to possess a showstopper by more than 50% of the respondents, the innovation idea is excluded from continuing to screen 2. This is done after the differences in opinion were cleared up.

Prior to this screen, the criteria used are determined by MT, based on the amount of innovation ideas received in the previous phase and the strategic focus. Because screen 2 is a more elaborate screen which takes a larger amount of time, the criteria of screen 1 can be adapted.
to reduce the amount of innovations evaluated in screen 2. A sensible amount of innovation ideas evaluated in screen 2 is 3 or more, but less than 7. Evaluating less than 3 gives no good comparison, while using more than 7 takes too much time.

If the amount of innovations is far too large for screen 2, criteria from screen 2 can be brought forward to screen 1. This means these criteria go from optional to mandatory. If the amount of innovation ideas for screen 1 is relatively small, some criteria can be transferred from screen 1 to screen 2. Here, these are transformed from “must-meet” to “can-meet”. Which criteria are transferred is decided based on the strategic focus as indicated up front. For instance: When the MT decides ASM purely needs to focus on innovations that improve the sustainability performance of Schiphol, the criteria evaluating the sustainability performance can be transferred from screen 2 to screen 1. The question could then be: “Does the innovation improve the sustainability performance of Schiphol? YES/NO.”

The questions that should minimally be present in this screen are:

1. Does the innovation meet environmental, health, safety and legal policies?
2. Does the expected advantage outweigh the risks?
3. Is there a reasonable likelihood of feasibility?
4. Strategic alignment: Does the innovation have potential to address a business need and is the innovation relatable to Schiphol’s strategy?
5. Is it possible to test the innovation on a small scale?

Question 4 of this list is already a first check to ensure the strategic match of the innovation ideas, one of the requirements of the selection method. Question 5 came forward from the semi-structured interview and is especially important in the context of Schiphol. Because the airport processes are vital, as explained in chapter 1, innovations are not allowed to disturb the airport processes. To make sure this is avoided, the possibility for a small-scale test of innovations is a must, and thus a “must-meet” criteria.

For this screen, it is not necessary to be in a group composition, it can be filled in from behind a computer, individually. The form used for screen 1 can be found in appendix H.

### 4.3.4 Screen 2: Scoring of innovations

The innovation ideas that pass screen 1 continue to screen 2. In this screen, respondents can give scores to a list of criteria for each innovation. The evaluation criteria are scored on a five-category scale. The average score on each criterion is multiplied by an importance weight, which is determined up front by the MT, based on the strategic focus. The total of all scores times the weights is added, and the summed scores of the innovation ideas are compared. The idea with the highest average score is considered the “best”. But, in round 3 which is explained further below, there is room for discussion on the scores and a possibility to indicate a preference for (possibly different) innovation ideas.

The evaluation criteria of screen 2 are divided in 6 groups. These groups contain all the criteria required from literature and from the semi-structured interviews. These groups are:

1. Financial value criteria
2. Non-financial value criteria
3. Sustainability criteria
4. Criteria for match with resources and strategy of ASM
5. Risks/feasibility criteria
6. Innovation necessity/desirability criteria
The groups are divided as such because these groups cover different types of value of an innovation idea. Group 1 assesses the potential financial value of an innovation to the department. Group 2 looks at the potential non-financial value of an innovation, factors like improvements in assets and/or services and image. Group 3 assesses an innovation's potential sustainable contributions, which is also value. Group 4 assesses how well an innovation idea “fits” in ASM based on the department’s resources and strategy. A good match gives an idea more value, since it contributes more towards strategic goals and is easier to fit in the existing processes and technology. Group 5 assesses the risks accompanying a certain innovation idea. Lower risks give a higher score to this group, representing value for the innovation idea as it presents the department with less (unexpected) unfavourable outcomes. The last group, group 6, evaluates how urgently an innovation is needed and demanded. An innovation idea that is urgently needed or demanded is more valuable to the department.

*By treating these 6 groups of criteria as value, it is possible to assess all types of potential value of an innovation idea. It does not treat sustainability as a competing goal, but one of the attributes giving an innovation value. This is in accordance with the SOI philosophy.*

Sustainability could also be argued to belong to the non-financial value criteria group. This was not done for 3 reasons. Firstly, if it was merely a part of the potential value for the organisation, its role, or impact, would be too small for the context of ASM. From the interviews, people indicated it would be good to keep separate. Secondly, by keeping it separate, it is easier to create an overview of all innovations in which the sustainability improvements can quickly and visually be compared. Finally, by keeping it separate, the selection method can also be used by airports that do not focus on sustainability. These airports can then give the sustainability criteria group a weight of zero.

It might be expected that innovation project budget is part of the financial value criteria. However, it is not included as it is not a factor on which innovation project ideas are compared, the size of the budget should not be a differentiating factor.

*An important criterion in the non-financial value part is the impact on provided services. This criterion is not standard in screening of innovation ideas, but very important for service firms. With this criterion, the improvement in service for passengers/airlines/handling agents is explicitly evaluated.*

There are 3 sustainability evaluation criteria, based on the sustainability goals of Schiphol. These can be adjusted to match the sustainability goals of other service firms if necessary. Currently, they evaluate the contribution towards the climate-neutral ambition, contribution towards zero-waste ambition and contribution towards better health conditions for employees, passengers and residents.

The fourth group, Match with resources and strategy of ASM, evaluates how well an innovation fits within the department and explicitly evaluates the strategic match of the innovations. Furthermore, the expected support of internal and external stakeholders is evaluated. This is a very important factor in the context of Schiphol, as innovations here need the cooperation of multiple stakeholders.

From the fifth group, risks/feasibility, the most notable criteria are Level of Control and trialability: The opportunity for small-scaled tests. Level of Control is added since the semi-structured interviews showed that this is seen as an important success factor within ASM. A higher Level of Control lowers the project risk, as the department has more influence on the choices made in the project.
In the final group, the demand for the innovations is evaluated as well as the timing. In appendix I, the form used for screen 2 with the list of criteria with their respective scales can be found.

The average score of the innovations on a group of criteria is multiplied by the weight that has been determined by the MT up front. In Figure 27 an example is given of how this works. In this example, the weights are set to be equal. The total of the weight should always be 100. This will for clarity be called group weight.

![Score overview](image)

To calculate the average score of the groups, the criteria making up the groups were given an importance weight as well. To get a clear average, the importance weights of the criteria belonging to a group should add up to 1. In Figure 28, an example is given using the sustainability criteria group. In consultation with the Corporate Responsibility (CR) department, the weights for contribution towards climate-neutral and zero-waste ambition was determined to be 0.4, whilst the weight for contribution towards better health conditions is set to 0.2. This weight will for clarity be called criteria weight.

![Figure 28: Example of criteria weights of the groups](image)

For the criteria weights, the idea is that these are kept (semi-) constant. Changing these should be possible, perhaps once a year, to better match the current reality. But, changing them for every screening round will result in outcomes that are not comparable, and the process can come across as untrustworthy. The group weights can be changed before every screening round by the MT, based on strategic focus. This will make it possible to select innovations with a focus on for instance sustainable performance or financial impact.

As was the case for screen 1, screen 2 can be done individually and does not require a group meeting. It can be filled in via a scoring form or from behind a computer. By doing the scoring individually, the idea is to make use of “wisdom of the crowds”. The principle of wisdom of the crowds is that the crowd possesses more knowledge than the individual. This effect is disturbed when individuals are possible to influence each other’s votes, hence screen 2 needs to be filled in individually.
4.3.5 Screen 3: Discussion, determining “belief” and timing

After screen 2, the results are collected, processed and visualized for screen 3. Screen 3 is performed in a group setting. This group, with around 5 or 6 people, must include one person per department representing external stakeholders. For instance, when an innovation idea is screened that involves airlines, a person from OPS should be present to represent the interests of OPS and the airlines. At least 3 persons from ASM should be present, to ensure the appropriate knowledge is present and the interests of ASM are sufficiently guaranteed.

During this group meeting, the results of screen 2 are presented by means of an overview of the scores in the shape of a table, as seen in Figure 27. Furthermore, a graph is shown in which the score breakdown can be seen. In Figure 29, this graph can be seen. By looking at this graph, it is possible to quickly compare the scores on the various groups of criteria.

Alongside the table with the score overview and the score breakdown graph, 2 matrices are provided. The first one is a standard risk-reward matrix, which is taken from the portfolio management literature and is seen often when comparing innovations. In this graph, seen in Figure 30, the technical feasibility is plotted against the potential value to the organization. Only the scores of these factors are included, not multiplied by the weights.

The second matrix is a less standard matrix and is created especially for the context of the research. In this matrix, the score on sustainability criteria is plotted against the score on financial criteria. A third factor is added that determines the sizes of the dots in the matrix, the
score on strategic alignment. With this matrix it is quickly observable what the potential sustainability gains of an innovation idea are compared to the financial score, whilst seeing how well it matches the organisation’s strategy. See Figure 31 for an example.

![Figure 31: Sustainable score vs financial score matrix, with strategic alignment](image)

By providing these graphs, the decision that is made at the end of screen 3 is not only based on the total score of the various innovations, but also on a deliberation between technical feasibility (risk) and value and between expected sustainable and financial performance combined with the strategic alignment of the innovation ideas. In appendix J, the form can be found which contains the scores and graphs that is provided in screen 3, and the final question as explained on the next page.

So, provided with the scores and visualizations, the group of people is invited to discuss the scores of the innovations ideas that are evaluated. A few questions are asked in the meeting to achieve a fruitful discussion:

- “Are there scores that surprise you?”
- “Do you believe certain scores should have been different?”
- “Do you think 1 or 2 of the evaluated innovation ideas better fit in the current innovation portfolio?”

Based on the overview of the scores, the score breakdown, the matrices and the discussion held within the selection group, the screening participants are asked to fill in a final question for each innovation idea, which is the final screen. The answer to this question is added as “advice” to the score overview. The question is:

“Do you believe it is a good idea for Schiphol to do innovation … now?”

<table>
<thead>
<tr>
<th>Innovation</th>
<th>Very bad idea</th>
<th>Bad idea</th>
<th>Neutral</th>
<th>Good idea</th>
<th>Very good idea</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>C</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

From this, a last overview can be made:

<table>
<thead>
<tr>
<th>Innovation</th>
<th>“Belief” score</th>
<th>Advice to MT</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1,5</td>
<td>Very bad/bad idea to perform this innovation now</td>
</tr>
<tr>
<td>B</td>
<td>4,5</td>
<td>Good/very good idea to perform this innovation now</td>
</tr>
<tr>
<td>C</td>
<td>3,5</td>
<td>O.K./good idea to perform this innovation now</td>
</tr>
</tbody>
</table>
With this last question, gut feeling is included. The screening participants are asked to follow their gut feeling in this last question. This was done to include the “belief” in certain innovation ideas of the people of the department.

From the semi-structured interviews, it became clear this is an important success factor for innovation within ASM, as belief in an innovation fosters sustained dedication towards achieving innovation success.

4.3.6 Save results in database
After the 3 screens have been completed, the results must be saved in a database. This database makes it possible to later retrieve innovation ideas that have been screened. In this database, it is important to save all information. The filled-in innovation idea submission forms, based on which the screening was done, must be included. The criteria used in screen 1 must be included, as well as the criteria used in screen 2 with the appropriate weights. The scores, score breakdown, graph and matrices must be saved, complete with the outcome of screen 3. Only when all this data is stored, it is possible to find out why certain innovation ideas were scored the way they were afterwards.

Having and keeping an up-to-date database has several benefits:

- The rationale behind innovation choices is available and accessible
- A clear overview is present of all innovation ideas that have been screened previously, including ideas that did not “win”
- Previously screened innovation ideas can be included in new screening rounds without having to score them again
- If strategic focus is shifted, weights can be adjusted to find out if previously screened innovation ideas are desirable in the new situation
- An overview is created of which actions were performed with a specific innovation
- Lessons learned from previous work/tests done on an innovation are better preserved and can be used later
- If a problem/challenge is identified that can be solved by an innovation, the database can be consulted to see if previous innovation ideas can achieve these goals

4.4 Conclusion
In this chapter, the process of creating the first prototype of the design has been presented. First, the design goals, requirement and assumptions are presented in §4.1, determining what the selection method must be capable of and which factors should be considered in the design.

In §4.2, the design process is explained. Generally, the design was done by combining the requirements of §4.1 with the building blocks from §3.2. By doing this, useful parts of various literature streams have been combined into one selection method usable by ASM.

The details of the design of the first prototype are found in §4.3. In brief, the selection method consists of 3 screens. The first screen serves the goal of quickly weeding out “bad” ideas. Screen 2 is used to rank the innovation ideas. After that, screen 3 serves the purpose of finding out the “belief” in an innovation idea. The selection is done by a group of people from ASM and internal stakeholders of Schiphol, in which the internal stakeholders represent external innovation stakeholders as well. The first prototype as presented in this chapter can be subjected to a first user test, which is explained in the next chapter.
5. Selection method testing and redesign

In this chapter, the results of the first user test are discussed first, in §5.1. This first user test is step 6 of the design cycle, the evaluation step. By performing this step, the first designing cycle has been completed and the research questions are answered. Based on the results of the first user test, some design alterations have been made, which are the first step of the second designing cycle. These alterations can be found in §5.2.

5.1 First user test results, evaluation of the first design

The first user test, as explained in §2.2.2, was performed on 25-6-2018 from 14:00 until 16:30. The goal of this test was to find out how well the prototype of the selection method realizes the design goals [G], meets the requirements [R] and satisfies the expectations of the users. By preparing and creating the test set-up, research question SQ5 has been answered. More information on the test set-up can be found in §2.2.2. More importantly, the results of the first user test provide the necessary information to answer SQ6.

The results as discussed in this sub-chapter are compiled from the observations made during the user test, the focus group at the end of the session and the answers on the questionnaires. The results are presented as follows: Evaluation of the selection method in general, evaluation of screens 1, 2, and 3, evaluation of the Goals and Requirements.

5.1.1 Evaluation of the selection method in general

Three innovation ideas were used in the test of the prototype, being: Fast-hardening concrete, value-stacking and de-icing tank modification for jet fuel. Fast-hardening concrete is a type of concrete that requires less time to cure. Although it is more expensive than normal concrete, it can save money by requiring less time for maintenance, disrupting less operational activities. Value stacking in in essence a large battery, capable of stabilising fluctuations in the electrical network of Schiphol. This can prevent the disruption of operations of assets relying on electrical energy, ultimately preventing disruption of the airport processes. Furthermore, it can unburden the network when there’s a large spike in demand, preventing the company having to pay premium prices for peak electricity. This is called peak-shaving and saves the company money as well. Modifying the de-icing tanks for kerosene storage during summer months enables the airport to refuel aircrafts on the J-platform without having to drive fuel tankers around and building new (expensive) infrastructure for refuelling.

In general, the test participants were enthusiastic about the selection method, as it makes it possible to evaluate and compare innovation ideas on more than the business case alone. The selection method was described as useful. Furthermore, the test participants reacted very positive to the inclusion of people from other departments (OPS and CR) in the selection process. According to them, this avoids the danger of pursuing an innovation that is not supported by other departments and stakeholders. The voices of other departments and stakeholders was indicated to be well-represented. Another positive effect of this screening method, according to the test participants, is that it tells how much support an innovation will likely receive, as non-experts are included in the screening process.

The structure of the selection method, with 3 screens, was also received positively. The contents of the screens led to some discussion, which is elaborated in the evaluation of the respective screens. When asked whether the structure of the selection process is complete or that there were parts missing, the group indicated that the current structure is satisfactory. The
process is indicated to be clear, fair, objective, and differentiating enough between ideas. The questionnaire used for the screens and the questions used were perceived as good, but a remark was made that perhaps less questions or more compact questions could be used. According to the participants, this could result in screening participants understanding the questions in one glance, and faster response times.

Although originally no discussion was allowed during screen 1 and screen 2, there were still some conversations. However, these were not about the screening questions, so there was no influencing of scores. The conversations were about the technical details of the innovations, indicating that perhaps the innovation idea submission forms did not provide enough knowledge to make deliberate choices possible. A possible solution to this is that the "innovation owners", the persons suggesting the innovation ideas, give a short presentation to the screening group. However, this might be too time consuming and dependent on availability of the "innovation owners". Another option might be to provide the "innovation owners" with the screening questions up front, so they can provide enough information to answer the questions. The "innovation owners" can then be asked to provide two A4's of information about the innovation idea, with answers to the screening questions. This has the added value of making people committed to an innovation idea by becoming the innovation owner.

The analysis of first user test provided some interesting insights.

First of all, the fact that there was no discussion on the selection method itself, only on the contents of the screens, proved that the structural specifications of the prototype fulfil the wishes of the department. Furthermore, it proves that the selection method is easy-to-use, but not too simple either. The selection method is up-and-running very quickly, as the prototype can be used in a real-life setting and provide an outcome that is accepted by all test participants. Another interesting observation is that the fast-hardening concrete came out of the test as the "winner", with all test participants agreeing it is the rightful "winner". This was unexpected and proves that the selection method is objective.

5.1.2 Evaluation of screen 1

According to the test participants, the idea of the first screen is good. When many innovation ideas are present, a quick pre-selection is necessary to narrow down the amount screened in screen 2. By making it a screen with only YES/NO questions, it is a fast and easy way of reducing the amount of innovation ideas for screen 2 if necessary.

However, the questions were sometimes perceived as unclear or hard to answer given the limited amount of knowledge of the innovation ideas. In other words, the criteria were not perceived as realistic by all participants. For instance, question 1: "Does the innovation meet environmental, health, safety and legal policies?" requires knowledge of the current policies. Another issue indicated by the test participants for this question is the use of 4 different terms (Environmental, Health, Safety, Legal). Also, question 4: "Does the innovation have potential to address a business need and is the innovation relatable to Schiphol's strategy?" was advised to be split up, as it covers 2 different questions. Furthermore, question 2: "Does the expected advantage outweigh the risks?" was indicated to be hard to answer. Even when the expected advantages and the possible risks of an innovation idea are clear, it is hard to determine whether the advantages outweigh the risks. In other words, question 1 and 2 are found to be too detailed, requiring too specific/specialist knowledge. Different wording of the questions could negate this issue. Another option is to let screen 1 be done by experts, that have the appropriate knowledge of the innovations. However, screen 1 and 2 will have to be done by the same group of people, so changes in opinion can be tracked.
Apart from this, the criteria were found to be differentiating enough and complete. The test participants were especially positive about question 5: “Is it possible to test the innovation on a small scale?” As discussed previously, this makes it possible to test innovations without risking the vital operational processes of the airport.

5.1.3 Evaluation of screen 2
In general, the questionnaire and questions of screen 2 were evaluated as good by the test participants. One participant indicated that the division over 6 groups was not 100% clear. For instance, it was suggested to reduce group 6 to 1 question and combine this with group 4.

The criteria used in screen 2 were perceived as operational, or easy to use for comparing innovation ideas relatively. The criteria were also perceived as differentiating enough:

“The screen makes it possible to look at and score innovation ideas on all different aspects, making it possible to differentiate innovations on all relevant aspects, not only on financial grounds.”

Furthermore, the criteria were indicated to be complete. Apart from maybe moving criteria to other groups, the test participants indicated that no criteria had to be added or deleted. Perhaps, some criteria were too detailed, as indicated by 1 participant.

However, the criteria were not always perceived as realistic, indicating that sometimes not enough information was present to be able to answer the questions well, or the question was not worded clearly enough. A possible solution is to either make the questions of screen 2 available to the “innovation owners” up front, so they can provide enough information to be able to answer the questions. Another option is to reduce the number of indicators, but the test participants indicated that the number of indicators was good. Especially the first question of part 2, potential advantages of innovation, was indicated to be too broad and thus not realistic.

Furthermore, the test participants indicated that the scales used were sometimes unclear and inconsistent: For some criteria the scale had a range from very negative to very positive, while for other criteria the scale had a range from no impact to very positive impact. This was perceived as confusing. Also, some criteria require more explanation as to what is considered positive and negative. During the focus group, the test participants had a discussion on whether it would be a better idea to use a 4-point scale ranging from very negative to very positive to provoke a larger scoring spread, or to keep a 5-point scale with 3 always being no impact/neutral/unknown. No definitive conclusion came from this, but it was advised to investigate this question.

Finally, from the focus group and the questionnaire it came forward that potential benefits for ASM could better be termed as potential benefits for “operational excellence”. This means providing the best, fastest operations for customers. This is the shared strategy of ASM and OPS, so this looks more at the benefits to Schiphol in general.

An interesting discussion that emerged in the focus group was whether it would be a good idea to evaluate innovation ideas relatively to each other, by ranking the innovation ideas for every single criterion. In its current form, the scores on each criterion of the different innovation ideas are given independent of the scores of other ideas. However, because of the design of the questionnaire it was not perfectly clear to all test participants if innovation ideas needed to be scored independently or in comparison with the other ideas. The discussion was finished with the conclusion that the scoring should remain independent, but that this should be made clearer.
5.1.4 Evaluation of screen 3
Screen 3 was also generally reviewed well by the test participants. The question asked was perceived easy to use, realistic and differentiating. The visuals in shape of the score overview, the score breakdown and the matrices presented were assessed to be clear and useful. One possible addition to these visuals is a radar or “spider-web” graph, which shows the score breakdown of the individual innovation ideas clearly and makes it possible to visualize a threshold value for the various aspects.

Another suggestion brought forward is to not only ask “Do you believe it is a good idea for Schiphol to do innovation … now?”, but also include the questions “Do you believe it is a good idea for Schiphol to do innovation … within 1-3 years?” and “Do you believe it is a good idea for Schiphol to do innovation … after 3 or more years?”. This provides the screening participants the opportunity to not only indicate their belief in an innovation in its current state, but also to indicate whether they think it is better to let the innovation idea mature outside of the borders of ASM/Schiphol. Also, for screen 3 a 10-point scale was suggested to perhaps be more useful.

One thing that was not perfectly clear is whether the answer on screen 3 should be given in consideration of the budget and capacity or not. The question brought forward is: "Is the ranking of screen 3 done first, and the ‘cap’ on budget and capacity done afterwards? Or is budget and capacity considered while evaluating?" This was unclear, and it greatly influences the scores given. For example, an innovation idea might be scored very low when there is currently not enough budget or capacity available but scored very high the screening process a quarter later.

5.1.5 Evaluation of the goals and requirements
During the focus group, the test participants were provided with the goals [G] and requirements [R] of the selection method, as presented in §4.1. The participants were then asked whether the selection method as used in the first user test accomplished the goals and meets the requirements.

The test participants all indicated that the goals are accomplished, and the requirements are met by the prototype of the selection method as used in the first user test.

The only remark that was given is that the selection method does not specifically make the choices easier, as stated in [G1], but it does make it easier for the MT. Consequently, this goal has been edited.

5.2 Selection method redesign
Based on the results of the first user test, a second design step can be made. The prototype will be altered considering all the feedback from the observations, focus group and questionnaires. In this sub-chapter, the changes to the design of the selection method are discussed. The overall structure of the selection method is kept the same, but the questions and scales are changed. Because of this, the design alterations will be discussed per screen.

5.2.1 Design modifications screen 1
The questions of screen 1 are split up and worded differently, to negate the issues/remarks as explained in §5.1. The new questions can be seen in Table 14 and in appendix K.
Table 14: Modified screen 1 questions

<table>
<thead>
<tr>
<th>Question</th>
<th>YES/NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Is there a reasonable likelihood of meeting environmental policies?</td>
<td></td>
</tr>
<tr>
<td>2. Is there a reasonable likelihood of meeting health policies?</td>
<td></td>
</tr>
<tr>
<td>3. Is there a reasonable likelihood of meeting safety policies?</td>
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<tr>
<td>4. Is there a reasonable likelihood of meeting legal policies?</td>
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<tr>
<td>5. Is the innovation expected to present an advantage?</td>
<td></td>
</tr>
<tr>
<td>6. Is there a reasonable likelihood the risks will be manageable?</td>
<td></td>
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<tr>
<td>7. Is there a reasonable likelihood of feasibility?</td>
<td></td>
</tr>
<tr>
<td>8. Does the innovation have potential to address a business need?</td>
<td></td>
</tr>
<tr>
<td>9. Is the innovation relatable to Schiphol’s strategy?</td>
<td></td>
</tr>
<tr>
<td>10. Is it possible to test the innovation on a small scale?</td>
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By changing the questions, they will be easier to answer. The questions do not cover multiple aspects in one question anymore, as these are split up in multiple questions. Furthermore, by asking “Is there a reasonable likelihood of meeting … policies?”, these questions are possible to be answered with limited knowledge.

5.2.2 Design modifications screen 2

For screen 2, the most striking changes are discussed here. The first big change is that the innovation ideas are now screened after each other instead of simultaneously. This ensures that the scores given are purely based on the innovation idea itself, and not based on a comparison with the other innovation ideas. So, first all questions are answered for innovation A, then for B, then for C etc.

The scales have been edited to be the same for all questions. The 5-point scales are kept but now all range from very negative to very positive, with 3 being average/medium/neutral/unknown. This was not done in the first designing cycle because it was determined that the innovation ideas must for instance at least present an improvement for ASM and are not allowed to have a negative impact on provided services for instance. But these conditions can still be incorporated in the selection method by implementing threshold values for scores on various criteria. These thresholds can easily be implemented in the graphs that are added to screen 3. Otherwise, these criteria can also be added to screen 1, in which they become “must-meet”.

In part 2: Non-financial value criteria, some changes have been made. The first question, potential value to ASM, was indicated to be too broad. Also, the test participants indicated it was better to look at the contribution towards the “Operational excellence” goal, as this is value to not only ASM but to Schiphol as a whole. One question has been added, being “Expected impact on asset base”. In part 3: Sustainability criteria, one question has been added to cover all CR themes of Schiphol. As explained before, the scales have been edited as well. Finally, in part 6: Innovation necessity/desirability, the timing question has been deleted, as this is now included in screen 3.

Furthermore, the criteria that were indicated to be unclear received a better, clearer explanation. The new list of questions for screen 2 can be found in appendix L.

5.2.3 Design modifications screen 3

For the visuals, radar-graphs are added. This makes it clearer how the scores of the separate innovation ideas are composed. Another benefit of the radar-graphs is that threshold values of the 6 groups can be visualized easily. See Figure 32 for an example of a radar graph based on the scores of innovation C used in the user test. Radar charts are especially good for visualizing comparisons of quality data, hence the selection of this graph type. It can be used to compare the score of an innovation idea with a threshold, or with other innovation ideas.
Based on the feedback of the test participants, screen 3 has been expanded to 3 questions per innovation idea. The questions are now:

- Do you believe it is a good idea for Schiphol to do innovation … now?
- Do you believe it is a good idea for Schiphol to do innovation … within 1-3 years?
- Do you believe it is a good idea for Schiphol to do innovation … after 3 years?

This way, the timing of the innovation ideas is given more consideration. The scales used for screen 3 are 10-point scales, as the first user test brought to light that the participants preferred to be able to indicate a more nuanced score. The new form that is used for screen 3 with the new graphs included can be found in appendix M.

5.3 Conclusion

The prototype of the selection method as designed in chapter 4 has been subjected to a first user test, to evaluate how well it achieves the design goals and meets the requirements. The results of this user test, retrieved from observation, a focus group and a questionnaire have been explained in §5.1. In general, the prototype was perceived as useful. The design goals have been achieved, and the requirements have been met. The structure of the selection process was received positively. There has been no discussion on the overall shape of the selection method, providing evidence it fulfils the wishes of the department and it is easy to use but not oversimplified. Furthermore, the selection method is objective, as it provided an unexpected “winner” which was accepted by the test participants. However, the questions and the scales used in the 3 screens were not always clear and easy to use. The biggest issue was found in how realistic (easy to answer with current knowledge) the criteria are.

The results of this user test served as input for a first design alteration cycle, the modifications done in this step are presented in §5.2. Mainly, questions of the screens have been split up, cleared up and otherwise adjusted to be easier to answer. For screen 2, the scales have been adjusted to be the same for every question. For screen 3, additional visuals have been added and the questions were changed to better cover the criterion “timing”.

Figure 32: Radar graph with threshold value
6. Design process for other service firms

To repeat, the research objective of this research was two-folded: (1) A sustainable innovation selection method design for infrastructure-providing service firms would be delivered, and (2) a process with design rules would be delivered that other service firms can follow to create their own adaptation of the selection method. In the previous chapters, the design of a sustainable selection method for an infrastructure-providing service firm (in this case ASM) has been performed and explained, fulfilling the first research objective. Doing this, a process was followed. In this chapter, this process is explained, which other service firms can follow to create their own sustainable innovation selection method. A visual representation (Figure 33) of the design process is given. The design rules are provided in this chapter as well.

![Design process for a sustainable innovation selection method](image)

Figure 33: Design process for a sustainable innovation selection method
Step 1: Research current situation

When one is unknown with the company and department, the first step is to map the current situation. The company culture, strategy, (sustainability) goals, problems & challenges, and internal & external stakeholders must be mapped. The company culture is necessary to have clear as it will give the first indication into what kind of selection method is desirable and will be accepted. If the company culture is very informal, a strictly formal selection method will have a lower chance of being accepted.

It is important to have clear the strategy of the company and department. After all, strategic fit is an important success factor for innovations, and thus an important evaluation criterion for innovations. This became clear from the literature research and the interviews with employees of ASM. To be able to assess the strategic fit, the strategy must be clear.

*Design rule:* Clearly map the strategy of the firm/department. Strategic fit is an innovation success factor, and thus an evaluation criterion. To use it as such, the strategy must be made clear.

The sustainability- and other goals of the department/firm must be made clear as well. The possible contribution of an innovation towards these goals is part of the evaluation criteria. The contribution is part of the value of an innovation, and to be able to assess it, the goals must be clear. This is necessary to construct the appropriate screening questions.

*Design rule:* The sustainability goals are especially important to map when designing a selection method to use for adhering to the SOI principles. To assess the contribution of an innovation idea to the sustainability goals of firm, these goals must be clear.

The internal and stakeholders are important to map. In service firms that operate in a network setting, in which stakeholders are often the adopters of innovations, the stance of the stakeholders is important to consider during innovation selection. To do this, the voices of these stakeholders must be represented in the selection process. To be able to include the appropriate people in the selection process, the internal and external stakeholders must be mapped in this first step.

*Design rule:* For service firms in a network setting, the internal and external stakeholders must be carefully mapped. The connections between these must be clarified. This must be done to involve the right persons in the selection process.

Finally, mapping the current situation will bring to light the current innovation process, innovation selection method, and the perceived effectiveness of these. This will provide problems, challenges, and thus possible improvement possibilities.

Step 2: Define & validate design goals, requirement, assumptions and criteria requirements

With the current situation made clear in the first step, the problems, challenges and thus possible improvement possibilities have become clear. To successfully create a design that tackles these problems, the next step is to define and validate the design goals, requirements and assumptions, following the approach of Verschuren and Hartog (2005). An extra list added for designing a selection method is a list of criteria requirements.

The design goals are the goals the design ultimately must fulfil. The requirements are functional requirements \([R_f]\), user requirements \([R_u]\) and contextual requirements \([R_c]\). Further explanation on what these are and how to define these can be found in §2.1, §4.1 and in the paper of (Verschuren & Hartog, 2005). In the case of ASM, these lists were defined based on
interviews with department employees. Important to note is these goals and requirements act as acceptance criteria of the design in the evaluation phase, it is thus vital to correctly define and validate the goals and requirements. The assumptions are the qualities that the users and context should possess to make fruitful use of the designed selection method possible.

However, in the case of designing a selection method, an addition to these lists is the list of criteria requirements. A sustainable innovation selection method assesses innovation ideas on multiple criteria. There are standard evaluation criteria in scientific literature, but a company might require the innovation ideas to be evaluated on non-standard criteria as well. To find out what these are, one must find out what the firm thinks are important evaluation criteria. This can either be done by interviews, questionnaires or other research methods.

*Design rule: On top of the lists of Goals, Requirements and Assumptions dictated by (Verschuren & Hartog, 2005), create a list of criteria requirements. Firms have non-standard evaluation criteria that are not found in literature. To bring these to light, create the criteria requirements list.*

After these are defined, it is important to validate the goals, requirements, and assumptions. This is not a one-time action but needs to happen in multiple instances. By reiterating the goals, requirements and assumptions multiple times they will more accurately reflect the demands of the firm and the final design will subsequently better match the demands of the firm.

**Step 3: Retrieve “building blocks”**

Once the current situation is clear and the demands are clear it is time to retrieve useful parts, or “building blocks”, from various literature streams. This is done since there are no off-the-shelf methods for evaluating innovations on their value, probability of success and sustainability in a service company operating in a network setting.

There are not many existing selection methods for service innovations but building blocks can also be retrieved from product innovation selection methods/processes. This is because in general, an innovation selection method for a service firm is not extremely different from an innovation selection method for a manufacturing firm, it is generally a question of using different selection criteria. These building blocks can encompass different structures of selection processes but also selection criteria, and ways to assess the sustainability of innovation ideas. In §3.2.3 and §3.2.4, building blocks for (infrastructure-providing) service firms can be found. It is always possible to retrieve more and other building blocks for different contexts.

*Design rule: Retrieve building blocks, as there are no off-the-shelf selection methods for sustainable innovation ideas in service firms. These can be combined to create a fitting selection method for the firm.*

**Step 4: Design**

In this step, the design goals, requirements and assumptions are combined with the building blocks defined in the previous step. In an iterative process, as explained in §4.2, requirements are coupled to building blocks. The combinations are checked for compliance with other requirements, and ultimately a combination of building blocks will be created that fulfils all requirements and does not contradict with any of the requirements.

This combination is the first prototype of the design, it should thus be testable but also light-weight (not too detailed). It is important to keep the prototype light-weight, as the design must be iterated after the user test of the next step. Any superfluous effort is wasted.
Design rule: To follow the SOI principle, sustainability must explicitly be part of the selection process. It must be measured at the same “level”, and at the same time as the other criteria.

**Step 5: Set-up user test protocol & perform test**

In this step, the first prototype is put to the test. In this **evaluation** stage the prototype is **implemented in a real-life context**. In this stage, it is checked how and how well the prototype accomplishes the design goals [G], meets the requirements and satisfies the designers’ and stakeholders’ expectations. Based on the results and feedback of this first user test, the second design cycle can be started.

For determining the real-life test context, the analysis of the internal and external stakeholders from step 1 comes into play again. The composition of the group for the test should be representative of the group composition of when the selection method is put to actual use.

*Design rule: The test must be done in a real-life context. In order to do this, the test participants must be chosen as to be representative of the group using the finished selection method.*

3 methods of data gathering can be used: Observation, focus group, and a questionnaire. First, the participants are observed while using the selection method. Secondly, a focus group is held after using the selection process, to discuss the structure of the selection process, the objectivity and fairness of the process, and whether it achieves the goals and meets the requirements or not. Finally, a questionnaire is filled in, in which the criteria and the scales of the selection process are evaluated. The observations made during the first user test are compared to the answers given on the questions of the focus group and the questionnaires. The combination of the observations and the answers given during the focus group and in the questionnaire provide the necessary test feedback. With this information, the second design cycle can be started.

*Step 6: Design iterations*

Based on the information gathered by the first user test, the prototype of the design can be altered. This is part of the second design cycle, which has the goal of delivering an improved design that better achieves the goals and meets the requirements. After this step, the improved design can be put through a second round of testing.
7. Conclusions, recommendations, discussion

In this chapter, the conclusions of the research will be presented first in §7.1. These will be based on the answers found to the research questions as presented in §1.4. After that, the practical and theoretical contributions of this research are presented in §7.2. A discussion on the research approach is laid out in §7.3, and the discussion on the selection method designed during this research is presented in §7.4. After that, the recommendations for future research based on the discussion are presented in §7.5. The chapter is finished by recommendations to Royal Schiphol Group in §7.6.

7.1 Conclusions

In this research, the Design Oriented Research method has been followed to design a selection method for sustainable innovation ideas within a service firm, in this case Royal Schiphol Group. To make this approach successful, various sub-questions have been composed that correspond with the various steps of the designing cycle. The answers to these sub-questions provide a design of a sustainable innovation selection method, but most importantly they provide design rules for other service organisations looking to design a selection method. The answers to these sub-questions are presented first, followed by the answer to the main research question.

7.1.1 Conclusion SQ1: Which methods for selecting innovation ideas are interesting for a service organisation?

a. What are existing methods in literature?
   (1) How are these methods utilized?
   (2) Is there a difference between innovation selection methods in general and sustainable innovation selection methods?

b. Which parts of various literature streams are interesting for a service organisation?

c. Which parts of various literature streams are interesting for an infrastructure-providing service firm?

d. Which parts of various literature streams are interesting for ASM?

A plethora of methods for selecting innovation ideas are found in the literature. The “Stage-Gate”, innovation funnel, portfolio management, evaluation methods & criteria, New Product Screening, success/failure factors for innovations and characteristics of innovations predicting innovation adoption literature streams have been investigated. The selection methods vary from strictly formal to informal, from purely quantitative to solely qualitative.

The literature field of sustainable innovation selection methods was found to be not very advanced. This is mainly since sustainability is a different dimension than selection criteria for innovation ideas. The criteria based on which innovation ideas are selected are in general criteria predicting or indicating probable innovation project success, whilst sustainability does not tell anything about innovation project success. The field of sustainability assessment has been studied, to give an idea of how to assess sustainability of innovation ideas.

There is not 1 method for selecting innovation ideas clearly most interesting for a service organisation, all literature streams present interesting features. “Building blocks”, or interesting features of the various selection methods, have been retrieved from these streams. This has been done for service firms in general, for infrastructure-providing service firms, and for ASM finally. Based on the design goals and requirements uncovered in a later stage of the designing
cycle, these building blocks were combined to create a sustainable innovation idea selection method for an infrastructure-providing service organisation, in this case being ASM.

6.1.1 Conclusion SQ2: What does the innovation process, of which idea selection is part, look like for ASM?

a. What are the goals that ASM aims to achieve with innovations?

b. What is the innovation process currently employed by ASM?

c. How is selection of innovation ideas currently done at ASM?

d. What is the effectiveness of the current innovation process and idea selection method as perceived by ASM?

In short, the main goals of innovating for ASM are improving the business processes of Royal Schiphol Group, contributing towards achieving the strategic goals of the department and contributing to the organizational objectives of Schiphol. The strategic goals of the department are: “Optimal and sustainable creation and management of profitable and reliable assets, with a deliberate consideration between functions, costs and risk” (Felten, 2017, p. 3) and “Making assets available that optimally align with the organizational objectives of Amsterdam Airport Schiphol (AAS)” (Felten, 2017, p. 3).

Furthermore, innovation is seen as one of the most important methods for achieving the sustainability goals of the company. The department ASM has a large influence on the sustainability of Schiphol, due to the scale of the asset base. Royal Schiphol Group has expressed 2 ambitious goals in terms of sustainability: Achieving zero-waste, or circularity, in 2030 and becoming climate-neutral (having a net zero carbon-footprint) in 2040.

ASM performs technical product and process innovations in the shape of pilots, proof of concepts or full-fledged innovation projects. Although the current way of working does sometimes result in successful innovation projects, indications were found that a more structured way of working could provide some benefits. There is currently no structured innovation process employed by ASM. It is informal and perceived as ad-hoc. There is no unambiguous, explicitly described innovation process in the shape of a funnel or the like. The lack of a structured, explicit innovation process is indicated by employees to be cause of a lack of oversight for employees.

As is the case with the innovation process, there is no explicitly described process for selecting innovation ideas at Schiphol Group ASM. Innovation selection is currently based done on the business case as presented in the Project Initiation Document. There is no comparison between innovation ideas, the ideas are evaluated one at a time. This combination of facts results in a situation in which the potential added value of innovation ideas are not compared against each other. Ultimately, this carries the danger of making sub-optimal innovation idea choices.

6.1.2 Conclusion SQ3: What are the goals, requirements and assumptions for a sustainable innovation selection method of Schiphol Group ASM?

Based on the problem definition of the department and the perceived improvement opportunities in the innovation selection process, there are 4 main goals that the design of the sustainable innovation selection method should fulfil for ASM. Condensed to a single sentence each, the goals are:

- Making better founded choices and making these choices easier for the management team.
- Create a pre-determined, structured and unambiguous innovation management process, a guaranteed process for all employees.
- Create (portfolio) overview of which innovation ideas are present in the department, and which have been considered previously.
- Enable ASM to select innovations according to the SOI philosophy, in which sustainability is not treated as a competing goal of traditional business values.

To achieve these goals, functional requirements have been determined. These are the functions that the selection method should fulfil or enable to perform once realised. User requirements, demands of the user of the selection method, have also been determined. The final class of requirements according to the Design-Oriented Research method are contextual requirements: Prerequisites set by political, economic, legal, and/or social environments.

Added to this, is a list of criteria requirements. These are criteria that must be included in the selection method, as interview participants indicated these to be important criteria for evaluating innovation ideas in ASM. These requirements are an important input in the designing phase of the selection method.

Finally, assumptions were drafted. These are assumptions about the qualities that the users and context should possess to make fruitful use of the selection method possible.

6.1.3 Conclusion SQ4: Based on the results of SQ1, SQ2 and SQ3, what are the structural specifications of the prototype of the sustainable innovation selection method for Schiphol Group ASM, and how can it be used?

Principally, the prototype consists of 3 screens to evaluate innovation ideas. The first screen evaluates innovations on "must-meet" criteria and potential showstoppers and is a quick check aimed at reducing the amount of innovation ideas going through to screen 2. Innovation ideas that lack a vital attribute or possess a potential showstopper and are therefore unfavourable can be discarded without wasting too much time/effort. Depending on the amount of innovation ideas present for the screening process, the number of criteria in screen 1 can be adjusted. When there are far too many innovation ideas for screen 2, a more time-consuming screen, screen 1 can be made stricter by adding more criteria. These can be moved forward from screen 2.

Screen 2 is a linear compensatory model, generally known as a scoring model. In this screen, a list of criteria with importance weights is used. People determine the scores on the criteria of the innovation ideas on a 5-point scale. For every criterion, the average score of an innovation idea is multiplied by the weighing factor and the total of all the scores times the weights are then added. The summated scores of the innovation ideas can then be compared, to see which scores the highest or which ideas score above a certain threshold and are interesting to further analyse. 6 groups of criteria are used in this screen: Financial value criteria, non-financial value criteria, sustainability criteria, criteria for match with strategy and resources of ASM, risk/feasibility criteria and necessity/desirability criteria. The attribute weights are determined up front by the MT and are not known to the screen participants, to reduce the risk of strategic voting. Screen 1 and 2 are done individually, to avoid screen participants influencing each other’s scores.

After this, the results are presented in the form of a score overview table, a score breakdown graph, a risk-reward matrix, a matrix that shows sustainability-, financial- and strategic alignment score, and a radar graph for all ideas. In screen 3, the group of screen participants can discuss the results and visualizations. Based on this, the participants are then asked to answer 3 questions per innovation idea. These questions, scored on 10-point scales, are whether the participants believe it is a good idea to do an innovation now, between 1-3 years, and after 3 years, respectively. This screen includes gut-feeling and the timing of innovations.
The result after 3 screens is an overview of the scores of the innovation ideas with an “advice” to undertake an innovation now, within 1-3 years, after 3 years, or not at all. The results are saved in a database, so it is later possible to see which innovation ideas have been considered.

6.1.4 Conclusion SQ5: How can the prototype of the method for selecting sustainable innovation ideas be implemented for testing in Schiphol Group ASM?

The prototype has been tested during a first user test. In this first user test, information on the performance of the selection method prototype was gathered through three channels: Observation, a focus group, and a questionnaire. To be able to observe the workings of screen 1 and 2, these were performed in a group setting as opposed to individually.

For the test, the importance weights of the criteria were distributed proportionally. This could be done since the test was aimed to find out the adequacy of the selection process and criteria, the weights were not part of the tested characteristics during this first user test.

The composition of the first user test group was in accordance with the composition of the group that will ultimately use the selection method. 3 persons from the department ASM were included, accompanied by 1 person from the department OPS (Operations) and 1 from the department CR (Corporate Responsibility). CR is responsible for determining and achieving the sustainability strategy of Schiphol and is involved in decision making in investments, tenders and operational processes. OPS is responsible for the operational processes of the airport and thus has close contacts with many stakeholders. Since the innovation ideas that are screened by the selection method often involve various stakeholders and must contain a sustainable component, these departments must be represented in the selection process.

For the first user test, it is important to not put too much effort in the design details of the selection method. The prototype must demonstrate the workings of the process and should contain the correct selection criteria but does not yet have to be a properly finished product. Because the first user test is meant to provide feedback for a design alteration, it would be a waste too put too much effort in the prototype. Because of this, the screens were performed largely manually. The answers on the questions of the screens were given on paper forms. The criteria of screen 1 were checked by hand to see whether an innovation would be excluded for further screening. The scores of round 2 were entered in an Excel sheet by hand to determine the summated scores and create the visualizations. These were then printed and presented as such. In further design steps, the screens can be automated or digitalized for higher user friendliness.

6.1.5 Conclusion SQ6: How does the prototype perform?

a. How well does the prototype realize the goals and meet the requirements and assumptions?

b. Which parts need to be redesigned?

From the observations and the focus group during the first user test, it became clear the prototype of the designed selection method realizes the design goals and meets the requirements and assumptions. The structure of the selection method was received well by the test participants, with the screens in the shapes as explained. The focus group at the end of the test did not spark a discussion on the overall shape of the method. This indicates the prototype of the selection method is easy-to-use, but not too simple either. Furthermore, there was no discussion about the surprising outcome of the test, indicating the prototype is objective as well.

Although the prototype realizes the goals and meets the requirements, the test participants provided feedback on components that could be improved so that the selection method can
realize the goals and meet the requirements even better. Structurally, no large parts of the prototype needed redesign. The components that needed most attention in the second design step were the criteria of the 3 screens. The largest overall issue perceived with the criteria used was how realistic (possible to answer with current knowledge) they were. Test participants indicated some screening questions were hard to answer due to mainly 2 reasons: Multiple factors were asked in 1 question and not enough information was provided to answer the question.

Further design alterations were further clarification of the selection criteria, and improvement of the scales of screen 2. Several scales were not uniform in screen 2 of the prototype; some ranged from very negative to very positive whilst other scales ranged from neutral to very positive. This came across as confusing and resulted in a distorted representation of scores in some areas. The choice for these inconsistent scales was based on the notion that some characteristics must be present in innovation ideas. But, ensuring that certain characteristics were present in innovation ideas can also be done by changing the (amount of) criteria in screen 1 or instating threshold values for the criteria concerned.

The last modification to screen 2 is the order of evaluation. In the form used during the first user test, the various innovation ideas were screened simultaneously. This also led to some confusion as to whether the ideas had to be screened in comparison with the other ideas or not. After the modification, the innovation ideas are screened 1 by 1.

Screen 3 was also redesigned on a few points. First, a radar-graph was added for all innovation ideas, which clarifies the composition of an innovation’s score and makes it possible to visualise the score compared to threshold values. Furthermore, the criterion “timing” has been taken from screen 2, and the scales were adjusted to 10-point scales.

Now the answers to these sub-questions are known, it is time to answer the main research question:

6.1.6 Conclusion main research question: How can a sustainable innovation idea selection method be developed for an infrastructure-providing service firm?

Although developing a method for selecting innovation ideas that can help in making a service organisation more sustainable will likely not be done in a research setting as presented in this thesis, the design-oriented research approach presents useful steps for designing a selection method outside of a research setting as well. The goal of following the design-oriented research method is to come up with design rules which others can use to design a similar artefact in a different environment. So, of course, the steps taken with this approach can also be design rules. The design rules, which ultimately tell how a method can be developed for selecting innovation ideas that can help in making a service organisation more sustainable, are presented here.

If not acquainted with the current innovation process, selection method and innovation goals of the organisation/department, the first step is to get to know and map these. This will bring to light problems or challenges in the current way of working. Solving these will be (part of the) design goals of the innovation selection method. Furthermore, uncover the strategy and goals of the firm and department, including the sustainability goals. Strategic match is an important criterion for innovation selection and uncovering the strategic goals will indicate the importance of the sustainability of innovation ideas. Finally, when the firm or department operates in a network setting, map all the internal and external innovation stakeholders. These must be present or represented during innovation selection decisions, since these must use the innovation and/or can influence the innovation process.
Then, the second step is to further identify what the organisation wants to achieve with the selection method. Uncovering this will yield the design goals, requirements and assumptions. The requirements will later serve as acceptance criteria of the design, so these must be validated properly. Use this step to also find out which innovation characteristics are important evaluation criteria for the organisation. There are standard innovation evaluation criteria which can be found in the literature, but every (service) organisation has a few non-standard criteria as well. This list of criteria requirements is not standard in the designing cycle but is important when designing a selection process based on criteria.

Because it is highly unlikely there is an existing innovation idea selection method that achieves all desired goals and meets all requirements, “building blocks” can be retrieved from various existing innovation evaluation/selection methods in the third step. To find useful parts of existing methods, find different building blocks that meet the requirements. These building blocks can encompass different structures of selection processes but also selection criteria. There are not many existing selection methods for service innovations but building blocks can also be retrieved from product innovation selection methods/processes. This is because in general, an innovation selection method for a service firm is not extremely different from an innovation selection method for a manufacturing firm, it is generally a question of using different selection criteria. Whereas a manufacturing firm only has to evaluate product innovation ideas, a service firm must evaluate both product and service innovations.

So, which criteria that are not standard in product innovation selection are important to add? For the service firm, a check on impact on provided services is added, as this represents value for a service firm. Another criterion that was added for the specific context of an airport is the ability to test the innovation on a small scale. For other service organisations that provide services that are vital, this is also an important factor to consider, as having the possibility to test an innovation on small scale reduces the chance of process disruption. Another criterion added for service firms is technical/process synergies. This evaluates how well an innovation fits in the current way of providing services and with the current technologies used, also reducing the risk of process disruption. Independent of the type of evaluation (qualitative/quantitative), these factors are important for service firms. While performing the second step as explained before, other non-standard criteria might be uncovered.

The fourth step is to combine the useful building blocks with the specified design goals and requirements. Building blocks from various selection/evaluation methods can be combined in the design phase, to create a prototype that is likely to meet the requirements and achieve the goals. This prototype is the complete design and can be used for empirical evaluation in a first user test.

This first user test, the fifth step, will act as a check whether the design does indeed meet the requirements and achieve the goals and provides input for design modifications. For this test, a test protocol must be created that has conditions similar or identical to the conditions in which the finished selection method will be used. Most important for this is to select the right test subjects. The subjects must be representative of the people that have to use the selection method in real-life. For a service firm that operates in a network, make sure to include the voice of the external stakeholders in the selection process.

Based on the results of the first user test, the design can be modified in the sixth step. This will yield a design that better meets the requirements and achieves the goals. This improved design can then be tested in a second user test, which has not been performed during this thesis.
So, these steps describe how a method can be developed for selecting innovation ideas. This process was followed to create a sustainable innovation selection method for ASM. A light-weight prototype of the design has been delivered and tested in practice. Overall, the design was well received, and feedback on the test has been used to create an improved prototype of the design.

So how does this method help in making a service organisation more sustainable? The challenge was to create a selection method that assesses innovation ideas on completely different dimensions; sustainability is a dimension incomparable with the dimension of innovation success/failure factors. By treating sustainability as a value of an innovation, and not in a trade-off with more traditional business drivers, the method enables a firm to assess innovation ideas on these different dimensions. By explicitly assessing the sustainability of all innovation ideas and having the opportunity to instate a threshold value for sustainability score, it is possible to select innovation ideas that can make a service organisation more sustainable.

With this, the theoretical knowledge gap as explained in the introduction has been closed. This report presented design rules which service firms operating in a network setting can use to create a selection method for sustainable innovations, enabling these firms to follow the SOI principle in selecting innovation ideas. On top of that, a sustainable innovation selection method has been designed and tested for ASM.

7.2 Practical and theoretical contribution

Ideally, all research has a practical and a theoretical contribution. Here, the practical and theoretical contribution of the research as presented is discussed. The practical contribution is rather clear. The department ASM of Royal Schiphol Group has a design for the selection of sustainable innovation ideas, which has already undergone a first redesign step. With this selection method, ASM can evaluate various innovation ideas compared to each other and select the most promising idea. The goal of using this method is to select more valuable, more successful, and more sustainable innovation projects. ASM can put the method to long-term test, to discover whether these goals are achieved by the selection method.

Another practical contribution is that the implicit way of working with and selecting innovations in ASM has been made explicit. This gives the department insights on other aspects of innovation management in ASM as well. Several employees indicated they thought it would be beneficial for ASM to have a portfolio management tool for innovations. As innovation project selection is an important part of a portfolio management approach, the selection method can become the first part of developing such a portfolio management tool.

Theoretical contribution is represented by several factors. First, the scientific literature on innovation selection in service firms is quite undeveloped. This research makes a modest contribution to this field. Second, a small contribution is made in the direction of innovation selection for firms in network settings. Firms that innovate in a network setting must consider the opinions and interests of other stakeholders in that network when selecting innovation
ideas. These stakeholders can have a large impact on the success of innovation projects and the potential adoption of innovations. Third, the research presents factors/criteria for innovation selection to consider for firms that operate vital processes. For service organisations with less vital processes and manufacturing firms, the risk of disruption by an innovation is not as important as it is for firms with vital processes. In the context of for instance an airport, innovations are not allowed to carry the risk of process disruption.

Another theoretical contribution is that the research presents design rules for other firms to use in designing a comparable method. This can enable other firms to design a selection process for innovations to work according to the SOI philosophy as well. The notion of SOI treats sustainability as a goal that is not competing with more traditional business goals. This is rather new, as generally sustainability is treated as being in a trade-off with traditional business values in firms. The designed selection method presents a tool which can compare innovation ideas on value, success/failure factors and sustainability, three completely different dimensions. By treating all factors as value of an innovation idea, it is possible to compare innovation ideas on these completely different dimensions. Furthermore, it makes it possible to make sustainability an integrated factor in all new innovation projects.

7.3 Discussion on the research approach

Every research has limitations, this one included. Discussing the limitations will give the reader the chance to properly estimate the value of the presented work. The limitations can provide starting points for future research, which are discussed later. The main discussion points are presented here. Further, more detailed, discussion points are presented in Appendix N.

1. From scientific literature, many researchers indicate that a structured innovation selection method leads to better innovation selection, more valuable and successful innovation projects; having a formal innovation selection method is a success factor for innovation projects. The design of the sustainable innovation selection method as presented in this thesis meets the design requirements, and thus fulfils the design goals. Although it has been tested in practice, it is yet unknown if long-term use of the selection method as presented does lead to more successful innovation projects and better sustainability performance. Furthermore, there are more success and failure factors for innovation projects. Only innovation-specific success and failure factors have been considered, as these are factors which make it possible to discriminate amongst innovation ideas and comparing innovation ideas was the focus of this research. However, if the goal is to improve innovation project success, the company-related, market-related and process-related success and failure factors must also receive attention. Another factor that has not received attention in this research is the actual adoption of the designed selection method in the firm. The effectivity of a selection method is not only dependent on its design, but also on how (well) it is adopted and used within an organisation.

2. The definition used for innovation success also carries a limitation. The definition used for innovation success is an innovation project that achieves the expected goals. This definition was chosen because innovation projects are non-standard, no innovation project is the same so there are no universal goals of innovation projects. The limitation of this definition is that it is possible to define ambitionless project goals, increasing the chance of innovation “success”. The question then becomes how valuable an innovation project can become for an organisation. In the case of the designed selection method it is not a big problem, as this also assesses the potential value to an organisation.
3. The qualitative nature of this research carries some limitations. First, there is a risk of interpretation bias by the researcher. Precautions have been taken to try to minimize this risk by validating results and conclusions multiple times, but it cannot be guaranteed that an unbiased view was kept during the research. Furthermore, it typically involves a relatively small number of respondents. This decreases the external validity of the research; a quantitative approach would allow for more respondents, increasing the external validity.

4. The conclusion of this research provides design rules that other service organisations can use to design their own sustainable innovation selection method. These design rules have been followed and have resulted in a practice-validated sustainable innovation selection method. But these rules have been made based on a study in a single department of a non-standard service organisation. The rules are thus applicable for the department in which the selection method has been designed, but the completeness and generalizability of these rules for other firms must be uncovered in future research. By performing the same type of research in multiple service firms, the design rules can be validated.

7.4 Discussion on the selection method design

Now the research limitations have been discussed, it is time to discuss the limitations of the sustainable innovation selection method designed for the department ASM of Schiphol. No design is free from imperfections, no design choice can be without other promising alternatives. Here, the main discussion points are presented. Again, more detailed discussion points can be found in Appendix N.

1. During this research, the design-oriented research approach has been followed, which states a design must be made based on determined requirements, and a successful design being a design that meets these requirements. The design presented in this thesis is in that sense a success, it meets the requirements and achieves the goals determined up front. Nevertheless, there are probably many more ways of doing this as perhaps, other service firms can combine different “building blocks” to achieve the same. This does not say the designed selection method is in any way insufficient, but there might be other designs that accomplish the same.

2. The design as presented is a prototype, with one design alteration based on the first user test. To get to a working, accurate, user-friendly selection method, more designing and testing steps are necessary. The test of the prototype evoked positive reactions from the test participants, indicating it is useful to continue design work to a finished product. Furthermore, there is no roadmap the department ASM can follow to adopt the designed selection method and incorporate it in the standard way of working. Another point worth noting is that the criteria weights, apart from those for the sustainability criteria, were all set to be equal in the first user test. The group weights were also distributed proportionally. The effect of changing these weights has not been investigated yet and is important to uncover. To add to this, the effectiveness of the chosen selection criteria has not been fully researched yet. The perceived effectiveness (which was high) has been uncovered in the first user test, but it might be interesting to quantify this.

3. The choice is made to not involve all internal and external stakeholders in the selection process, as this will have a negative effect on the speed and practicability of the decision process. Instead, the deliberate consideration was made to appoint “representatives” from internal stakeholders that have good and many contacts with the external stakeholders. The assumption with this is that these representatives have a clear view of the opinions and interests of the external stakeholders. This is a clear
limitation, as chances are quite high that this is not always exactly the case. However, the participants of the first user test indicated that the voices of the stakeholders are adequately represented in the selection method as is.

7.5 Recommendations for future research
The limitations as discussed are not only “imperfections” of the current research, but also present interesting opportunities for future research. Here, the main recommendations from a theoretical perspective are given. More detailed recommendations can be found in appendix O.

1. The design rules that have been presented to help service organisations to design a sustainable innovation selection method must be validated on completeness and correctness. Furthermore, the evaluation criteria presented in this research must be verified and validated for other service firms as well. For this, research must be done in more service organisations. Since the term service organisation encompasses a wild variety of firms ranging from banks to universities, it is interesting to see if the design rules and evaluation criteria are applicable to all types of service firms. One way of doing this is by following the same research approach in different service firms, perhaps creating a sustainable innovation selection method for these firms as well.

2. The design rules are for service firms to design a selection method which can be used to follow the SOI principles. These principles state that sustainability must no longer be treated as a conflicting value to traditional business values. Following this, a firm following the SOI principles in selecting innovations should be able to demonstrate improved sustainability performance as well as more valuable innovation projects and a higher innovation project success rate. There is no scientific literature yet whether this is the case, this is thus a very interesting research field. This can be researched by studying the effects of long-term use of a sustainability-oriented innovation selection method designed following these principles.

3. One of the major design rules is the inclusion in the selection process of internal stakeholders that are representative of the external stakeholders. This has been well received by the test participants, with them indicating that the different viewpoints of stakeholders are well represented in the selection process. This design rule has the goal of selecting innovation ideas that are more easily adopted by external stakeholders in the network of a service firm. A very interesting topic to research is whether this way of including the voice of stakeholders in the selection process does indeed lead to a higher rate of innovation project success or innovation adoption by external stakeholders.

7.6 Recommendations to Royal Schiphol Group
Apart from recommendations for future research, recommendations can be made for Royal Schiphol Group as to what I think could or should be done in the (near) future. Of course, one of the recommendations is to use the selection process as designed by me. Below, the main recommendations are presented, the detailed recommendations can again be found in appendix O.

1. Because the design is not fully completed yet, continue the designing and testing steps until a finished tool is produced. Also, spend time determining the correct criteria weights. The next step is a second user test, to test the altered design of the prototype. This second user test can be used to determine the correct criteria weights as well. The prototype as presented in this report uses paper forms for the 3 screens, and the results are presented by filling in the scores of the paper forms in excel by hand. The next
design step is to make these forms digital, so the calculation of the scores and presentation of the graphs can be done automatically. After these design alterations have been done and the test results of the second user test have been processed, the tool can be implemented in ASM. To be able to effectively use the selection method with enough innovation ideas to screen and with the correct information to do so, make sure all employees of ASM are known with the new process. Further research might be done to find out how the selection method can be implemented in the department. On the long term, it is very interesting to find out if using the sustainable innovation selection method does lead to more valuable innovation projects and higher rate of success of innovation projects within ASM and better sustainability performance of Schiphol.

2. The selection method can be part of a larger overarching portfolio management tool for (sustainable) innovations. Some interview participants indicated it would be very useful for the department to have this, and the selection method design can be very good first step towards realization of such a tool. Creating a portfolio management tool for (sustainable) innovations for the department can be a very valuable research objective of a successive master thesis project.

3. As said before, having a formal selection method for (sustainable) innovations is a success factor for innovations within firms. During my time at Schiphol, I discovered that there is more to be done to improve the innovativeness of the department ASM. For instance, one employee told me that some project owners in the department are hesitant to implement innovations in their project, as they would be responsible if the innovation would fail. It would be very interesting for Royal Schiphol Group to do a broader research on which organisational factors improve or hamper the innovativeness of the firm.
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Appendices

Appendix A: Expert interview questions
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Appendix F: Summary answers questionnaire
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A: Interview questions

*Introductie*

- Persoonlijke introductie: Onderwerp onderzoek, hoe ver ben ik.
- Doel van interview uitleggen
- Vertrouwelijkheid
- Uitleggen hoe het interview in elkaar zit (Persoonlijk, doelen, proces, selectie, hoe goed die is, vereisten)
- Lengte van interview aangeven
- Heb je al vragen vooraf? Kan altijd achteraf anders.
- Toestemming vragen voor opnemen gesprek
- Introductievragen

*Vragen*

Intro/ feiten vragen (Kan je jezelf kort introduceren?)

- Wat is jouw rol in het bedrijf/ de afdeling?
- Hoe lang doe je dat al?
- Wat is jouw ervaring met innovatieprojecten in ASM?
- Wat is jouw rol in het huidige innovatieproces?

In de vragen die komen zal ik je eerst wat vragen over wat het doel is van innoveren binnen ASM, hoe het huidige innovatieproces eruitziet, hoe selectie van innovaties plaatsvindt en hoe goed deze manier van selecteren is, en hoe volgens jou een selectiemethode eruit zal moeten zien.

*What are the goals that ASM aims to achieve with innovations?*

- Wat is het doel van innovaties voor Schiphol, en welke rol speelt ASM daarin?
- Wat is volgens jou het doel van innoveren voor ASM?
- Wat is de toegevoegde waarde van innovaties voor ASM?
- Hoe denk jij dat innovaties ASM kan helpen gestelde doelen te behalen?

*What is the innovation process currently employed by ASM?*

- Hoe ziet het innovatieproces van ASM eruit?
- Is er een expliciet model of proces dat wordt gevolgd voor het doorvoeren van innovaties?
- Wat vind jij van de huidige manier van werken?
- Wat is volgens jou een essentieel onderdeel dat mist in het huidige innovatieproces?

*How is selection of innovations currently done at ASM?*

- Hoe selecteert Schiphol innovaties, en welke rol speelt ASM daarin?
- Is er een formele methode voor het selecteren tussen verschillende innovatie ideeën?
  - Zo ja: Hoe ziet deze eruit?
  - Wat vind jij hiervan?
  - Zo nee: Hoe wordt er dan gekozen tussen innovaties?
- **Wie** is er verantwoordelijk voor het selecteren van innovaties?
- Wanneer wordt er geselecteerd?
- Hoe ziet het selectieproces eruit? Wordt er gekozen in meerdere stappen? Wie is er bij welke stap betrokken?
- Op basis van welke criteria wordt er gekozen?
- Hoe wordt duurzaamheid meegenomen in de overweging? Oftewel, wordt er bij duurzame innovaties anders geselecteerd?

What is the effectiveness of the current innovation idea selection method as perceived by ASM?
- Wat vind jij van de (effectiviteit) van de manier van innovaties selecteren op dit moment? Wat kan er beter?
- Denk jij dat ASM profijt heeft van een gestructureerde selectiemethode om te kunnen kiezen tussen innovaties?

Questions to find out the goals, requirements, assumptions of the method.
Ik wil een methode maken om duurzame innovaties te selecteren. In de literatuur zijn er veel verschillende methodes, en ik wil nu uitvinden wat voor ASM de beste methode zou zijn.

- Hoe moet volgens jou het proces van innovaties selecteren eruitzien? Welke stappen op welke momenten, met welke mensen?
- Op welke criteria/factoren zou deze methode moeten selecteren?
- Welke rol moet duurzaamheid krijgen? Een van de factoren, of de meest belangrijke?
- Is ASM meer gebaat bij een kwantitatieve of kwalitatieve selectiemethode? En, misschien nog belangrijker, wil je dat de innovaties absoluut of relatief gescoord worden?
- Op welke momenten zou er een selectie gemaakt moeten worden?
- Wie moeten er selecteren?
- Denk je dat de methode gebaseerd moet zijn op succes/failure criteria of op karakteristieken die de adoptie van een innovatie voorspellen?
- Denk je dat er voor duurzame innovaties er op een andere manier gekozen moet worden?

Afsluitende vragen
Heb jij nog vragen of opmerkingen?
Zijn er nog mensen die ik zeker moet interviewen over dit onderwerp?

Afsluitende opmerkingen
Ik hou je op de hoogte van de resultaten, en zal je in de toekomst waarschijnlijk nog eens benaderen voor de focus groep. Dit zal over een maand of 2 maximaal zijn. Bedankt voor je tijd.
Participant 1: Participant 1 is the team lead of the strategic advisors of the department ASM. In this role, his main tasks are writing policy documents for the department to make sure the strategic goals are met. He has finished a MSc in Architectural Design and Engineering, on the topic of innovation diffusion. He also finished an MBA and has several years of experience in innovation management, as an innovation consultant. After that, he has been a business/strategy consultant for a couple of years before coming to Schiphol ASM. Here he continued to use his experience in the field of innovations and strategy for strategically advising ASM. Furthermore, he has been involved with several innovation projects within the department ASM.

Participant 2: Participant 2 has been the strategic advisor on sustainability for the department ASM for 1.5 years. He has done the management traineeship at Royal Schiphol Group prior to the function of strategic advisor sustainability, giving him a good insight of the complete company. Before that, he has run a start-up that connects independent contractors to companies. He finished a BSc degree in Public management (Bestuurs- & Organisatiewetenschap) and a BSc in psychology. In his role as strategic advisor sustainability, his task was to write policy as a roadmap to enable ASM to achieve the sustainability goals of Schiphol: Zero waste in 2030 and climate neutral in 2040. Furthermore, he was involved with many sustainable innovations and pilot projects, in a leading role.

Participant 3: Participant 3 is Senior Manager Development in the department ASM of Schiphol Group. In this role, she is involved in making investment choices concerning innovations, as part of the MT. Furthermore, she oversees the development projects of ASM, in which innovations are done as well. Before this function, she has been project manager in various asset-oriented organisations, and manager in a couple of organisations. She has completed an MSc in Architecture from the TU Delft.

Participant 4: Participant 4 currently works at the department Operations (OPS) of Schiphol Group. His function here is strategic advisor. In this role, he works with many innovations and proof of concepts to improve the daily operations of the airport. Previously, he has worked for ASM for 8 years, from 2008 until 2016, on sustainability and innovations. In this function, he has initiated and led many innovation projects that carry a large sustainability component.

Participant 5: Participant 5 has been working for Schiphol for 4.5 years now, as Strategic Advisor for Airside within ASM. Airside encompasses runways, taxiways and aircraft stands. He finished an MSc in Aerospace Engineering, with the track Airline and Airport process management. He has been involved with multiple innovation projects. For instance, he has been project leader of the Helispot project, where a lighting innovation was tested in an airport for the first time. Previously, he has worked for I.E.S. Asset Management, consulting on asset-related issues. For his master thesis, he has constructed a Value Operations Methodology Framework to Strategically Rank Sustainable Airport Innovations.

Participant 6: Participant 6 is senior manager of TEC within ASM. He has been doing this since 2015, and before that has worked in the IT department of Schiphol. Here, he has been senior manager from 2009 until 2015. From 2001 until 2009, he has had varying roles in the IT department. Currently, he is the holder of the budget for innovations of TEC. Innovation proposals are checked and approved by participant 6. He makes the final calls about
innovations, and if the budget size requires an approval from the MT, his role can be seen as sponsor of innovations within the MT. When using the new innovation selection method, he is still in charge of the final call.

Participant 7: Participant 7 is relatively new in Schiphol, she started at ASM in October. Initially she started within TEC, but later transferred to the Strategy Office of ASM. She is responsible for digitalization within ASM. Following this, she has much knowledge about digital innovations. Examples of these digital innovations are IoT, predictive maintenance, sensing etc. These innovations aid in making the maintenance and development of assets of Schiphol faster, cheaper, more reliable. Previously she has worked at the Port of Amsterdam for 4 years, after working in consultancy for 5 years. She has finished a MSc in Strategic Management. Digitalization within the airport is reasonably unexplored but is receiving of much attention.
### C: Expert interview answer overview

<table>
<thead>
<tr>
<th>Goals of innovating for ASM</th>
<th>Participant 1</th>
<th>Participant 2</th>
<th>Participant 3</th>
<th>Participant 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Contribution to the improvement of services/products for passengers and airlines.</td>
<td>- Contribution to the improvement of services/products for passengers and airlines</td>
<td>- More efficient assets</td>
<td>- Improvement of assets or situations</td>
<td></td>
</tr>
<tr>
<td>- Improving quality of the assets</td>
<td>- Helping to achieve the other strategic goals of the department and company.</td>
<td>- Contribution to the improvement of services/products for passengers and airlines</td>
<td>- Innovating is necessary for solving problems/challenges, but the pay-off is inspiration.</td>
<td></td>
</tr>
<tr>
<td>- Decreasing costs (TCO of assets)</td>
<td>- React to changing world/environment, to remain an up-to-date airport and Europe’s preferred airport.</td>
<td>- Achieving the strategic goals</td>
<td>Inspiration towards passengers, companies, fans of Schiphol, employees</td>
<td></td>
</tr>
<tr>
<td>- Increasing income</td>
<td>- Innovation is one way of achieving the sustainability goals: zero waste and climate neutral.</td>
<td>- Working on social responsibility</td>
<td>- Meeting sustainability goals</td>
<td></td>
</tr>
<tr>
<td>- Improving sustainability (zero waste and climate neutral)</td>
<td>- More efficient, reliable, available, sustainable assets, with lower costs (strategic goals)</td>
<td></td>
<td>- Necessary for sustained competitive advantage</td>
<td></td>
</tr>
<tr>
<td>- Working on social responsibility</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Current innovation process</strong></td>
<td><strong>Ad-hoc</strong></td>
<td><strong>Unstructured</strong></td>
<td><strong>Problem oriented. A problem is identified, and possible solutions to the problem are found.</strong></td>
<td></td>
</tr>
<tr>
<td>- No specific process, not formal.</td>
<td>- Bottom-up</td>
<td>- Based on business case</td>
<td>- Process or product innovation. Process innovations are favoured, as you have more control over these.</td>
<td></td>
</tr>
<tr>
<td>- Unstructured, based on coincidences.</td>
<td>- No focus, priority on certain strategic goals.</td>
<td>- No comparison between innovations, no comparison with strategic goals.</td>
<td>- For product innovation, the market is involved. Innovate together with market, then a pilot, then a proof of concept.</td>
<td></td>
</tr>
<tr>
<td>- Innovations from both inside and outside the department</td>
<td>- Unstructured</td>
<td>- There is no focus on what is currently most important.</td>
<td>- Not a standard way of innovating</td>
<td></td>
</tr>
<tr>
<td>- There is no focus in which innovations are selected. Management does not indicate a focus area for innovations.</td>
<td>- No overview what is going on and coming.</td>
<td>- TEC brings forward innovations, based on solutions for problems or external parties</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- No structured search for innovations matching problems in operations.</td>
<td>- There is no check on what an innovation will yield on all strategic goals.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Current selection method</strong></td>
<td><strong>Selection done solely on business case</strong></td>
<td><strong>No fixed moments in the year</strong></td>
<td><strong>Based on business case, money oriented. Money is in many cases the most important factor, more important than sustainability.</strong></td>
<td></td>
</tr>
<tr>
<td>- No formal selection method, purely informal.</td>
<td>- No comparison on performance, match with strategic goals.</td>
<td>- No formal method</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Unstructured and unfocused</td>
<td></td>
<td>- Based on business case, checklist at MT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- There is no consideration between various options. If an</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Effectiveness of current innovation and selection process</td>
<td>Innovation idea has a good business case, it is selected. But no comparison is made with other ideas. Other department handles the selection of innovations in another way. Richard Leurs is end responsible.</td>
<td>Not based on a focus set by mgmt. indicating a certain field is important. Not based on a fixed list of criteria Not done on fixed moments in a year. Unstructured, unfocused Based on financing, which changes every year.</td>
<td>No comparison between innovations, no comparison with strategic goals. Unstructured, unfocused The business case, brought forward by TEC, is only checked by the MT. A simple check.</td>
<td>Assumptions cannot be made. This is an important issue for innovations. Example: Solar panels on rooftops of cargo buildings. Priority in which innovation projects is pursued is often forced by operational (short term) issues. It is purely following facts. No selection method.</td>
</tr>
</tbody>
</table>
| Process requirements + assumptions | - More structured way of innovating Selection method is very welcome. | Create focus in the type of innovation projects that are considered. Makes it possible for employees to search more effectively. | Compare innovations with each other Compare innovations on contribution towards strategic goals | Portfolio management Easy to use Visual tool, which can be used by the managing board to
- Create oversight of all current and future innovation projects.
- Standard evaluation moments with standard criteria.
- Informal. The company/department is used to working informally, will result in least resistance
- Subjective.
- Easy to use, small investment of time and effort.
- People bringing in innovations need to have an overview up front of what the innovation’s potential is, to be able to make a founded choice.
- Up front decide on which area the focus is put. Sustainability/cost reduction? Communicate, find innovations in the focus area.
- Use meetings, in which people are present from the relevant departments.
- Not only a first screen, but also an evaluation of running innovation projects.
- Create a portfolio overview, including end dates of projects, to look forward
- Qualitative selection
- Consider innovations compared to “choices”.
- Have a selection process with multiple phases, a screen and evaluation.
- Compare various innovation projects against each other, and on their contribution to all the strategic goals.
- A meeting with various people, a couple of times a year, with people from the relevant departments present.
- More structured way of working.
- Create an overview of all innovations considered.
- Create a portfolio, to know which innovations are happening and what their status is.
- Create a checklist with all criteria
- Quantitative and qualitative mix
- Give weights to the criteria
- Have meetings 4 times a year
- People bringing in innovations must have an overview up front, of the several criteria
- Be able to screen innovations in different stage of development
- Create a focus
- Create a more structured way of working
- Create an overview of which innovations are undertaken (portfolio), and which are not and why
- Must be usable on different levels in the department.
- Combination of quantitative and qualitative
- Subjective ranking
- Uniform method, easy to use
- Create a portfolio overview
- CO2
- Zero waste
- Energy efficiency
- Investment: Ballpark figure, +/- 15%
- Uncertainty
- Feasibility
- (Financial) risk
- Dependency on other parties
- Comparison of sustainable factors (CO2, air quality, material use)

<table>
<thead>
<tr>
<th>Criteria requirements</th>
<th>- Lead time of innovation</th>
<th>- Uncertainty (risk?)</th>
<th>- Contribution to strategic goals</th>
<th>- Contribution to strategic goals</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Is the project financeable?</td>
<td>- Contribution to strategic goals, compared to that of other innovation ideas</td>
<td>- Impact</td>
<td>- Improvement in service for traveller and airlines</td>
<td>- Costs</td>
</tr>
<tr>
<td>- Does the innovation match with the strategic goals, department, environment?</td>
<td>- Costs</td>
<td>- Uncertainty</td>
<td>- Uncertainty</td>
<td></td>
</tr>
<tr>
<td>- Is the innovation feasible? What are the success/failure factors?</td>
<td>- Split up strategic goals into more, understandable, criteria.</td>
<td>- Quantitative and qualitative</td>
<td>- Quantitative and qualitative</td>
<td></td>
</tr>
<tr>
<td>- Sustainability (emission, waste), Costs of project.</td>
<td>- Make sustainability an important factor</td>
<td>- Subjective</td>
<td>- Subjective</td>
<td></td>
</tr>
<tr>
<td>- Controllability</td>
<td>- Mix of qualitative and quantitative.</td>
<td>- Timing</td>
<td>- Timing</td>
<td></td>
</tr>
<tr>
<td>- Income</td>
<td>- A comprehensive list of all criteria</td>
<td>- A comprehensive list of all criteria</td>
<td>- A comprehensive list of all criteria</td>
<td></td>
</tr>
<tr>
<td>- Safety (risk)</td>
<td>- CO2</td>
<td>- Zero waste</td>
<td>- Energy efficiency</td>
<td></td>
</tr>
</tbody>
</table>

- Create an overview quickly see differences when weighing factors differ
- Use criteria with weighing factors
- Long-term vision of which steps can be taken to achieve (sustainability) goals
- Managing board should use the tool
- “Jip en Janneke”
- Must be able to prioritize various factors
- Up-to-date, easy to maintain, database with ideas
- Can be used by managing board to ask questions about why certain projects are not done
- Does not have to provide 1 winning idea, multiple can be used to approach a department
- Do not include the other strategic goals, only look at sustainability. Otherwise, the focus will only be put on the other strategic goals
| Goal of the selection method | - Create overview  
- Create a mixed portfolio  
- Create clarity in the department  
- Make choices easier  
- Manage risks | - Create overview, clarity for employees  
- Make it possible to "look forward": see which projects end and which new ones can be started. | - Create an overview of which innovations are undertaken and considered.  
- Make it possible to easier communicate to employees why/ why not an innovation is undertaken.  
- Make it easier for employees to select innovations in the first place | - Creating a clear focus of which areas require innovations most  
- Eliminate a part subjectivity from the selection process, to avoid that a director pushes his own preferred innovation projects  
- Create a clear overview of what innovation achieves what |
| Further interesting remarks | - Maybe sustainability should be part of quality?  
- Current way of working is not professional.  
- There is no long-term vision  
- Match with strategic goals is most important!  
- Sustainability is covered enough in the form of a strategic pillar. Does not have to be a special factor. | - Innovation versus “choices”?  
- Assumption: Have people from various relevant departments involved in the selection process. | - DEV handles innovation differently than TEC. In DEV, the work is structured in projects with a project board and a given budget. The project board can decide to implement an innovation or not.  
- The goals set for sustainability are met every year. | - Focus on sustainability, not on the other strategic goals.  
- If sustainability is connected to saving money, it is very easy.  
- One of the goals of innovating is inspiring.  
- Electricity generation should be done on own property, in contrary to the current method of working |
<table>
<thead>
<tr>
<th>Participant 5</th>
<th>Participant 6</th>
<th>Participant 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goals of innovating for ASM</td>
<td>- Helping to achieve the strategic and operational goals of Schiphol&lt;br&gt;- Increasing the capacity of the airport, on a limited amount of area.&lt;br&gt;- Contribute to the operational processes by supplying reliable, more available, quicker assets&lt;br&gt;- Decreasing total cost of ownership (TCO) by for instance reducing maintenance costs&lt;br&gt;- Creating an infrastructure that costs virtually nothing, requires zero maintenance, and never breaks</td>
<td>- 2016-2017: Make people of the department look for solutions outside of the company, to keep up with technical developments&lt;br&gt;- Improve the business processes. Make it easier, smarter, more sustainable. Mostly, a business case is underneath, but not always&lt;br&gt;- Achieve operational goals and achieve strategic goals.&lt;br&gt;- Decreasing TCO of the assets&lt;br&gt;- Achieving smart, safe, sustainable assets&lt;br&gt;- More profitable, safer, more sustainable asset management&lt;br&gt;- More efficient assets, both financially and when looking at sustainability&lt;br&gt;- Make more efficient use of the limited area capacity Schiphol has&lt;br&gt;- Lowering OPEX as well as CAPEX, by requiring less repeat investments&lt;br&gt;- Achieving the strategic goals, of which sustainability is one</td>
</tr>
<tr>
<td>Current innovation process</td>
<td>- Problem-oriented innovation process.&lt;br&gt;- Focused on urgent problems in the airport processes&lt;br&gt;- No structured way of working, no funnel or comparable method&lt;br&gt;- No innovation portfolio overview of projects&lt;br&gt;- No focus on innovations that deliver a strategic advantage&lt;br&gt;- Sustainability has an important role in ASM&lt;br&gt;- Does not look at the long-term</td>
<td>- Small innovation projects are split up in phases and are done in TEC. When projects become bigger, MT needs to be asked for permission for more money or risk.&lt;br&gt;- No described innovation process. There is a description of how to come to innovations, but not a description of the innovation process. People know how to do the innovation process.&lt;br&gt;- Can be professionalised&lt;br&gt;- There are no department-wide agreements on innovation and how to execute it.&lt;br&gt;- No structured organisation on operational, tactical, strategic level</td>
</tr>
<tr>
<td>Current selection method</td>
<td>- Not a balanced innovation portfolio&lt;br&gt;- Based on problems with high urgency.&lt;br&gt;- Technical Management (TM) sits together with a manager, looks at which projects are currently underway, which opportunities are there, and if there is room for an additional project.&lt;br&gt;- There is no distinction in the types of innovation.&lt;br&gt;- Based on business case</td>
<td>- From 2016-2017, all innovation projects were selected to create an innovative culture&lt;br&gt;- Richard selects. When projects become too large, Richard becomes sponsor and tries to pass it through the MT of ASM.&lt;br&gt;- First come, first serve. The budget is divided based on who comes first. Not on fixed points of the year.&lt;br&gt;- The funnel is not filled completely</td>
</tr>
<tr>
<td>Effectiveness of current innovation and selection process</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Not a balanced innovation portfolio</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Too much focus on short-term, problem-oriented innovation projects. Long-term vision is lacking.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Questionable whether the selected innovation projects should be done by Schiphol, or maybe better by another party</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- There is no oversight of which innovation projects are done in the department. Only an oversight of the projects within TEC.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- There are no fixed point of contacts, that are capable to join in thinking about opportunities and willing to take risks.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- We miss structure and that is bad. Innovations are vital for improvements.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- It is hard to quickly start innovation project, because there is no unambiguous process</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Projects die because they don’t fit in the current processes, or because people do not have time to think about new solutions/innovations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- The 80-20 rule is not followed, changing the business gets no attention</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Process requirements + assumptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>- A more structured way of working</td>
</tr>
<tr>
<td>- It requires a long-term vision</td>
</tr>
<tr>
<td>- Don’t compare innovation ideas based on operationally urgent problems with other innovation ideas, urgent innovations will always be chosen.</td>
</tr>
<tr>
<td>- Make a separation between short-term and long-term issues.</td>
</tr>
<tr>
<td>- Active, continuously used and updated method.</td>
</tr>
<tr>
<td>- Funnel-like process</td>
</tr>
<tr>
<td>- Stage-gate like process</td>
</tr>
<tr>
<td>- Portfolio management overview.</td>
</tr>
<tr>
<td>- Method must be accepted and guaranteed by the whole organisation</td>
</tr>
<tr>
<td>- TM makes the choices, Richard Leurs should empower them</td>
</tr>
<tr>
<td>- Make a separation between long/short-term Schiphol/product specific innovations, and say up front how many of each are possible within the budget</td>
</tr>
<tr>
<td>- Continuous monitoring meet a couple of times a year, with TM or maybe only strategic advisors.</td>
</tr>
<tr>
<td>- Do not focus on TEC-wide, but department-wide. Make a portfolio oversight of all innovation projects done within the whole department. Make an integral tool.</td>
</tr>
<tr>
<td>- Make a process that is applicable for operational, tactical, strategical use and sure to include the main contractors in this selection process. They will carry many innovations.</td>
</tr>
<tr>
<td>- A fixed point of contact for main contractors, that has oversight over the innovation projects.</td>
</tr>
<tr>
<td>- A complete list of criteria should be included. All employees should be able to fill in the complete list of criteria, or it is useless</td>
</tr>
<tr>
<td>- Funnel-like process. In which currently, the focus does not have to be on selection but filling the funnel.</td>
</tr>
<tr>
<td>- Select with a group of knowledgeable people, and pay attention to belief</td>
</tr>
<tr>
<td>- We need a structure, quickly</td>
</tr>
<tr>
<td>- Funnel with go/no-go decisions</td>
</tr>
<tr>
<td>- Unambiguous innovation process for the whole department. Everybody knows how the process looks like, how you can use the process, and which criteria determine the go/no-go decision of an innovation.</td>
</tr>
<tr>
<td>- Gain experience before December 2018, when the new main contractors are coming on board</td>
</tr>
<tr>
<td>- Make strategic buckets, based on which you do innovations. 1 bucket: must-do, based on regulation and compliancy. 1 bucket: efficiency. 1 bucket: structural innovations because processes are not optimal. 1 bucket: radical innovations.</td>
</tr>
<tr>
<td>- Ranking based on weighing factors</td>
</tr>
<tr>
<td>- Selection method based on translation of Schiphol’s strategic goals. What are the strategic goals we want to focus on the coming years? So, define themes to choose in.</td>
</tr>
<tr>
<td>- Multiple phases. Let MT choose</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Criteria requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Qualitative, relative comparison</td>
</tr>
<tr>
<td>- Costs</td>
</tr>
<tr>
<td>- Sustainability</td>
</tr>
<tr>
<td>- Operational capacity</td>
</tr>
<tr>
<td>- Strategic advantage/contribution to strategy</td>
</tr>
<tr>
<td>- Lead time</td>
</tr>
<tr>
<td>- Technological readiness</td>
</tr>
<tr>
<td>- Does Schiphol need to do this innovation? Or is it better to let the market do this one?</td>
</tr>
<tr>
<td>- Value for the organisation (objective)</td>
</tr>
<tr>
<td>- Strategic goals</td>
</tr>
<tr>
<td>- Operational goals (costs, capacity etc.)</td>
</tr>
<tr>
<td>- Subjective selection based on gut feeling or even belief</td>
</tr>
<tr>
<td>- Strategic goals/strategic value</td>
</tr>
<tr>
<td>- Business case positive (financial picture)</td>
</tr>
<tr>
<td>- Lead time</td>
</tr>
<tr>
<td>- Complexity vs feasibility</td>
</tr>
<tr>
<td>- Risk</td>
</tr>
<tr>
<td>- Qualitative comparison, no bureaucratic tiger.</td>
</tr>
<tr>
<td>- Sustainability should be interwoven, integrated in all actions</td>
</tr>
</tbody>
</table>
| Goal of the selection method | - A guaranteed innovation process, with a clear overview of current and coming innovation projects.  
- A pre-determined way of working, creating clarity for both management and employees  
- Put innovations of ASM on the map in the organisation  
- Making it possible to communicate to higher management |
|-----------------------------|----------------------------------------------------------------------------------|
|                            | - Create an oversight of which projects are running and on which basis these are selected  
- Oversight of innovation projects on different levels in the organisation.  
- Retrieve innovations done in Development, and apply them in TEC.  
- Integral tool for the whole department |
|                            | - Create clarity in the department, people know which process is followed, with which phases and based on which criteria.  
- Focus on strategic goals with selection  
- Create an oversight of which projects are undertaken in various layers of the department |

| Further interesting remarks | - Schiphol ASM should focus on innovations that provide a strategic benefit. Currently, some projects are done that can easily be copied by other airports.  
- Some innovations will have to be killed, this needs to be accepted  
- Appoint core domains in which ASM wants to innovate for a given period. |
|-----------------------------|----------------------------------------------------------------------------------|
|                            | - An innovation does not have to be implemented to be considered a success! A test resulting in data is also useful.  
- A revenue model must be devised that makes it possible for both the suppliers and Schiphol to earn money. The suppliers are challenged to come up with innovations, that can hurt volume and revenue, so they need an incentive to come up with innovations.  
- From December, the new contracts will go into effect in which suppliers are asked to come up with innovations |
|                            | - A proof of concept can be discarded after the project is finished  
- A pilot has the intention to continue working on it structurally, after the project.  
- Look at portfolio management tool of Marleen vd. Geer  
- Maybe introduce the 80:20% rule, to let people work on innovations more  
- Do not forget the amount of work that goes into keeping the business running  
- Sustainable can also be that you can use assets longer, by using data. It is not as strict as using less energy or creating zero waste but increasing the lifespan of assets is also sustainable. |
D: Observations during first user test

<table>
<thead>
<tr>
<th>Date:</th>
<th>25-6-2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration:</td>
<td>14:00-16:30</td>
</tr>
<tr>
<td>Participants:</td>
<td>5, as explained in §2.2.2</td>
</tr>
</tbody>
</table>

During this first user test, 5 participants were present, as discussed in §2.2.2. From the department ASM, 3 people were present. 1 person from OPS was present, and 1 from CR. 2 innovation ideas were selected up front: Fast-hardening concrete, and value-stacking. Fast-hardening concrete is more expensive than normal concrete but requires less time to cure. This makes it possible to do maintenance on platforms quicker, resulting in higher availability for aircraft operations. Value-stacking is a mega-battery capable of stabilising fluctuations in the energy network of Schiphol. This can prevent assets requiring electrical power from a disrupted electricity supply, preventing malfunctioning in the operational processes.

The idea that was added before the first screen was the use of de-icing tanks for kerosene in the summer months. Because Schiphol is operating on its limits during the summer months, the Juliet platform is used to handle airplanes during these months. This platform is normally a parking space, so there is no infrastructure for kerosene delivery. However, there are de-icing tanks on the platform. The innovation idea is to use these tanks for kerosene in the summer, to get rid of the tanker trucks driving the kerosene to the platform. It takes 2 days to clean the tanks and fill them with kerosene instead of de-icing fluid.

The observations are written down in Dutch, as this was the language spoken during the first user test.

**Ronde 1**

Uitleg fast hardening concrete is gehaast gemaakt, maakt nu niet uit omdat er ruimte voor uitleg is. Er kan dus wel wat meer informatie worden gegeven op de innovation submission forms.

Vraag 1 blijkt moeilijk te beantwoorden. Het is moeilijk om van tevoren te weten of aan alle milieu-, gezondheids-, veiligheids-, en wettelijke regels wordt voldaan. Dit is al helemaal het geval als de mensen die screenen niet op de hoogte zijn van alle regels. De vraag is nog eens moeilijker te antwoorden omdat er eigenlijk 4 vragen worden gevraagd in 1 vraag.

Possible advantage/risk blijkt moeilijk te beantwoorden. Zelfs als de voordelen en de risico’s van een innovatie-idee bekend zijn, is het moeilijk om te zeggen of de mogelijke voordelen afwegen tegen de risico’s.

De vragen die moeilijk te beantwoorden zijn moeten anders verwoord worden, en uitgesplitst.

De vraag kwam naar boven of ronde 1 misschien beter in te vullen is door experts van verschillende afdelingen, die weten welke randvoorwaarden er allemaal van toepassing zijn op de innovaties.

**Ronde 2**

Er wordt toch overlegd over de inhoud van de innovaties. Dit is wel nodig, om onduidelijkheden over innovatie beton op te helderen. In het echt gebeurt dit niet. Er wordt gezegd dat er altijd 1 iemand aan tafel moet zijn die de techniek helemaal begrijpt/weet. Misschien is het een idee om de innovatie eigenaars erbij halen? Maar misschien wordt het dan weer een “shark tank” achtig idee.
De testdeelnemers zijn enthousiast over het feit dat ronde 2 ook kijkt naar hoe niet-experts over de innovaties denken. Dit zegt iets over het draagvlak van een innovatie.

Er wordt aangegeven dat het lastig is inzicht te geven in de effecten op de kosten.

Het is onduidelijk wat een positief/negatief effect op havengelden is. Duidelijker zijn en uitleggen.

Schaalverdeling op letten. Dit geeft onduidelijkheden. De range is niet bij elke vraag hetzelfde, daardoor is het lastig voor de respondenten om snel te antwoorden. De respondenten geven ook aan dat het een goed idee is om te overwegen of een 4-punts schaal misschien beter is dan de 5-punts schaal. Zo dwing je mensen om een meer uitgesproken mening te geven, dit geeft meer spreiding in de scores. Andere respondenten zeggen weer dat de 5-punts schaal goed is, maar dat 3 “onbekend”, “geen mening” of “neutraal” moet zijn. In ieder geval moet bij alle vragen de schaal hetzelfde zijn. Verder geeft de schaalverdeling een beetje vertekend beeld. Nu lijken ze allemaal wel redelijk te scoren op duurzaamheid, terwijl ze eigenlijk niet zo veel doen.


Er wordt geopperd dat er experts op de verschillende gebieden (operatie, kosten, risico’s etc.) aanwezig moeten zijn bij ronde 2. Dit wordt weer weerlegd, omdat de respondenten het goed vinden dat niet-experts ernaar kijken. Dit zegt juist iets over draagvlak, en gaat niet alleen om technische kennis.

Ronde 3

De grafiek en matrices worden positief ontvangen. Er wordt geopperd om per idee een spinneweb grafiek erbij te doen. Hierin is het ook mogelijk om een ondergrens aan te geven.

Er wordt gesuggereerd om niet alleen te vragen naar of een idee nu een goed idee is, maar ook binnen 1-3 jaar en over 3 of meer jaar. Hierin kan je dan aangeven dat je niet launching customer wil zijn, maar fast follower. Je kan hier dus aangeven dat het een beter idee is om de markt een innovatie iets verder te ontwikkelen.

De waarde voor de passagier mag wat duidelijker naar voren komen in het overzicht van de scores in ronde 3. Net zoals het in ronde 2 wat explicieter gevraagd mag worden.

Verdere algemene opmerkingen

De deelnemers van de test waren heel erg te spreken over het feit dat de selectiemethode innovatie-ideeën vanuit alle invalshoeken beoordeelt, en niet alleen vanuit een financieel oogpunt. Ook gaven ze aan dat het proces in de huidige vorm goed kijkt naar het draagvlak van een bepaalde innovatie binnen verschillende afdelingen, en niet alleen naar de mening van technisch experts.
E: Summary answers focus group

<table>
<thead>
<tr>
<th>Date:</th>
<th>25-6-2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration:</td>
<td>43 minutes</td>
</tr>
<tr>
<td>Participants</td>
<td>5, as explained in §2.2.2</td>
</tr>
</tbody>
</table>

In this appendix, the final answers to the questions asked in the focus group are written down in a very condensed manner. The discussions preceding the final answers have not been written down. The questions and answers are in Dutch, as this was the language used during the first user test.

1. **Wat vinden jullie van de opbouw van dit selectieproces? De verschillende blokken die samen het selectieproces vormen. Vinden jullie dat er blokken missen? Wat vinden jullie van ronde 1, 2, 3?**

Huidige vorm is goed, er hoeven geen blokken bij of af. De vragen van screen 1 mogen iets duidelijker worden gedefinieerd, ze zijn nu nog multi-interpretabel. Screen 2 is erg goed. Screen 1 kan misschien worden uitgevoerd door een andere groep dan de groep de screen 2 doet. Misschien CR of een andere stafafdeling die de randvoorwaarden eerst checkt. Een groep van experts die de randvoorwaarden kan checken. Maar aan de andere kant moet het ook niet te veel werk worden. Het is redelijk moeilijk om op basis van gebrekkige informatie een “go” of “no-go” te geven.

2. **Is het proces duidelijk?**

Ja.

3. **Vinden jullie dat het proces eerlijk is?**

Ja, niemand is erbij gebaat om zijn eigen innovatie er doorheen te pushen terwijl het een slecht idee is. Het is namelijk niet voordelig voor jezelf als je een innovatie er doorheen pusht en die later in het proces strandt, dat is ook niet goed voor je eigen naam. Het proces geeft een objectieve afweging, het is goed dat mensen van andere afdelingen er ook naar kijken. Het is wel belangrijk dat mensen breder scoren.

4. **Vinden jullie dat het proces objectief is?**

Zie antwoord van vraag 3.

5. **Maakt het selectieproces goed genoeg onderscheid?**

Er moet nog even goed naar de schaalverdeling worden gekeken. Moet die 4 opties krijgen of 5 met een neutrale in het midden? Misschien ook nog even goed nadenken over hoe je de ranking laat doen. Misschien een idee om iedereen de optie te geven om 3x een 5 uit te delen, 3x een 4, 3x een 3 etc.? Maar, dan wordt de ranking alleen maar relatief, en kan je de innovaties niet op een later moment terughalen uit de database, omdat dan de scores weer anders moeten. Dus op deze manier laten, maar beter elke innovatie na elkaar te scoren, in plaats van elke criteria meteen voor alle innovaties. Zo geef je niet scores ten opzichte van elkaar, maar kan je achteraf wel scores met elkaar vergelijken.

Het is goed dat niet alle aspecten hetzelfde zijn, het is heel divers. Alle invalshoeken worden bekeken en gescoord. Daarom is het makkelijk om te waarborgen dat een hoge score op 1 aspect niet de totaalscore te veel beïnvloed.
6. Vinden jullie dat het selectieproces op deze manier de doelen behaalt en aan de eisen voldoet? Bijvoorbeeld dat er bij alle innovaties naar duurzaamheid wordt gekeken? Wordt er genoeg gelet op de match met strategie?

Ja, het selectieproces behaalt de doelen en voldoet aan de eisen. Het is objectief, gaat niet alleen af op de pitch en het financiële plaatje. Ook is het opslaan in de database goed.

Goal 1, de keuze makkelijker maken is misschien niet te zeggen. Het wordt wel een beter onderbouwde keuze, maar niet per se makkelijker. Het is wel makkelijker voor het hogere management, maar niet voor de mensen die screenen.

G2 is heel goed, en wordt goed behaald.

Het is goed dat er niet een enorme business case nodig is. Deze methode is goed om aan te geven of het zin heeft om een business case te schrijven.

Screen 3 is goed, daarmee is het draagvlak van verschillende afdelingen meetbaar. Screen 1 en 2 zijn rationeel, 3 is op buikgevoel. Het is ook goed om te kijken waar we nu behoefte aan hebben.


Bij goal 1 moet het misschien niet zijn een makkelijkere keuze, maar een makkelijkere keuze voor het hogere management. Het wordt namelijk niet per se makkelijker voor ons.

8. Was de informatie over de innovaties voldoende?

Het mag eventueel iets uitgebreider. Misschien moeten de personen die de innovatie-ideeën aandragen de vragen waarop wordt gescreend van tevoren krijgen, zodat ze de juiste informatie kunnen geven. Of je laat ze kort presenteren, maar dat kost waarschijnlijk te veel moeite en tijd.

9. Zouden jullie dingen anders willen zien?

Misschien moet je minimale waardes voor criteria toevoegen. Er moeten thresholds komen. Maar, het is kwalitatief dus misschien is dit erg moeilijk. Het kan als richtlijn.


5 zou ideaal zijn, tussen de 3 en 7 is goed.
F: Summary answers questionnaire

In this appendix, the questions asked in the questionnaire concerning the criteria used in the prototype of the selection method can be found, with a summary of the answers. This questionnaire was given to the first user test participants after the first user test. 4 of the 5 participants answered, and the answers can be found here. Again, the questions and answers are in Dutch.

**Ronde 1**

**Zijn de criteria makkelijk te gebruiken?**
- Participant #3: Eerste en tweede vraag vind ik te gedetailleerd
- Participant #4: Vraag 1; evt. onderscheid (ende vraag) maken in/van de 4 termen…
  - Idem vraag 4: 2 termen
- Participant #1: Ja, maar is geen kwestie van direct invullen, vraagt wel wat tijd om over na te denken
- Participant #2: Ja/Nee is op zich voor deze fase goed genoeg

**Zijn de criteria realistisch (is er genoeg informatie om deze criteria te kunnen gebruiken)?**
- Participant #3: Vijf extra goed
- Participant #4: Ja, maar let op: dit kan vrij specifieke/specialistische kennis vragen/vergen. “Legal..” is al op velerlei manieren uitlegbaar: havengelden, energie, arbo, veiligheid, security, etc.
- Participant #1: Ja, aansprekend en realistisch
- Participant #2: De eerste is behoorlijk breed; niet al deze informatie zal bij alle beoordelaars aanwezig zijn.

**Zijn de criteria differentiërend genoeg?**
- Participant #3: Ja
- Participant #1: Ja, maken onderling vergelijk goed mogelijk
- Participant #2: Ja, dat denk ik wel. Een goede innovatie zou op een meerderheid van deze aspecten Ja moeten scoren; toch zullen er innovaties zijn die nee scoren en daarmee afvallen

**Zijn de criteria compleet of moeten er criteria bij/af?**
- Participant #3: Prima zo. 4 kan beter worden toegelicht
- Participant #4: Ik denk voor een overall “veto” of “force in” een prima set aan criteria
- Participant #1: Niet compleet maar dat moet ook niet het streven zijn. Gaat om voldoende onderling vergelijken.
- Participant #2: Ja, dit lijkt me voldoende.

**Ronde 2**

**Algemeen ronde 2**
- Participant #2: Let op met de schaalverdelingen. Is beter om ‘Neutraal’ altijd in het midden te zetten, slechter links en beter rechts. (In plaats van neutraal links en alleen maar beter naar rechts).
Criteria zijn niet altijd realistisch. Soms is in deze fase van een innovatie een vraag gewoon nog niet te beantwoorden. Dat wil echter niet zeggen dat deze vraag niet gesteld mag
worden. Het proces zal aan moeten geven of het toegestaan wordt dat indiener extra informatie geeft aan beoordelaars, of dat indiener op de hoogte is van de vragen zodat vooraf de juiste informatie meegegeven kan worden.
Criteria zijn zeker differentiërend genoeg! De verschillende invalshoeken worden allemaal gebruikt, waardoor sommige innovaties op het een scoren en andere op de andere invalshoek.
Criteria zijn compleet, prima zo.
Over de schaalverdeling, zie de eerste vraag.

**Part 1**

**Zijn de criteria makkelijk te gebruiken?**
- Participant #3: Onvoldoende kennis om dit te bepalen. Wellicht dat dit onderdeel in de innovatie beschrijving ook beter toegelicht kan worden. Tot nu toe kun je er niet veel uithalen.
- Participant #1: Zeker goed te gebruiken om onderling te vergelijken maar niet om er een absolute waarde aan te koppelen.

**Zijn de criteria realistisch (is er genoeg informatie om deze criteria te kunnen gebruiken)?**
- Participant #3: Wellicht dat dit onderdeel in de innovatie beschrijving ook beter toegelicht kan worden. Tot nu toe kun je er niet veel uithalen.
- Participant #1: Ja

**Zijn de criteria differentiërend genoeg?**
- Participant #1: Schaal van scoren zou meer differentiërender kunnen, moet je echt verplichten om een keuze te maken

**Zijn de criteria compleet eller moet er criteria bij/af?**
- Participant #3: Je zou nog benodigde CAPEX hieraan kunnen toevoegen
- Participant #1: Zeer compleet, soms zelfs iets te veel in detail.

**Is de schaalverdeling goed?**
- Participant #3: 1 tot 4 beter, moet degene een keuze maken
- Participant #1: Zie boven, kan beter.

**Part 2**

**Zijn de criteria makkelijk te gebruiken?**
- Participant #3: Eerste vraag te algemeen. Misschien veranderen naar potential advantage for operations. Sommige factoren gaan over geld. (asset efficiency. Tweede en derde vraag vind ik erg goed, met name omdat ze compact zijn.
- Participant #1: Zeker goed te gebruiken om onderling te vergelijken maar niet om er een absolute waarde aan te koppelen.

**Zijn de criteria realistisch (is er genoeg informatie om deze criteria te kunnen gebruiken)**
- Participant #3: Eerste vraag niet echt.
- Participant #1: Ja

**Zijn de criteria differentiërend genoeg?**
- Participant #3: Ik zou twee criteria eraan toevoegen i.p.v. de eerste (en mogelijk de laatste) Of deze naar part 4 verplaatsen: Impact on operations, Impact on assets, In lijn met (ASM/OPS/Schiphol) strategie.
- Participant #1: Schaal van scoren zou meer differentiërender kunnen, moet je echt verplichten om een keuze te maken

**Zijn de criteria compleet of moeten er criteria bij/af?**
- Participant #1: Zeer compleet, soms zelfs iets te veel in detail.
Is de schaalverdeling goed?
- Participant #1: Zie boven, kan beter.

Part 3
Algemeen part 3
- Participant #3: Goed
- Participant #4: Hier zou je ipv 3 criteria de 5 CR-thema’s kunnen gebruiken die Schiphol hanteert: Duurzame werkgelegenheid, bereikbaarheid, klimaatvriendelijke luchtvaart, grondstoffen en reststromen en omgeving, geluid en luchtkwaliteit.

Zijn de criteria makkelijk te gebruiken?
- Participant #1: Zeker goed te gebruiken om onderling te vergelijken maar niet om er een absolute waarde aan te koppelen.

Zijn de criteria realistisch (is er genoeg informatie om deze criteria te kunnen gebruiken)?
- Participant #1: Ja

Zijn de criteria differentiërend genoeg?
- Participant #1: Schaal van scoren zou meer differentiërender kunnen, moet je echt verplichten om een keuze te maken

Zijn de criteria compleet of moeten er criteria bij/af?
- Participant #3: Ik vind vraag 1 hier niet passen. Die zou ik in een naar part 2 verplaatsen en dan part 4 een andere naam geven
- Participant #1: Zeer compleet, soms zelfs iets te veel in detail.

Is de schaalverdeling goed?
- Participant #1: Zie boven, kan beter.

Part 4
Zijn de criteria makkelijk te gebruiken?
- Participant #1: Zeker goed te gebruiken om onderling te vergelijken maar niet om er een absolute waarde aan te koppelen.

Zijn de criteria realistisch (is er genoeg informatie om deze criteria te kunnen gebruiken)?
- Participant #1: Ja

Zijn de criteria differentiërend genoeg?
- Participant #3: yes
- Participant #1: Schaal van scoren zou meer differentiërender kunnen, moet je echt verplichten om een keuze te maken

Zijn de criteria compleet of moeten er criteria bij/af?
- Participant #3: Ik vind vraag 1 hier niet passen. Die zou ik in een naar part 2 verplaatsen en dan part 4 een andere naam geven
- Participant #1: Zeer compleet, soms zelfs iets te veel in detail.

Is de schaalverdeling goed?
- Participant #1: Zie boven, kan beter.

Part 5
Zijn de criteria makkelijk te gebruiken?
- Participant #3: level of control beter toelichten
- Participant #1: Zeker goed te gebruiken om onderling te vergelijken maar niet om er een absolute waarde aan te koppelen.
Zijn de criteria realistisch (is er genoeg informatie om deze criteria te kunnen gebruiken)?
- Participant #3: Nee, onvoldoende kennis om echt iets over te zeggen maar dat hoeft niet uit te maken.
- Participant #1: Ja

Zijn de criteria differentiërend genoeg?
- Participant #3: Prima
- Participant #1: Schaal van scoren zou meer differentiërender kunnen, moet je echt verplichten om een keuze te maken

Zijn de criteria compleet of moeten er criteria bij/af?
- Participant #3: Prima
- Participant #1: Zeer compleet, soms zelfs iets te veel in detail.

Is de schaalverdeling goed?
- Participant #3: Prima
- Participant #1: Zie boven, kan beter.

Part 6
Algemene opmerkingen:
- Participant #3: Ik denk dat deze drie vragen samengevoegd kunnen worden tot één vraag en onderdeel kunnen worden van bijvoorbeeld part 4.

Zijn de criteria makkelijk te gebruiken?
- Participant #1: Zeker goed te gebruiken om onderling te vergelijken maar niet om er een absolute waarde aan te koppelen.

Zijn de criteria realistisch (is er genoeg informatie om deze criteria te kunnen gebruiken)?
- Participant #1: Ja

Zijn de criteria differentiërend genoeg?
- Participant #1: Schaal van scoren zou meer differentiërender kunnen, moet je echt verplichten om een keuze te maken

Zijn de criteria compleet of moeten er criteria bij/af?
- Participant #1: Zeer compleet, soms zelfs iets te veel in detail.

Is de schaalverdeling goed?
- Participant #1: Zie boven, kan beter.

Ronde 3
Zijn de criteria makkelijk te gebruiken?
- Participant #3: Eén vraag
- Participant #2: Ja

Zijn de criteria realistisch (is er genoeg informatie om deze criteria te kunnen gebruiken)?
- Participant #3: Eén vraag
- Participant #2: Ja

Zijn de criteria differentiërend genoeg?
- Participant #3: Eén vraag
- Participant #1: Ja, moet jezelf verplichten een keus te maken, dus het beperken van de uit te delen scores zou nog beter zijn
- Participant #2: Ja
**Zijn de criteria compleet of moeten er criteria bij/af?**
- Participant #3: Misschien kun je hier een grotere schaalverdeling maken. Bv van 1 tot 10.
- Participant #2: Wil je ook een Ja wanneer er vervolgens geen budget of capaciteit blijkt te zijn? Kortom, is dit puur een ranking en volgt daarna de ‘cap’ op het aantal uit te voeren innovaties? Of neem je budget en capaciteit mee in deze afweging (in dat geval kan een innovatie nu laag scoren omdat er betere opties zijn en in een volgende ronde een kwartaal later als nog hoog. Puur omdat de concurrentie dan slechter is). Dit uitgangspunt was we niet helemaal duidelijk..

**Is de schaalverdeling goed?**
- Participant #2: Ja.

**Verdere algemene opmerkingen**
- Participant #3: Goede vragenlijst en goede vragen. Als verbeterpunt mogen er van mij minder vragen en/of compacter. Zodat we in één oogopslag de vraag snappen en snel antwoord kunnen geven. Daarnaast zoals ik aangaf klinkt voor mij de verdeling over de diverse onderdelen (parts) niet altijd logisch.
- Participant #1: Bruikbaar
G: Innovation idea submission form

Title/name of innovation:
Submitter + department:
Date:

*Invullen mag ook in het Nederlands!*

1. **Idea description + goals of innovation** (Explain what the innovation is, explain the possible advantages for Schiphol, airlines, passengers, handing agents, explain the scale of the impact):

   ...

2. **Project goals** (What are the goals of the PoC, pilot, or innovation project? Example: I want to do this PoC to find out if this technology works, or I want to do this pilot to find out if I can implement this innovation on all VOPs):

   ...

3. **Strategic alignment** (How well does the innovation project match with the strategic goals of ASM):

   ...

4. **Feasibility** (Probability of project success, based on previous work or other projects. What are critical success factors and potential showstoppers?):

   ...

5. **Technical advantage** (What are alternatives, and why is this innovation better than alternatives?):

   ...

6. **Technical maturity** (How mature is the innovation? Is it completely new, or has it been implemented somewhere else?):

   ...

7. **Internal and external stakeholders** (Who is needed for support, and which resources do they need?):

   ...

8. **Business case estimation** (What is the estimated budget, in which phases?):

   ...

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### H: Form for screen 1 of first prototype

Name: __________  
Date of selection: _____

Innovations:

<p>| | | | | | |</p>
<table>
<thead>
<tr>
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<tbody>
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</tbody>
</table>

**Innovation A**

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<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>11. Does the innovation meet environmental, health, safety and legal policies?</td>
<td>YES</td>
<td>NO</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Does the expected advantage outweigh the risks?</td>
<td>4x</td>
<td>1x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Is there a reasonable likelihood of feasibility?</td>
<td>5x</td>
<td>0x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Strategic alignment: Does the innovation have potential to address a business need and is the innovation relatable to Schiphol’s strategy?</td>
<td>5x</td>
<td>0x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Is it possible to test the innovation on a small scale?</td>
<td>4x</td>
<td>1x</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Innovation B**

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>16. Does the innovation meet environmental, health, safety and legal policies?</td>
<td>YES</td>
<td>NO</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. Does the expected advantage outweigh the risks?</td>
<td>5x</td>
<td>0x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. Is there a reasonable likelihood of feasibility?</td>
<td>5x</td>
<td>0x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19. Strategic alignment: Does the innovation have potential to address a business need and is the innovation relatable to Schiphol’s strategy?</td>
<td>5x</td>
<td>0x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20. Is it possible to test the innovation on a small scale?</td>
<td>5x</td>
<td>0x</td>
<td></td>
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</tr>
</tbody>
</table>

**Innovation C**

<p>| | | | | | |</p>
<table>
<thead>
<tr>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>21. Does the innovation meet environmental, health, safety and legal policies?</td>
<td>YES</td>
<td>NO</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22. Does the expected advantage outweigh the risks?</td>
<td>5x</td>
<td>0x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23. Is there a reasonable likelihood of feasibility?</td>
<td>4x</td>
<td>1x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24. Strategic alignment: Does the innovation have potential to address a business need and is the innovation relatable to Schiphol’s strategy?</td>
<td>5x</td>
<td>0x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25. Is it possible to test the innovation on a small scale?</td>
<td>5x</td>
<td>0x</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
I: Form for screen 2 of first prototype

Name: ____________________
Date of selection: _______
Innovations:
A
B
C

Important reminder: Fill in what you think/expect is the performance on a certain criterion! If something is unclear, just ask.

**Part 1: Financial value criteria**

Expected effect on profitability of Schiphol (profitability = income – cost. So, consider both possible new revenue streams and cost reductions)

<table>
<thead>
<tr>
<th>Innovation</th>
<th>Very negative effect</th>
<th>No effect</th>
<th>Very positive effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1 2</td>
<td>3</td>
<td>4 5</td>
</tr>
<tr>
<td>B</td>
<td>1 2</td>
<td>3</td>
<td>4 5</td>
</tr>
<tr>
<td>C</td>
<td>1 2</td>
<td>3</td>
<td>4 5</td>
</tr>
</tbody>
</table>

Expected effect on airport charges (havengelden)

<table>
<thead>
<tr>
<th>Innovation</th>
<th>Very negative effect</th>
<th>No effect</th>
<th>Very positive effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1 2</td>
<td>3</td>
<td>4 5</td>
</tr>
<tr>
<td>B</td>
<td>1 2</td>
<td>3</td>
<td>4 5</td>
</tr>
<tr>
<td>C</td>
<td>1 2</td>
<td>3</td>
<td>4 5</td>
</tr>
</tbody>
</table>

**Part 2: Non-financial value criteria**

Potential advantages of innovation (For instance: Improvement in operational capacity, asset reliability, asset availability, asset efficiency, asset safety, asset quality, and all other qualitative benefits. Effect on 1 aspect is sufficient, do not take the effect on all aspects):

<table>
<thead>
<tr>
<th>Innovation</th>
<th>No (observable) advantages</th>
<th>Strong advantages for ASM</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1 2</td>
<td>3</td>
</tr>
<tr>
<td>B</td>
<td>1 2</td>
<td>3</td>
</tr>
<tr>
<td>C</td>
<td>1 2</td>
<td>3</td>
</tr>
</tbody>
</table>

Impact on provided services. Is there an improvement in service for passengers/airlines/handling agents?

<table>
<thead>
<tr>
<th>Innovation</th>
<th>No (observable) impact</th>
<th>Positive impact</th>
<th>Very positive impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1 2</td>
<td>3</td>
<td>4 5</td>
</tr>
<tr>
<td>B</td>
<td>1 2</td>
<td>3</td>
<td>4 5</td>
</tr>
<tr>
<td>C</td>
<td>1 2</td>
<td>3</td>
<td>4 5</td>
</tr>
</tbody>
</table>
Part 3: Sustainability criteria

Contribution towards the climate-neutral ambition. Does the innovation contribute to the goal of achieving zero emissions of CO₂, NOₓ, particulates (fijnstof)?

<table>
<thead>
<tr>
<th>Innovation</th>
<th>Very negative contribution</th>
<th>No contribution</th>
<th>Very positive contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>C</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Contribution towards zero-waste ambition. Does the innovation contribute to the goal of achieving zero waste by eliminating waste, conserving and recovering resources?

<table>
<thead>
<tr>
<th>Innovation</th>
<th>Very negative contribution</th>
<th>No contribution</th>
<th>Very positive contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>C</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Contribution towards better health conditions for employees, passengers and residents. Think about noise, air quality etc.

<table>
<thead>
<tr>
<th>Innovation</th>
<th>Very negative contribution</th>
<th>No contribution</th>
<th>Very positive contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>C</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Part 4: Match with resources and strategy of ASM, stakeholders

Contribution towards strategic goals of Schiphol: Ambition to become Europe’s preferred airport. This means providing best service quality for fair price for passengers, airlines, logistics providers.

<table>
<thead>
<tr>
<th>Innovation</th>
<th>No (observable) contribution</th>
<th>Positive contribution</th>
<th>Very positive contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>C</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>
Organisational feasibility (resources, people, knowledge). Does ASM have the right people and capabilities to do the project? What is the match with the department?  

<table>
<thead>
<tr>
<th>Innovation</th>
<th>Very bad</th>
<th>Neutral/unknown</th>
<th>Very good</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>C</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Technological and process synergies. How well does this innovation fit in the current (operational) processes and with the current technologies?  

<table>
<thead>
<tr>
<th>Innovation</th>
<th>Very bad fit</th>
<th>Average</th>
<th>Very good fit</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
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<td>3</td>
</tr>
<tr>
<td>C</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Expected support of internal stakeholders (based on match, interest, stance, resources)  

<table>
<thead>
<tr>
<th>Innovation</th>
<th>Strong resistance</th>
<th>Neutral</th>
<th>Strong support</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>B</td>
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<tr>
<td>C</td>
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<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Expected support of external stakeholders (based on match, interest, stance, resources)  

<table>
<thead>
<tr>
<th>Innovation</th>
<th>Strong resistance</th>
<th>Neutral</th>
<th>Strong support</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
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<tr>
<td>C</td>
<td>1</td>
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<td>3</td>
</tr>
</tbody>
</table>

**Part 5: Risks/feasibility**

Technical feasibility (complexity, uncertainty)  

<table>
<thead>
<tr>
<th>Innovation</th>
<th>Low feasibility</th>
<th>Medium feasibility</th>
<th>High feasibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>C</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Level of Control  

<table>
<thead>
<tr>
<th>Innovation</th>
<th>Influence</th>
<th>Guide</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>C</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Business case risk (financial risk, envisioned financial value is not achieved)  

<table>
<thead>
<tr>
<th>Innovation</th>
<th>Very high risk</th>
<th>Average risk</th>
<th>Very low risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>C</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>
Project risks: Technical risks, risks of disrupting operations, risk of insufficient budget, risk of bad cooperation with stakeholders

<table>
<thead>
<tr>
<th>Innovation</th>
<th>Very high risk</th>
<th>Average risk</th>
<th>Very low risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>C</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>

Trialability: Are there good and safe opportunities to test the innovation on a small scale?

<table>
<thead>
<tr>
<th>Innovation</th>
<th>No (good) opportunities</th>
<th>(Some) good opportunities</th>
<th>Very good opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>C</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>

---

**Part 6: Innovation necessity/desirability**

Necessity of innovation for Schiphol. How urgent is it to do this innovation? Is there a large demand from a customer or regulation?

<table>
<thead>
<tr>
<th>Innovation</th>
<th>Low urgency</th>
<th>High urgency</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>C</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

Customer need fit. Does the innovation fit a certain customer demand?

<table>
<thead>
<tr>
<th>Innovation</th>
<th>No need/bad fit</th>
<th>Average/unknown</th>
<th>Large need/good fit</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>C</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Timing. Is the timing for this innovation right, or is it better to wait a couple of years to let the innovation develop?

<table>
<thead>
<tr>
<th>Innovation</th>
<th>Extremely bad time for this innovation</th>
<th>Unclear / no difference</th>
<th>Perfect time for this innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>C</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>
J: Form for screen 3 of first prototype
### Innovation Scoring Results

#### Dot size = strategic alignment

- **A**: Low Sustainability, High Financial
- **B**: High Sustainability, Low Financial
- **C**: High Sustainability, High Financial

#### Opmerkingen/ scores die ik opvallend vind:

- 
- 
- 
- 
- 

<table>
<thead>
<tr>
<th>Name: ____________________</th>
<th>Date of selection: _____</th>
</tr>
</thead>
</table>

#### Innovations:

- **A**
- **B**
- **C**

#### Do you believe it is a good idea for Schiphol to do innovation A now?

<table>
<thead>
<tr>
<th>Innovation</th>
<th>Very bad idea</th>
<th>Neutral</th>
<th>Very good idea</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

#### Do you believe it is a good idea for Schiphol to do innovation B now?

<table>
<thead>
<tr>
<th>Innovation</th>
<th>Very bad idea</th>
<th>Neutral</th>
<th>Very good idea</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

#### Do you believe it is a good idea for Schiphol to do innovation C now?

<table>
<thead>
<tr>
<th>Innovation</th>
<th>Very bad idea</th>
<th>Neutral</th>
<th>Very good idea</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>
## K: Redesign of form for screen 1

Name: __________
Date of selection: ______

Innovations:

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Innovation A

26. Is there a reasonable likelihood of meeting environmental policies? YES/NO
27. Is there a reasonable likelihood of meeting health policies? YES/NO
28. Is there a reasonable likelihood of meeting safety policies? YES/NO
29. Is there a reasonable likelihood of meeting legal policies? YES/NO
30. Is the innovation expected to present an advantage? YES/NO
31. Is there a reasonable likelihood the risks will be manageable? YES/NO
32. Is there a reasonable likelihood of feasibility? YES/NO
33. Does the innovation have potential to address a business need? YES/NO
34. Is the innovation relatable to Schiphol's strategy? YES/NO
35. Is it possible to test the innovation on a small scale? YES/NO

### Innovation B

1. Is there a reasonable likelihood of meeting environmental policies? YES/NO
2. Is there a reasonable likelihood of meeting health policies? YES/NO
3. Is there a reasonable likelihood of meeting safety policies? YES/NO
4. Is there a reasonable likelihood of meeting legal policies? YES/NO
5. Is the innovation expected to present an advantage? YES/NO
6. Is there a reasonable likelihood the risks will be manageable? YES/NO
7. Is there a reasonable likelihood of feasibility? YES/NO
8. Does the innovation have potential to address a business need? YES/NO
9. Is the innovation relatable to Schiphol's strategy? YES/NO
10. Is it possible to test the innovation on a small scale? YES/NO

### Innovation C

1. Is there a reasonable likelihood of meeting environmental policies? YES/NO
2. Is there a reasonable likelihood of meeting health policies? YES/NO
3. Is there a reasonable likelihood of meeting safety policies? YES/NO
4. Is there a reasonable likelihood of meeting legal policies? YES/NO
5. Is the innovation expected to present an advantage? YES/NO
6. Is there a reasonable likelihood the risks will be manageable? YES/NO
7. Is there a reasonable likelihood of feasibility? YES/NO
8. Does the innovation have potential to address a business need? YES/NO
9. Is the innovation relatable to Schiphol's strategy? YES/NO
10. Is it possible to test the innovation on a small scale? YES/NO
L: Redesign of form for screen 2

Name: ____________________
Date of selection: ______
Innovations:
A
B
C

Important reminder: Fill in what you think/expect is the performance on a certain criterion! If something is unclear, just ask.

Part 1: Financial criteria

Expected impact on profitability of Schiphol (profitability = income – cost. So, consider both possible new revenue streams and cost reductions)

<table>
<thead>
<tr>
<th>Very negative impact</th>
<th>No impact/neutral/unknown</th>
<th>Very positive impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Expected impact on airport charges (havengelden). A negative impact is a rise in airport charges, a positive impact is a decline in airport charges.

<table>
<thead>
<tr>
<th>Very negative impact</th>
<th>No impact/neutral/unknown</th>
<th>Very positive impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Part 2: Non-financial value criteria

Potential contribution towards the “Operational excellence” goal. Does this innovation contribute towards the goal of achieving the best operational processes?

<table>
<thead>
<tr>
<th>Very negative contribution</th>
<th>No impact/neutral/unknown</th>
<th>Very positive contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Expected impact on provided services. Is there an improvement in service for passengers/airlines/handling agents?

<table>
<thead>
<tr>
<th>Very negative impact</th>
<th>No impact/neutral/unknown</th>
<th>Very positive impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Expected impact on asset base. Is there an improvement in the asset base?

<table>
<thead>
<tr>
<th>Very negative impact</th>
<th>No impact/neutral/unknown</th>
<th>Very positive impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Expected impact on image of Schiphol Group

<table>
<thead>
<tr>
<th>Very negative impact</th>
<th>No impact/neutral/unknown</th>
<th>Very positive impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Lead time to first result

<table>
<thead>
<tr>
<th>≥5y</th>
<th>3y</th>
<th>≤1y</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>
**Part 3: Sustainability criteria**

Expected contribution towards the climate-neutral ambition. Does the innovation contribute to the goal of achieving zero emissions of CO₂, NOₓ, particulates (fijnstof)?

<table>
<thead>
<tr>
<th>Very negative contribution</th>
<th>No contribution/neutral/unknown</th>
<th>Very positive contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very negative contribution</td>
<td>No contribution/neutral/unknown</td>
<td>Very positive contribution</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

Expected contribution towards zero-waste ambition. Does the innovation contribute to the goal of achieving zero waste by eliminating waste, conserving and recovering resources?

<table>
<thead>
<tr>
<th>Very negative contribution</th>
<th>No contribution/neutral/unknown</th>
<th>Very positive contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very negative contribution</td>
<td>No contribution/neutral/unknown</td>
<td>Very positive contribution</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

Expected contribution towards better health conditions for employees, passengers and residents. Think about noise, air quality etc.

<table>
<thead>
<tr>
<th>Very negative contribution</th>
<th>No contribution/neutral/unknown</th>
<th>Very positive contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very negative contribution</td>
<td>No contribution/neutral/unknown</td>
<td>Very positive contribution</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

Expected contribution towards the “optimal accessibility” goal. Does the innovation provide a contribution towards achieving better accessibility for Schiphol?

<table>
<thead>
<tr>
<th>Very negative contribution</th>
<th>No contribution/neutral/unknown</th>
<th>Very positive contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very negative contribution</td>
<td>No contribution/neutral/unknown</td>
<td>Very positive contribution</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

**Part 4: Match with resources and strategy of ASM, stakeholders**

Expected contribution towards strategic goals of Schiphol: Ambition to become Europe’s preferred airport. This means providing best service quality for fair price for passengers, airlines, logistics providers.

<table>
<thead>
<tr>
<th>Very negative contribution</th>
<th>No contribution/neutral/unknown</th>
<th>Very positive contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very negative contribution</td>
<td>No contribution/neutral/unknown</td>
<td>Very positive contribution</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

Expected organisational feasibility (resources, people, knowledge). Does ASM have the right people and capabilities to do the project? What is the match with the department?

<table>
<thead>
<tr>
<th>Very negative contribution</th>
<th>No contribution/neutral/unknown</th>
<th>Very positive contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very negative contribution</td>
<td>No contribution/neutral/unknown</td>
<td>Very positive contribution</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

Expected technological and process synergies. How well does this innovation fit in the current (operational) processes and with the current technologies?

<table>
<thead>
<tr>
<th>Very negative contribution</th>
<th>No contribution/neutral/unknown</th>
<th>Very positive contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very negative contribution</td>
<td>No contribution/neutral/unknown</td>
<td>Very positive contribution</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

Expected support of internal stakeholders (based on match, interest, stance, resources)

<table>
<thead>
<tr>
<th>Strong resistance</th>
<th>Neutral/unknown</th>
<th>Strong support</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>
Expected support of external stakeholders (based on match, interest, stance, resources)

<table>
<thead>
<tr>
<th>Strong resistance</th>
<th>Neutral/unknown</th>
<th>Strong support</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
</tr>
</tbody>
</table>

**Part 5: Risks/feasibility**

Expected technical feasibility (complexity, uncertainty)

<table>
<thead>
<tr>
<th>Very low</th>
<th>Medium/Neutral/unknown</th>
<th>Very high</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
</tr>
</tbody>
</table>

Expected Level of Control. How much control does ASM have over the choices made regarding the innovation? Can ASM dictate which choices are made (control) or merely influence an external party that makes the choices?

<table>
<thead>
<tr>
<th>Influence</th>
<th>Guide</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
</tr>
</tbody>
</table>

Expected business case risk. Financial risk: Envisioned financial value is not achieved.

<table>
<thead>
<tr>
<th>Very high risk</th>
<th>Average/Neutral/unknown</th>
<th>Very low risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
</tr>
</tbody>
</table>

Expected project risks. Technical risks, risks of disrupting operations, risk of insufficient budget, risk of bad cooperation with stakeholders

<table>
<thead>
<tr>
<th>Very high risk</th>
<th>Average/Neutral/unknown</th>
<th>Very low risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
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<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
</tr>
</tbody>
</table>

Trialability. Are there good and safe opportunities to test the innovation on a small scale?

<table>
<thead>
<tr>
<th>Very bad opportunities</th>
<th>Average/Neutral/unknown</th>
<th>Very good opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
</tr>
</tbody>
</table>

**Part 6: Innovation necessity/desirability**

Necessity of innovation for Schiphol. How urgent is it to do this innovation? Is there a large demand from a customer or regulation?

<table>
<thead>
<tr>
<th>Very low necessity</th>
<th>Average/Neutral/unknown</th>
<th>Very high necessity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
</tr>
</tbody>
</table>

Customer need fit. Does the innovation fit a certain customer demand?

<table>
<thead>
<tr>
<th>Very bad fit</th>
<th>Medium/Neutral/unknown</th>
<th>Very good fit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
</tr>
</tbody>
</table>
M: Redesign of form for screen 3
Do you believe it is a good idea for Schiphol to do innovation A now?

<table>
<thead>
<tr>
<th>Very bad idea</th>
<th>Medium/neutral/unknown</th>
<th>Very good idea</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Do you believe it is a good idea for Schiphol to do innovation A within 1-3 years?

<table>
<thead>
<tr>
<th>Very bad idea</th>
<th>Medium/neutral/unknown</th>
<th>Very good idea</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
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<td>6</td>
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<tr>
<td>7</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Do you believe it is a good idea for Schiphol to do innovation A after 3 years?

<table>
<thead>
<tr>
<th>Very bad idea</th>
<th>Medium/neutral/unknown</th>
<th>Very good idea</th>
</tr>
</thead>
<tbody>
<tr>
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These same questions are asked for innovation B and C as well, but it is of no use to include them in the appendix.
N: Extended discussion

**Extended discussion on research approach**

1. This research assumes that implementing a structured sustainable innovation selection method leads to better innovation selection, more valuable and successful innovation projects and better sustainable performance of innovations. The design of the sustainable innovation selection method as presented in this thesis meets the design requirements, and thus fulfils the design goals. However, it has not been tested for an extended period, so nothing is known whether the selection method does indeed lead to better innovation choices, more successful innovation projects, and improved sustainable performance of selected innovations. The added value of the designed selection method is still unclear. The “old” implicit way of working is based on intuition, is the “new” way of working better?

2. The definition used for innovation success also carries a limitation. The definition used for innovation success is an innovation project that achieves the expected goals. This definition was chosen because innovation projects are non-standard, no innovation project is the same so there are no universal goals of innovation projects. The limitation of this definition is that it is possible to define ambitionless project goals, increasing the chance of innovation “success”. The question then becomes how valuable an innovation project can become for an organisation. In the case of the designed selection method it is not a big problem, as this also assesses the potential value to an organisation.

3. Organisational factors concerning the adoption of the selection method itself have not been considered in this research. The assumption is made that a design that meets the user requirements is what users want and is consequently automatically used. (Other) Barriers and drivers for adoption of the selection method have received no attention in this study. To add to this, there are many other factors influencing the choice for innovation ideas. Although the selection method attempts to cover as many of these factors (like organisational feasibility, internal & external support) as possible, nothing can be said about what happens with the outcome of the selection process. A possible organizational factor that could determine what is done with the outcome of the selection process is whether working with the selection method is unanimously recognized and accepted in the organisation.

4. Only innovation-specific success and failure factors have been considered. This is quite logical, as these are factors which make it possible to discriminate amongst innovation ideas and comparing innovation ideas was the focus of this research. However, if the goal is to improve innovation project success, company-related, market-related and process-related success and failure factors must also receive attention.

5. The qualitative nature of this research carries some limitations. First, there is a risk of interpretation bias by the researcher. Precautions have been taken to try to minimize this risk by validating results and conclusions multiple times, but it cannot be guaranteed that an unbiased view was kept during the research. Furthermore, it typically involves a relatively small number of respondents. This decreases the external validity of the research; a quantitative approach would allow for more respondents, increasing the external validity.

6. Upon recommendation, I have decided to give the first user test participants the opportunity to add 1 innovation idea to the screening process. This was done to see whether this would impact the scoring the innovation ideas received. However, the
choice to do this is rather arbitrary. The goal of the first user test was to find out how well the selection process and the selection criteria meet the requirements, not to find out which factors influence the scoring of various innovation ideas. Would this be the goal, there are many more factors that need to be tested. Perhaps, this could be done in future user tests.

7. The conclusion of this research provides design rules that other service organisations can use to design their own sustainable innovation selection method. But these rules have been made based on a study in a single department of a non-standard service organisation. The completeness and generalizability of these rules is thus unknown so far, this could perhaps be uncovered in future research. By performing the same type of research in multiple service firms, the design rules can be validated or discarded.

8. The literature review was done before finding out what the goals, requirements, assumptions are. This was done to gain more knowledge on innovation processes and selection before commencing the interviews, to be able to ask more focused questions. Also, it gave a very broad view of possible selection/evaluation methods in the literature. It could also be done the other way around, this would make it possible to have a more focused, in-depth, literature review but on the other hand limit the amount of “building blocks”.

**Extended discussion on designed selection method**

1. During this research, the design-oriented research approach has been followed, which states a design must be made based on determined requirements, and a successful design being a design that meets these requirements. The design presented in this thesis is in that sense a success, it meets the requirements and achieves the goals determined up front. Nevertheless, there are probably many more ways of doing this as perhaps, other service firms can combine different “building blocks” to achieve the same.

2. The design as presented is a prototype, with one design alteration based on the first user test. To get to a working, accurate, user-friendly selection method, more designing and testing steps are necessary. The test of the prototype evoked positive reactions from the test participants, indicating it is useful to continue design work to a finished product. For the prototype, the screens were done by hand on printed forms. The results were calculated and visualized using Excel. In further design steps, this can be automated and/or digitalized, potentially ultimately creating a digital tool that is easy to use and can be adapted to all departments of Schiphol.

3. Currently, there is no statement of conditions under which innovation ideas can be brought “back into the loop” after failing screen 1. When an innovation idea possesses a showstopper, what is the course of action to take? Is time and effort invested to fix this? Or is it better to wait, and let for instance the market fix it? Or maybe the next screening round does not have this criterion as a showstopper, is the idea then included again? All these questions have not been answered in my thesis but are very interesting to discuss. This could be an interesting add-on to the selection method, providing possible actions to undertake when a certain innovation idea fails on a “must-meet” criterion or showstopper. The same could be said for innovation ideas that achieve a low score on screen 2. Will something be done to improve the score? Or will all effort and time be invested in the highest scoring idea? Saving the ideas and scores in a database will make it easier to later retrieve (failed) innovation ideas but does not tell anything about which actions should further be taken with the ideas.

4. The criteria weights, apart from those for the sustainability criteria, were all set to be equal in the first user test. The group weights were also distributed proportionally. This was done because this test was to find out whether the concept worked, and the criteria
used were complete. But, criteria are not all equally important to any department or firm, ASM included. More work is required to find out the correct weighing factors for all criteria, which could possibly be validated in a second user test. The impact of changing the group weights is also not investigated in this research but is very important for the outcomes of the selection process.

5. The choice is made to not involve all internal and external stakeholders in the selection process, as this will have a negative effect on the speed and practicability of the decision process. Instead, the deliberate consideration was made to appoint “representatives” from internal stakeholders that have good and many contacts with the external stakeholders. The assumption with this is that these representatives have a clear view of the opinions and interests of the external stakeholders. This is a clear limitation, as chances are quite high that this is not always exactly the case. However, the participants of the first user test indicated that the voices of the stakeholders are adequately represented in the selection method as is.

6. The innovation idea submission form has proven to not be optimal. “Innovation owners”, people that bring forward the innovation ideas, fill in the form in different ways. One might fill in all small details, the other might only include a rough description. Due to this, the information of all innovation ideas in the screening process might not be complete. A possible solution is to invite the innovation owners to give a short presentation detailing their idea and to answer questions. However, this is time-consuming and dependent on availability of the innovation owners. Furthermore, when screen 1, 2 and 3 are not done by the same group of people as discussed in the previous point, this is not feasible. Another (possible more feasible) solution to this is to send the innovation owners the selection criteria up front, enabling them to provide the information necessary to select. However, this presents the possible danger of the innovation owners sketching a too positive picture, resulting in unrealistically high scores in the selection process.

7. Because ASM is legally not allowed to turn a profit, the question might arise as to why client need/fit is a selection criterion in the second screen. With this, the existing literature tries to assess the sales potential of an innovation. When a new service clearly meets a customer demand, the service firm will sell more of these services. For “normal” service firms, this is a justified reason to pursue this innovation, and a clear success factor when present in an innovation idea. However, ASM does not innovate with the goal of selling (new) services to as many customers as possible, so why is this criterion still included? The criterion client need/fit is in this case used to assess the prospected adoption of an innovation amongst other stakeholders on the airport. Although this does not lead to higher sales, it justifies the investment in an innovation.
O: Extended recommendations

Extended recommendations for future research

1. Validate the completeness and correctness of the design rules that have been presented to help service organisations to design a sustainable innovation selection method. For this, research must be done in more service organisations. Since the term service organisation encompasses a wild variety of firms ranging from banks to universities, it is interesting to see if the design rules are applicable to all types of service firms, and if they are correct in the first place.

2. Verifying and validating the evaluation criteria presented in this research. This must be done to verify if the chosen criteria do indeed have the potential to lead to the selection of innovation projects that have more value, are more successful and improve the sustainable performance of a firm. This can be done by setting up a research on these criteria in multiple service firms.

3. When the evaluation criteria are verified and validated, long-term use of the selection method must verify if a selection method that assesses innovation ideas on the completely different dimensions of sustainability performance and innovation project success factors does indeed provide a firm with more valuable innovation projects, a higher innovation project success rate and better sustainability performance.

4. Research barriers and drivers for the adoption of a new method of selecting innovation ideas. The design of the method is merely 1 of the factors that determine the effectiveness of the method. How (well) it is used is another one.

5. Research other factors that influence the value and success of innovation projects and the sustainability performance of service firms. These factors can be company-related, market-related and process-related. Implementing a structured innovation selection process could improve outcomes for firms, but there are also other things a firm can do to improve.

6. Research on a bigger scale whether firms that adhere to the SOI principles perform better not only on sustainability but also on the more traditional business goals.

7. For service firms in network settings, study whether the inclusion of stakeholders in the selection process of innovations does indeed lead to more innovation project success or higher innovation adoption.

Extended recommendations to Royal Schiphol Group

1. Because the design is not finished yet, continue the designing and testing steps until a finished tool is produced. The criteria that are now used have been indicated by the test participants to be good, but perhaps managers think other criteria should be added. Also, spend time determining the correct criteria weights. The next step is a second user test, to test the altered design of the prototype.

2. The selection method can be part of a larger overarching portfolio management tool for (sustainable) innovations. Some interview participants indicated it would be very useful for the department to have this, and the selection method design can be very good first step towards realization of such a tool.

3. The conditions under which innovation ideas can be brought “back into the loop” after failing screen 1 or achieving a low score on screen 2 must be specified. Not only does this make the selection method more useful, but it is also necessary when you want to create the portfolio management tool.
4. To be able to effectively use the selection method with enough innovation ideas to screen and with the correct information to do so, make sure all employees of ASM are known with the new process. Improve the innovation idea submission form (so people know what is important to fill in) and make it publicly available. Clearly communicate as to when the screening moments are, and what is the strategic focus is. Do we want to select only between innovations that have a positive sustainable contribution, or do we only want to compare innovations meant to solve problem X?