BEYOND ILLUMINATION AND BACK

The use of the Internet of Things in the design of circular supermarket lighting

BEYOND ILLUMINATION AND BACK

The use of the Internet of Things in the design of circular supermarket lighting

Master Thesis

Integrated & Strategic Product Design

Delft University of Technology

Signify: Philips Retail Lighting

Helen Nieuweboer

Oktober 2018

Supervisory team:

Prof. dr. ir. R. Mugge

MSc. E.K. Ingemarsdotter

Company mentors:

Elena Ferrari

Frank van den Berg

contact: info@helennieuweboer.com

PREFACE

This master thesis is the final deliverable of the double master's degree Integrated Product Design and Strategic Product Design at the faculty Industrial Design Engineering of the TU Delft. Nine months ago I went to the office of Ruud Balkenende looking for a graduation project related to circular economy and system thinking. I want to thank Ruud for introducing me to Emilia Ingemarsdotter, helping me to set up the project with Signify and providing me with feedback during the project.

Secondly, I want to thank my supervisory team from the TU Delft, Ruth Mugge and Emilia Ingemarsdotter. I want to thank Ruth for her critical view on my design process and communication. I want to thank Emilia for her support, patience and critical questions during every weekly meeting.

I want to thank Signify for giving me the opportunity to base my project on their case. I especially want to thank Elena and Frank for providing me with the necessary information, contacts and feedback.

In addition I want to thank the Circular Design Lab for their feedback and insights during the monthly meetings. I especially want to thank Ella Jasmin for arranging a physical lab and setting up meetings with experts and students. I want to thank Piek and Tjits for making the physical space a pleasant place to work.

Besides, I want to thank everybody who inspired me during this project. I want to thank Rens, Saskia, Piek, Sylvia, Marie, Jorben and Mirte for sharing their ideas about circular supermarket lighting. I want to thank Sjoukje, Jolenthe, Tessa, Sieb, Bart, Maurice, Dorien, Stef, Manuela, Wouter, Ulker, Ralph, Marleen and Gonneke for providing feedback on my ideas. Additionally I want to thank my sister for providing me with tips for writing.

Lasty, I am grateful for the people supporting me during the graduation process. I especially want to thank my parents, Jorben, Mirte and Yasmine for being a listening ear and helping me to gain more confidence.

LIST OF ABBREVIATIONS AND TERMS

Business-to-business (B2B) - An offer from one company to other companies or business consumers.

Business-to-consumer (B2C) - An offer from a company to consumers.

Business Consumer - An organisation or company that buys or uses a product, service or system.

Capital Expenditures (CAPEX) - the money a company spends to buy, maintain, or improve its fixed assets (e.g. buying a photocopier).

Circular Economy (CE) - A circular economy is a regenerative system which aims to minimise resource input and waste by slowing, closing, and narrowing material loops. This can be achieved by future ready design, maintenance, repair, upgrades, reuse, remanufacturing, refurbishing, and closed recycling loops.

Consumer - A person that uses a product, service or system. In this report a consumer refers to a supermarket visitor.

Customer - A person or organisation that buys a product, service or system. In this report a customer refers to a retailer.

Conversion - The transformation from a store visit towards a purchase.

Economic lifetime - The period during which a product is still relevant for the user of the product.

Ecosystem - A system of stakeholders connected by the circulation of products, services, information or money.

Future ready design - Design aimed at staying relevant for the user over the technical lifetime of a product.

Internet of Things (IoT) - IoT describes the concepts of objects being equipped with identifying, sensing, networking and processing capabilities to allow them to communicate with one another and with other devices and services over the Internet to achieve some useful objective.

Indoor Positioning System - A System that uses visible light communication (VLC) in combination with an app that is able to detect the code of a specific luminaire to indicate the location of a shopper on a digital map of the store.

LED drivers - Lighting electronics that convert input power into a current which remains constant despite fluctuations in voltage.

LED lamp - A solid-state semiconductor device that converts electrical energy directly into light.

LED luminaires - Light fixtures where LED modules are integrated into the luminaire as light source and cannot be separated from the luminaire by the user.

Light as a Service contract (LAAS) - Contracts enabling an integrated solution for customers where customers pay for the provision of light to their premises, while the company plans and builds the lighting infrastructure and ensures its performance until the end of the contract.

Light-Emitting Diode (LED) - A LED is a semiconductor that emits light when a current passes. This light can be visible in different colours but also be ultraviolet or infrared.

Lighting services - Services offered to customers buildings on a lighting system and enabled by data.

Lighting systems - The combination of luminaires, controls and software. The automation and related controls of lighting within a room, building or outdoor facilities for end-users.

Lighting Plan - An overview of which luminaire will be placed where in a room.

Luminaire - Electrical device that produces, controls and distributes light. Also called light fixture. A luminaire consists of one or more light sources, lamps or sockets that connect the lamps to the electrical power (as well as drivers in some luminaires), and the mechanical components required to support or attach the housing.

Maintenance - Activities that lead to the extension of the lifetime of a product (e.g. updates, cleaning).

Move - The installation of a product at a different location (in the same building), owned by the same owner. Move is also called repositioning.

Operational Expenditures (OPEX) - An ongoing cost for running a product, business, or system. (e.g. the paper, toner and power a photocopier uses, see CAPEX)

Omni-channel experience - A seamless brand experience on different channels (web shop, app, physical store) by orchestrating the information from these different channels.

Product-Service System (PSS) - A combination of products and services which aims at creating customer utility and generating value.

Recycling - Harvesting of materials from used products to use them for new products.

Refurbish - Activities to extend both the technical and economic lifetime of a product to make it ready for reuse.

Refurbishment Cycle - Cycle of refurbishment and use till the next refurbishment of a building or a product.

Remanufacturing - Harvesting used parts to use them into a new product.

Repair - Activities that lead to the extension of the technical lifetime of a product.

Reuse - The use of a product by another owner.

Shopper - Consumer visiting a store to buy products. In this report a shopper referred to a visitor of a supermarket.

Store Refurbishment - Work such as replacement, repair and renewal of both the interior and exterior that is done to make a store look new again. A deep refurbish refers to the complete refurbishment of a store that usually takes place once in 5 to 10 years.

Store Refresh - Small changes to the layout of the store to keep triggering consumers.

Technical lifetime - The period during which an product can technically perform before it breaks down and needs to be replaced.

Trunking - Trunking is an enclosure provided for the protection of cables which is normally square or rectangular in cross-section, having one removable side.

Update - Installation of (partly) new software on a product or system.

Upgrade - Renewing or adding components at location of use.

EXECUTIVE SUMMARY

The effects of the linear economy on our environment are becoming more visible every day. Governments act by introducing sustainability related laws and legislation, stimulating companies to make their products ready for a circular economy (CE).

Circular supermarket lighting for Signify
A progressive Dutch company that is working on the development of products and services for a circular economy is Signify. Signify already offers lighting services (e.g. Light as a Service) in a few segments, but it is aiming to also do so in the supermarket segment. However, the length of the refurbishment cycles of the supermarkets hinders Signify to offer Circular Lighting as it is offered in other segments. The length of the refurbishment cycles of supermarkets are often a lot shorter than the technical lifetime of a lighting system. As a result, luminaires are replaced and thrown away despite being in perfectly good condition.

CE and IoT
Different academics point out that the Internet of Things (IoT) creates opportunities for circular propositions (e.g., Ellen MacArthur Foundation, 2016; GESI and Accenture, 2016; Pagoropoulos et al., 2017; Bressanelli et al., 2018). The connection of physical objects through the internet enables them to sense their own and their environments status, process this information and interact with their users. These capabilities help service providers to extend the useful life of products, maximise the utilisation of products, loop products through additional use cycles, regenerate natural capital from their products, and make sure these products are used efficiently. Since Signify wants to become a player in the field of IoT and is already equipping its products with sensors and internet connections, there is an opportunity to use this for circular purposes as well.

StoreSight
The result of this design project is the StoreSight concept. StoreSight is a circular result oriented product-service combination that enables the reuse of retail luminaires. Initially it aims to enhance the attractiveness of the store by means of responsive lighting. Over time, StoreSight will evolve from a service that enhances attractiveness of the store, into service that enhances the shopping comfort and finally into a service that gathers different types of data to enable store optimisation. The StoreSight system roughly consists of three components: hardware, a service squad, and a software platform. The first component, the hardware, consists of a modular lighting grid with movable CE ready luminaires and upgradable sensing devices. The second component, the service squad, consists of the stakeholders from Signify and its partners that will interact with the store owner during the contract period and make sure the luminaires will be reused when the store is refurbished. The final element is the platform, a digital software application that enables the different stakeholders to control the lighting and access data about the luminaires from so-called luminaire passports. The StoreSight concept shows how IoT could enable stakeholders to communicate between each other about the luminaires and their remaining value. These insights improve the collaboration of stakeholders in reusing the luminaires in a new lighting plan.

Conclusions
An important insight gained during this project is that IoT and circularity can create, especially in use or result oriented product-service systems, a lot of value. However, in order to capture the value that circular and IoT enabled services offer, companies need to work in a more iterative way and learn to think in long term relationships instead of short term transactions.

This project aimed at using IoT to design a circular product-service lighting system for Signify that creates value beyond illumination in supermarkets.

TABLE OF CONTENTS

CHAPTER 1: INTRODUCTION

Photo by Ryan Searle on Unsplash

CHAPTER 1: INTRODUCTION

In this chapter the origin of the assignment behind this master thesis will be explained. First, some understanding about a few for the assignment important concepts will be created. Next, the assignment itself will be presented. Finally, the approach used during this design project will be presented accompanied by a reading guide to lead the reader through this report.

1.1 Background information

The effects of the industrial economy on our environment are becoming more visible every day (Dunlap & Jorgenson, 2012). The public is becoming more and more aware of problems as pollution, global warming, overpopulation, natural resource depletion, and public health issues. Governments act upon this by introducing more sustainability* related rules and legislations (Dutch government, 2017a; European Commission, 2017) and customers become more critical (Unilever, 2017; Nielsen, 2015) on the sustainability of products they buy.

Circular Economy (CE)

The Dutch government has realised that the current linear take, make, and dispose model has to change and aims to develop a circular economy** in the Netherlands by 2050 (Dutch Government, 2017b). To achieve these goals, the Dutch government will apply new laws and legislations.

As a result companies will need to change their way of working. A progressive Dutch company that is already working on the development of products and services for a circular economy is Signify. Signify offers a circular lighting service that provides customers with guaranteed lighting performance while Signify makes sure these will be reused, refurbished or recycled (Philips Lighting, 2018a). This service is also known as 'Light as a Service'. Signify already offers these lighting services in a few segments, but it is aiming to do this also in the supermarket segment.

The length of refurbishment cycles of the supermarkets hinders Signify to offer Circular Lighting as it is offered in other propositions. The length of the refurbishment cycles are often a lot shorter than the technical lifetime of a lighting system. As a result, luminaires are replaced despite being in perfectly good condition causing a lot of value being destructed. Where often the technical lifetime is key in developing a viable circular business proposition, this case asks for the elongation of the economic lifetime.

The Internet of Things (IoT)

Besides circular economy, Signify tries to become a player in the Internet of Things*** (IoT) by implementing sensors and connectivity in its products. IoT refers to the networked connection of physical objects through the internet, enabling them to sense their own and their environments status, process this information and interact

** Sustainability: "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Bruntland Report for the World Commission on Environment and Development (1992)*

*** Geissdoerfer et al (2016) defined a circular economy as follows: "A regenerative system in which resource input, waste, emission and energy leakage are minimised by slowing, closing and narrowing material and energy loops. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling"*

****"the core concept is that everyday objects can be equipped with identifying, sensing, networking and processing capabilities that will allow them to communicate with one another and with other devices and services over the Internet to achieve some useful objective" (Whitmore, Agarwal and Da Xu, 2015)*

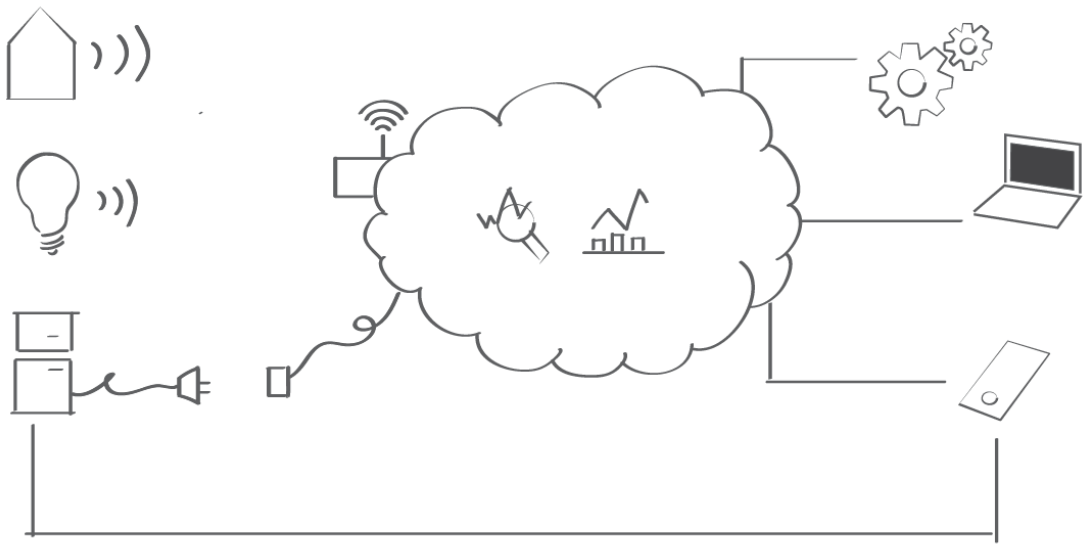


Figure 1.1 Visualisation of an IoT system

with their users. Figure 1.1 visualises how a house, light bulb and fridge sense their status, send this information to an online cloud and allow users to control them based on this information by using an application on a digital device.

Ingemarsdotter et al. (in Press) summarised the capabilities of IoT into seven categories: Tracking, Monitoring, Control, Optimisation, Design Evolution, Autonomy, and Processing/Networking/Communication (fig. 1.2).

A well known IoT enabled Signify product for the consumer market is the Philips Hue, a light bulb that can be controlled through a smartphone application.

In supermarkets Signify mainly uses IoT to create services that go beyond lighting:

"Retailers are looking to attract, engage and entertain modern shoppers. Connected lighting systems enable retailers to create engaging experiences in the store and gain new insight into consumer behaviour" (Philips Lighting, 2018b)

An example of a connected lighting system that offers more than lighting only is the Indoor Positioning System (IPS). IPS enables a smartphone application to navigate shoppers through a supermarket by using the different luminaires as a point of reference. Additionally, it allows retailers to use the data from the application to optimise the store layout.

The use of IoT for circularity

Different academics point out that the use of IoT creates opportunities for circular business models (e.g., Ellen MacArthur Foundation, 2016; GESI and Accenture, 2016; Pagoropoulos et al., 2017; Bressanelli et al., 2018). Firstly, IoT has the capability to support the procedures that create value in a CE (fig. 1.3). The first four strategies from this figure are in line with the CE value drivers defined by the Ellen Macarthur Foundation (2016). Efficient utilisation, is added, but does only create value for a company when the business model requires the company to pay for resources during use (e.g. energy) (HGB, 2018a).

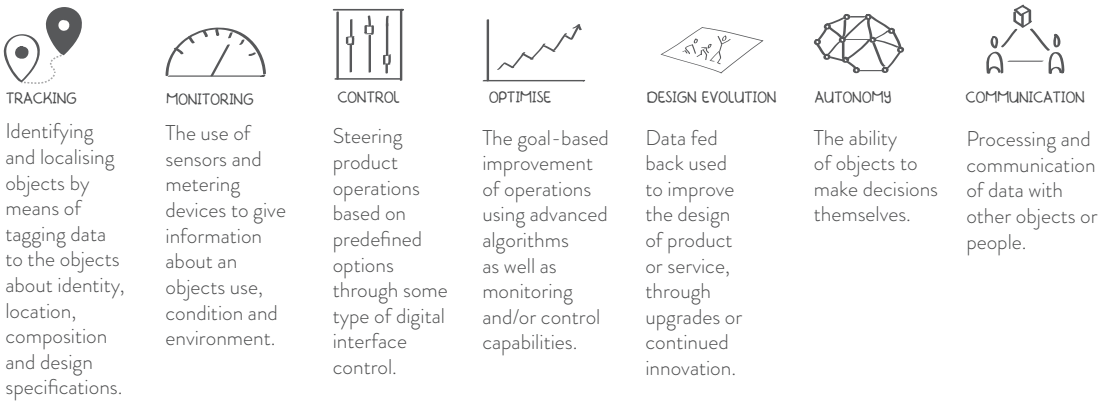


Figure 1.2 Different capabilities of IoT

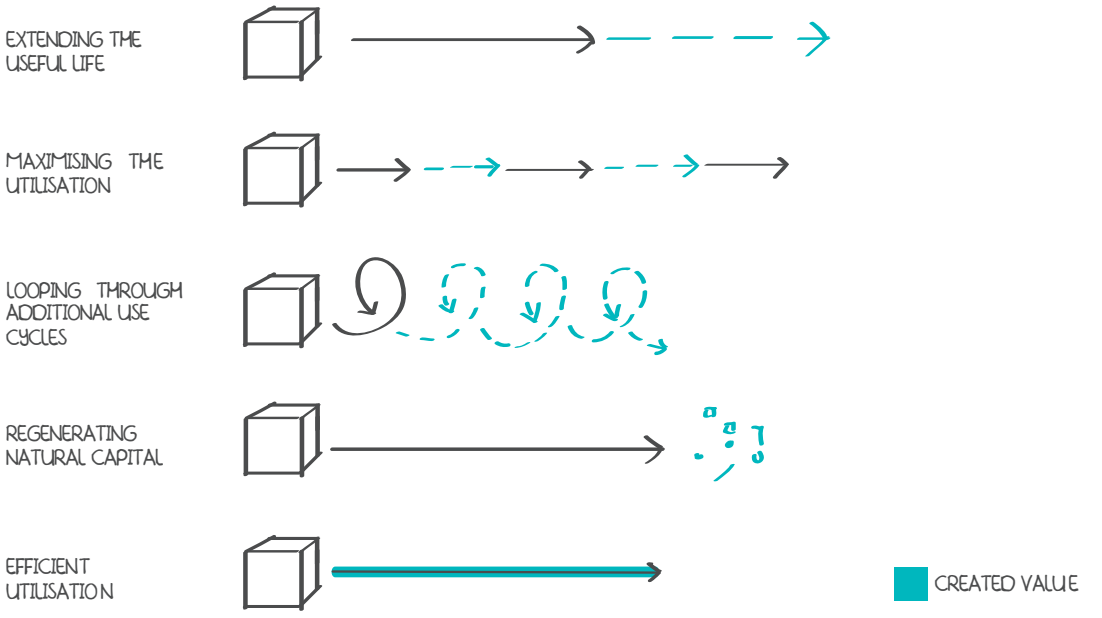


Figure 1.3 Ways to create value in a CE

Figure 1.4 (left) Mobike waiting for a new user

Figure 1.5 (right) Swapfietsen waiting to be used by their users

For instance, a product that is able to sense and send whether it is being used, creates the possibility to increase the utilisation of a product. This enables service providers to decrease the costs of their service by efficiently using their resources. An example is Mobike (fig. 1.4), a bicycle service that shows the users the location of available bicycles. The fact that the bikes are able to track and send their location, enables Mobike to optimize the amount of bikes needed to deliver a bike as a service. Where a product-service system like Swapfiets (fig. 1.5) (where users pay a fixed rate per month) requires a bike for every user, Mobike only needs a part of them.

Next to supporting the value drivers from figure 1.3, IoT creates the possibility to add services to products, which makes them more attractive. For example, running shoes that give you advice on how to run have a benefit over normal shoes. However, not all product-service combinations are circular or more sustainable. A product-service construction and especially constructions in which the service provider owns the product, increases the ability of the service provider to control the slowing, closing, and narrowing of material and energy loops. In the example of the running shoes, the manufacturer could ask the user through the connected application to send the shoes back when they are no longer used. If the service provider would own the product instead, the user could be obliged to return it.

One of the Signify Employees describes the potential of using IoT to enable value creation in CE using the metaphor of a refugee:

"The interesting thing of an orphan or a refugee or somebody who has no passport or whatsoever, they don't belong to anything. Waste to a certain aspect has a similar status and so it has no identity, and as a consequence people have no clue what the value is. In most cases they think that has negative value or the value is ignored. So the big potential of IoT is to give materials clear identity and once it has an identity that means that it has value. I think IoT, is an enabler for identifying materials, parts, products, over multiple lifecycles, and that is exactly what we need in the circular economy, so I think there is the quintessence where IoT and CE meet each other." (Employee Signify)

1.2 The assignment

The opportunities IoT creates for circular product-service systems, in combination with the willingness of Signify to create a circular offering for supermarkets results in the following assignment:

Use IoT to design a circular[1] product-service[2] lighting system[3] for Signify[4] that creates value beyond illumination[5] in supermarkets.

From this assignment the following requirements can be distilled:

1. The designed concept should include an IoT element that supports circularity.
2. The designed concept should be a combination of product(s) and service(s).
3. The designed concept should provide a lighting solution for supermarkets.
4. The designed concept should create value for Signify.
5. The designed concept should create more value for the customer than a lighting solution without IoT.

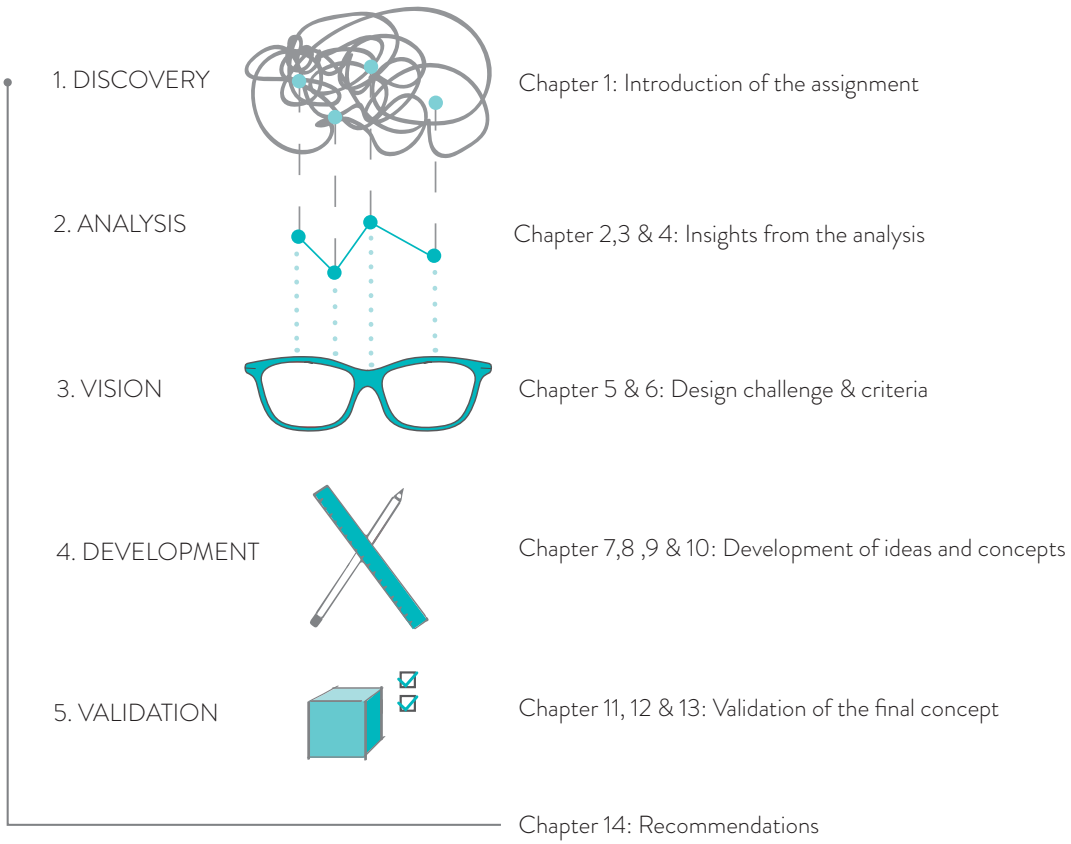


Figure 1.6 five phases of this project's design process

1.3 Approach

The project's approach consists of five phases (fig. 1.6): discovery, analysis, envisioning, development, and validation. During the first phase, the discovery phase, the broader context of the assignment is explored. This phase is followed by an analysis phase in which the information about company and context are analysed. As input for this analysis five different types of information are used:

1. Signify's promotional materials (website, brochure, whitepapers) were used to gain insight into their strategy and their current offers in terms of IoT and CE. (Chapter 2)
2. Twelve transcripts from interviews from an exploratory single case study conducted by E. Ingemarsdotter are analysed to gain more insight into the current efforts and capabilities of Signify in the field of IoT and CE. In these transcripts the employees talk about supermarket lighting, circular economy, internet of things, and the connections between them. (Chapter 2)
3. Nine semi structured interviews with different relevant actors (two supermarket owners, two supermarket employees and five Signify employees) are conducted to verify thoughts about the supermarket lighting ecosystem and gain insight into the needs of the different stakeholders. (Chapter 2 & 3), and get insights in the needs of the different stakeholders. (Chapter 2 & 3)
4. Personal observations during supermarket visits are used to get an understanding and confirmation on the topics mentioned by the interviewees. (Chapter 2 &3)
5. Literature is reviewed to get insight in the drivers and barriers for PSSs, IoT and CE. (Chapter 4)

The results from the analysis are presented in chapter 2, 3 and 4. After the analysis a phase follows in which the insights from the analysis phase are used to define a design challenge and the available solution space. The design challenge and criteria can be found in chapter 5 and 6. The challenge and criteria are used to generate ideas and create concepts during the development phase which can be found in chapter 7, 8 and 9 and the final concept in chapter 10. The validation of the final concept and the limitations of the process are discussed in chapter 11 and 12. Chapter 13 contains a personal reflection on the process. Finally, recommendations that build on the validation, limitations, and reflection are shown in chapter 14.

PART I: ANALYSIS

This part of the report presents the insights from the analysis phase. It discusses observed strengths, weaknesses, opportunities, threats, and requirements that are the basis for the SWOT analysis in part II. Additionally, the analysis provides insights in the opportunities and challenges of a circular IoT enabled supermarket lighting PSS. These insights lead to wishes that stimulate the PSS to exploit the opportunities and deal with the challenges. Finally, this part provides elaboration on the requirements provided in the introduction.

CHAPTER 2: COMPANY

Photo from Signify.com

CHAPTER 2: COMPANY

This chapter presents the insights from the company analysis. First some background information about Signify will be provided. Secondly, insights on Signify's strategy will be given. Finally, insights will be provided on the current efforts of Signify in relation to the assignment.

2.1 Signify

Signify (fig. 2.1) is the company that was previously known as Philips Lighting (fig. 2.2). In the past it was part of the Koninklijke Philips Electronics N.V. Signify's headquarters is located on the High Tech Campus in Eindhoven. The company has around 32 thousand employees in 70 countries and sells their products in 180 countries around the globe. Their daily activities include the production and sales of LED electronics, lamps, luminaires, systems, and services (Signify, 2018a).

The largest part of Signify's products, is still sold under the Philips brand. This has advantages since the Philips brand is number 41 on the best global brands, just after well-known brands like Audi, Nissan and Volkswagen (Interbrand, 2018). Additionally, Signify can, just as companies as Unilever, act as an overarching company of different sub brands.

Signify is one of the market leaders with expertise in the development, manufacture, and sales of innovative, energy efficient lighting products, systems and services (Philips Lighting, 2018a). Signify is in a leading position as the lighting industry transitions from conventional to LED lighting technologies now moving towards connected lighting. With connected lighting, the offering of internet connection enabled LEDs is intended. Signify offers lighting products, systems and services for both consumers, business, and public areas. Currently they offer their connected systems in seven areas: Home, Government, Cities, Offices, Industry, Stadiums, and Retail (fig. 2.3).

As stated in the introduction, the focus of this project will be on connected lighting for supermarkets.

Strengths:

- Signify has the possibility to create new sub brands.
- Signify's Philips brand has high brand equity.
- Signify is a market leader in the area of innovative, energy efficient lighting.

Figure 2.1 Logo of Signify (LightNOW, 2018)

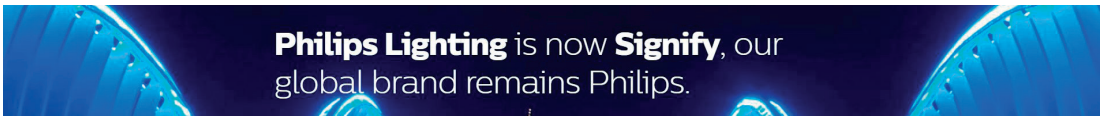


Figure 2.2 Philips Lighting is now Signify

Figure 2.3 Areas where Signify offers connected lighting

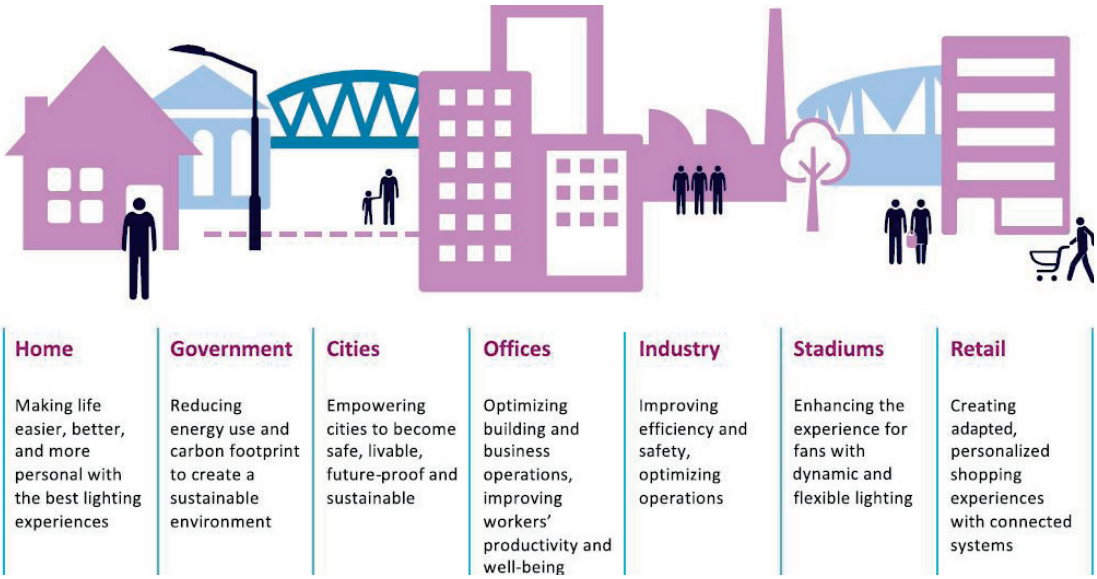


Figure 2.4 Quote showing Signify Retail's circular ambitions

2.2 Strategy

The annual report of Signify (Philips Lighting, 2018a) states the following strategic goals:

1. Optimize cash from conventional products to fund our growth
2. Innovate in LED products commercially and technologically to outgrow the market
3. Lead the shift to systems, building the largest connected installed base
4. Capture adjacent value through new services business models
5. Be our customers' best business partner locally, leveraging our global scale
6. Drive our operational excellence improvement

As goal three shows, Signify aims to be market leader in the field of connected lighting. Signify is currently exploring how to offer additional services through IoT. It calls itselve the lighting company for the Internet of Things. The additional services offered (see goal four) go beyond lighting only and are therefore referred to as 'Light Beyond Illumination'. In doing so they try to:

"Unlock the extraordinary potential of light for brighter lives and a better world"
Philips Lighting (2018c)

From this mission statement, which connects to their 'Brighter lives, better world' programme, Signify's sustainable ambitions can be derived. Their sustainable ambitions and moreover, their ambitions in circular economy are supported by the following quotes:

"Our vision is to make the world healthier and more sustainable through meaningful innovation"

"For a sustainable world, the transition from a linear to a circular economy is essential"

The ambition to offer circular services is also expressed by Signify's retail department (fig. 2.4).

2.3 Innovation Process

The retail department uses end user driven innovation to come up with new propositions (fig. 2.5). First they collect market insights through interviews with business consumers. Based on these insights they create propositions, which they validate with business customers in a test environment. Finally, they pilot the propositions in the field. This designed process shows Signify Retail aims for a customer focused way of working.

To illustrate, they used this process to come up with the following propositions for supermarkets:

- Fresh: Illuminating the fresh food to make it more attractive and preserve it longer
- Store Refresh: Enabling retailers to refresh their store and reposition and upgrade the look of luminaires
- Set the scene: Enabling retailers to change the ambiance in different parts of the store
- Beyond lighting: Offer online channels that connect to the lighting

For all propositions solutions exist that are currently being offered to supermarkets. Currently, the retail department is looking for new solutions for the 'Store Refresh' proposition. The team struggles with the fact that refresh and upgrade causes the use of additional materials and causes luminaires to be thrown away. This does not fit with the Signify's strategy as stated before.

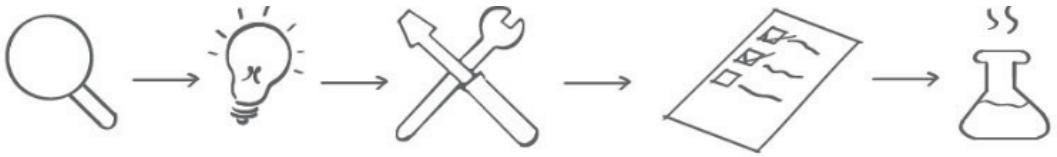
The different propositions are offered separately. Once a complete system is sold, it is not always possible to sell additional propositions to a retailer because the system might not be enabled for these functions. Offering an all-in-one solution could prevent a lighting system to become outdated when a retailer is interested in the other propositions as well. Another option could be to make sure the sold lighting systems are at least always enabled for other or new functions, to make it future ready. In this case, future ready includes readiness to both future technologies and future desires of the retailer. Signify Retail has proven to be able to offer future ready luminaires, since it currently tries only to sell luminaires that are Indoor Positioning enabled. This way, the retailer does not need to buy new luminaires once he decides to upgrade his system.

Strengths:

- **Signify Retail has a customer focused way of working.**
- **Signify Retail is able to offer luminaires that are enabled for future functionalities.**

Weakness:

Signify Retail struggles to come up with a flexible lighting solution that does not lead to disposal of still functional luminaires.



1. Market insights 2. Propositions 3. Test 4. Validate with customer 5. Pilot in the field

Figure 2.5 Design process Signify Research Retail Department

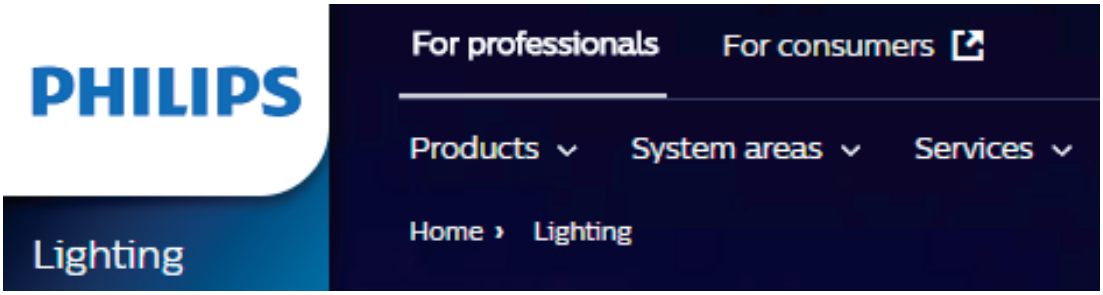


Figure 2.6 Division in products, services and systems on the Philips Lighting website

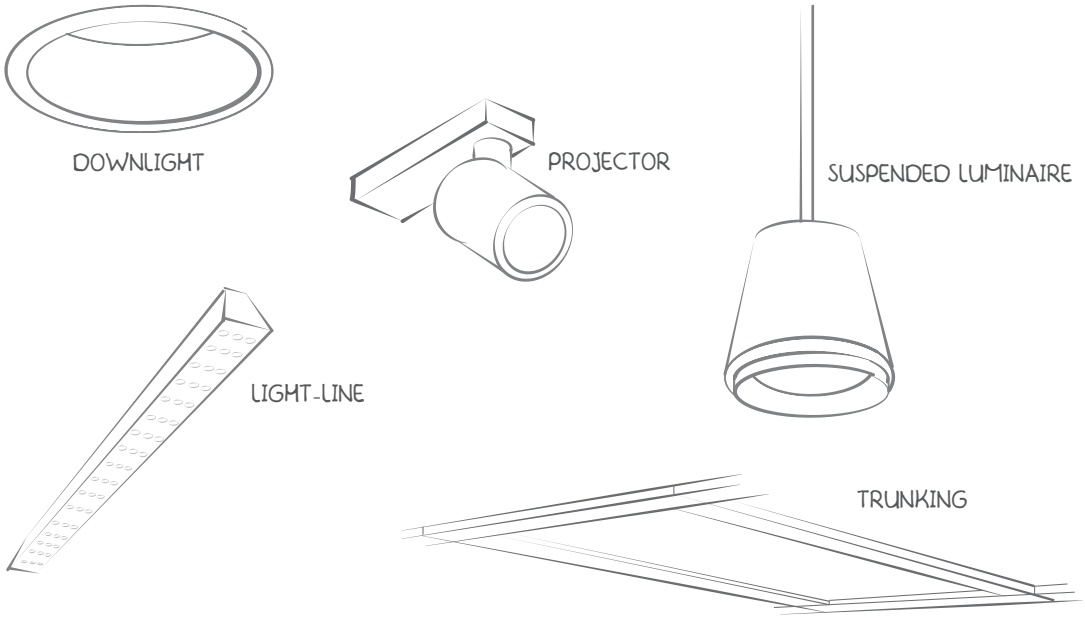


Figure 2.7 different products from Signify retail

Figure 2.8 Telecaster luminaire

2.4 Portfolio Supermarket Lighting

The current portfolio of Signify is divided in three different categories: Services, Systems, and Products. With products Signify means separate hardware pieces as luminaires, trunking and sensors. With systems the control systems that are able to control these hardware parts are meant. Services relates to Signify's maintenance, financing and lighting design services. These categories will be explained in more detail in the next paragraphs. The division in products, systems, and services is not only made on their Philips Lighting website (fig. 2.6) to clarify their portfolio to customers, but also in their organisation. Signify also has separate departments for the design and sales of products, services, and systems. In retail, the product and system department work closely together. Observations and interviews with stakeholders from Signify indicate that the collaboration with the service department can be improved. As can be imagined, a close collaboration of the different departments is needed when offering a product-service system.

Products

As said before, the product category includes luminaires, which are mainly LED luminaires, and trunking. Figure 2.7 shows the most commonly used product types in the retail segment. A product that could already be used in the StoreRefresh proposition is the Maxos Fusion trunking, an adaptable LED trunking system. For this trunking system, specific Maxos Fusion luminaires are needed. Maxos Fusion is not only used in retail, but also in warehouses. Another product that fits the StoreRefresh proposition is the Telecaster luminaire, a suspended luminaire with a changeable 3d printed housing (fig. 2.8). Additionally Signify offers projectors that change direction on distance using a smartphone or tablet application. These projectors are called 'Easy Aim' spots. Important is that they are not used yet in supermarket applications.

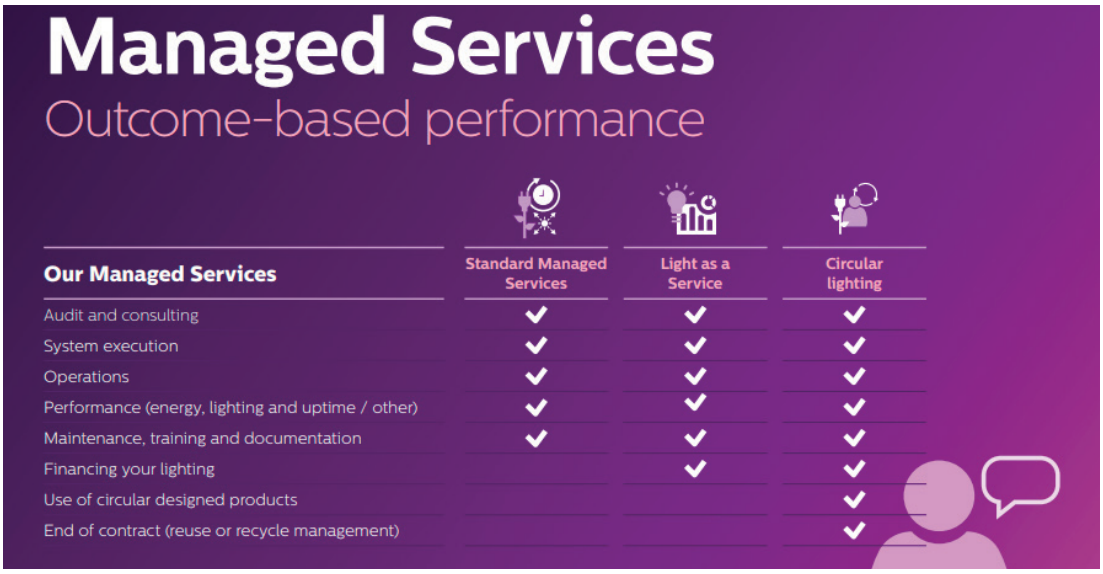


Figure 2.9 Overview of different managed services (Philips Lighting, 2018d)

Systems
For supermarkets, currently three systems are available: StoreWise, Fresh food, and Indoor Positioning.

StoreWise is a connected LED supermarket lighting system. It allows supermarkets to change the dimming settings for different parts of the store. The system senses the amount of daylight to save energy when less artificial light is needed.

Fresh food accent lighting enables extended shelf life of fresh products. It uses 'light recipes' that ensure the best presentation and elongation of the shelf life of certain types of fresh food. These 'light recipes' describe the tuned LED spectrum of the luminaire.

Indoor Positioning provides highly accurate location data of shoppers. It works through an application on the phone of shoppers that collects light frequencies through the front facing camera. The gathered data allows the optimisation of shopping routes, location-based promotions, notifications and finally, instore analytics.

Services
Where the product and systems are categorised by segment (e.g. retail or industry), the services are not. Signify offers three different types of services for all segments: professional, lifecycle, and managed services.

Professional Services
These services include Audit & Design (Design of a lighting plan), and Consulting Services (Options and financing).

Lifecycle Services
Lifecycle Services include preventive maintenance, software, remote assistance, spare parts and analysis of customers lighting usage and needs. These services also include extended warranty.

Managed Services
Under the name managed services Signify offers Standard Managed Services, Light as a Service and Circular Lighting (fig. 2.9). Standard Managed Services is basically a combination of the services mentioned before (Professional Services and Lifecycle Services). Light as a Service, where business consumers pay for the amount of lumen instead of luminaires is also included in Standard Managed Services. The service centre monitors the performance of the luminaires to be able to repair in time and optimise the energy usage. Finally, Circular Lighting, which is Light as a Service with CE ready luminaires and reuse or recycle management. Circular Economy ready luminaires are luminaires that are future proof and in theory recyclable or able to be refurbished.

Recently, Signify Retail started to offer Light as a Service on their website. This service is currently only being offered to one supermarket chain. As said before Light as a Service does not include CE ready luminaires and end of contract management. Therefore 'Light as a Service' is not necessarily circular.

Weaknesses:

- **The system and product department are collaborating well, however, the collaboration between those and the service department can be improved.**
- **Signify Retail does not offer yet a circular service proposition.**

Strengths:

- Signify Retail offers products that enable the repositioning of luminaires.
- Signify Retail offers luminaires that allow their looks to be upgraded.
- Signify Retail is able to offer a different ambiance in different parts of the store.
- Signify Retail is able to save energy on lighting.
- Signify Retail is able to make fresh food look more attractive.
- Signify Retail is able to preserve fresh food longer.
- Signify Retail is able to connect the lighting to shopper channels as smartphone applications.

2.5 Circular efforts

This section pays attention to the circular efforts of Signify. All circular efforts mentioned by the interviewed employees, so not only in retail, were taken into account to get a broader view on which circular processes are currently in place.

Light as a Service (LAAS)

There are a few examples where Signify already offers circular propositions. The Light as a Service (LAAS) case at Schiphol especially attracted a lot of media attention (VPRO tegenlicht, 2015; Iamsterdam.com, 2018; circulatenews.org, 2018). In this LAAS proposition Schiphol pays a fixed rate (per lux) and Signify provides the luminaires, service and energy. In this specific case Schiphol asked for circular lighting. Signify was therefore externally motivated to come up with an circular offering. The whole value proposition to Schiphol is therefore built around the idea of circularity.

Signify employees mentioned that Signify's shareholders do not like external hardware on their balance sheet. The luminaires in the LAAS proposition are therefore owned by a financing company. The contracts are mostly between five and ten years and can be extended with a minimum of three years. To make this service viable the luminaires need to last significantly longer than a contract period. From an environmental perspective this is a good thing because material loops will be slowed down. The fee Schiphol pays is based on assumptions of the technical lifetime of a luminaire and what the residual value will be.

Signify only started this circular proposition three years ago, therefore limited knowledge about the end of contract procedure is available. Moreover, little is known about the end of life procedure of the luminaires. Signify aims to keep the luminaire at highest value all time or even increase the value by updates to make sure they meet and preferably increase the technical lifetime. However, when something is changed to the luminaire, a new contract is needed. According to one employee, this means when you continuously want to upgrade a luminaire, the contract should be revised over and over again.

Next to Schiphol, Signify also offers circular lighting in the industry segment, for example to Bruynzeel, a producer of kitchens and interior elements

Circular Lighting

In the circular lighting cases, as offered on Schiphol, LAAS is combined with "CE ready" luminaires. To be able to assess the circular readiness of a luminaire, a scorecard is used (Van den Berg, 2014). This assessment includes the future readiness, ease of disassembly, the ease of maintenance, the ease of reusing parts, and the recyclability of a luminaire. It is important to realise that a CE ready luminaire is in practice not always part of a circular service proposition as Circular Lighting. It is still possible that these luminaires are sold to customers and end up in landfill. Additionally, the circular proposition guarantees luminaires to be reused or recycled, but Signify is unclear about the exact end of life procedures in these propositions. The fact that none of the employees was able to tell if and how luminaires are reused, indicates most of these luminaires end up as waste electrical and electronic equipment (WEEE) and are recycled.

Telecaster
As discussed in the paragraph about Signify Retail's portfolio for supermarkets, one project that aims to develop CE ready products is the telecaster project. The telecaster project made it possible to shred old housings and use this material to 3D print new housings to upgrade the look of the luminaires.

Caterpillar
The Caterpillar project was a project which used the housing of a gas discharge lamp and put a LED module in it. This makes throwing the complete luminaire away redundant.

CE ready Projector
Another circular effort by Philips is the development of a projector for retail that can be built into a downlight. This luminaire will be on the market at the beginning of 2019. Around this time, also other types of CE ready retail luminaires will be available.

WEEE
It is compulsory to sort luminaires as waste electrical and electronic equipment (WEEE). This waste is recycled by recycling companies as WeCycle. An example of a product that is specifically designed for this process is the SlimStyle bulb (fig. 2.10). This consumer bulb was designed to be easily disassembled to make the recycling process easier.

Internal ideas about circular propositions for retail
In addition to propositions that already on the market, some ideas about circular propositions were extracted from the interviews with Signify employees (figure 2.11).The found ideas were clustered under different topics to get a better overview on which possibilities the employees see regarding to CE. The amount of ideas shows there are still opportunities for circular propositions in retail left.

Strengths:

- Signify has experience with the offering of circular service propositions.
- Signify is developing luminaires that fit in a circular economy.

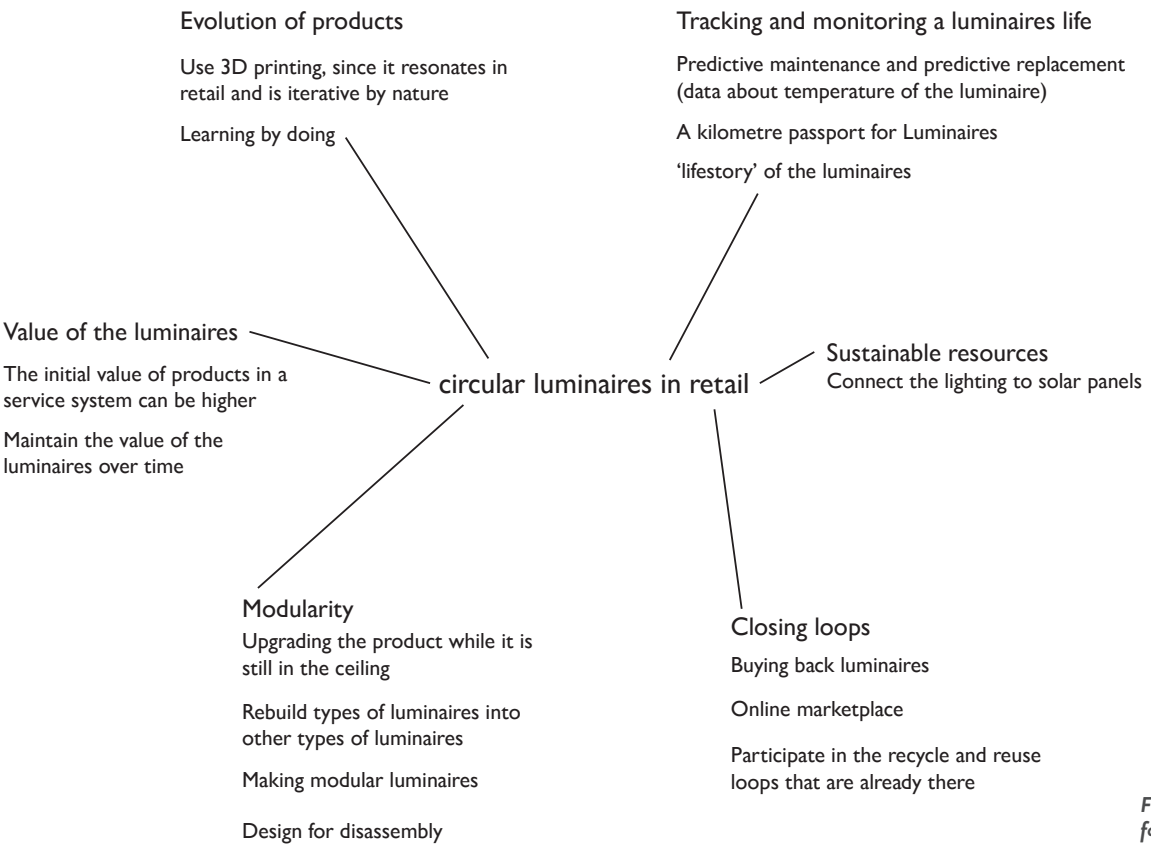


Figure 2.11 Internal ideas for CE in retail

Figure 2.10 SlimStyle Bulb

Weaknesses:

- Signify has little experience with end of contract procedures of circular propositions.
- Signify needs to renew contracts every time something is added to a luminaire.
- Signify is not transparent enough about the end of life of their circular propositions.

2.6 Developments in IoT

This section pays attention to the developments of Signify in the field of IoT. The different presented IoT solutions were derived from the interviews with Signify employees. To get a more complete overview in the technological capabilities of the company, this analysis focused not only on the IoT solutions offered by Signify Retail, but on the efforts of the whole company.

CityTouch
With the CityTouch system, Signify is able to track parts of luminaires and monitor burning hours. To do so, a service tag (QR code) is used that can be scanned by the people that repair the luminaires. By scanning they know which luminaire they have in front of them and are able to add information by using an accompanying smartphone application. In the future they also want to monitor the environment to get insights in what in the environment of the luminaire influences its life span. CityTouch only provides data about energy usage and enables some asset management. According to Signify's employees the type and amount of data can be improved. It is for example not always clear which products are installed where.

CityTouch seems to be a good example of a system where Signify already uses IoT for a circular goal. However, the idea behind CityTouch is about not closing the loop. The aim of CityTouch is mainly to keep the value of the assets at the highest value all time to save money. The link with the circular opportunities of service tag can therefore be improved.

Dynalite
Dynalite is another example were Signify controls the luminaires and gathers data about the performance of the luminaires. However, this system is local and is not yet connected to the cloud. This control system is for example used for the light-as-a-service proposition at Schiphol as well as for the StoreWise system for retail.

Philips Hue
According to the Signify employees from the transcripts, the Hue is the most advanced connected system from Signify. It has cloud connectivity and the open source software is easily updatable. This differs from the professional systems, which are often local and cannot be updated from distance.

Beyond Illumination
There are only a few examples of cases where IoT is already used to offer something beyond lighting.

For a Deloitte office building Signify used occupancy sensors not only to control the light, but also as input for the cleaning services: If a room is not used, it does not have to be cleaned.

In retail, the indoor positioning system could be seen as a value beyond illumination. The data from the application provides retailers insights in how shoppers move through the store.

Recently, Signify introduced LiFi. LiFi-enabled luminaires are able to provide high speed broadband Internet (Philips Lighting, 2018e). The fact that the luminaires can provide internet on top of light could provide an extra beyond illumination value.

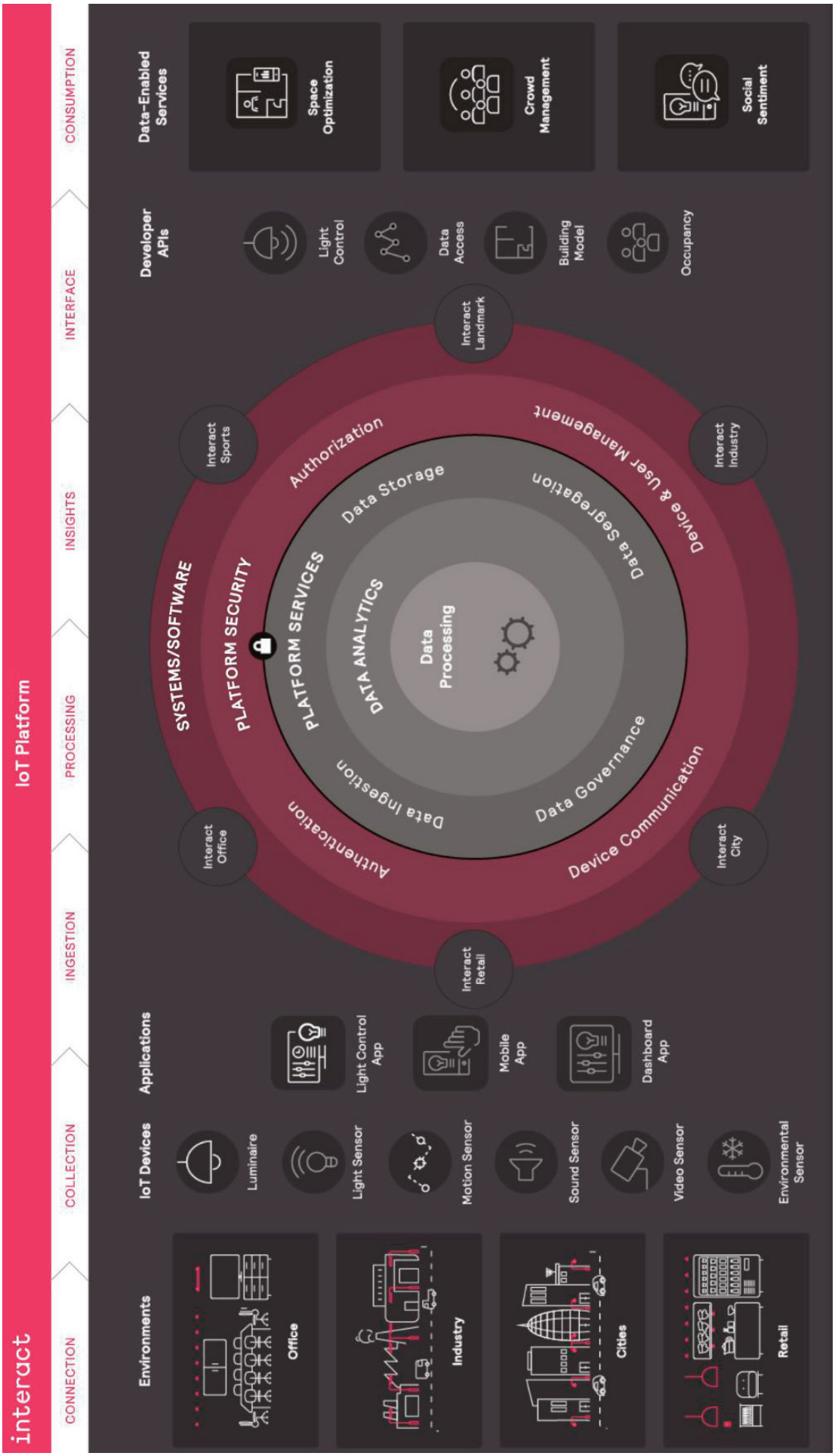


Figure 2.13 A visualisation of interact's interface

Interact
This year, Signify introduced an IoT platform to its portfolio. As can be seen in figure 2.12, this brand covers both the service as well as the system category. This cloud platform, on which all data is stored, is called interact. Each segment, or environment, has its own platform, for retail this platform is called interact retail. This cloud platform could provide the infrastructure to build on the IoT part of the designed product-service system. However, little details could be found on what it is already capable of. As the visualisation of the interface in figure 2.13 shows, the platform can be used to store data from different sensors (at the right of the different environments) and control the system (right from the sensors).

Connection with circularity
Some of the capabilities IoT provides are already used by Signify, but as the examples show, these solutions are not yet related to circular economy.

Internal ideas about the possibilities of IoT
The lighting system provides a great backbone for IoT systems: on top of every room, connected to electricity and able to be connected to internet. Using the lighting system as base for IoT can be compared to shooting satellites into space. Satellites are able to create a birds eye view of the earth to collect different kinds of data to enable a broad range of services. In the same way, the lighting system will be able to create a birds eye view of different rooms. This creates many technological possibilities. However, it is questionable whether all these possibilities are desired and how they are connected to Signify's core business, Lighting. Nevertheless, the Signify employees from the interviews have different ideas of what could be enabled by such an IoT system in supermarkets. The ideas that were derived from the transcript are clustered and shown in figure 2.14. The figure shows that a lot of ideas already exist of what could be possible. However, a clear overview or roadmap on what developments will be made, is not widely available. Furthermore, similar to the already existing IoT solutions little links are made yet with circularity.

Strengths:

- Signify has its own platform to store, process and send data.
- Signify is able to provide an internet connection for other systems.
- Signify does use the capabilities of IoT.
- Signify is aware that IoT creates opportunities for a circular economy.
- Signify's lighting systems provide a great backbone for IoT.

Weaknesses:

- Signify does not use yet the opportunities of IoT to make their propositions more circular.
- Signify is unclear on how their IoT solutions connect to their core business: Lighting.

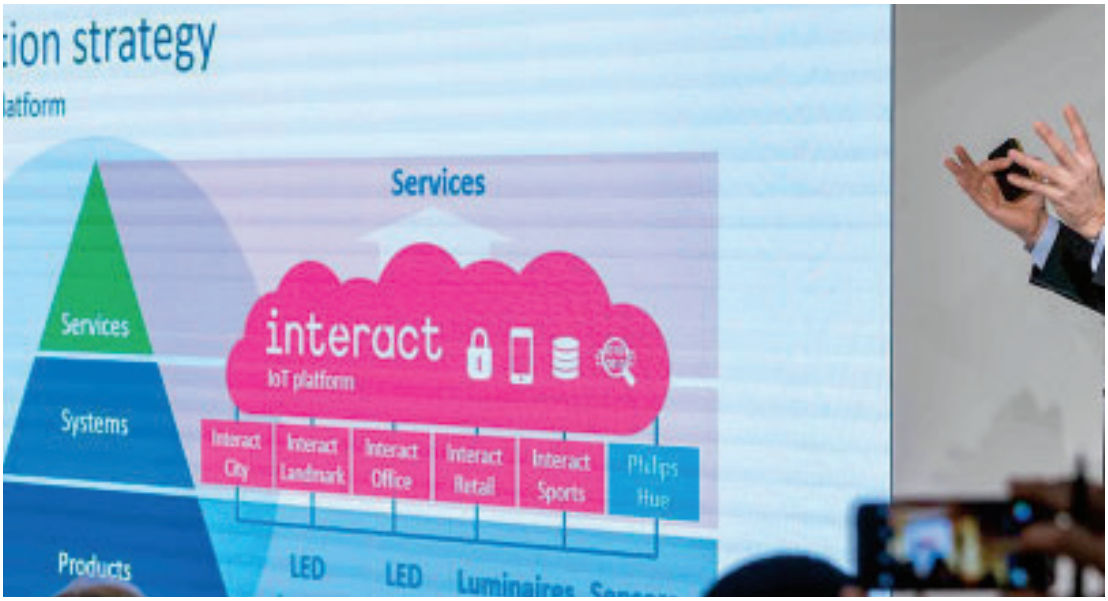


Figure 2.12 Presentation of the new developments of Signify on the light and building fair

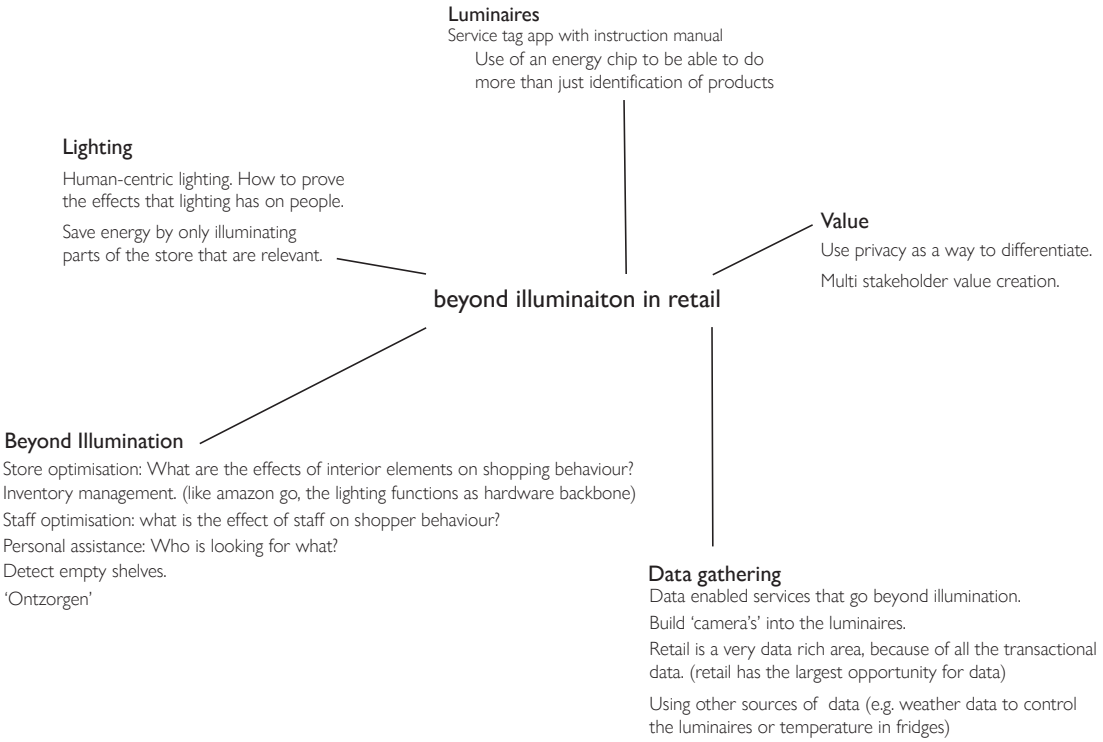


Figure 2.13 Internal ideas about the use of IoT in retail

2.7 Takeaways

Signify is a big company with a lot of experience in the lighting industry. It is part of Signify's strategy to become a more sustainable brand and use circular propositions to get there. Signify has a customer focused innovation process and is already offering some propositions that go beyond lighting. Because of the customer focused way of working, these propositions pay attention to real pains and wants of the customers. For this project, one important take away is that Signify retail is still looking for a way to offer lighting that is more flexible while having less environmental impact.

Signify has some experience with circular service propositions and the design of CE ready luminaires. Additionally, Signify employees do have several ideas on how to make supermarket lighting more circular. Despite of the efforts made to offer circular propositions, the selection of stratagies to close the loop in these offerings could be improved.

So when it comes to the use of IoT, Signify has some practical experience. The efforts made in this field show examples of how IoT could be used to improve the circularity of these propositions. Besides, Signify employees have ideas on what could be possible with IoT in relation to IoT. However, no insights could be obtained in how these developments are connected.

Although Signify has spotted the potentials IoT could have for CE, in retail IoT is not used yet in relation to CE. This project could therefore provide Signify with an example of how this might look like.

CHAPTER 3: CONTEXT

Photo by Food Retail Design

CHAPTER 3: CONTEXT

This chapter provides insights in the whole ecosystem around supermarket lighting. First, an explanation will be given about how customers perceive supermarket lighting. Next, the trends and developments that influence this customer journey are presented. These insights are used to provide the reader with an overview of the complete ecosystem around supermarket lighting. Finally, the stakeholders and product journey related to this ecosystem will be presented.

3.1 Supermarket lighting

According to a Signify employee, in retail, lighting is seen from different viewpoints. Firstly, lighting is often seen as a burden in terms of cost. Secondly, it is seen as a way to a create an atmosphere that fits the brand (e.g. cosiness). Finally, lighting is a way to guide people through the store.

The way retailers see lighting creates opportunities. Seeing lighting as a burden in terms of cost, creates an opportunity to offer lighting that saves costs. Additionally, retailers understand a nice atmosphere could attract shoppers to the supermarket. By guiding shoppers towards certain products, possibly lighting could also improve the conversion rate. Supermarkets are therefore interested in which ambiance factors have a positive influence on sales and how they can steer the behaviour of shoppers using these factors. An in-store IoT system creates the opportunity to track data about all these parameters.

Opportunities:

- Retailers want cheaper lighting systems.
- Retailers want lighting that makes their store more attractive.
- Retailers want lighting that enables them to guide shoppers to buy certain products.
- Retailers are interested in insights about the effects of atmospheric parameters on sales.

3.2 Customer journey

This part provides insights in the customer journey of retailers when buying and using a lighting system. This customer journey is based on interviews with supermarket employees, supermarket owners, and a customer insight expert from Signify.

The margins in supermarkets are low. To stay profitable, retailers pointed out that they need to be aware about every penny spent and earned. The conversion rate is therefore a highly important number for them. To keep the conversion rate as high as possible, retailers need to optimize their sales per square meter. According to the store owners themselves, lighting is an important factor in optimizing sales. When products are not illuminated well enough, shoppers will not buy them.

Often, retailers do not choose the lighting and luminaires themselves. Supermarket organisations (e.g. AH or Plus) have a formula manager who decides which strategy (e.g. comfort, price aggressive) they want to use in a certain type of stores (e.g. AH to go, AH XL). Based on this strategy and the brand of the supermarket, a formula is designed. A formula contains the look and feel of the store and which interior elements, hardware and lighting are needed for that look.

When a new formula is designed, a lighting designer is asked to make a new lighting plan (fig. 3.1) (1). This lighting plan will first be tested in a pilot store. Based on this pilot store, the lighting plan will be revised a few times. To design a lighting plan (fig. 3.1) (2, 3 & 4), lighting designers use software called DIAlux (fig. 3.2), this software enables them to model the lighting plan in 3D. The model calculates the illuminance of different surfaces. Signify offers a software application, called the Philips Product Selector (PPS) that contains all luminaires and their specifications. DIALux can use these specifications to calculate the exact illumination onfcertain surfaces.

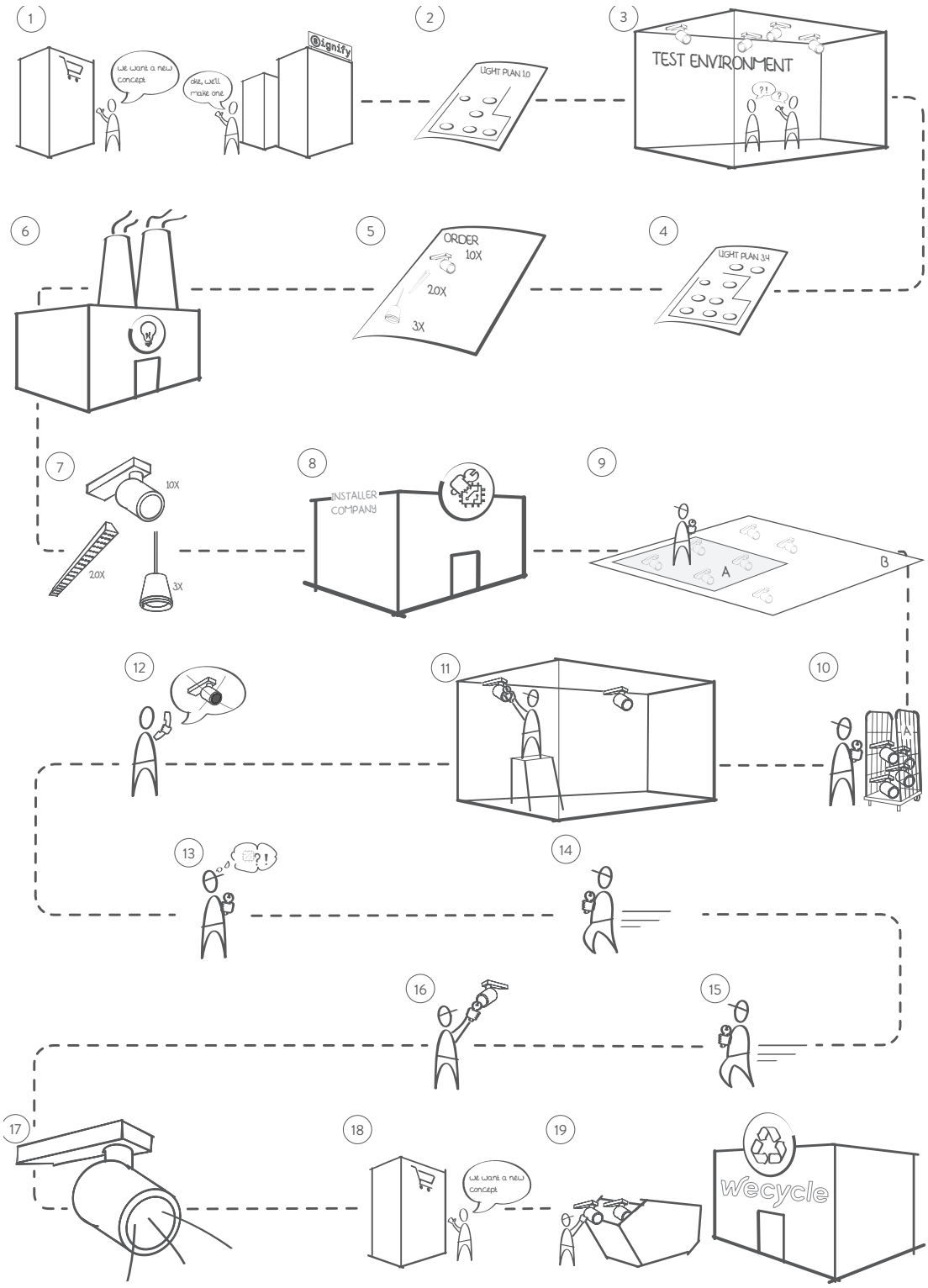


Figure 3.1 Scenario supermarket lighting

When the formula is set, a building contractor or BWI manager (building, living and interior) defines how many shelves and luminaires are exactly needed for certain a store. Based on these lighting plans, production orders are made (fig 3.1) (5, 6 & 7).

The retailers stated that franchisers have the opportunity to select different options within the selection from the formula managers. In this case, the supermarket organization provides the retailers with a predefined set of luminaires from different manufacturers. Franchisers do also order luminaires themselves from online web shops. This allows them to buy cheaper luminaires. It also happens that second hand luminaires are bought directly from the companies that install the luminaires. This is also possible when the initial lighting plan was designed by Signify.

So-called installer companies are hired to install the luminaires. In the Netherlands luminaires first go to the warehouse of the installer company before they go to the supermarket (fig. 3.1) (8).

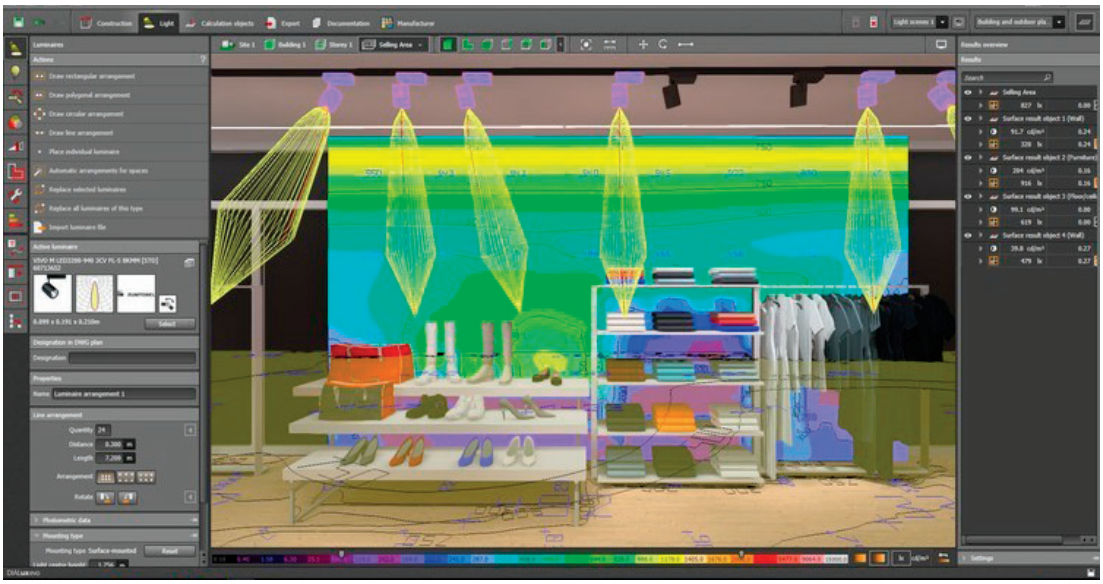


Figure 3.2 a snap-shot of DIAlux

Figure 3.3 luminaires in two different interior configurations

To make the process of installation more efficient, the luminaires are combined here with other electronics and sorted on their location in the store (fig. 3.1) (9). A Signify employee noticed the installers sometimes reinstall the software on the luminaire. This is important since it might affect the performance of the lighting. Additionally, it might allow installers to acces data collected in the driver of the luminaires without Signify being aware of it.

In some cases an outliner, hired by Signify, will realign the luminaires and measure the illumination after the installers have installed the luminaires (fig. 3.1) (10).

When the luminaires are installed, the supermarket employees often touch the luminaires in case of failure only. But, according to Signify employees, failure of LED luminaires in retail is rare. When a luminaire breaks down, an installer company is called (11). Installers have an overview of the installed luminaires. However it might happen that this overview, which was previously updated by hand, is not up-to-date. This causes problems (fig. 3.1) (12, 13, 14, 15, 16, 17) since every luminaire requires different components and tools. To save time and costs, franchisers do also replace luminaires themselves.

Supermarkets undergo a deep refurbish every 5 to 10 years (fig. 3.1) (18 & 19). To keep triggering customers in between these refurbishments, supermarkets use store-in-store concepts, sales stands and change their store layout due to new product categories. These in-between changes of the store are referred to as store refresh and happen once or twice a year.

Changes in the interior of a store requires retailers to have flexible lighting. To underline this need figure 3.3 shows a supermarket in Delft that replaced its interior four months ago, but did not adapt the lighting to these changes. The pictures show the location of the same luminaires in September 2017 and July 2018. When looking closely at these pictures, it will be noticed that the locations and outlining of the luminaires are exactly the same in both situations whereas the location of the shelfs changed. Not adjusting the lighting to the interior, can result in products not being illuminated well enough (fig. 3.4). A reason not to change the lighting might be that store owners are not aware of the bad illumination of products. Another reason could be high operational costs required to change the lighting. Finally, the trunking or ceiling does not always allow the luminaires to be positioned rightly. The trunking in

Figure 3.4 products being not illuminated well enough

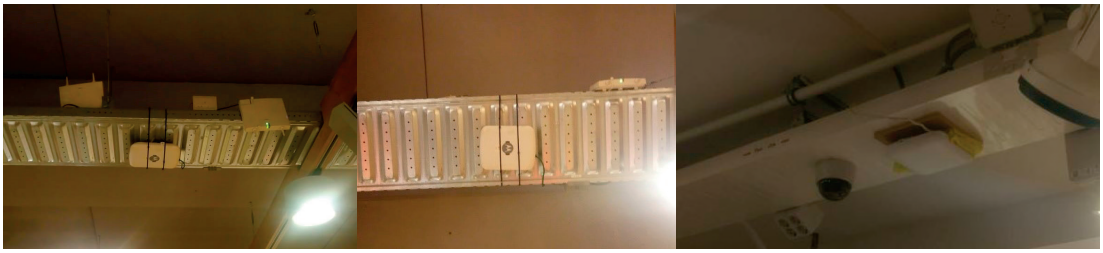


Figure 3.5 Router connected to air vents with tyraps

figure 3.4 for example does not allow the light lines to be rotated a 90 degrees, while the shelfs do.

Not only the attractiveness requires a more flexible store interior, also the availability of new technologies requires the store to be ready for implementations of these technologies. Figure 3.5 shows how retailers dealt with the implementation of a new technology, Wi-Fi beacons, by attaching them to the air vent with tyraps and tape.

Currently, supermarkets are still moving from traditional lighting to LED lighting (fig. 3.6 to 3.8). This is one of the reasons why all luminaires are removed, thrown away and replaced by new LED luminaires. These luminaires end up in WEEE (waste electrical and electronic equipment) or will be taken by the installers. Installers sell these luminaires to start-ups or other supermarkets.

Opportunities:

- If lighting designers have the specifications of used luminaires they are able to reuse them in a new lighting plan.
- Installers want to improve the efficiency of the installation procedure.
- Retailers want their Supermarket's interiors to allow for future technologies.

Threats:

- Retailers buy luminaires from other (cheaper) brands .
- Retailers buy second hand luminaires from installers.
- Installers have a lot of influence on the (perceived) performance of the lighting.
- Store owners are very cost sensitive when buying new lighting.

Requirement specification:

The designed concept should facilitate adaptation of supermarket lighting to changes in the layout of the store.

3.3 Trends and developments

Signify is constantly observing the trends in the different segments of their business. The most relevant trends in the field of supermarket lighting, derived from Signify's own trend reports (Philips Retail Lighting, 2018), are summarized below:

The Sustainable Supermarket
A growing pressure from shoppers forces retailers to become 'green'. This translates in a growing amount of 'sustainable' choices, but also in reducing food waste and energy usage. By using an intelligent control system, the energy usage of the lighting system can be minimised. Additionally, certain lighting can also preserve fresh food to prevent waste and make fresh and local food more attractive.

Enhancing the physical store experience
Also a trend was spotted of supermarkets going online and offering a delivery service. However, most stores are and will be omni-channel instead of only online, since physical stores have benefits that online stores do not have. The possibility to touch, feel, and experience products before you buy them, seems to be the most important one. According to Albert Heijn, the supermarket of the future will be a green, social meeting place where people go for a day-trip (Emerce, 2017). Flexible and controlable lighting systems create the possibility to create multi-functional 'brand theatres' that attract shoppers.

Getting 'phygital'
Retailers become more and more interested in real time data about the behaviour of customers. Gathering this data through an omni-channel experience allows them to provide personal promotions and create operational efficiency. If the retailers know what individual shoppers want to buy, they are able to adapt their promotions and stock towards this. The lighting system provides an ideal backbone for instore omni-channel systems. Systems as indoor positioning are able to provide data about the real time location of shoppers and staff members. This allows retailers to promote a particular lifestyle in their store.

A study performed by Zebra (2017)(Fig. 3.9) shows retailers plan to invest in technologies to

Figure 3.6 Decommissioning old supermarket lighting

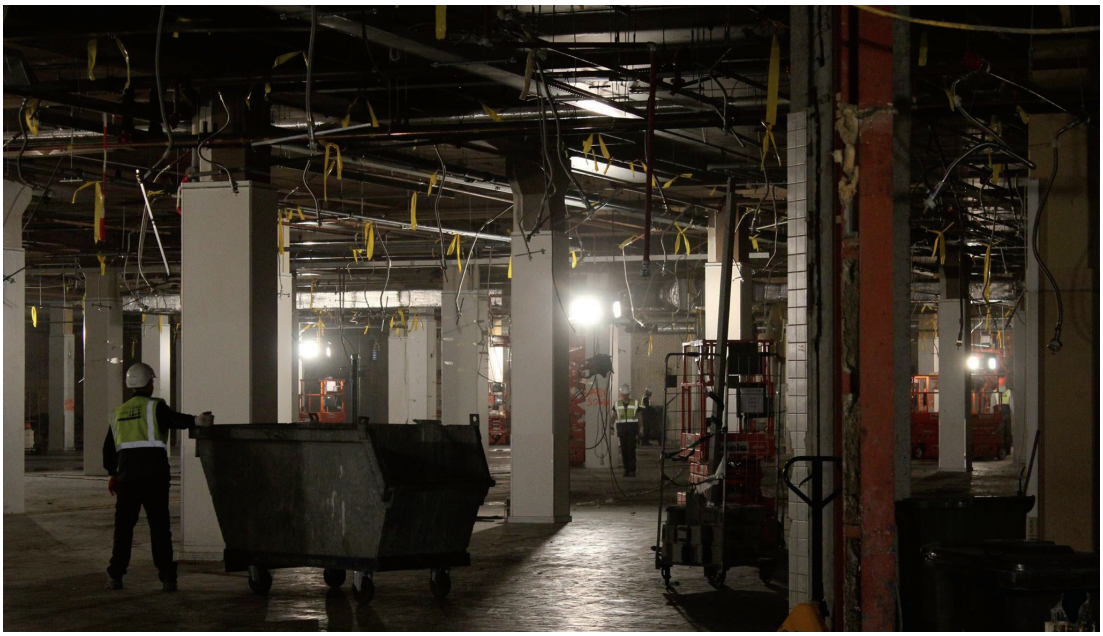


Figure 3.7 Empty store after removal of interior

Figure 3.8 New LED lighting after refurbishment

gather and process this data. The figure shows that most of the retailers from the study plan to have done so by 2021. It states for example that the amount of retailers planning to invest by 2021 in location based services to make a store visit more personal is around 75%. The bottom part of the figure also presents that they are not only planning to invest in the localisation of shoppers, but also of inventory. Since most of the retailers plan to invest in IoT enabled solutions by 2021, the right time to introduce an IoT solution for retail is between now and 2021.

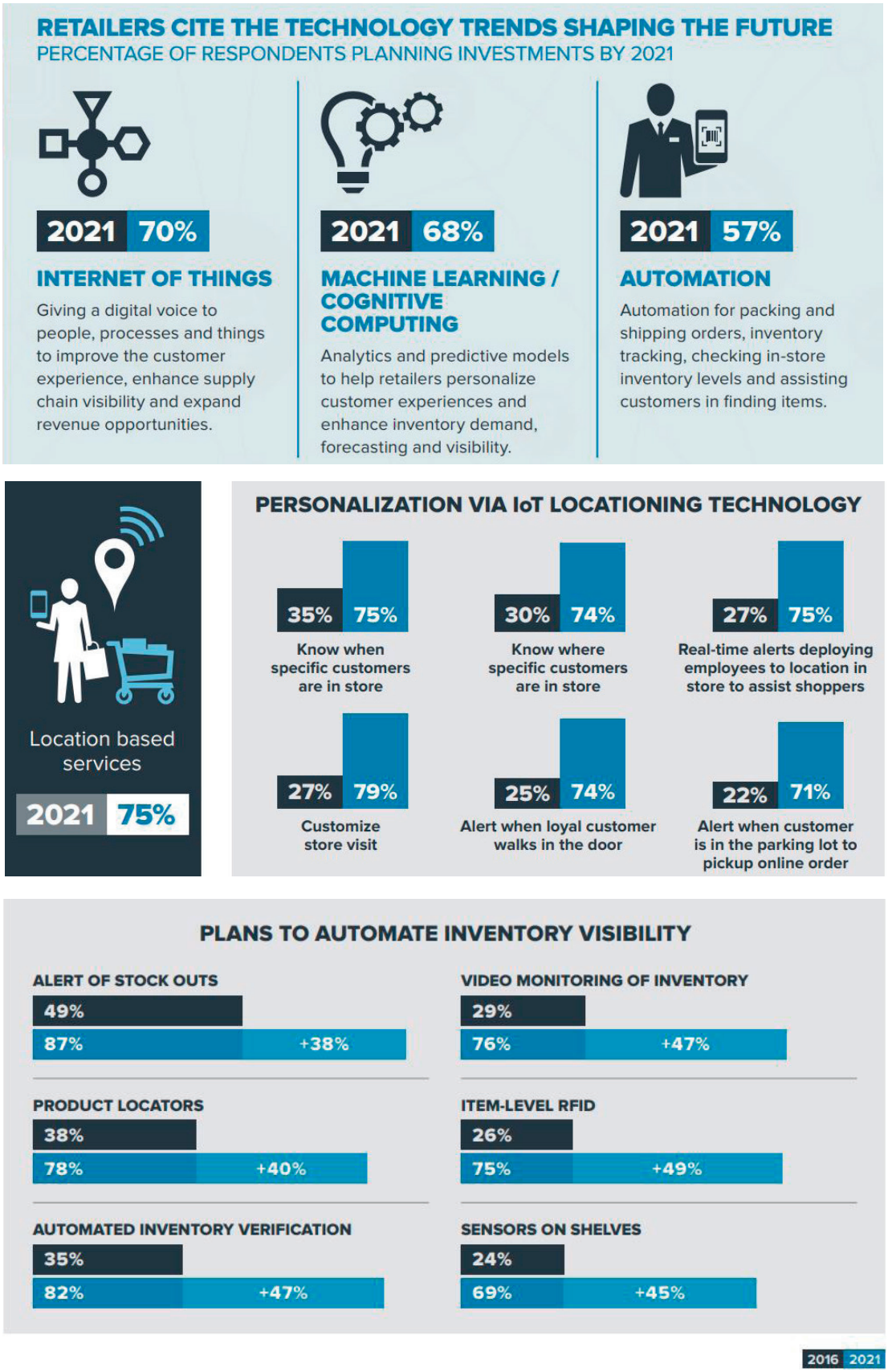


Figure 3.9 Retailers Cite The Technology Trends Shaping The Future, Zebra (2017)

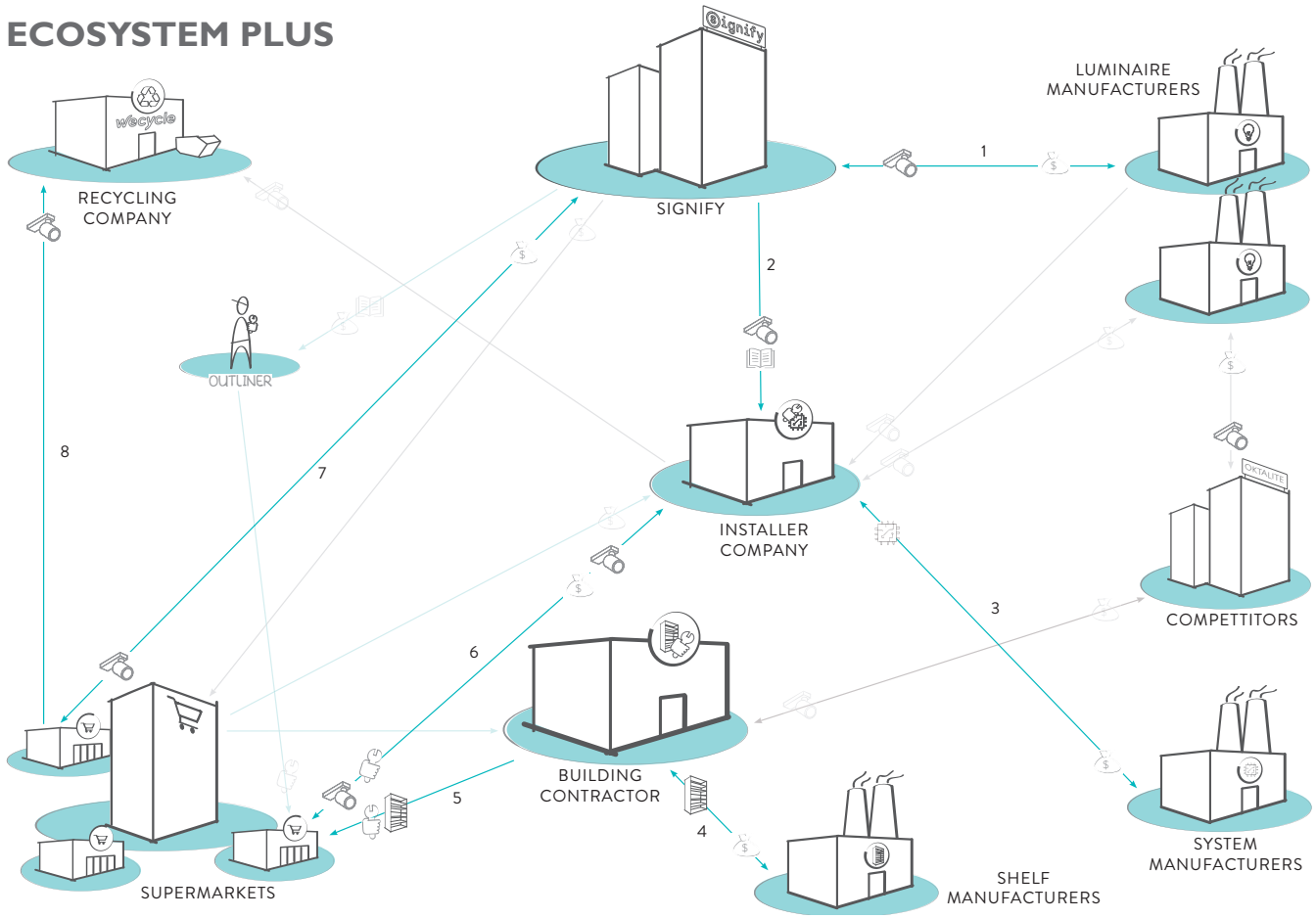


Figure 3.10 PLUS supermarket lighting ecosystem

Wish:

The designed concept can be offered before 2021.

Opportunities:

- Retailers want sustainable lighting.
- Retailers want to improve the physical store experience.
- Retailers want to provide an omni-channel experience.

3.4 Ecosystem PLUS

The interviews and observations led to the creation of an overview of the complete supermarket lighting ecosystem. During the interviews, this ecosystem map was verified multiple times with stakeholders. Since these kind of ecosystems can be complex and differ per segment, organisation, and even country (Personal conversation, Ingeborg Gort-Duurkoop from Partners for Innovation, 2018 May 3th), it was decided to focus on one supermarket organisation. Additionally, a more specific service is able to provide a better fit with the specific needs of a certain business consumer.

Signify is already investigating the circular opportunities for the ecosystem of Albert Heijn. To get different insights the ecosystem of a decentralised supermarket organisation, PLUS Netherlands, was chosen as scope. A circular lighting system could possibly be interesting for PLUS since it was elected, four times in a row, as most socially responsible supermarket in the Netherlands (GfK, 2018). On their website PLUS (2018) also claims to aim for supermarkets with lower impact on the environment. Circular lighting could help them to reduce the impact of their stores on the environment. PLUS, which is part of Superunie, differentiates itself by its focus on customer satisfaction. PLUS aims to be the supermarket for everyone and offer 'good

food' and convenience. In comparison, Albert Heijn focuses for example more on innovation and Jumbo is focusing on customer satisfaction as well, but less on sustainability (Merkelijkeheid, 2018). The transactions made in the PLUS ecosystem are shown in blue in figure 3.10. The figure shows the exchange of money, luminaires, operations and information. To give an indication about the complexity of taking all supermarket organisations into account, transactions made in other ecosystems are shown in light grey.

1. Signify gets the luminaires from the manufacturer.
2. Signify ships the luminaires to the installer.
3. The installer gets the other electronics from another electronics manufacturer.
4. The luminaires are installed in the supermarket. Old luminaires are taken back by the installer.
5. If a luminaire is broken, the store owner orders luminaires from lampenlicht.nl and installs them himself or asks the installer for a leftover used luminaire.
6. The broken luminaires end up at WeCycle.

Wish:

The designed concept fits the ecosystem of PLUS Netherlands.

The designed concept fits the brand identity of PLUS.

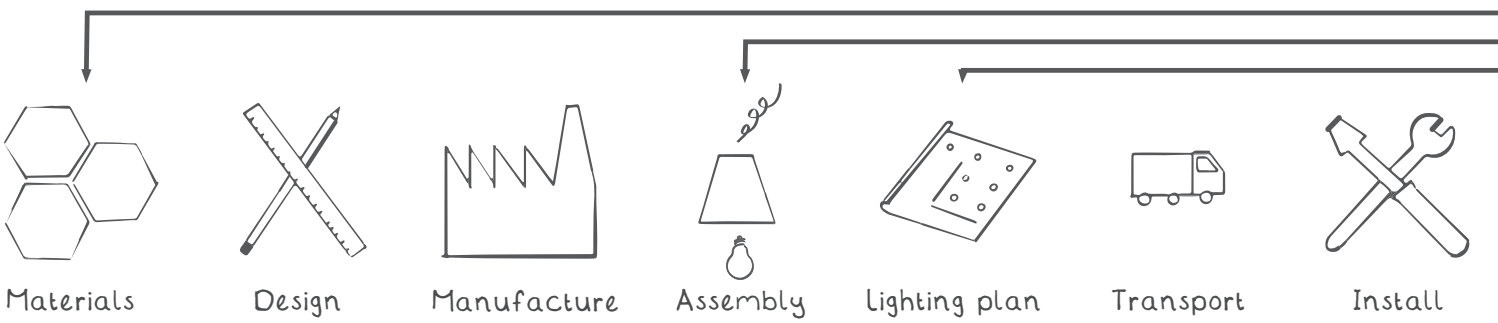
Requirement Specification:

The designed concept should provide a lighting solution for franchise supermarkets.

3.5 Stakeholders

The stakeholders in figure 3.11 were dirived from the ecosystem and customer journey (fig. 3.1). In the left upper corner of figure 3.11 the supermarket headquarters with the formula manager and the BWI manager are shown. Next to the headquarters, the supermarket can be found. In the supermarket the retailer, staff member, and the shopper are the most relevant stakeholders. Left in the middle, the warehouse of the installer with the installer is show. In the middle of the figure the outliner, which is often a freelancer hired by Signify, can be found. This stakeholder makes sure the luminaires are lined out rightly and produce the right light intensity. According to the supermarket owners, this stakeholder is not included in the PLUS ecosystem. This stakeholder does however exist in the ecosystems of other supermarkets. As can be imagined an outliner could be desirable when lighting is being offered as a service. Therefore, the outliner is still defined to be a relevant stakeholder. In the left bottom corner the recycler and the recycling facility are shown. The recycler refers to a recycling company such as WeCycle. Right next to the recycler the manufacturer and his factory are shown. In the right bottom corner Signify and its relevant employees are shown, including the

Figure 3.12 The product journey of supermarket lighting



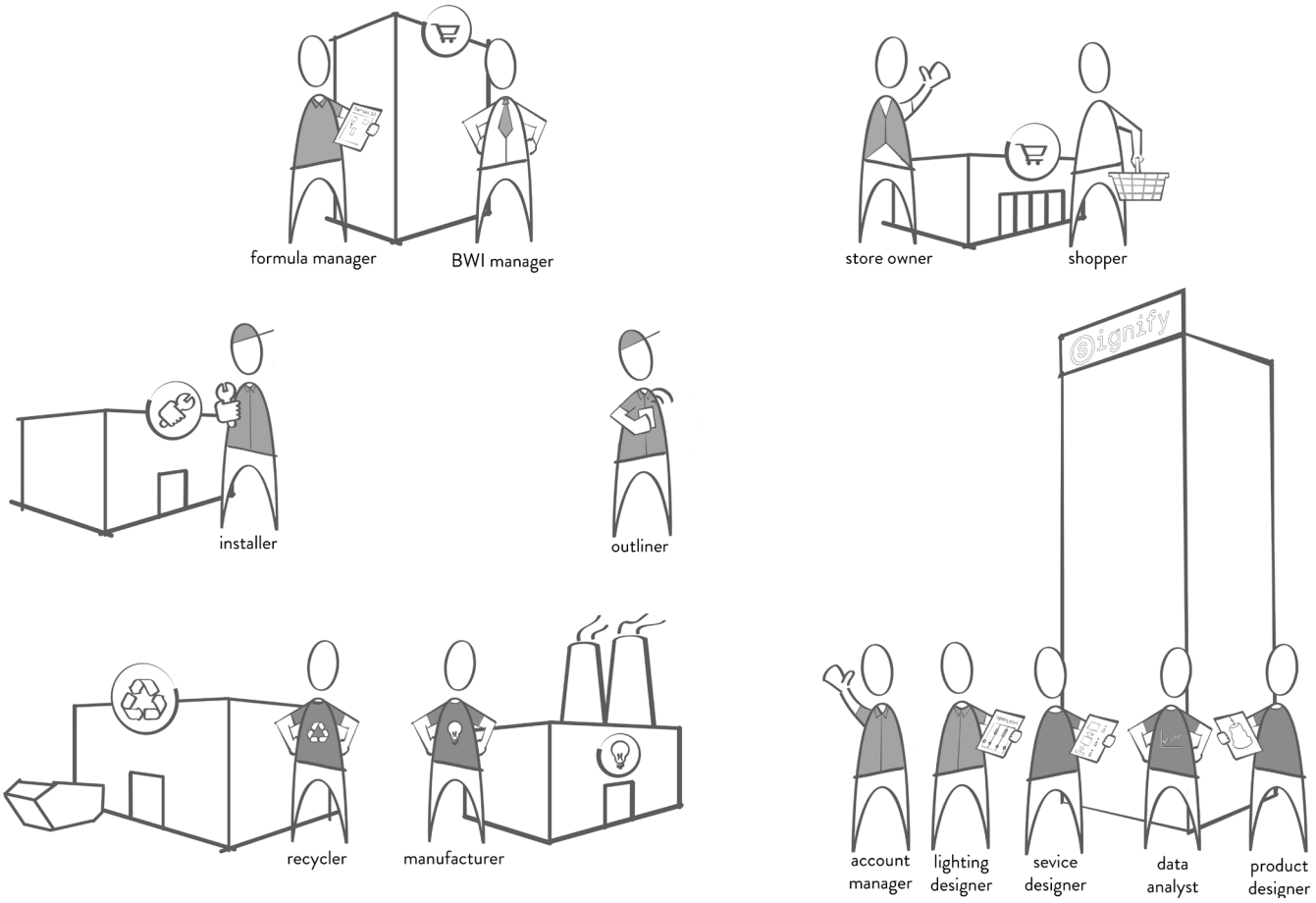
account manager, which is the contact person for the retailer, a lighting designer, a service designer, a data analyst, and a product designer. The interviewees mentioned the existence of two competitors (Triluxoctalight and Fagerhult). Because these competitors are according to the interviewees not active in the Dutch supermarket segment, these competitors where left out of this analysis. In appendix A an overview of the tasks, needs, and wants from the stakeholders shown in figure 3.11 can be found. These needs should be taken into account in the designed concept.

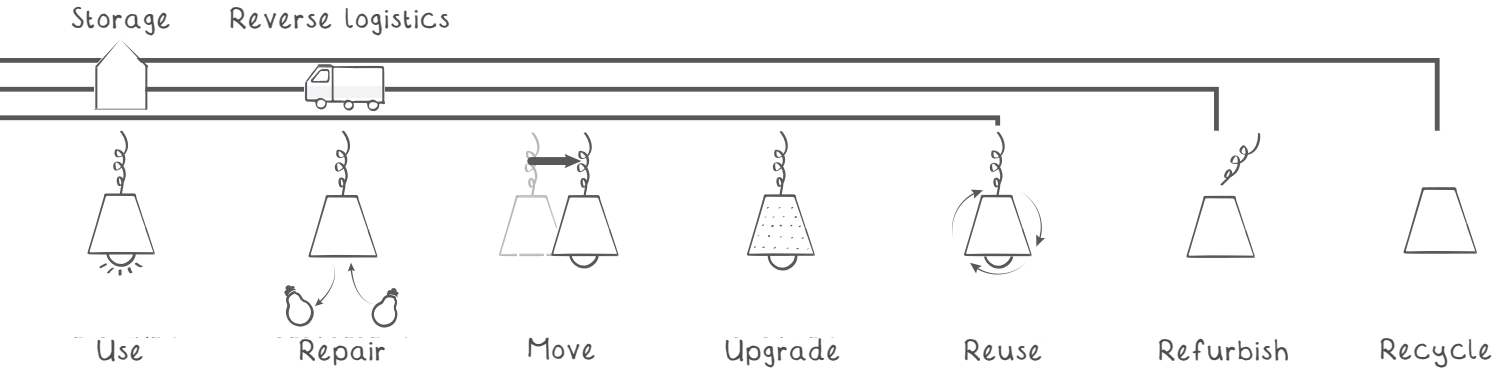
The wants should be taken into account when possible.

Wish:

The designed concept adresses the wants of Signify, PLUS, installer, outliner, recycler and manufacturer.

Figure 3.11 Stakeholders





Requirement Specification:

The designed concept should take the needs of Signify, Plus, Installer, Outliner, Recycler and Manufacturer into account.

3.6 Product journey

From the interview also a product journey, the procedures a luminaire goes through, was derived (fig. 3.12). The product journey starts with the materials. Next follows the design of the luminaire. The materials are during the manufacturing step used to produce the parts of the designed luminaire. During the assembly step these parts are combined into a luminaire. Then the luminaires are used to design a lighting plan. When the lighting plan is ready the luminaires are transported, first to the installer, then to the supermarket. The next step is the installation of the luminaires. After installation the luminaires are ready for use. When a part of a luminaire is broken it is being repaired by an installer. When the store is refurbished, the luminaires are sometimes moved to a different location in the store. Sometimes luminaires are upgraded with a new part in the store. When the store is refurbished the installers take still functioning luminaires back to reuse them in other stores or sell them. Parts of these luminaires can also be used to repair other luminaires or to be assembled into a refurbished luminaire. Finally, when the luminaire breaks down it is being recycled and turns into materials that can be used for new luminaires.

3.7 Takeaways

It can be concluded that the economic lifetime of the luminaires is way shorter than the technical lifetime of the luminaires. So where often the question is 'how to elongate the technical lifetime of the product to make to make a circular proposition viable?', the question is now rather 'how to elongate the economic lifetime?'

When supermarkets change their layout, the adaptation of the lighting stays out of scope in some cases. This results in products not being illuminated well enough. To make sure their products are always illuminated rightly, retailers need lighting that can be adapted towards the store interior.

The growing demand for sustainability in retail creates opportunities for Signify to offer circular lighting. Store owners indicate they want to invest in IoT before 2021. This creates opportunities for Signify to offer more data enabled services in retail.

The context of supermarket lighting is complex. The needs and wants of multiple stakeholders need to be taken into consideration when implementing a PSS lighting system. To be able to focus on a fixed set of stakeholders, it was decided to focus on the ecosystem around one supermarket organisation in one country: PLUS in the Netherlands. Since PLUS aims to decrease the environmental impact of their stores, a circular lighting proposition could fit them.

CHAPTER 4: THEORETICAL ANALYSIS

Photo by Janko Ferlič on Unsplash

CHAPTER 4: THEORETICAL ANALYSIS

This chapter discusses how the findings from previous chapters relate to literature. First it will show whether Signify's circular efforts are in line with CE as described by literature and whether opportunities are untaken. In addition, it will discuss the drivers and barriers of CE as described by literature. Secondly, it will discuss Signify's IoT capabilities, drivers, and barriers. Finally, it will show the drivers and barriers of product-service systems and provide insights in the challenges that Signify will phase during the implementation of the designed concept.

4.1 Circular Economy

Circular Economy (CE) is one of the buzzwords of the 21st century (Bet et al., 2018). Although many talk about CE, companies do not practice it widely yet (CIU, 2018).

CE is an economical system in which products are designed to be shared, serviced, reused, refurbished or recycled to minimise material input and waste (fig 4.1). As can be seen in figure 4.1 this requires separation of a biological cycle (in green), where materials can be absorbed by nature and a technological cycle (blue) where materials need to be used in other products by means of different procedures to close the loop (maintain, reuse, refurbish, recycle).

From Signify's annual report, similar to literature, was derived that circular for Signify is mainly related to the efficient use of resources and the elimination of products ending up in landfill. For Signify to be able to say the concept is circular, it should at least take these two points in consideration. The efficient use of resources could be specified by minimizing the material and energy input and creation of waste. This can be accomplished by maintaining, reusing, refurbishing and recycling products.

Benefits of joining a circular economy

According to the EMF (2015) the economic benefits of moving towards a circular system are: improved economic growth, substantial savings on material cost, creation of employment, and increased innovation.

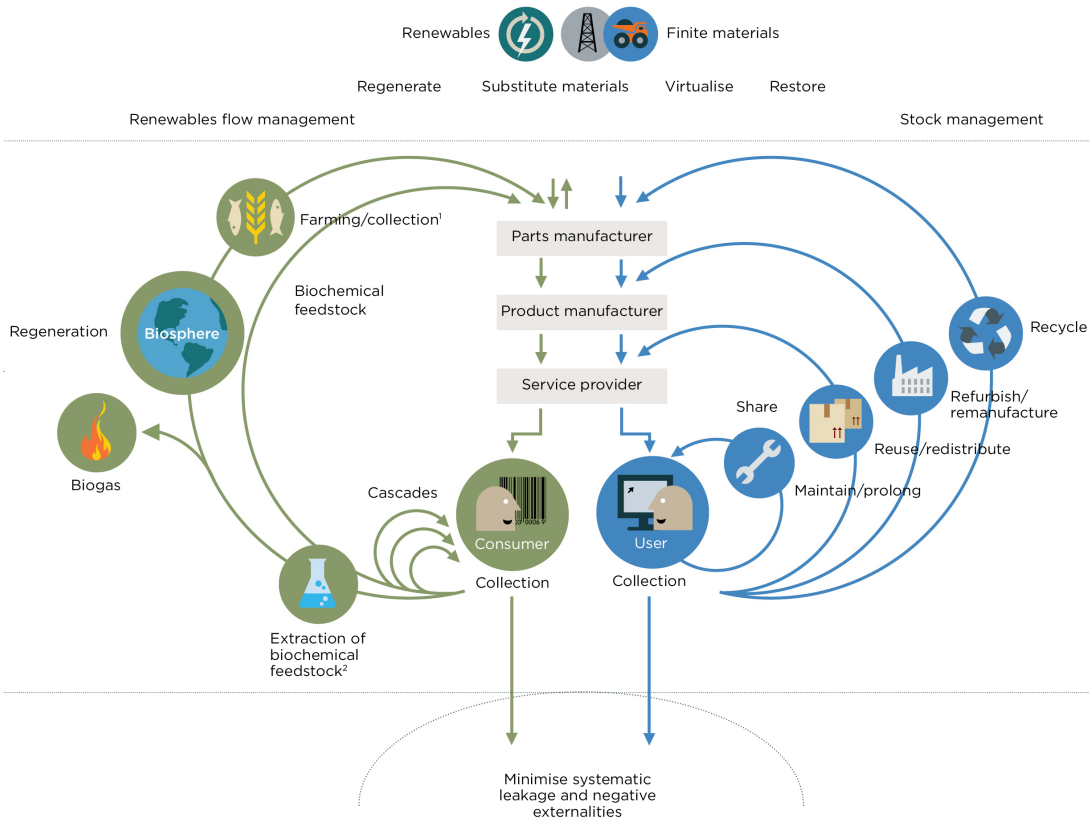
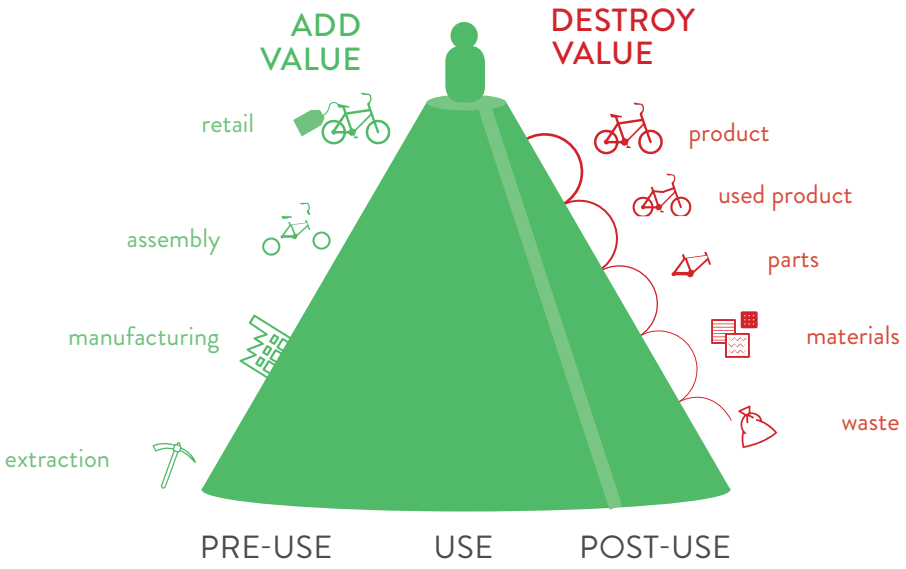


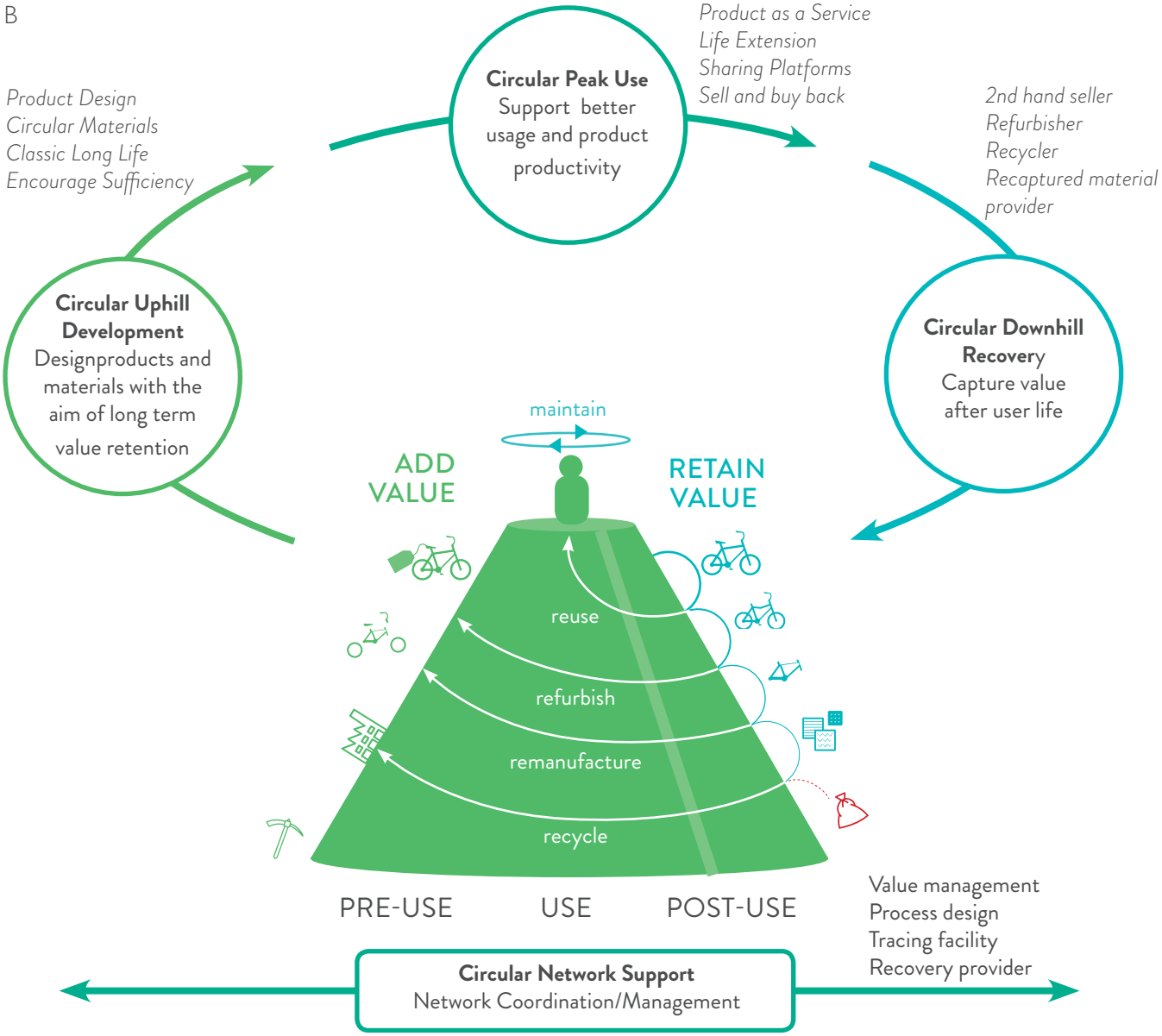
Figure 4.1 Visual representation of the Circular economy (EMF, 2018)

Figure 4.2a Value Hill (Circle Economy, 2018)
Figure 4.2b Value Hill (HGB, 2018b)

A.



B



	Signify	Signify Retail
Maintain/Prolong	Light as a service Circular Lighting CityTouch (service tag)	Telecaster
Reuse/Redistribute		
Refurbish/Remanufacture	Caterpillar	Development CE ready luminaire
Recycle	SlimStyle bulb Circular Lighting	Telecaster

Figure 4.3 CE Efforts by Signify

Financial	Measuring financial benefits of circular economy
	Financial profitability
Structural	Missing exchange of information
	Unclear responsibility distribution
Operational	Infrastructure/ Supply chain management
Attitudinal	Perception of sustainability
	Risk aversion
Technological	Product design
	Integration into production processes

Figure 4.4 categorisation of CE Barriers by Ritzén & Sandström (2017)

On top of that, the move to a CE has a positive impact on the environment. Het Groene Brein (2018c) summarized the benefits, based on insights from EMF (2015; 2016) for the environment as follows:

"The circular economy has the potential to result in a reduction in emissions and use of primary raw materials, a optimisation of agricultural productivity, and a decrease in negative externalities"

For companies, a CE results in the following opportunities (EMF, 2015):

- New ways to generate profit
- Resilience of supply
- Demand for service models
- New and enhanced customer relationships

The main difference with the current, linear, system is that the value of products is kept as high as possible instead of destroying it after use (fig. 4.2).

As can be seen in figure 4.2, every step in the value chain creates value. By letting the product drop to a lower level in the value chain, the value of the product or resource is decreasing again. Maintaining value instead of destroying it is what could make circular propositions more profitable than linear propositions.

To keep this value as high as possible the loop has to be closed and the strategies in the middle of the value hill need to be in place: Maintenance or prolong, reuse or redistribute, refurbish or remanufacture and finally, recycle.

In figure 4.3 the different CE efforts of Signify from chapter 2 are mapped on the loop closing strategies they use from figure 4.1. As also discussed in chapter 2, Signify relates circularity mainly to preventing products to end up in landfill. If we look at the circular lighting proposition in figure 4.3, recycling is the only thing that is currently happening to close the loop. This matches Signify's statements about CE. If this is related to the value hill from figure 4.2, it becomes clear that a lot of value is still being destroyed in Signify's circular propositions. As can be seen in figure 4.3 reuse or redistribution is currently

Figure 4.5 CE challenges mentioned by Signify employees

Type of c CE challenge	Challenge mentioned by Signify employee
Financial	• Calculating the residual value of the luminaires is difficult. • It costs more to refurbish a luminaire than buying a new one. • Costs of modular luminaires are higher than non-modular ones. • Design decisions are mainly based on keeping the cost as low as possible.
Structural	• There is a lack of overview on what is happening/going to happen in the field of CE and IoT. • Being part of an ecosystem of products and data is still new to Signify. • There is a tension between offering something yourself and giving space to others.
Operational	• As a big company it is difficult for Signify to move towards CE quickly. • Scalability of the reverse logistics is a problem.
Attitudinal	• The CE opportunity of projects is often not spelled out well enough. • Employees have different views on CE • People have difficulties in changing the way they work. • CE does not resonate in retail. • Designers are not really using the scoring card.
Technological	• CE ready luminaires still need to be developed within retail • Making it modular makes it less 'slim and aesthetic'

not happening. As said in chapter 2, the circular lighting propositions guarantee reuse or recycling, but no signs of reuse could be found. This suggests that there is still room for a reuse or redistribute platform.

The challenges of joining a circular economy
Ritzén & Sandström (2017) defined multiple barriers for moving towards a circular economy. They categorised these barriers under five categories: Financial, Structural, Operational, Attitudinal and also Technological barriers. These barriers show many similarities with the barriers as defined by Kirchherr et al. (2017) and Bet et al. (2018). Figure 4.4 gives an overview of the different barriers per category.

Kirchherr et al. (2017) argue that the cultural barriers are the biggest. Creating awareness and willingness to engage in circular economy has proven to be a difficult job. Additionally, Bet et al. (2018) state that product-based industries have problems in envisioning the complete product life-cycle, because they look at their own company rather than considering all the stakeholders in the chain:

"As one can imagine, material chains may be closed in many different ways, making a circular economic system a very complex network compared to the traditional linear system. As a result, making a transition from a linear to a circular economy poses a very complicated paradigm shift, demanding a lot of knowledge from the many involved stakeholders and close cooperation between them. Even though a lot of valuable scientific research and professional expertise on circular economy is available, this knowledge often does not find its way to the relevant stakeholders, leaving many opportunities to accelerate the transition to circular economy untaken." Bet et al. (2018)

This challenge is also stated as one of the most important challenges by one of the Signify employees in the interviews. He states the importance of working with customers that know how to make changes.

The other barriers that Signify employees mention in the interviews from Ingemarsdotter are categorised based on the categories defined by Ritzén & Sandström (2017) (figure 4.5).

As can be seen in figure 4.6, all categories of challenges mentioned in literature are also covered by the challenges Signify employees mention. This means offering a circular lighting concept for supermarkets is not without difficulty. Therefore employees could be hesitant to work on circularity related topics. To change the mindset of the employees, the designed concept should provide solutions for as much of these challenges as possible.

Weaknesses:

- **In Signify's current propositions value is being wasted.**
- **Signify does not reuse or redistribute products to create additional use cycles yet.**

Wishes:

- The value of the product is kept as high as possible.
- The designed concept is profitable.
- The designed concept includes responsibilities for each stakeholder.
- The designed concept provides a solution for reverse logistics.
- The designed concept provides insights in its environmental benefits.

Requirement Specifications (1/2):

- **The designed concept should use resources more efficient than a non-circular alternative.**
- **The designed concept should minimise the material input by maintaining, reusing, refurbishing and recycling.**

Requirement Specifications (2/2):

- **The designed concept should prevent resources from ending up in landfill.**

4.2 The Internet of Things

As already stated in the introduction and Chapter 2, Signify tries to become a player in the Internet of Things* (IoT) by equiping its products with internet connectivity and sensors. IoT refers to the networked connection of physical objects through the internet, enabling them to sense their own and their environments status, process this information and interact with their users.

"the core concept is that everyday objects can be equipped with identifying, sensing, networking and processing capabilities that will allow them to communicate with one another and with other devices and services over the Internet to achieve some useful objective" (Whitmore, Agarwal and Da Xu, 2015)

Benefits of IoT

As already stated in the introduction, IoT provides Signify with the possibility to add value on top of the lighting functions of their products. Ingemarsdotter et al. (in Press) summarised the capabilities of IoT into seven categories: Tracking, Monitoring, Control, Optimisation, Design Evolution, Autonomy and Processing/Networking/Communication (fig. 1.2). As already stated in the introduction as well, IoT provides the opportunity to support the value drivers in a CE (fig. 1.3).

Challenges of IoT

Lee & Lee (2015) defined five different challenges that companies face when using IoT:

Data management
IoT sensors and devices generate massive amounts of data that need to be processed and stored. This challenge is acknowledged by Gartner (2014), who states that the current architecture of the data centre is not prepared to deal with different types of data in these amounts (Gartner, 2014).

Data analysis
To create useful insights from these massive amounts of data, computer models are needed to make it understandable. The current computer models are not capable of processing all data. Besides, more data analysts are needed to actually analyse the data.

Privacy
IoT devices can provide highly personal data, as location, movement and purchases. This requires the protection of the privacy of people and therefore their data, however, this data allows companies to improve their product and service offerings.

Security
The amounts of data IoT generates can be sensitive

Figure 4.6 IoT challenges mentioned by Signify employees

Type of IoT challenge	Challenge mentioned by Signify employee
Data management	• Scalability of iterative IoT services might be a problem.
Data analysis	• There is not enough 'good' data available. Data collection and analysis is not sufficient yet. • The people who do the maintenance are not willing or forgetting to update the service tag. • A lack of data analysts exists.
Privacy	• Data from local systems is not always accessible for Signify.
Security	• -
Chaos	• Value chain collaboration key when a lot of data has to be shared.
Additional challenges	• Getting the products connected. • If the IoT (sensors or drivers) is not in the luminaire yet, it cannot be added later.

for security issues. Therefore it is important the protection of this data is secured. The lack of security might lead to resistance of consumers towards IoT.

Chaos
Finally, Lee & Lee (2015) warn for the chaos that could be created if a mistake is made in a highly connected system:

"In an unconnected world, a small error or mistake does not bring down a system; however, in a hyper-connected world, an error in one part of a system can cause disorder throughout"

An analysis has been conducted on whether or not the barriers mentioned by employees of Signify are in line with the challenges mentioned by literature.

As can be seen, there is overlap with the challenges from research. However, the security barrier was rarely mentioned and some of the mentioned challenges did not fit the topics found in literature. As can be seen, these additional challenges are mainly about getting products connected. These challenges seem mainly a matter of time, since Signify has shown it is able to get luminaires connected as well as gather data. Although the security barrier is not mentioned, this is a very important barrier to cross when Signify wants to convince stakeholders to collaborate. For IoT as well as for the CE, Signify has to be convinced barriers can be crossed and that it will create benefits to do so.

Requirement Specifications:

- **The designed concept provides stakeholders access to data that is useful for them.**
- **The designed concept takes the privacy of shoppers into account.**
- **The data gathered in the designed concept is secured.**

Wishes:

- **The designed concept provides a way to manage large amounts of data.**
- **The designed concept is as resilient as possible to misuse.**
- **The designed concept improves the collaboration between stakeholders.**

4.3 Product-Service Systems

Signify has acknowledged circular lighting requires a different approach than traditional lighting. According to Signify this new approach requires product-service systems (PSSs) where performance and service are offered for a contracted period of time (Philips Lighting, 2018f).

When talking about a product-service system, this report refer to the following definition: "A Product-Service System (PSS) is an integrated bundle of products and services which aims at creating customer utility and generating value" (Boehm &Thomas, 2013)

Chapter 2 shows Signify divides its portfolio in products, systems and services. These terms should not be confused with the term product-service system as defined by Boehm & Thomas (2013). It could be argued that only the Light as a Service propositions offered in the service category consist of product-service systems, since they are a combination of products and services.

Benefits of developing product-service systems
Implementing a service has multiple ways in which it is able to create value for a company (Oliva & Kallenberg, 2003):

- Service design enables more adaptable, useful, and desirable solutions
- Services are a source of sustainable competitive advantage, since they are difficult to imitate
- Services enable higher margins than products
- Services enable a stable source of revenue

A desirable solution for business customers could be the fact that product-service systems allow the manufacturer to take responsibility for administration and monitoring tasks so business customers can focus on their core activities (Baines et al., 2007).

By offering their products as a PSS, Signify is able to create more adaptable and desirable solutions for retailers. Additionally, they are able to capture more value than by selling products only. Servitization offers Signify new ways of capturing value and maintain their position as global market leader. It can be said developing product-service systems could create a sustainable competitive advantage for Signify. Moreover, with LED luminaires lasting for over twenty years, Signify needs to find new ways to generate a more frequent income. If product-service systems are designed to create long-term relationships with customers, they have the possibility to create a more stable and more predictive source of revenue. A service contract provides more insight in revenue streams, but also pay per use models provide more insights than selling a product to a different customer every time.

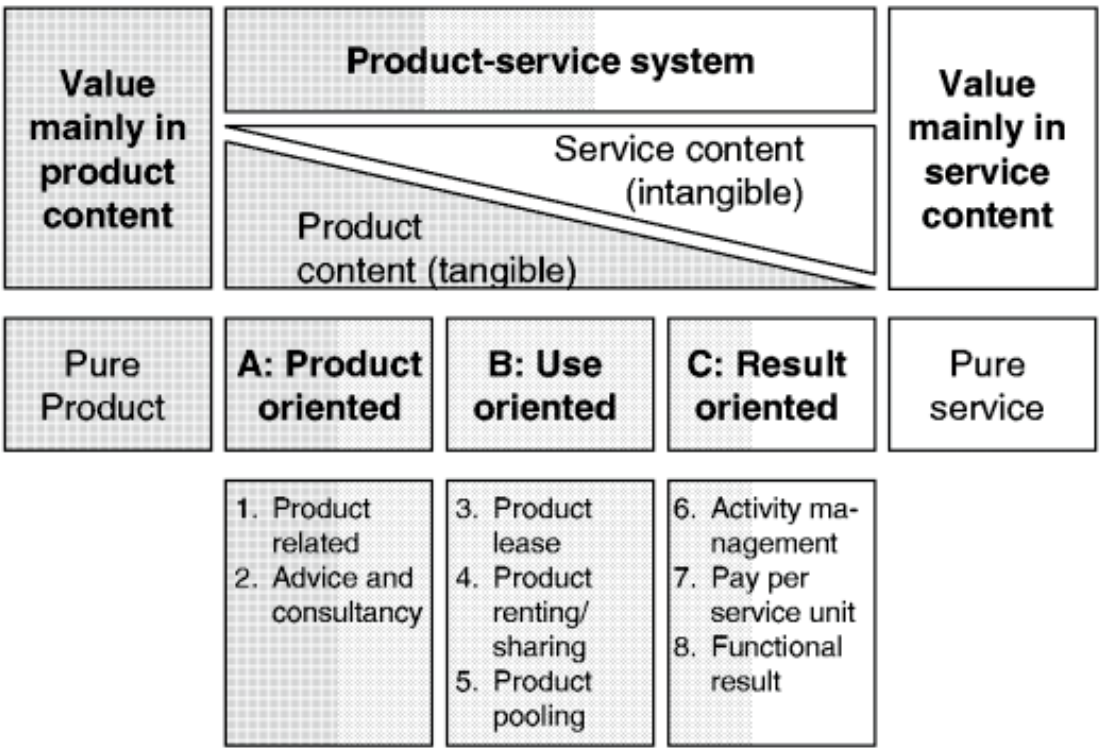


Figure 4.7 Different types of product-service systems (Tukker, 2004)

Figure 4.8 Different types of product-service systems offered by Signify

Product oriented	Use oriented	Result oriented
Professional services Standard managed services	Financing	Light as a Service Circular Lighting

According to Tukker (2004) product-service systems can be categorised based on whether their value is based on the product or the service (figure 4.7). PSSs where the service is more like an add-on to the product are placed on the left of the framework and PSSs having a product as add-on to the service are placed on the right of the framework. Tukker (2004) defined eight different kinds of product service systems, which can be found in figure 4.7.

According to Mentink (2014), services are usually more circular than products. As stated in chapter 2, Signify's vision on circularity focuses mainly on preventing luminaires to end up in landfill. If we look at the PSSs types from Tukker (2015) from this perspective, the use oriented and result oriented PSSs would have the highest potential to be circular, since Signify in these cases has control about the end of life procedure of products. In case of a product oriented service, Signify is not able to claim their service to be circular, since they are not able to control the end of life of a product.

However PSSs are often more circular, PSSs sare not inherently sustainable. This is important to keep in mind, since Signify aims for more sustainable offerings.

Tukker (2015) states the potential sustainability of product-service systems differs per type of PSSs:

Product-oriented services have some environmental gains through better maintenance. However, companies are still trying to sell as many products as possible (Tukker, 2015).

Use-oriented services might be a bit more sustainable than product oriented services. Due to using instead of owning products, leasing often leads to less careful behaviour with the need for more products as result. Product renting and sharing have significant environmental benefits, however, the impact of the use stage is multiplied (Tukker, 2015).

Finally, result-oriented services have the theoretical-potential to be the most sustainable. In theory these PSSs do not require the existence of a product and its additional impact during the use phase. Additionally, limiting resource usage is for service providers one of the ways to reduce costs (Tukker, 2015).

Since Signify's reasoning for a CE is partly based on sustainability, the points mentioned above should be taken into consideration when designing a circular PSS. If a close look is taken at the reasoning of Tukker (2015), every point relates back to the limitation of produced products and used resources. To be as sustainable as possible, the designed PSS should therefore stimulate Signify to minimise production and use products more efficiently.

As can be seen in figure 4.8 Signify does offer product-service systems in each category. In retail very recently the LAAS offering was introduced. It can be seen that the result oriented product-service systems focus on lighting as a result and not on the result beyond lighting yet. This is an opportunity since the added value of a service could be in stressing the value beyond lighting. Signify could for example, think about the indoor positioning, start to offer shopper guidance as a service.

Although Light as a Service belongs in the framework of Tukker (2015) in the category result oriented, the service is still focused on the products. It could be argued that the term luminaires-as-a-service suits the Light as a Service proposition better, since the services are mainly focused on the luminaires. Although the amount of daylight is used to minimise energy usage, no alternatives for luminaires (e.g. windows, mirrors, candles) are used yet in the PSS propositions yet. Additionally, Signify does not interfere yet with the architecture or interior of a building. This is important because the way lighting is perceived is effected by what it is shining on. If Signify wants the result of a service to be nice lighting, Signify should also try to take the architectonical aspects into account.

Challenges of developing product-service systems

To make a product-service system a success, Signify needs to move from a goods-dominant (GD) logic to a service-dominant logic (Vargo & Lush, 2007). In order to do so, multiple challenges need to be tackled. Nudurupati (2013) defined eight different challenges product based companies, as Signify, face in their journey to selling services instead of products (fig. 4.9): Incorporating the customer perspective, redefining the interface, the pricing of their offerings, the design of PSSs, the supply network, the organisational architecture, the performance measurement and the cultural transition. According to Vargo & Lush (2007), the most important challenges are those related to the change in mindset from a GD logic to a SD logic.

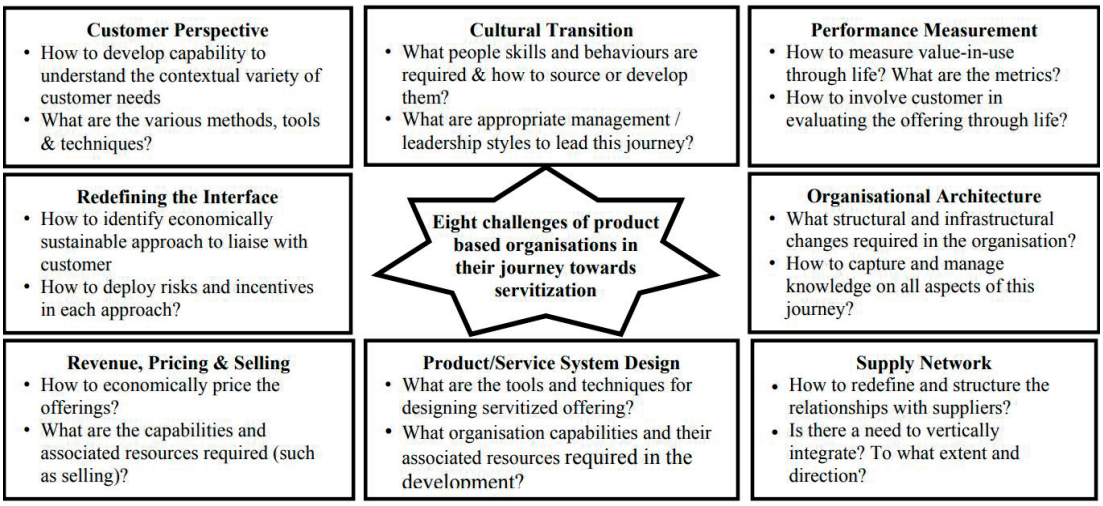


Figure 4.9 Challenges of servitization in product based organisations (Nudurupati, 2013)

Firstly, the business model of a GD organisation is based on transactions while a SD logic focuses on a long-term relationship with the customer. Therefore, the success of the service needs to be measured by the value of the relationship instead of the units sold (Vargo &Lush, 2007). The fact that Signify employees often refer to offering services as selling contracts, indicates that Signify still measures the success of their services and employees based on the amount of contracts they sell. It is important that Signify and their employees change this mindset. For the designed PSS it means that concepts should be selected based on whether they improve the value of the relationship with customers instead of creating a big amount of transactions.

Secondly, services are not static end-products, but need to be dynamic: Service innovations are needed to stay relevant in a changing environment. The designed product-service system should therefore allow adaptability.

Thirdly, SD companies should focus on selling solutions instead of products. Therefore, a SD company requires different organisational structures and processes. A critical success factor for this transition is the creation of a separate business unit to take care of the service offering (Oliva & Kallenberg, 2003). The separation will make sure the service is not seen as an added value to a product but as a value in itself. The designed PSS should thus be a by the customer desired solution rather than a combination of technological possibilities. However the product, system and service department of Signify are already separated, the designed product-service system will be a combination of those three and should be seen and treated as an integrated whole. This can be a problem since employees of the product and system departments do not collaborate intensively with the service department yet.

Several employees confirm Signify deals with cultural barriers related to the process of becoming a service provider. Employees have difficulties in changing the way they work. However, not only Signify itself, but also their business customers have a cultural barrier against buying services.

Weaknesses:

- Signify faces organisational barriers in becoming a service provider.
- Signify faces cultural barriers in becoming a service provider.
- Signify Retail does not stress the result beyond lighting.
- Signify Retail still focuses on the product instead of the desired result.

Threat:

Retailers prefer buying products over services.

Requirement Specifications:

- The designed concept should be an integrated bundle of product(s) and service(s).
- To enable Signify to control the end of life of their products, the designed concept should be use or result oriented.
- The designed concept should strengthen the relation with the retailer.
- The designed concept should be adaptable to the changing needs and wants of retailers.
- The designed concept should deliver a desired result, not a combination of (technical) possibilities.
- The designed concept should create long-term relationships with customers.

Wishes:

The designed concept stimulates Signify to minimise production and increase efficient utilisation.

4.4 Takeaways

The idea of using IoT to offer a circular PSS in retail provides possibilities for Signify to create more predictive sources of revenue. Despite this, using IoT to offer a circular PSS for retail comes with a lot of challenges. During this project ways should be found to overcome these challenges. The analysis shows that a lot is happening on PSSs, CE and IoT within Signify already. However, it seems an overview of what is happening and how these projects are connected towards one common goal is missing. The biggest problem might therefore be to get all employees and projects aligned towards one common goal. It is therefore that this project provides a common goal and a roadmap for the future.

PART II: VISION

This part of the report will present the envisioned design goal and the restrictions related to that. First chapter 5 will provide an overview of all found strengths, weaknesses, threats, and opportunities using a SWOT analysis. This SWOT analysis will be used to formulate the design challenge. In chapter 6 the restrictions related to this design challenge will be shown.

CHAPTER 5: DIRECTION

Photo by Gabriel Barletta on Unsplash

CHAPTER 5: DIRECTION

This chapter presents the vision that was built upon the insights from the analysis. First, a SWOT analysis will be presented to give an overview of the strengths and weaknesses of Signify as well as the threats and opportunities from the context. Secondly, two opportunity areas will be presented. At the end of this chapter the design challenge is presented.

5.1 SWOT

An overview of the strengths, weaknesses, opportunities, and threats which resulted from the analysis can be found in figure 5.1. The overview shows that there are multiple opportunities to address wants of retailers. Many opportunities are related to helping retailers to improve the store experience: Attractiveness, atmospheric effects, omni-channel experience and experience of their physical store. The overview shows Signify has multiple strengths, like a different ambiance in different parts of the store, that can be used to anticipate on these opportunities. However, as the SWOT analysis shows as well, Signify needs to move to a service oriented mindset and create more transparency in how they close their loops. Additionally, Signify needs to be aware that customers not yet see the link between IoT and lighting. Next to anticipating on opportunities, Signify could bend threats into opportunities. The fact franchisers buy second hand luminaires suggests there is a market for second-hand luminaires. This could be seen as an opportunity for Signify to start offering second-hand luminaires.

5.2 Design challenge

The knowledge about lighting, luminaires and the effects of lighting can be used to anticipate on opportunities to enhance the attractiveness of the store, using lighting to guide shoppers and improve the omnichannel experience of the store. Acting on these opportunities fits within a bigger goal of enhancing the store experience. This is in line with the trend of supermarkets becoming a place to experience food.

To create the right store experience, supermarkets need flexibility and upgradability of the lighting. Currently upgradability of the lighting means renewing complete luminaires or trunking for every new function. This way the gap between the economic lifetime and technical lifetime becomes even bigger than it is right now. With the current ecosystem in mind, a lot of value is and will be wasted. Wasting value does not fit with the brand identity of Signify and PLUS. By reusing materials, parts or complete luminaires less value will be wasted. This allows Signify to offer a service that adds value while keeping the prices relatively low.

By enabling upgradability of the service, Signify is able to build long-term relationships with customers by addressing their needs with new solutions. However, change of process requires the collaboration of the stakeholders. The 'communication' capability of IoT creates the possibility to share useful data about the luminaires and improve collaboration between stakeholders.

The points mentioned above lead to the following design challenge:

*Design a **circular PSS** that improves the store experience by offering **flexible & upgradable** supermarket lighting for PLUS that uses IoT to **enhance collaboration** between relevant stakeholders in using resources more efficiently and closing the loop.*

Figure 5.1 SWOT analysis

	HELPFUL	HARMFUL
INTERNAL	**Strengths** • Signify has the possibility to create new sub brands. 2.1 • Signify's Philips brand has high brand equity. 2.1 • Signify is a market leader in the area of innovative, energy efficient lighting. 2.1 • Signify Retail has a customer focused way of working. 2.3 • Signify Retail is able to offer luminaires that are enabled for future functionalities 2.3 • Signify Retail offers products that enable the repositioning of luminaires. 2.4 • Signify Retail offers luminaires that allow their looks to be upgraded. 2.4 • Signify Retail is able to offer a different ambiance in different parts of the store. 2.4 • Signify Retail is able to save energy on lighting. 2.4 • Signify Retail is able to make fresh food look more attractive. 2.4 • Signify Retail is able to preserve fresh food longer. 2.4 • Signify Retail is able to connect the lighting to shopper channels as smartphone applications. 2.4 • Signify has experience with the offering of circular service propositions. 2.5 • Signify is developing luminaires that fit in a circular economy. 2.5 • Signify has its own platform to store, process and send data. 2.6 • Signify is able to provide an internet connection for other systems. 2.6 • Signify does use the capabilities of IoT. 2.6 • Signify is aware that IoT creates opportunities for a circular economy. 2.6 • Signify's lighting systems provide a great backbone for IoT. 2.6	**Weaknesses** • Signify Retail struggles to come up with a flexible lighting solution that does not lead to disposal of still functional luminaires. 2.3 • The system and product department are collaborating well, however, the collaboration between those and the service department can be improved. 2.4 • Signify Retail does not offer a circular service proposition yet. 2.4 • Signify has little experience with end of contract procedures of circular propositions. 2.5 • Signify needs to renew contracts every time something is added to a luminaire. 2.5 • Signify is not transparent enough about the end of life of their circular propositions. 2.5 • Signify does not use the opportunities of IoT to make their propositions more circular yet. 2.6 • Signify is unclear on how their IoT solutions connect to their core business: Lighting. 2.6 • In Signify's current propositions value is being wasted. 4.1 • Signify doesnot reuse or redistribute products to create additional use cycles yet. 4.1 • Signify faces organisational barriers in becoming a service provider. 4.3 • Signify faces cultural barriers in becoming a service provider. 4.3 • Signify Retail does not stress the result beyond lighting. 4.3 • Signify Retail still focuses on the product instead of the desired result. 4.3
EXTERNAL	**Opportunities** • Retailers want cheaper lighting systems. 3.1 • Retailers want lighting that makes their store more attractive. 3.1 • Retailers want lighting that enables them to guide shoppers to buy certain products. 3.1 • Retailers are interested in insights about the effects of atmospheric parameters on sales. 3.1 • If lighting designers have the specifications of used luminaires they are able to reuse them in a new lighting plan. 3.2 • Installers want to improve the efficiency of the installation procedure. 3.2 • Retailers want their Supermarket's interiors to allow for future technologies. 3.2 • Retailers want sustainable lighting. 3.3 • Retailers want to improve the physical store experience. 3.3 • Retailers want to provide an omni-channel experience. 3.3	**Threats** • Retailers buy luminaires from other (cheaper) brands . 3.2 • Retailers buy second hand luminaires from installers. 3.2 • Installers have a lot of influence on the (perceived) performance of the lighting. 3.2 • Store owners are very cost sensitive when buying new lighting. 3.2 • Retailers prefer buying products over services. 4.3

CHAPTER 6: SOLUTION SPACE

Photo by Riccardo Annandale on Unsplash

CHAPTER 6: SOLUTION SPACE

This chapter presents the solution space the designed concept should fit in. First, a set of requirements is presented that partly consist of the requirements from the introduction and is completed by additional requirements from the analysis. Secondly, criteria are presented which create the basis of the idea selection in chapter 7.

6.1 Requirements

The analysis led to the definition of a few additional requirements. These additional requirements add more details to the requirements from chapter

1. Requirement are aspects that the designed concept needs to meet. Ideas that do not fit these requirements will be eliminated.

Requirements

1. The designed concept should include an IoT element that supports circularity (Chapter 1.1)

1a The designed concept should use resources more efficient than a non-circular alternative (Chapter 4.1).

> The designed concept should minimise the material input by maintaining, reusing, refurbishing and recycling. (Chapter 4.1)

1b The designed concept should prevent resources from ending up in landfill. (Chapter 4.1).

> To enable Signify to control the end of life of their products, the designed concept should be use or result oriented. (Chapter 4.3)

2. The designed concept should create value for Signify (Chapter 1.1)

2a The designed concept should create long-term relationships with customers (Chapter 4.3)

> The designed concept should strengthen the relation with the retailer. (Chapter 4.3)

> The designed concept should be adaptable to the changing needs and wants of retailers. (Chapter 4.3)

3. The designed concept should provide a lighting solution for franchise supermarkets (Chapter 1.1 & 3.4)

3a The designed concept should deliver a desired result, not a combination of (technical) possibilities. (Chapter 4.3)

3b The designed concept should take the needs of Signify, Plus, Installer, Outliner, Recycler and Manufacturer into account. (Chapter 3.5)

3c The designed concept should facilitate adaptation of supermarket lighting to changes in the layout of the store. (Chapter 3.2)

4. The designed concept should be an integrated bundle of product(s) and service(s) (Chapter 1.1 & 4.3)

5. The designed concept should create more value for the customer than a lighting solution without IoT (Chapter 1.1)

5a The designed concept provides stakeholders access to data that is useful for them. (Chapter 4.2)

5b The designed concept takes the privacy of shoppers into account. (Chapter 4.2)

5c The data gathered in the designed concept is secured. (Chapter 4.2)

6.2 Wishes

Based on the analysis and design challenge, multiple criteria were defined. These criteria were divided under desirability, viability, and feasibility criteria. Based on these criteria design decisions will be made.

Wishes

Desirability: Do stakeholders want this?

The designed concept fits the brand identity of PLUS. (Chapter 3.4)

The designed concept addresses wants of Signify, PLUS, Installer, Outliner, Recycler and Manufacturer. (Chapter 3.5)

The designed concept is resilient to misuse. (Chapter 4.2)

Viability: Should Signify do this?

The value of the product is kept as high as possible. (Chapter 4.1)

The designed concept is profitable. (Chapter 4.1)

The designed concept provides insights in its environmental benefits. (Chapter 4.1)

The designed concept stimulates Signify to minimise production and increase efficient utilisation. (Chapter 4.3)

Feasibility: Can Signify do this?

The designed concept can be offered before 2021. (Chapter 3.3)

The designed concept fits the ecosystem of PLUS Netherlands. (Chapter 3.4)

The designed concept includes responsibilities for each stakeholder. (Chapter 4.1)

The designed concept provides a solution for reverse logistics. (Chapter 4.1)

The designed concept provides a way to manage large amounts of data. (Chapter 4.2)

The designed concept improves the collaboration between stakeholders. (Chapter 4.2)

PART III: DEVELOPMENT

This part of the report will show how ideas were developed based on the design challenge from chapter 5. Furthermore, it will show how ideas were selected using the requirements from chapter 6. Finally, it will show the concept that was created using the wishes from chapter 6.

CHAPTER 7: IDEATION

Photo by James Pond on Unsplash

CHAPTER 7: IDEATION

This chapter provides an insight in the process of idea generation. It shows which methods and tools were used to generate ideas. Additionally, it will show which ideas were the result of this ideation phase.

7.1 Creative session

A creative session with students who were not involved in the project before was held to break loose from the criteria. The idea was that the students would provide more out of the box ideas than people being aware of the restrictions. The results of the session were used as inspiration for the next ideation phase. More detailed insights in the results of the session can be found in appendix B.

7.2 Morphological chart

After the creative session an individual ideation phase followed. In this phase a morphological chart* was created. This morphological chart provided an overview of the possibilities for different aspects of a PSS. By connecting these possibilities and looking back to the creative session, three ideas were created. More insights in the morphological chart can be found in appendix C.

** In a morphological chart the different aspects or subproblems of a concept are listed vertically and the different solutions for each of the aspects horizontally. By connecting different solutions for subproblems, concepts can be created.*

7.3 Created Ideas

The three ideas which resulted from the morphological chart were developed further. It was decided to develop them all to an explainable but not too detailed level. This way they would allow feedback on the ideas rather than the details. This small detailing phase led to the following ideas:

Store Experience As A service

The first idea was Store Experience As A Service (fig. 7.1). It is a service were retailers pay a fixed rate per month. By gathering insights about the effects of lighting on the way shoppers experience the lighting, the store experience can be improved. With this idea it might even be possible to combine these insights with the sales data to see if an improved experience increases sales. If this is the case, the fixed rate can be exchanged for a rate that is depending on the sales of a store. The fact that the result of this service is clear and might cause increase of sales, might convince store owners to go for a service contract. Signify makes sure the lighting will change when the store layout changes. Over time, Signify will add new light recipes and beyond lighting functions as indoor positioning to improve the store experience. The difference with the LAAS as offered before is that it focuses on the store experience as result instead of just lighting. This means that also applications can be added that go beyond lighting. At the end of a contract, or when luminaires break down, Signify has to take care of their products.

ModuLuminaires

In the ModuLuminaires (fig. 7.2) idea store owners buy the whole lighting system. The system comes with an accompanying application that provides an overview of the owned lighting elements. For this application the store owners will pay a small fixed rate per month. Both the application and the lighting system allow for upgrades. This allows store owners to start with a basic lighting system first, and add functions as indoor positioning or Li-fi later on. This upgradability is possible because the luminaires consist of separate 'blocks' that can be assembled in the store by the store owner. Another benefit of this idea is that these luminaires are very easy to install, which saves a lot of operational costs. This fits with entrepreneurial and self-regulating mindset of the store owners. When certain 'blocks' are not used anymore, the retailer can return the 'block' and will receive discount on new 'blocks'.

SecondLightLife

SecondLightLife (fig. 7.3) is a combination of tagged luminaires and a platform were retailers can buy second hand luminaires. The tags create the possibility to track information about the luminaire. This data can be used in a 'lighting passport' to show how much life and light is still left in the luminaire. This idea stimulates franchisers to return their old luminaires to Signify by providing a deposit fee on luminaires with a service tag. The idea also stimulates Signify to restore the value of the luminaires to make it more profitable to sell them. By clearly branding them as second-hand, the retailers are able to show their corporate social responsibility,.

Figure 7.1 Store Experience As A Service

Store Experience As A Service

- Francisers pay a fixed rate per month (possibly percentage of conversion rate)
- Store experience: Perfect lighting at all times
- Insights about store expierence of shoppers
- Possibility to improve the store experience of shoppers
- System will grow, functionallities will be added
- Signify owns the complete system
- Signify will take care of the end of life

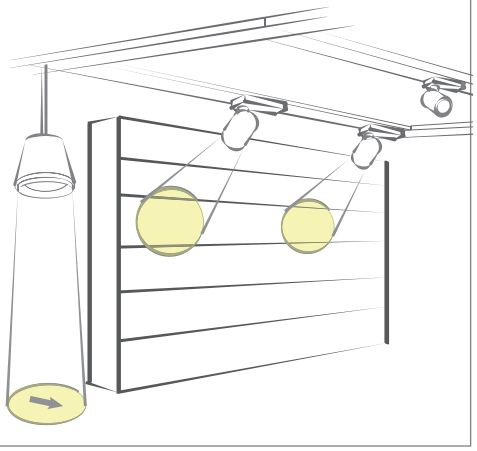


Figure 7.2 ModuLuminaires

ModuLuminaires

- Francisers pay a small fixed rate per year for the basic software application
- Products, systems and services are bought as separate 'blocks' that can be installed by the franchisers themselves (plug and play)
- The application gives an overview of all installed products, systems and services and their performance.
- More 'blocks' will be added over time
- Franchisers get a discount on new 'blocks' when they return old ones.
- Signify has to do something with the returned luminaires

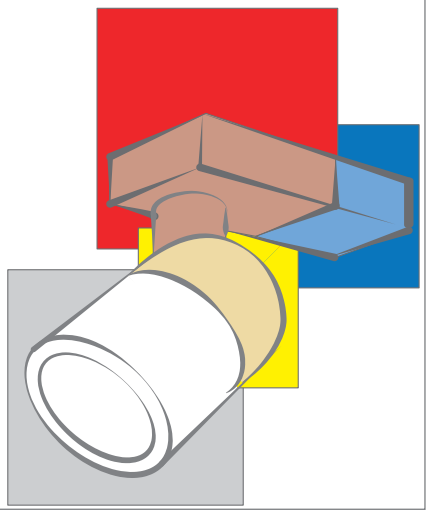
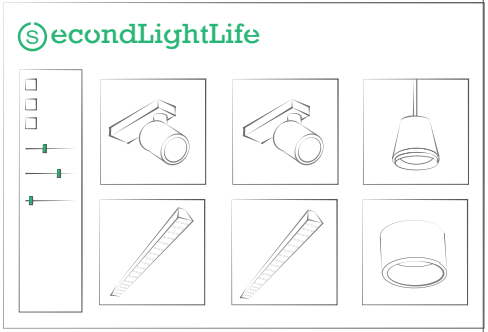


Figure 7.3 SecondLightLife

SecondLightLife

- Franchisers can buy single luminaires online
- Lighting designers can acces the platform via their design software
- Franchisers get a deposit fee if they return old luminaires to Signify (buying back)
- The specs of the luminaires need to be assessed
- In the future a 'lighting passport' will track the specs of the luminaires
- Signify refurbishes the luminaires when needed.
- The luminaires are branded under a different Signify second-hand brand



CHAPTER 8: SELECTION

Photo by Mickael Tournier on Unsplash

CHAPTER 8: SELECTION

This chapter provides insights in the choices that were made to get from the ideas from chapter 7 to one concept. First, some insights in the pros and cons of the ideas are provided. Secondly, the ideas are confronted with the requirements. Finally, the selected elements for the final concept will be shown.

8.1 Feedback Sessions

To gain insights into the pros, cons, and interesting points of the ideas, two feedback sessions were organized. One session was held with fellow students, because they are not restricted by Signify's cultural and organisational barriers. The other session was held with Signify employees because they do know about the Signify's internal restrictions. Detailed results of these sessions can be found in appendix D.

Feedback from the Signify employees

The group with Signify employees consisted of an IoT expert, a product expert, a sustainability expert, a lighting expert, a customer expert, and a proposition expert.

According to the employees all ideas had multiple pros, cons and interesting points. A main issue with the Store Experience As A service was that the employees thought retailers are not really eager to pay for service contracts. However, they also mentioned that this mindset might change in the future and that an added value as improvement in sales could maybe help. A deal breaker for the ModuLuminaires was the fact that letting the retailers install parts themselves was not in line with the safety protocols. Currently, retailers do already install the luminaires themselves, but if Signify wants to sell the luminaires as self-installable, they need to make sure it completely safe to do so. This requires another power inlet, for example a LAN cable. The idea of selling luminaires second hand seemed to be new and inspiring for the Signify employees. This is in line with the fact that no examples of reuse or redistribution were found (Chapter 4.1). Additionally, they saw the value of this idea for starting retailers that do not yet have enough money to invest in high-end lighting. A huge benefit of this idea for the employees was that it would improve the sustainable image of Signify. In the end, Signify was most interested in the SecondLightLife idea because it was something they were not yet working on themselves.

Feedback from the students

The students saw pros, cons and interesting point in all ideas as well. However, their overall conclusion was that the different ideas should be combined. Store experience as a service was according to the students most sustainable and valuable for retailers on the long term. However, this would require Signify to use modular products and be able to reuse products from the one store in the other. In order to efficiently reuse product Signify would require a system that would tell them for which functions available luminaires were still suited.

8.2 Fit with requirements

Figure 8.1 shows whether the ideas fit with the requirements as stated in chapter 6. If an idea does fit a requirement the box is ticked, if not a red cross is placed and when it is unclear whether an idea does fit the requirements, a question mark is shown.

As can be seen in figure 8.1 Store Experience As A Service (SEAAS) is the only idea that possibly fits all requirements. In appendix E the complete reasoning behind why an idea does or does not fit a requirement can be found. The most important reason why ModuLuminaires and SecondLightLife do not fit the requirements is because these ideas are not use or result oriented. The question mark at requirement 1b is placed because, although these ideas do try to stimulate retailers to send their products to Signify, it is unknown whether or not retailers would really do that. Signify can therefore not guarantee products do not end up in landfill and can therefore not position this ideas as circular. SecondLighttLife, although it creates value for Signify on the short term, does not meet the criteria of creating a long-term relationship with the retailer. Finally, it is unclear how the IoT element in the SEAAS and Moduluminaires ideas supports circularity. It could be said that it allows for predictive maintainance or a digital material passport, but how that would work, is not clearly explained.

8.3 Combining ideas

Altough Store Experience As A Service is the only idea that has the possibility to fit all requirements, some questions about the fit with the design challenge* remain unanswered. How to make this PSS flexible and upgradable? How to enhance

** Design a circular PSS that improves the store experience by offering flexible & upgradable supermarket lighting for PLUS that uses IoT to enhance collaboration between relevant stakeholders in using resources more efficiently and closing the loop..*

Figure 8.1 ideas meeting requirements

the collaboration between relevant stakeholders in using resources more efficiently and closing the loop? Some aspects of the other ideas provide answers to these questions. The modularity and upgradability of the ModuLuminaires could enable the SEAAS to be more flexible and upgradable. The idea of a platform with lighting passports could enhance the collaboration between stakeholders involved in the SEAAS idea by providing insights in the status of the luminaires. Additionally, this platform could also store and process data related to the result of the service to enable stakeholders to also communicate about how to improve this result. To answer the design challenges it was therefore decided to use the SEAAS idea as a basis and add modular luminaires and a platform with data about the luminaires and the result of the service to it.

CHAPTER 9: CONCEPTUALISATION

Photo by Milan Popovic on Unsplash

CHAPTER 9: CONCEPTUALISATION

The previous chapter ended with the combination of three ideas into a concept that delivers an improving store experience as a service. The idea of a flexible lighting grid would enable this improvement by being adaptable to changes in the store. Additionally, this grid would be upgradable to new technologies. The concept used the idea of a platform to make sure the luminaires can be reused when the contract with a store owner ends. This chapter provides insights in how these ideas were united into one integrated whole. It shows which choices were made to create the final concept.

9.1 Store experience & store optimisation

During the development of the concept, it became clear that store experience was not the right term to describe all the beyond illumination ideas in the concept. Some ideas as, for example theft prevention, had more to to with optimisation of resource usage and operations rather than experience. Since those ideas were still very valuable for the store owners, it was decided to keep them part of the concept, but refer to them as a different result: store optimisation.

At that point, two separate results existed: store experience and store optimisation. The enhancement of the store experience relates to actions that improve the in-store customer experience. This experience can be influenced by multiple factors as, for example, the appearance of the store and the convenience of the store. Store optimisation relates to actions including the change of the store's interior or store's operations that decrease the use/waste of resources and/or boost sales.

As stated in the analysis, most customers see Signify still as a provider of light and not of IoT solutions or data enabled services. If Signify wants to move from being just a lighting company to a provider of data enabled services, it is important they start with lighting, build customer relations and add data enabled services step by step. Providing all possible solutions at once might cause confusion and, in the worst case, customers selecting competitor brands.

In combining store experience and store optimisation, it was therefore decided to focus on lighting experience first and enable the concept to evolve into total store optimisation in the future.

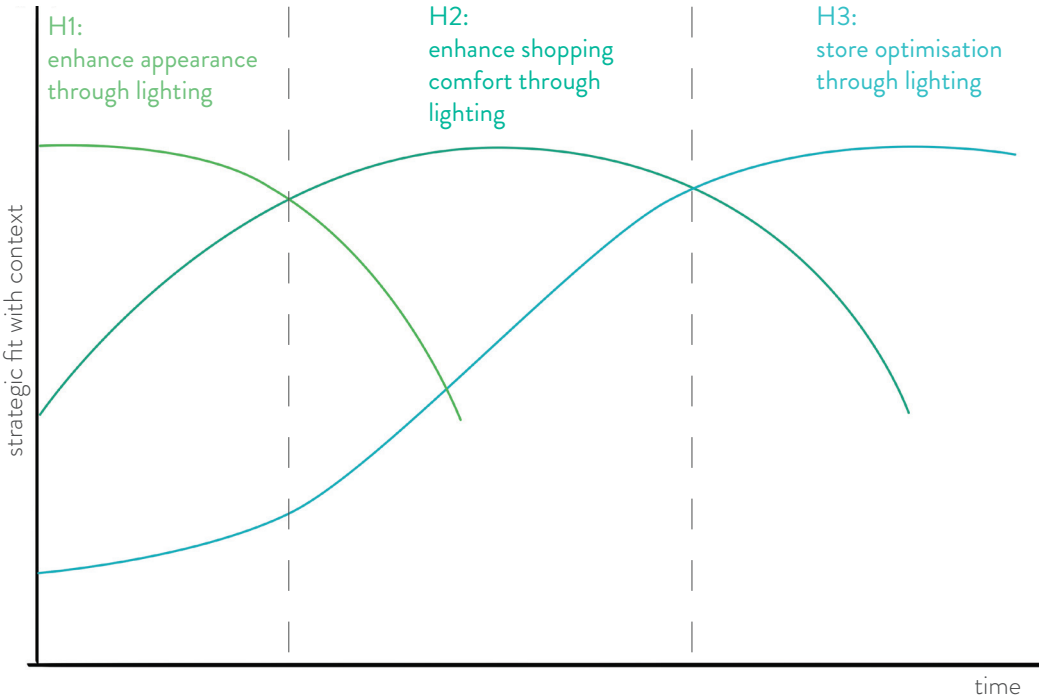
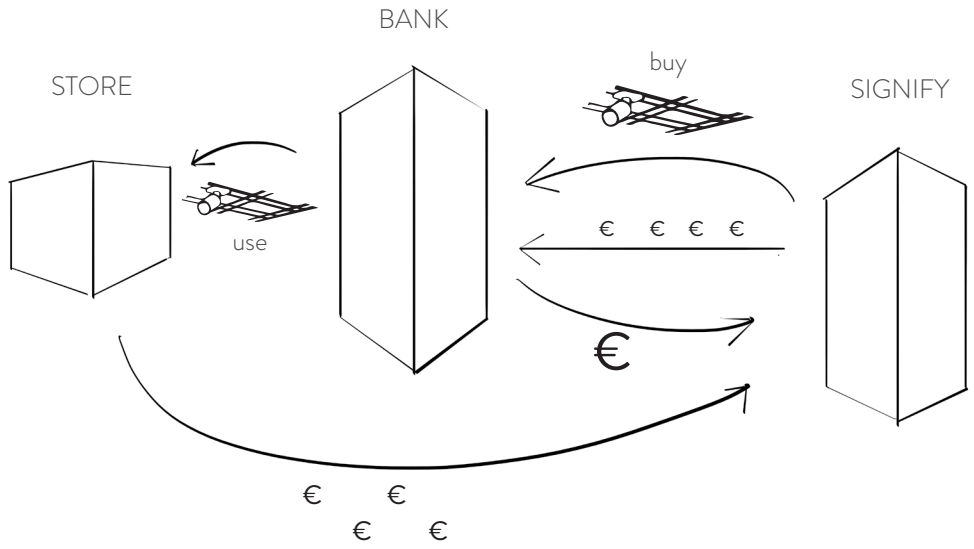


Figure 9.1 horizons based on three horizon model Curry & Hodgson (2008)

Figure 9.2 financial structure



Starting with light is especially important in the case of PLUS. Today, a quite basic lighting system is installed in the PLUS stores. Buying a high tech lighting grid with multiple new functions might currently be a bridge too far for the store owners. The possibility to start with a basic lighting grid, but be flexible to add functionalities in the future, suits the mindset of the PLUS store owners better.

To link store experience and store optimization, the three horizon model of Curry & Hodgson is used (2008). This model states that companies should start with maintaining and defending current core business, then nurture an emerging business and finally create a new business. In figure 9.1 can be seen how the concept will in the first horizon focus on Signify's current core business: improving the appearance of the store through lighting. Seconldy, a horizon follows that focuses on the enhancement of the store's shopping convenience. This horizon acts as a bridge between store experience and store oprimisation. This means functions as Indoor Positioning, which increase the convenience of the store will not be standard but can be added to the service afterwards. This second horizon is followed by a third horizon where Signify offers something that is new to PLUS: data enabled optimisation services. As the figure shows as well, the development of these data enabled services starts at the beginning of the first horizon. As can be imagined, these services require the existence of relevant data and gathering right and accurate data, requires time.

9.2 The financials

The fact that Signify wants to position this PSS as circular, makes an 'as a service' model, as explained in the analysis, the most suitable. This way Signify is able to control the end of life of the products they install. Ideally this would mean that Signify owns the products, since this would increase Signify's efforts to keep the value of their products as high as possible. Unfortunately, multiple employees indicated that Signify's shareholders do not like outsourced hardware on their balance sheet. It was therefore decided to, for now, add a financing company in between the store and Signify (fig. 9.2) that owns the lighting. Signify is familiar with similar constructions from other cases. To make the construction as easy as possible for the store owner, the store owner only pays Signify, who will pay the bank. It should be investigated whether the existence of a lease bank or financing company affects the way service providers and their clients treat their products in circular models. If it does, Signify should reconsider to ownership of the hardware.

Store experience as a service

An 'as a service' model also means that store owners will pay for a certain result. In this case this result is at first store experience and later on store optimisation. However, it is difficult to measure and express store experience in absolute numbers.

Store experience is influenced by the attractiveness and convenience of the store. The first one is affected by material and atmospheric variables. Both are determined by the formula manager when developing the store formula. Light is one of the atmospheric variables (Turley & Milliman, 2000) and can therefore affect or even enhance the store experience. The other variables (sound, scent, interior elements, temperature) are, however, more difficult to influence by Signify. Since Signify is currently only controlling one atmospheric variable, it seems tricky to let store owners pay for an increase in store experience in terms of percentages.

Additionally, store owners want to be able to control what the lighting is going to cost them, since their profit margins are low. If they pay for the increase in store experience, it is possible that they need to pay more and more over time. If their sales does not increase to the same extent, they get in trouble with their financials.

Since store experience is not only influenced by the offerings of Signify and store owners might not like the variability of the costs it was decided to let store owners pay a fixed rate per month. This rate is based on the layout of the store, the opening hours and the functionalities the store owner wants to add to the system.

According to Signify's website, an 'as a service' proposition for supermarkets could save a store of 400 m2 €234 per year (Philips Lighting, 2018g). You can imagine this relatively small amount is not going to change the product oriented mindset of the store owners and since the designed concept will contain additional technologies it will probably not be cheaper. This proposition has to convince store owners by the flexibility to upgrade the lighting.

Store optimisation as a service
If Signify has in the third horizon access to the financial data of the supermarket, it becomes possible to let retailers pay based on the profit of their store. If the profit of the supermarket is for example 100 Signify would get 1%, so in this case 1. If the profit thereafter rises to 120, Signify would get still get 1% so 1.2. In this case store owners do not have to worry they cannot afford the increase in costs, because their profit increases to the same extent. This business model would require Signify to be really sure on how to optimize a store. The assumption is that, by that time, Signify has gathered enough data to do so. As an additional benefit, Signify could also offer this data and insights to other parties.

9.3 IoT

Data sharing & collaboration
To be able to use the gathered data to improve the store experience and provide store optimisation in the third horizon, Signify should be able to access the generated data and be able to control the quality of the collected data and hereby the quality of the delivered result. Without data access the system will not work: The experience cannot be improved and adapted, sales cannot be increased and maintenance, reuse and improvement of products will be less efficient. If Signify would own the hardware, gaining access to this data would be relatively easy. However, as said before, Signify is not yet willing to own the hardware. Another solution is to store all the data on a platform that is owned by Signify. For stakeholders it is beneficial to store their data on the same platform. Combining the data layers from different stakeholders could lead to insights that are beneficial for the operational efficiency of all stakeholders. So they give something and get something back in return. This is similar to for example, Google Maps: If you share data about the speed of your car to Google, it can be combined with the speed of other cars. By combining these data layers Google is able to provide insights in traffic jams. Next time when you are approaching a traffic jam, Google Maps helps you to avoid it and you have time to do something fun. So, the whole system around this PSS should be about taking and giving. Each stakeholder will provide data and will get insights in return. This taking and giving principle (fig. 9.3) will be the basis of an improved collaboration between the stakeholders within the ecosystem. Signify needs to use this giving and taking principle to convince stakeholders to join the system and store their data on this platform. Keeping this in mind, it would make sense that parties that do not add data to the system, but want insights, give something back in terms of money. This money can be used to pay for the development and energy usage of the platform.

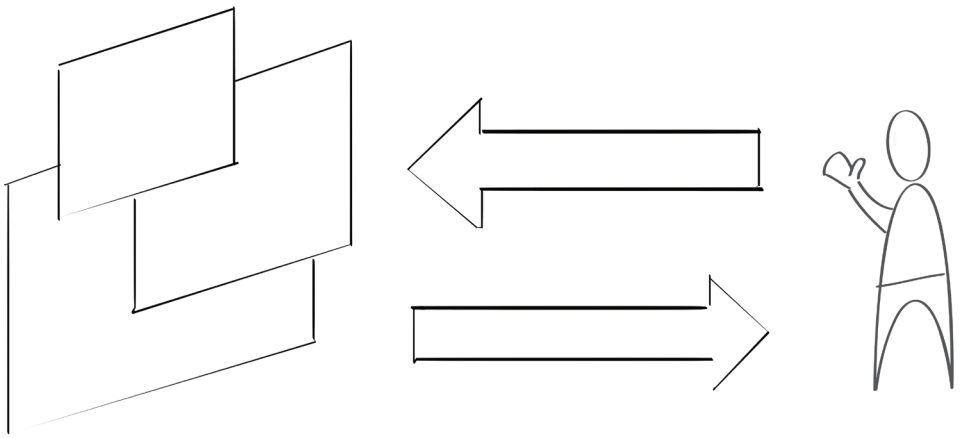


Figure 9.3 Taking and giving princliple

Adaptable sensors
To enable Signify to gather data about the store and the luminaires, the system requires ingoing data streams and sensors. Some of the data can, according to Signify's employees, be directly accessed through the driver of the luminaire (e.g. burning hours). Others can be accessed through the control software of the luminaires (e.g. light recipes). As can be imagined it is also beneficial to track data that is not yet accessible. This could for example include the temperature in the store, vibrations, movement, dust, outlining of the luminaires etc. Since data analysts explained that it is often difficult to predict which data will actually provide you with insights and which sensor works best to this, the type and amount of sensors should be flexible. This way it is possible to easily add new sensors and remove them when they appear to be useless.

According to the Signify employees it is hard to add sensors to a luminaire that were not there before. To make the system as flexible as possible it was therefore decided that the sensors will be separated from the luminaires (fig. 9.4).

9.4 Circularity

Adaptive lighting
Not only the sensors should be flexible. To make sure the appearance of the store is optimal, the groceries need to be illuminated by the right luminaire in the right way. This is why the lighting should be able to adapt to changes in the layout of the store. These changes are currently occurring once or twice a year. However, it should be noticed that these changes might increase and a promotional island is already changing more often. Additionally, improving the physical store experience comes with food related activities as wine tastings and craft afternoons. These activities require different lighting settings.

The changes in activities, the floorplan and preferably also changes in shelf layout should therefore be known by the system. Once an activity, floorplan or the shelf layout is changed, the settings, location and outlining of the luminaires should be changed as well (fig. 9.5).

Upgrade, update, and recycle
With luminaires that technically last over ten years, not only the appearance of the light should

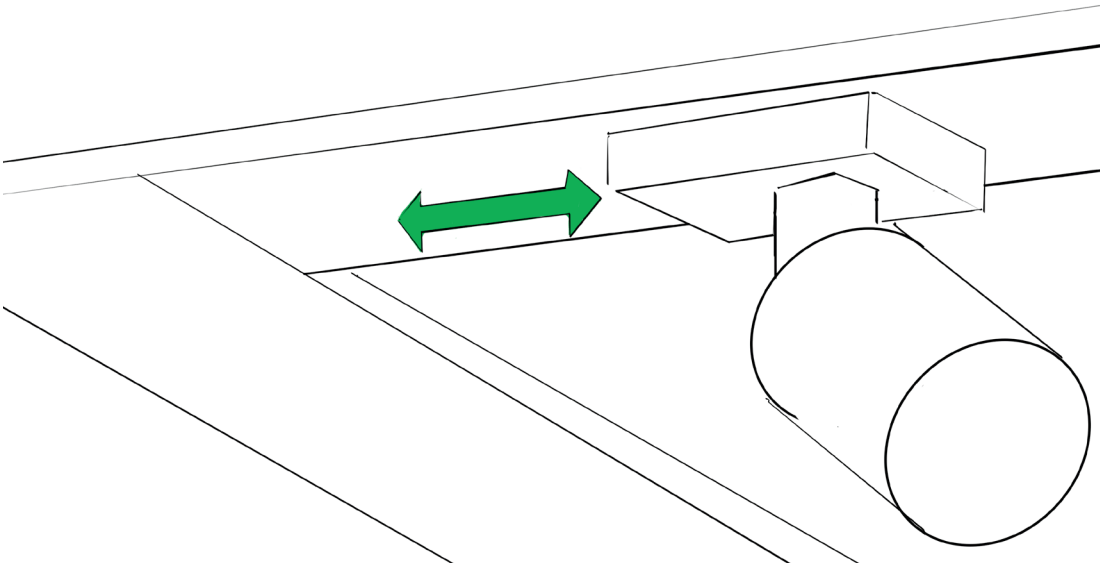


Figure 9.5 movability of luminaires

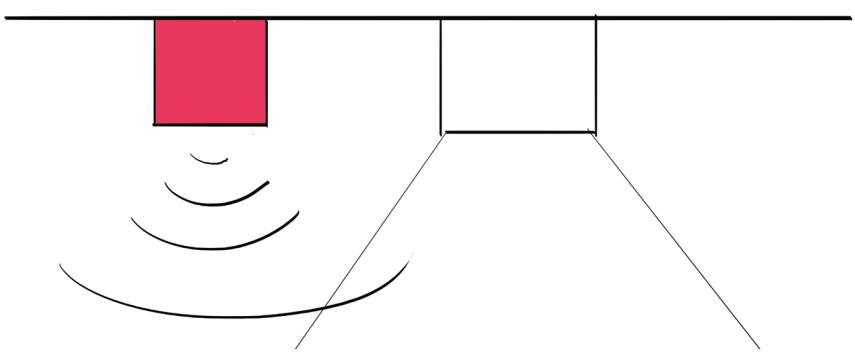


Figure 9.4 seprate sensor device

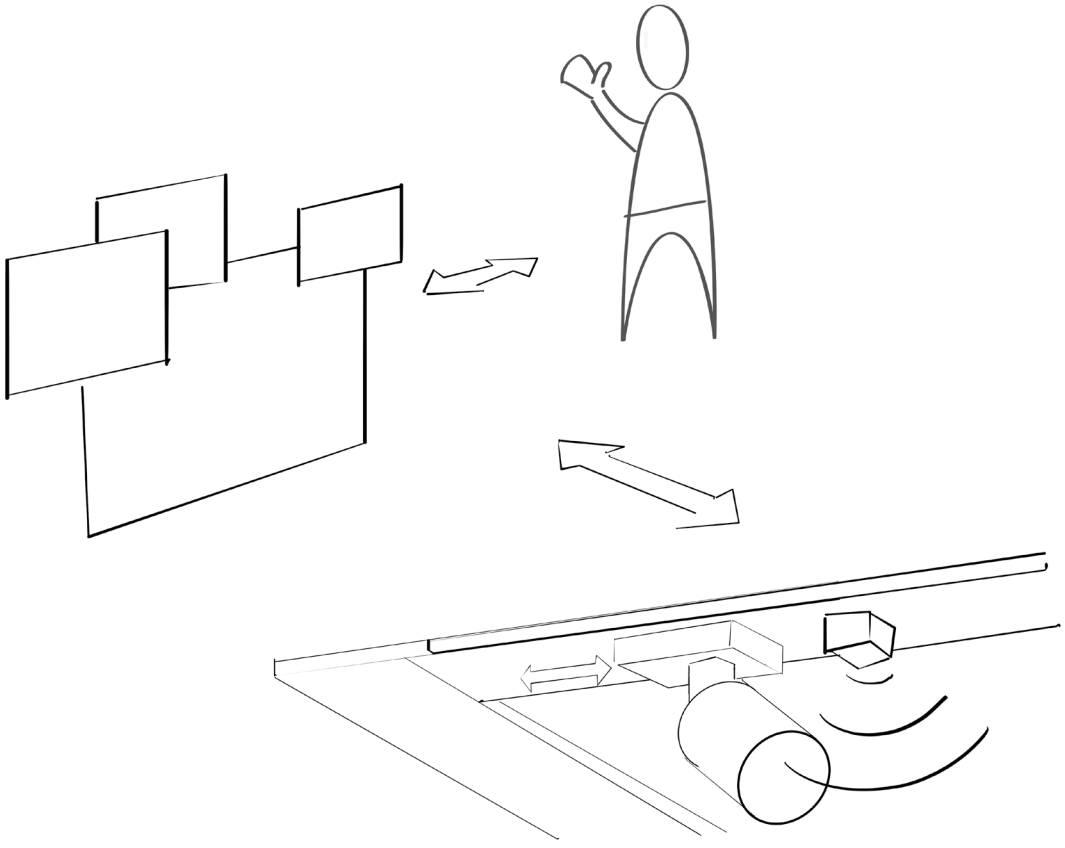
be able to change, but also the appearance of the luminaires themselves. Additionally, not only the appearance of the luminaires should be upgradable, ideally also the functionalities of the luminaires should be upgradable. According to Signify employees, it is in practice often difficult to upgrade the luminaires with new functions that did not exist when the luminaires were produced. This is why an effort has to be made to make sure the luminaires are at least enabled for the functionalities that currently available, or soon will be, and are enabled to be updated using the lighting grid.

Reuse

Since these luminaires are able to last more than ten years, they will face a deep refurbish, which happens every 5 to 10 years. This deep refurbish might cause luminaires to become redundant. Additionally, there is an indication that store owners are not willing to sign a contract for over 3 to 5 years (5 years is the technical lifetime of conventional lighting). This means that Signify, in order to keep the value of their materials as high as possible, should be able to reuse the luminaires. Reuse means in this case reuse in another store.

To be able to reuse luminaires in another lighting plan, the functionalities, remaining lifetime and current photometrics should be available. This is why the platform should also store so called 'luminaire passports'. The platform should show the lighting designer which luminaires are available for reuse and support him or her to design a lighting plan that requires as little new luminaires as possible.

As can be imagined the luminaires need to be somewhere between being installed in one store and the other store. The concept therefore requires a storage area, where the luminaires can 'wait' until they are needed. A reuse manager is needed to manage this stock and see if luminaires can easily be upgraded, updated or are too outdated an need to be recycled.



CHAPTER 10: FINAL CONCEPT

CHAPTER 10: FINAL CONCEPT

This chapter presents the final concept. First, the different components of the concept will be explained. Secondly, an overview will be given on how these components work together. Finally, a roadmap will show how the concept develops during the three horizons.

10.1 StoreSight

The final concept is called StoreSight. StoreSight is a circular result oriented product-service combination that initially aims to enhance the attractiveness of the store by means of responsive lighting. Over time, StoreSight will evolve from a service that enhances attractiveness of the store, into service that enhances the shopping comfort, and finally into a service that gathers different types of data to enable store optimisation. The name StoreSight was chosen because it fits with both improving the look (ambiance) of the store and the insights that lead to store optimisation.

Three components: Products, people and platform

Before the concept will be explained in more detail, first a few elements of the concept are explained. As figure 10.1 shows, the StoreSight system roughly consist of three components: lighting products, people or stakeholders and a software platform. The first component, in the bottom right, are the products, the hardware, which consist of a modular lighting grid with movable luminaires and an upgradable sensing devices (shown in pink). The second component, in the upper right corner, are the people that perform the service, here called the service squad. The service squad consists of the stakeholders from Signify and its partners who will interact with the store owner during the contract period. The final element is the platform, a digital software application, visualised in figure 10.1 as the encircled rectangles, which enables the different stakeholder to control the lighting and access the data gathered by the lighting grid.

10.2 Products: the adaptable lighting grid

In this paragraph, the hardware component of the concept will be discussed in more detail. The hardware refers to a smart and upgradable lighting grid including the trunking, luminaires, and sensing devices.

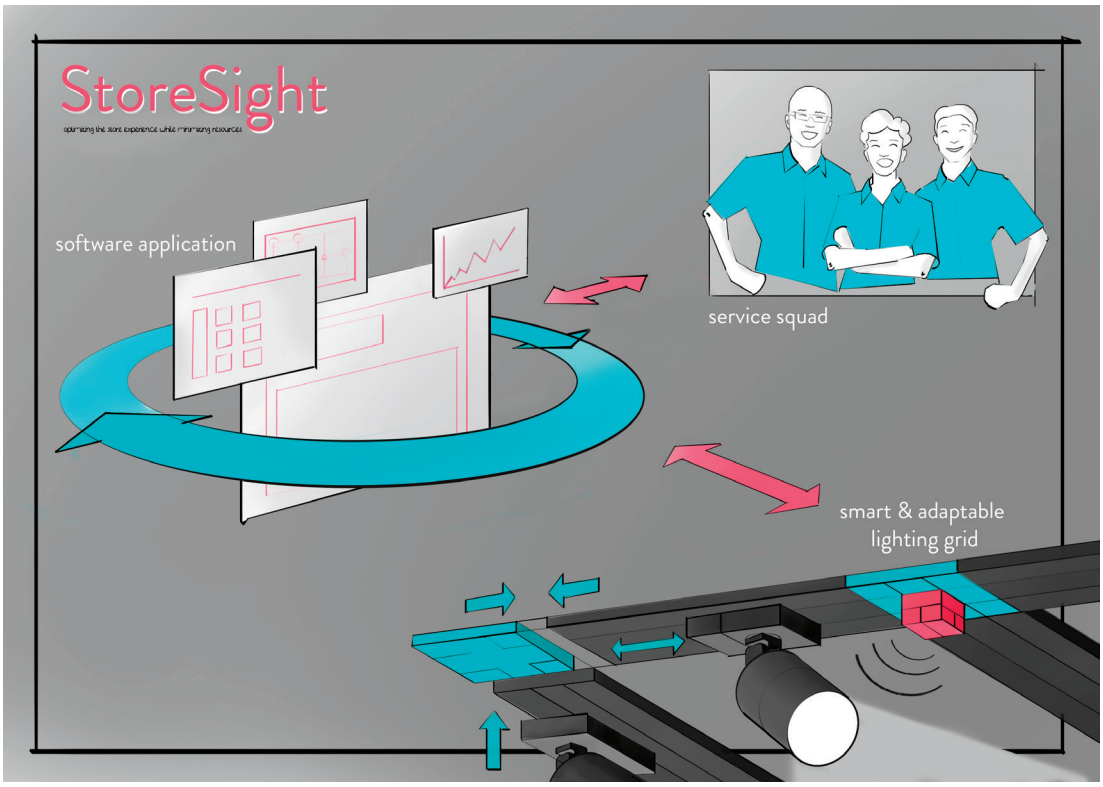


Figure 10.1 An overview of the different elements in StoreSight concept

Flexible trunking & control system
To be able to adapt the lighting system to the floorplan, the trunking should allow the luminaires to move to different locations in the store. To be able to get lighting at every location in the store, a grid shape will be used (fig. 10.2).

The system should enable flexibility of power groups, to allow the control and regrouping of single luminaires. This allows the lighting to adapt to the change of areas (e.g bread or vegetables) in the store. Additionally, this allows for the control of single luminaires.

Ideally the grid stays in one store for the duration of multiple contracts. Since store owners are free to end the collaboration after each contract period, the trunking should be able to be reused in another store. Therefore, the trunking should be able to be disassembled. To make it easier to fit used trunking in another store, the dimensions should be standardised. Figure 10.2 shows an idea of how this modularity could work.

For the sensors and drivers to be able to send their data automatically to the database, the system requires an internet connection. This means data is first gathered locally from a wired grid and then immediately send to the database. Additionally, these electronics need to be compatible with future technologies.

Currently, the Maxos Fusion trunking allows for replacement of the luminaires. Luminaires are wirelessly connected to the trunking and can be easily taken out of the trunking and placed at another point in the trunking. Also the somewhat older tracks allow spots to be moved.

With the currently available control systems it is not yet possible to control individual luminaires. However, Signify is improving the flexibility of power groups.

According to Signify it would be possible to deinstall the Maxos Fusion trunking and reinstall it in another store. It is important to keep in mind this trunking is not designed for that purpose. In Signify's current business model it is beneficial for store owners to use as less trunking as possible. Therefore sizes might not always be standardised. In StoreSights 'as a service' model it is beneficial to use more trunking now to make sure the grid will be still suitable in the future.

There are systems available that allow data to be send through the grid. Not all systems that are installed in stores today allow for this.

Flexible luminaires and responsive lighting
Being able to replace the luminaires on the trunking does not only affect the trunking, but also the luminaires themselves. Plug & play luminaires (fig. 10.3) make the installation and movement of the luminaires easier, quicker and therefore cheaper. Cheaper operations are beneficial for Signify when the StoreSight concept is considered. Ideally, the luminaires can be clicked onto the

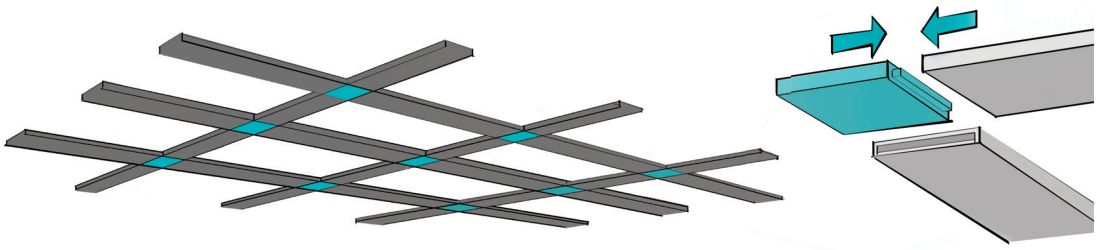


Figure 10.2 standardized trunking grid

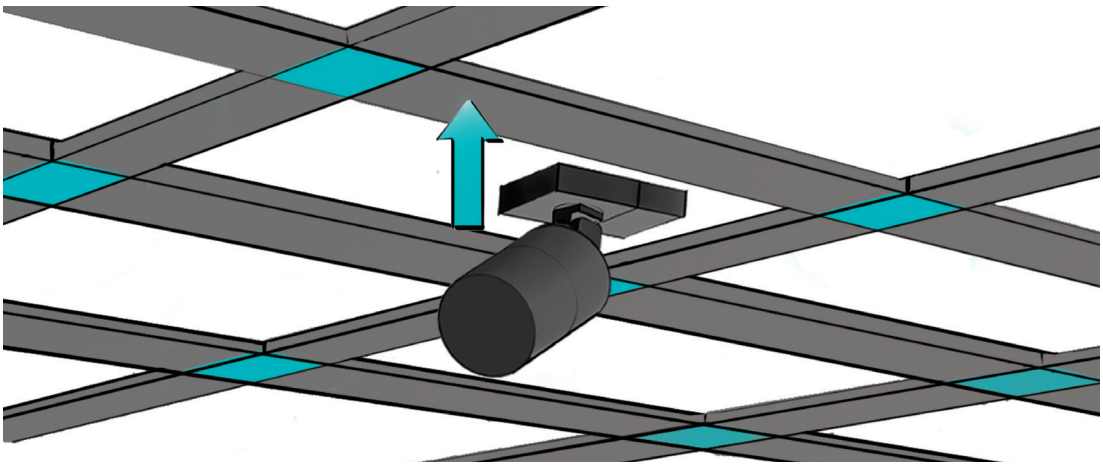


Figure 10.3 Plug & play luminaires

trunking in one movement and do not require additional wires to be connected.

Replacing luminaires could be done by the store owner, but this is not in line with the 'as a service' proposition and can, moreover, be unsafe because the store owner is not educated to do this. Replacing the luminaires could also be done manually by the outliner or installer. However, when the luminaires need to be replaced weekly, this would become costly.Then there is the option to motorize the luminaires and move them on distance. However, motorized luminaires are quite expensive as well.

In figure 10.4 and 10.5 calculations are made to show the costs of different options. The prices are based on the average cost of a luminaire for PLUS and numbers provided verbally by Signify employees. In this calculation the assumption is that motorized luminaires can be controlled from outside the store. 10 years is chosen as time span since, according to Signify the average lifespan of a LED in retail is 10 years.

As can be seen motorizing all luminaires (fig. 10.4)(2) would in comparison to the current system (fig. 10.4)(2) be four times as expensive. But, if luminaires have to be moved weekly by an outliner (fig.10.4)(3), motorizing all luminaires would be cheaper. The question is whether moving luminiares weekly is realistic. A more realistic assumption is that store owners change their layout once or twice a year and make smaller adaptations, to for example promotional islands, every season and during events as Christmas, the world championships or Easter. This means that somebody has to go to the store twice a year to move luminaires and if motorised luminaires are available, the other 6 adaptations can be done automatically. A calculation of this scenario shows that a few motorized spots would actually beneficial (fig. 10.4)(4&5). These spots would allow for small changes that promotional islands require without the need for an installer to go to the store. In figure 10.5 can be seen that the longer the contracts last, the more beneficial it is to have a few motorised spots. It would in this case be enough to be able to

Figure 10.4 Calculation of total cost in different scenarios

Variables	
Number of luminaires	400
Price of an avarage luminaire	€ 100,00
Price of an motorized luminaire	€ 400,00
Costs of sending someone to the store	€ 300,00
Time span of calculation	10 years

1. Current situation (twice a year to the store)
2. All luminaires motorised (no need to go to the store)
3. No motorised luminaires and weekly adaptations
4. No motorised luminaires and seasonal adaptations
5. 25 motorised luminaires and seasonal adaptations

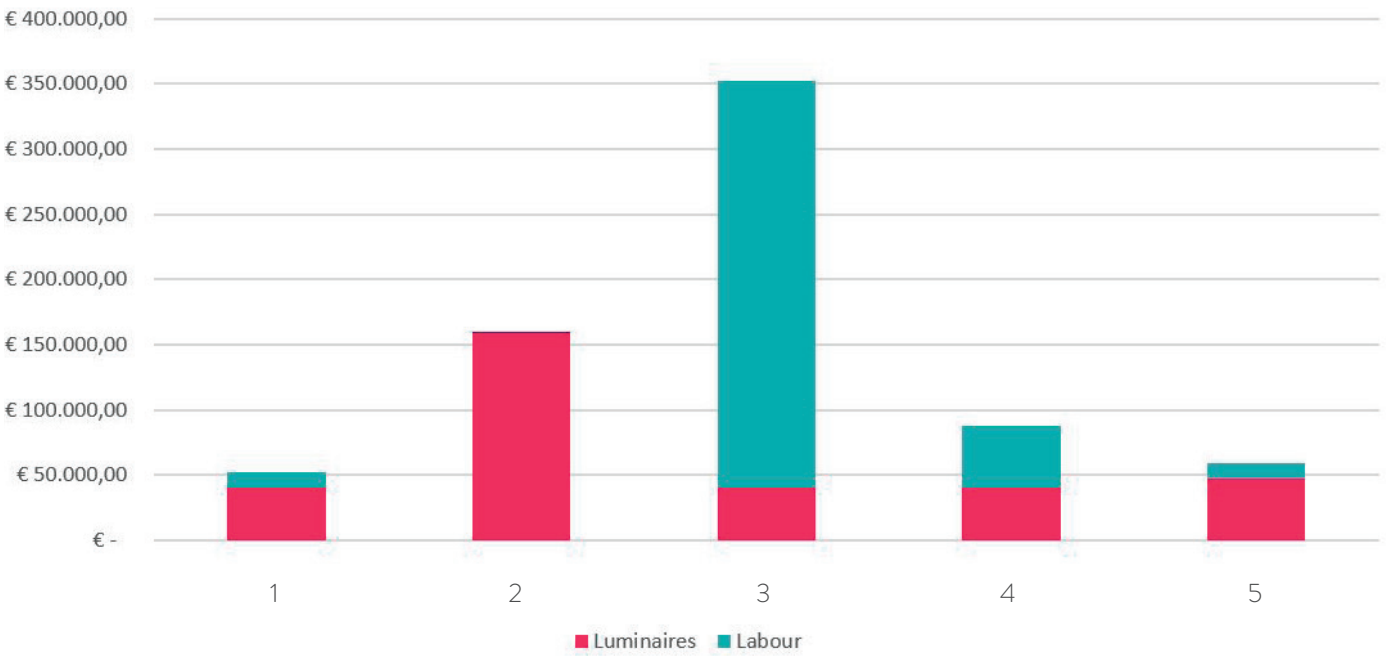


Figure 10.5 Development of total costs over time

redirect the beam of the spot. A spot similar to the in 2019 available EasyAim spot could therefore do the job.

To enable the re-outlining of luminaires on distance, something is needed 'see' what to aim at. Appendix F gives an overview of ideas on how to do this. Finally the idea where the store owner uses his StoreSight interface seemed to be the most feasible and viable idea to start with. This could later on be automated to minimise the sensitivity of the service to human mistakes. A way to do this is by installing cameras and learning the system to detect the location of the island and the outlining of the luminaires.

To summarise, StoreSights responsiveness works in two ways: First, when the store owner reports bigger adaptations, an installer will come over to move the luminaires. Secondly, when the store owner indicates smaller changes, to for example promotional islands, he can use his tablet to redirect the lighting. This could be automated over time.

CE ready luminaires

With the business model of StoreSight it is important luminaires are as CE ready as possible. Signify has it own checklist to check the luminaires on future readiness, ease of disassembly, serviceability, ease of reusing components and recyclability. The product designers should aim to make their products score as high as possible on these points.

Signify already has a solution for making the look of suspended luminaires upgradable by allowing for change of casing: the telecaster luminaires. In the new concept this idea of being able to renew the look of the luminaire by locally printing a new casing from old casings could also be used for other types of luminaires like spots. Additionally, 3D printing allows for a reduction in the amount of parts and makes disassembly easier due to the limited amount of fasteners. This is important since this makes maintenance, recycling, and upgrading easier as well.

Another important requirement in the design of these luminaires is the fact that their drivers need to be able to record some usage data and share this through the grid. Currently some drivers exist that are able to record burning hours and failure data. For the StoreSight concept to work, it is important that this data is not only stored local, but send to a central database.

Tags

When the lighting system is flexible and the luminaires are being replaced, the lighting plan should be updated as well to enable installers to quickly indicate a luminaires location when one needs to be repaired or upgraded. Additionally, to make the system ready for Indoor Positioning (second horizon) it requires an up-to-date location of the luminaires. Currently, the IPS system is based on stationary luminaires. The app indicates the position of the shopper in relation to the luminaire. By combining this data with the lighting plan, the app is able to indicate the location of the shopper in the store. There are diferent ideas about how to get the locations of the luminaires into the system (Appendix G). Adapting the lighting plan could for example be done manually in the application by somebody from the service squad. However, to make the service independent from stakeholders and prevent human mistakes, it was chosen to use the stationary sensing devices on the trunking in combination with a tag on the luminaire to indicate positions of the luminaires to enable an up-to-date the lighting plan.

There are different ways to tag the luminaire. The most used ones are QR, RFID, NFC, and barcodes.

The QR, barcode and NFC chip are only readable from a close distance and would require a installer to climb on a ladder to actively scan the tags. RFID tags have a longer range and can be accessed from a bigger distance up to 100 m. Additionally, RFID tags can also be used to indicate distance. This is necessary when the location of the luminaire should be defined.

Since this application does not require to be tracked continuously (active RFID), the passive RFID would be a suitable and cheaper option.

To make sure the luminaires can always be identified, even when the RFID tag breaks down, a QR code is added to the product as well. This allows recycling companies to be still able to access the material passport of the product and allow the reuse manager to see if there are relatively new parts left in the luminaire that can be reused.

Sensing devices

Separate sensing devices come with a few additional benefits. The first one is, as already mentioned in chapter 9, the fact that is easier to upgrade the technology in a separate device than upgrading the luminaire. The device can be made as a box on to which all kinds of sensors and other modules can be connected (fig. 10.6). This enables the system to gather data about factors that possibly influence the degradation of the luminaire. This enables Signify to improve the designs of newer luminaires. Moreover, this allows to track data which can lead to insights for store optimisation.

Secondly, the devices can be placed in such a way they cover the complete store (fig. 10.7a), whereas the lighting plan determines where the luminaires should be placed (fig. 10.7b). If the sensor covering should also be taken into account when designing a lighting plan, the complexity of a lighting plan would be increased and the flexibility be reduced.

A third benefit of an external sensing device is the fact that the actual light intensity can be measured outside the luminaire. The actual light intensity provides insights in the degradation and failure of the LEDs. Measuring currents through the luminaire could also provide insights in the failure of LEDs, but are not able to take into account external factors such as dust. This data can be used to check if the lighting is still as preferred and send someone over to repair a luminaire. It can also be used in combination with the data about temperature and humidity to create models that predict the failure of a luminaire and finally to improve the design of the luminaires.

One advantage of adding multiple sensors to one device instead of using multiple devices is that it could minimise the amount of material needed: One device would require only one power inlet, one driver and one casing.

Another benefit could be that it is easier to map the locations of these devices if they are attached to a cross in the grid (fig. 10.7). Randomly attaching sensors to the grid requires someone to carefully map these locations. This accurate location is needed to be able to combine different layers of sensor data. To make the system less dependent on the accuracy of a person, it was decided to attach the devices to pre-defined locations on the grid. It is also still possible to determine the location of sensors by adding RFID tags to the sensing devices.

To illustrate the importance of accurate locations of the sensors, figure 10.8 shows multiple data layers that could be created by the system. By combining these layers it becomes possible to generate new layers. If the location of the sensors is missing, this is not possible. For example, the second layer on top shows the location of the sensors. The first bottom layer shows the distance of a certain luminaire to different sensing devices. By combining these two layers with the grid layer, the location of the luminaire on the grid can be calculated. If the location of this device is unknown, the exact location of the luminaire also remains unknown.

Something similar would be possible for the light intensity. When the luminaires are installed, the outliners makes sure the luminaires are outlined the way the DiaLux file tells them to. Next, the sensors need to be calibrated using the values provided in the same DiaLux File. When the measurements of the sensors are no longer in line with the given values, the system knows something is wrong with the lighting and could be programmed to send a message to the right stakeholder. After calibration this idea could also be used to line out the luminaires from outside the store.

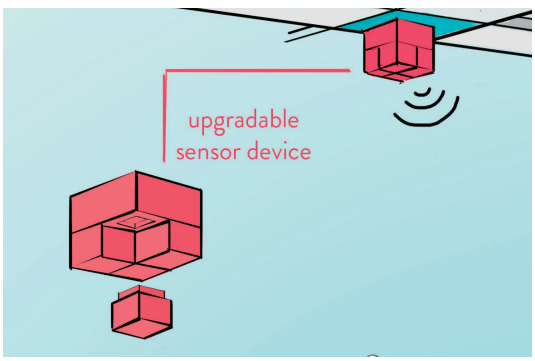


Figure 10.6 Upgradable sensor device

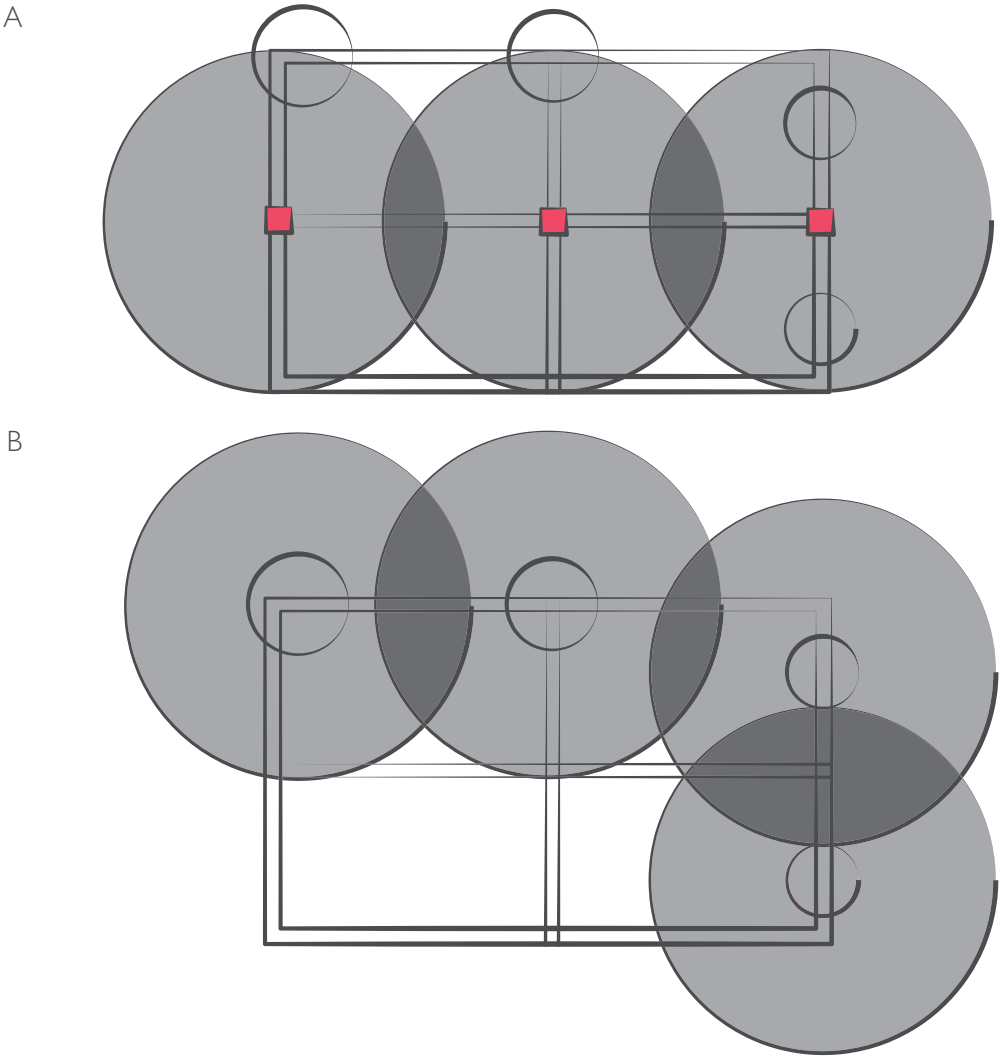


Figure 10.7 Sensing area covered by the luminaires

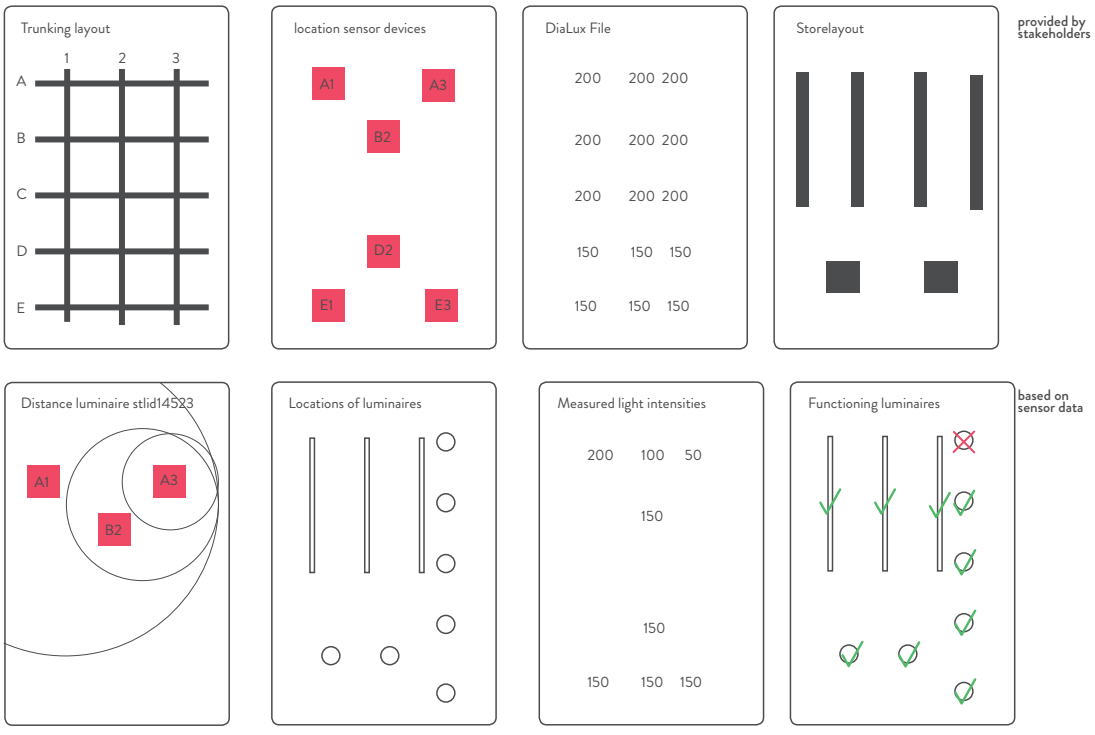


Figure 10.8 possible layers of data

10.3 People: The service squad

As said before, the stakeholders that interact with the store owner are called the service squad. The current members of the service squad are, as shown in figure 10.9, an installer, an outliner, a lighting designer and an account manager. The service squad is however not able to deliver the service autonomously. Firstly, the confirmation and collaboration of the formula manager and BWI manager, shown in figure 10.10 in green, is needed to fit the service with the formulas of the headquarters of PLUS. Secondly, the collaboration of the support squad, shown in figure 10.10 as the puppets in pink, is needed to close the loop and have the right resources. In the support squad a new role is added: the reuse manager. It is the responsibility of this stakeholder to store the luminaires and check which luminaires are available for reuse. All stakeholders will get new responsibilities. These new responsibilities will be discussed below.

The stakeholders from the PLUS headquarters have to keep in mind the look and feel of the luminaires that are already installed in stores in the design of their formulas instead of having the choice to buy new ones. The store owner has to report the changes he makes to the layout of the store in the StoreSight application.

The installer has to report all changes he makes to the luminaires in the system. Additionally, he needs to carefully take luminaires from the ceiling when a deep refurbish takes place or a store owner ends the collaboration.

The outliner has to be educated to control the luminaires using the StoreSight interface. It is also preferred to educate installers to line out luminaires. In this case only one person has to go to a store once or twice a year to reposition and re-outline luminaires. This would save the cost for an additional person.

The platform allows the account manager to directly contact the store owner and the other way around. Currently, the account manager is in contact with the headquarters only. The communication with store owners would require some additional time from the account manager.

Lighting designers need to keep the adaptability of the lighting in mind when designing a new lighting plan. This is mainly the case for the initial formula lighting plan. The lighting designers that create the plans for specific stores need to use the luminaires that are available for reuse. It could however be possible that no used luminaires are available to create a consistent look. In this case the reuse manager should upgrade the looks of some luminaires before the used luminaires go to the store.

Also the support squad has to change its behaviour. The recycler has to indicate which luminaires are being recycled. This way passports from luminaires that do not exist anymore can be deleted. This also creates the opportunity to provide insight in how and how many loops are closed and luminaires saved.

The manufacturer will have to enter which materials are exactly used. He also has to connect the luminaires to the system to enable the luminaires to be tracked during transport.

The service designer will also get a more extensive role. He/she has to come up with additional functions based on insights from the account manager. The service designer will also be responsible for the testing of these functionalities in real stores.

The data analyst will be more involved in the development of the concept. His/her task will not only be focusing on analysing the data afterwards, but also on what data to gather, how and when.

Product designers have to collaborate more with the service designers to make sure their products enable the services of the service designers. Additionally, the CE readiness in this service model is more important than in other propositions. Additionally, Product designers also have to enter information about the luminaires in the system to enable luminaires to be connected to these specifications.

10.4 Platform: The software application

Since Signify is already working on the development of a platform, Interact, SotreSight uses this platform to store, secure and access the data. What this platform is already capable of was not clear during this project. The capabilities this platform should have in order to make use of the functionalities of the StoreSight concept are explained below.

The platform should be accessable in different ways. Phone- or tablet applications might be the most useful for stakeholders in the field such as the installer and the store owner. For the data analyst a desktop application would be sufficient enough. But also for the store owner and installer a desktop version or a web application that would allow desktop use could be useful.

To provide more insight in which data is gathered and what it is used for, an overview of the dataflows including the most important stakeholders is shown in figure 10.11. In the middle of the figure the cloud on which all the data is stored is visualised. The pink lines and boxes represent the data that is

Figure 10.9 The service squad

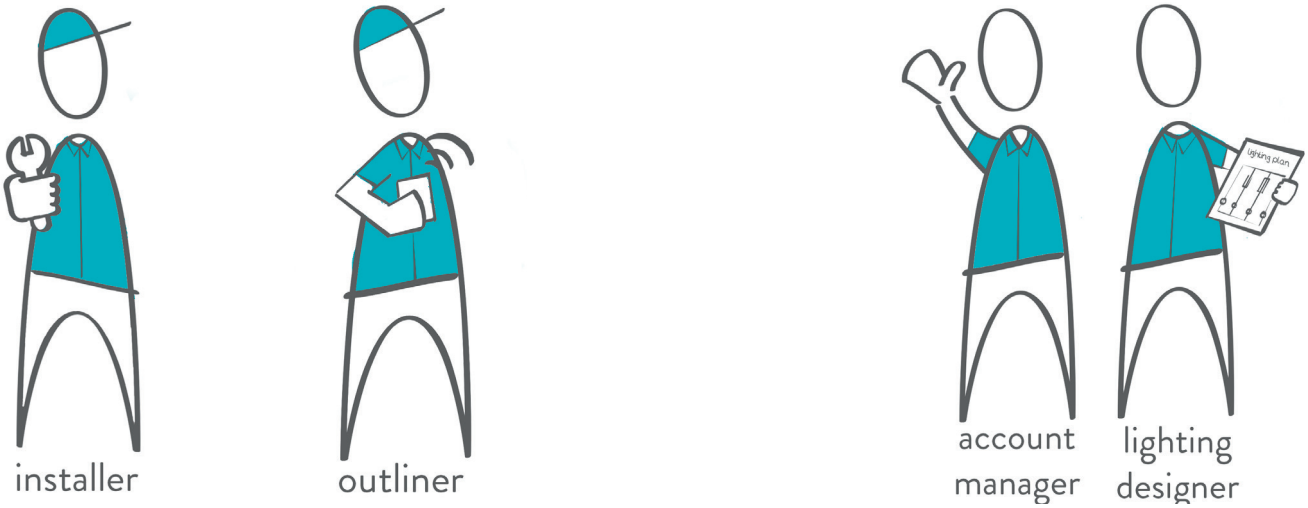
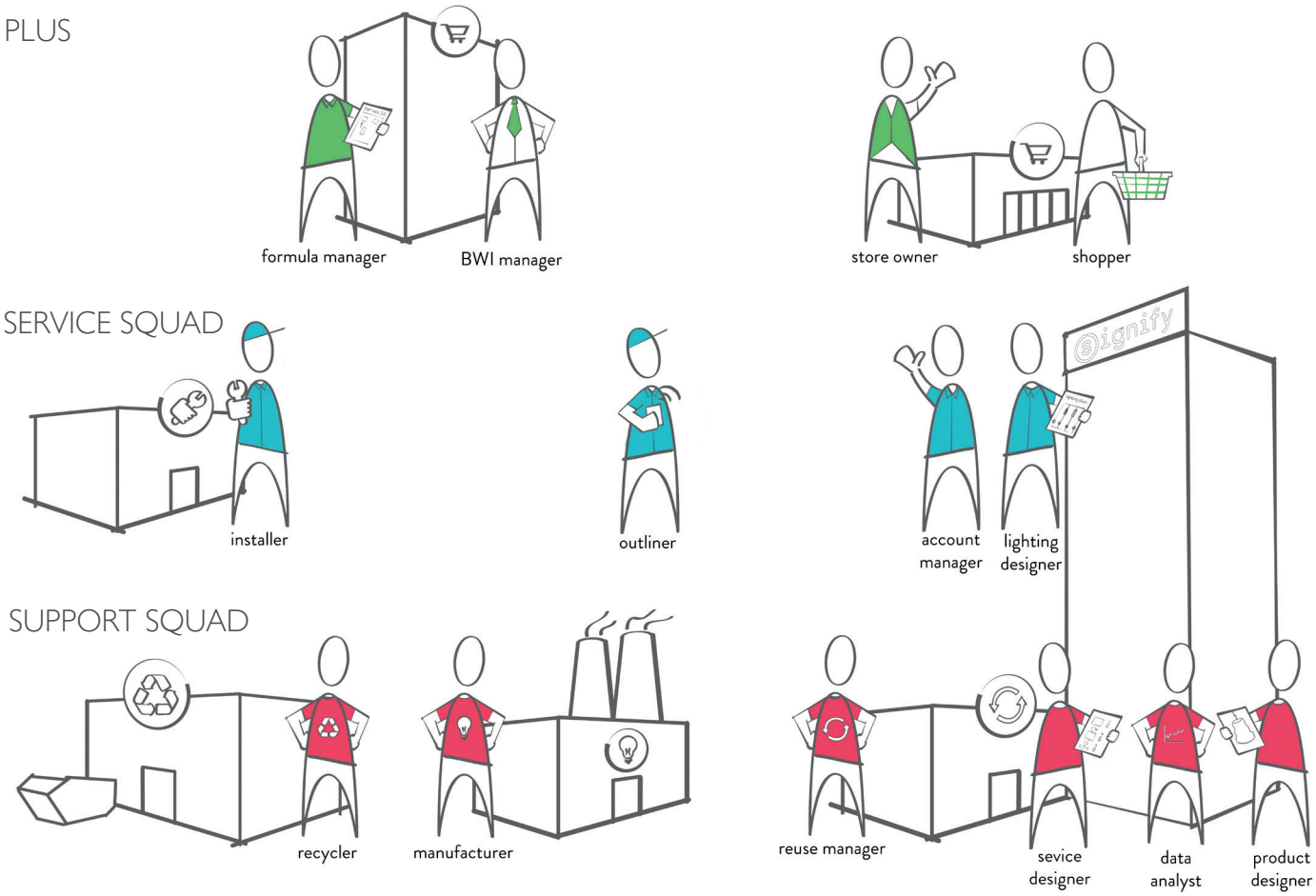


Figure 10.10 Involved stakeholders



transferred to this cloud. This can be data that is added manually, data tracked by sensors or data measured inside the luminaires.

The dashed lines represent the raw data from the store. As can be seen in the bottom left corner, the store owner will indicate the floorplan, the activities he is doing and provide feedback on the service. In the bottom right corner, the data input of the lighting system is shown. The lighting systems sends the location of the luminaires, the measured light intensity and environmental factors that could possibly influence the functioning of the luminaires.

All this data from the store is send to the data analyst, at the top. The data analyst has the task to create insights from this data and send these back to the cloud. These insights are represented by the dotted lines. The product and service designers can use these insights to improve their products.

The software will be able to send notifications, indicated by the solid pink arrows, to the lighting designer without intervention of the data analyst when the store owner has indicated the change of the floor plan. The same counts for the installer when the light intensity has dropped below a certain level. When the installer repairs or upgrades a luminaire, he will report this in his application. This way, the software is always able to provide a detailed passport of the luminaire.

A new stakeholder in this system is the reuse manager. This is the person that manages the warehouse with used luminaires. He/she indicates which luminaires can be reused, which are refurbished and which cannot be reused anymore and need to be recycled.

The system provides a dashboard were every stakholder can choose which information he/she want to see first. The system also alows the shielding of certain information for specific stakeholders. This allows Signify to deny the installers access to certain details of the luminaires. This way the installers are unable to start producing luminaires themselves. In a similar way the data about individual shoppers can be stored on the platform by the supermarket, but secured from other stakeholders in the system to protect the privacy of these shopers.

Since it is still questionable whether all stakeholders are really willing to change their behaviour, it is unclear to what extend they are really going to perform the tasks the concept requires them to. Initialy, some audit might be needed to check whether stakeholders are doing what they should do and enter the right data. A blockchain protocol as Circularise, uses would be more resilient to misuse by stakeholders, but requires a lot of calculating capacity (Personal conversation, Mesbah Sabur from Circularise, 2018 Juli 17th). Also by making the connected application as easy and quick as possible for the stakeholders the chance on right information can be increased a lot. Additionally, the fact that each stakeholder has a benefit from the platform as well also increases the chance that stakeholders will collaborate.

It is important to be aware that data storage is not free. To store dataflows from seven sensors that collect a datapoint every second, results in 16 mb per day per device, which results in 6 gigabite per year. According to a Machine Learning Expert, this would cost around 30 dollar cents per gigabite per year (Personal conversation, Bart Hazen, 2018 September 26th). This means that it would cost $1,80 per device per year to store the data. This does not seem a lot, but over 10 years this would be a tenth of the price of a lumianaire. It is important that not too much data is collected. For example: It does not make sense to store data points of the indoor store temperature on every second, because it does simply not change that rapidly.

10.5 The Product-Service System

Figure 10.12 provides an overview of the complete StoreSight product-service system.

In the middle the platform is shown with the available information. The involved stakeholders float arount the platform on small islands. The pink arrows indicate the flows of information between the stakholders and the platform. This shows for example that for the installer an up-to-date lighting plan with the up-to-date locations of the luminaires is relevant. The fact that all arrows are double sided, indicates that all stakeholders have to provide information and recieve information.

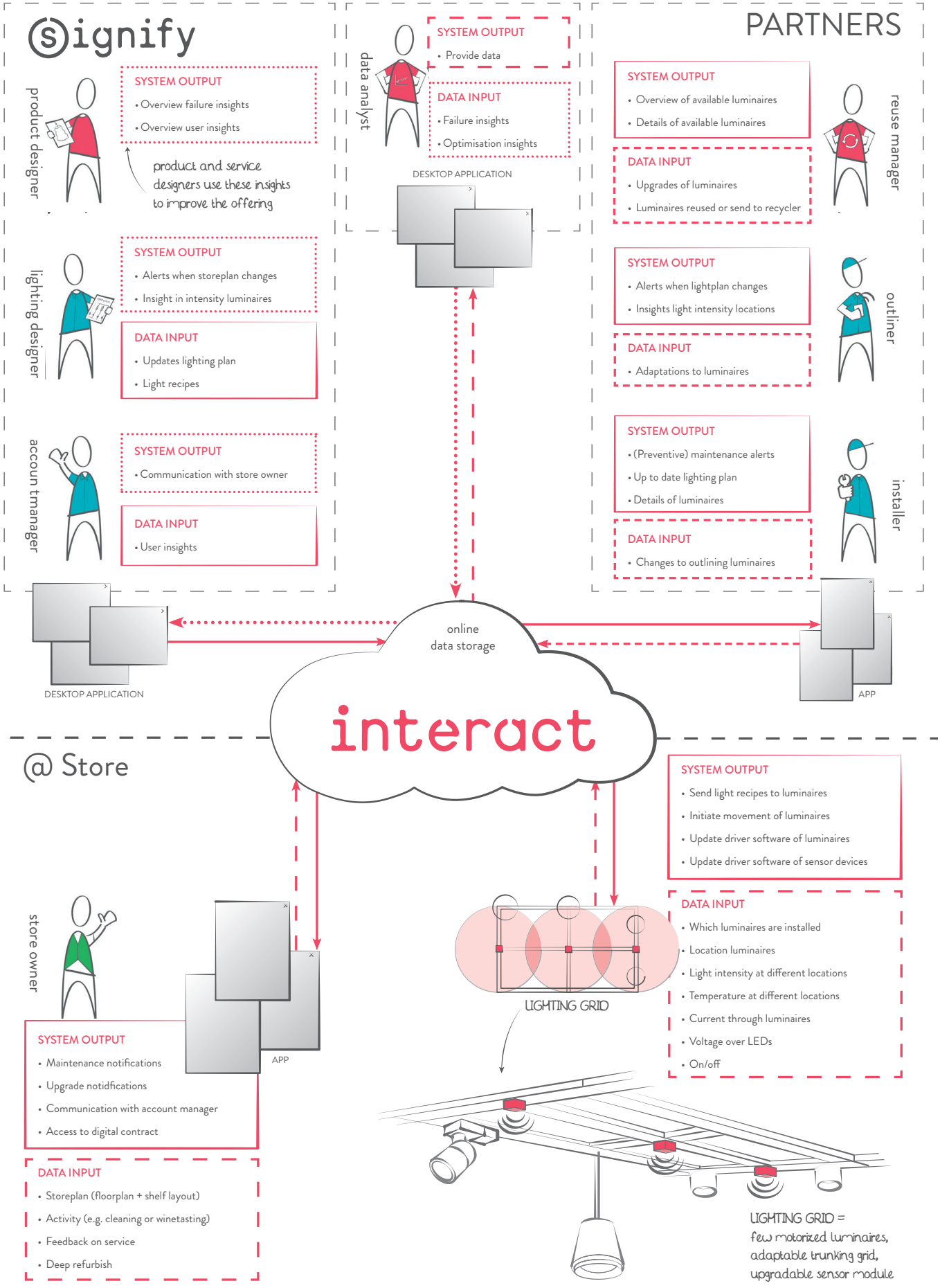
There is a possibility to give the installer some additional roles from other stakeholders. The installer could for example take on the role of the reuse manager and the outliner. In this figure these roles are shown separately to stress the need for these roles in the StoreSight ecosystem.

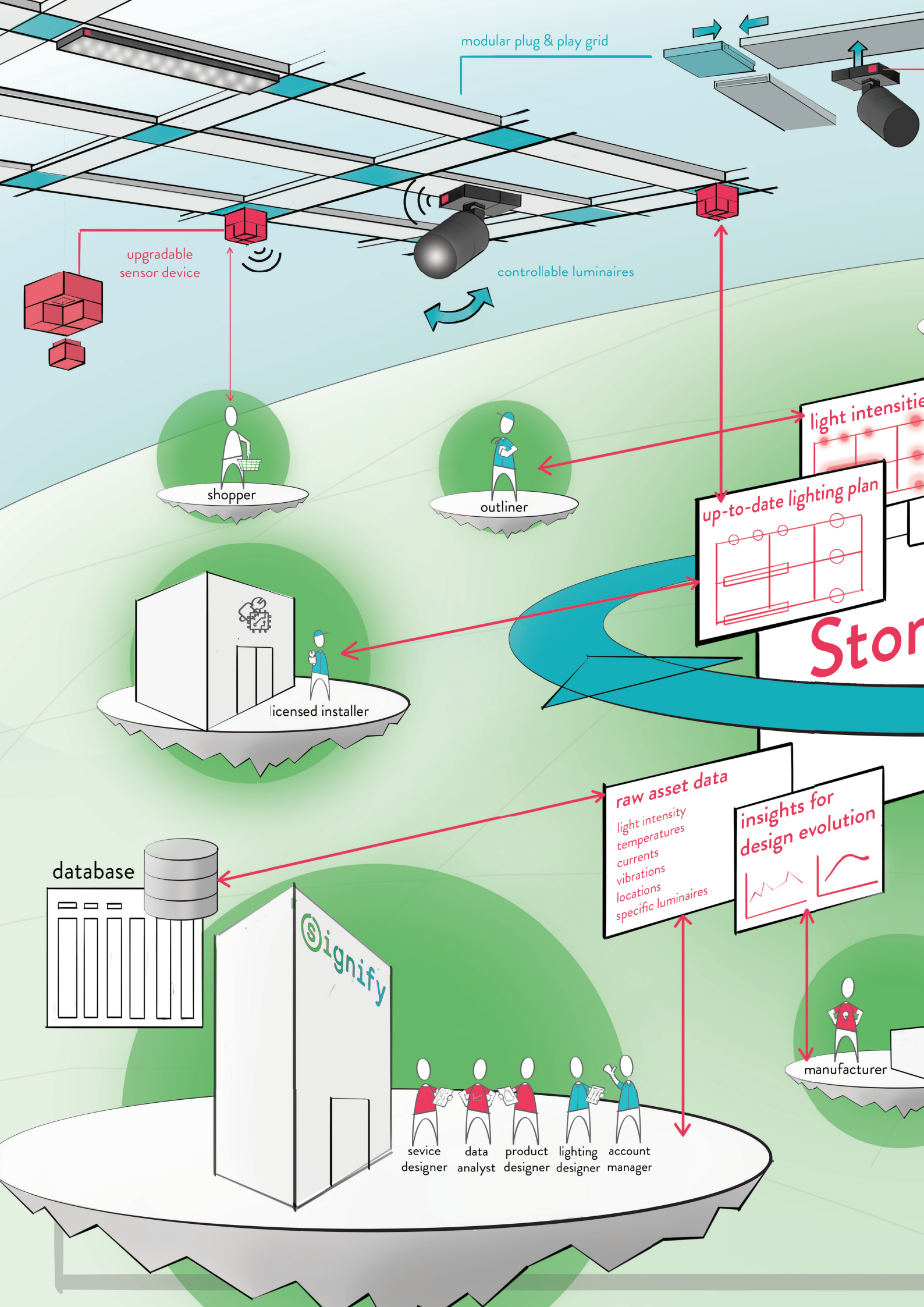
In the bottom left corner the database is shown. The fact that this database is connected to the Signify island, means that it is Signify's responsibility to run this database.

In the upper left corner the hardware is shown. As explained before this includes upgradable sensor devices. Here is also show that some of the luminaires are controllable on distance. Finally, it shows that the luminaires are tagged with RFID and an analog code.

In the upper right corner the proposition to the store owners is explained. The gray arrows indicate how the luminaires circulate from one store to the

Figure 10.11 System overview


Signify
product designer
SYSTEM OUTPUT
• Overview failure insights
• Overview user insights
product and service designers use these insights to improve the offering
lighting designer
SYSTEM OUTPUT
• Alerts when storeplan changes
• Insight in intensity luminaires
DATA INPUT
• Updates lighting plan
• Light recipes
accoun tmanager
SYSTEM OUTPUT
• Communication with store owner
DATA INPUT
• User insights
data analyst
SYSTEM OUTPUT
• Provide data
DATA INPUT
• Failure insights
• Optimisation insights
DESKTOP APPLICATION
PARTNERS
SYSTEM OUTPUT
• Overview of available luminaires
• Details of available luminaires
DATA INPUT
• Upgrades of luminaires
• Luminaires reused or send to recycler
reuse manager
SYSTEM OUTPUT
• Alerts when lightplan changes
• Insights light intensity locations
DATA INPUT
• Adaptations to luminaires
outliner
SYSTEM OUTPUT
• (Preventive) maintenance alerts
• Up to date lighting plan
• Details of luminaires
DATA INPUT
• Changes to outlining luminaires
installer
DESKTOP APPLICATION
online data storage
interact
APP
@ Store
store owner
SYSTEM OUTPUT
• Maintenance notifications
• Upgrade notidfications
• Communication with account manager
• Access to digital contract
APP
DATA INPUT
• Storeplan (floorplan + shelf layout)
• Activity (e.g. cleaning or winetasting)
• Feedback on service
• Deep refurbish
SYSTEM OUTPUT
• Send light recipes to luminaires
• Initiate movement of luminaires
• Update driver software of luminaires
• Update driver software of sensor devices
DATA INPUT
• Which luminaires are installed
• Location luminaires
• Light intensity at different locations
• Temperature at different locations
• Current through luminaires
• Voltage over LEDs
• On/off
LIGHTING GRID
LIGHTING GRID = few motorized luminaires, adaptable trunking grid, upgradable sensor module


modular plug & play grid
upgradable sensor device
controllable luminaires
shopper
outliner
licensed installer
light intensitie
up-to-date lighting plan
Stor
raw asset data
light intensity
temperatures
currents
vibrations
locations
specific luminaires
insights for design evolution
database
Signify
manufacturer
sevice designer
data analyst
product designer
lighting designer
account manager

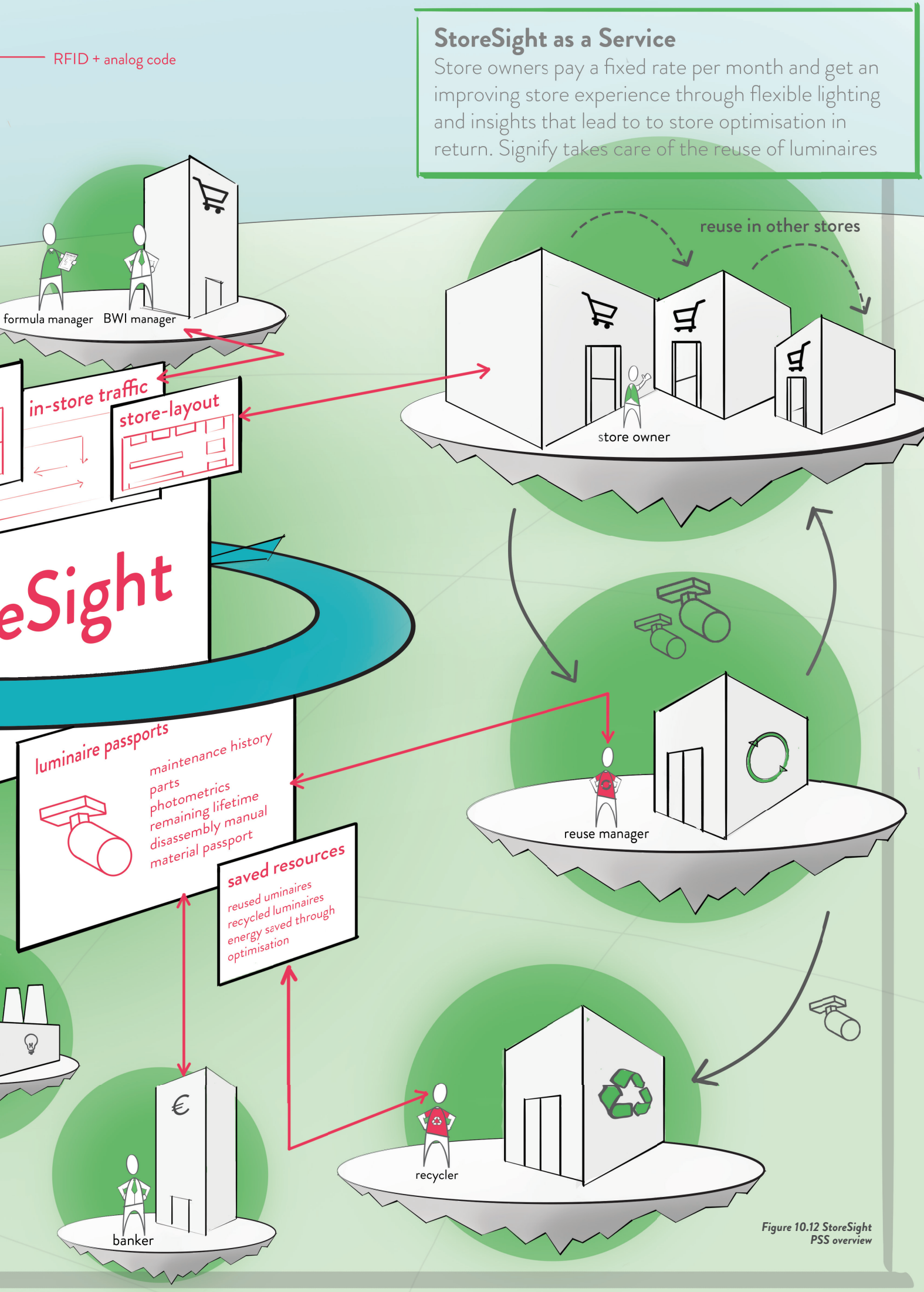


Figure 10.12 StoreSight PSS overview

other by passing the reuse manager. The luminaires end up at the recycling facility. The materials that result from the recycling can be used in the products again by the manufacturer.

Service blueprint
To provide more insights in how the stakeholders interact with each other and the system, a service blueprint was made (separate document*).

On top, the grey line shows the different stages of the service. The process is divided in four stages: marketing (before the contract is signed), preparation, during the contract period, and after the contract period. These stages are subsequently divided in different substages. The green dotted boxes show the activities of the store owner during the different phases.

The green boxes show the physical evidence, (in service design sometimes also called the touchpoint). The green boxes show the actions and interactions with the store owner by different stakeholders. As can be seen in the blueprint, stages exist where the store owner does not interact with the system, but other stakeholders have a task. An example is the analysis of data by the data analyst. It could still be a possibility to show the store owner the support squad is working on his service.

The blue dotted boxes show the requirements of the software and hardware in case of a certain interaction. This is placed above the line of visibility since the store owner is able to see the hardware and software.

Next we see the row with backstage actions. This are actions performed by the service squad but not visible for the store owner. The support processes are the actions performed by the support squad. Finally, the pink bottom row shows what is new for Signify in this phase of the process.

In the next paragraph, each phase of the service blueprint will be explained in more detail.

Marketing
Before the contract starts, the headquarters of PLUS should learn about the benefits of the StoreSight service. This could be done through all kinds of touchpoints: the website of Signify, a commercial or a brochure. The stakeholder involved in this phase is the account manager. He should make sure the support squad aligns the service with the requirements of the PLUS headquarters. If the headquarters is convinced, it will promote the StoreSight proposition as a lighting option for the store owners. New is the fact that the account manager will try to sell ambiance and store experience instead of just luminaires.

When a store owner is interested, a quick and clear overview should be provided of the benefits and consequences for the particular store.

Preparation
If a store owner has decided he wants the StoreSight service, a digital contract will be made. This contract allows the store owner to see at all times what he is paying for.

The second step in the preparation of the service is the creation of a lighting plan. The lighting designer will use the requirements of the headquarters to make a lighting plan for the specific store. To save resources, the system will propose luminaires that are available for reuse. The reuse of luminaires into a new contract will require the existence of a warehouse were used luminaires can be stored.

During the next step, the luminaires and trunking will be prepared. If this requires a new look (casing) or technology, this will added during this step. In the beginning not enough used luminaires will be available so new luminaires are needed as well.

After preparation the luminaires are transported to the warehouse of the installers. Here the luminaires are combined with other electronics and finally shipped to the store. In this phase it is important that the installation of different software or settings is prevented. Different software could enable the installers or third parties to access the data gathered by the system. The settings of the luminaires should therefore be able to be easily adaptable through the application in store. Additionally, installers should be able to scan the luminaire and quickly see where it needs to be placed in the store.

The installation of a complete new grid in the store, still requires the store owner to close the store. But because the system is easier to install, the time of closure can be decreased.

After installation the system needs to be calibrated. First the location of the luminaires needs to be determined. When the location of the specific luminaires is known, the right settings will be updated to the luminaires. The system will be turned on and the outliner will check if the light intensity is right. Then the light intensity sensor of the sensing device can be calibrated. Finally, the connection with the cloud and the data of the other sensors will be checked. In the future it might be possible to automate the work of the outliner by drones with lightsenors.

During the contract period
When the system is calibrated and the store owner knows how to use his control panel, the experience can begin. To enable this, Signify will also pay the electricity the system is using.

When the store owner wants to organise an

** this separate document is attached to the back of this report.*

activity that requires a different atmosphere, he can control this in his StoreSight application. The system will upload another recipe to the luminaires.

When the store owner changes the floorplan, he can also indicate this in the application. The lighting designer will get a notification, will change the lighting plan and send a message to the outliner to change the location and outlining of the luminaires. The data from the lighting sensors can be used to see if the light intensity at a certain location is as preferred.

Data about factors that influence the degradation of the LEDs is gathered as well. Additionally, the application will collect the feedback the store owner is giving to the account manager.

The data analyst will try to get insights from the gathered data and use the software to communicate these insights to the product and service designers.

The software will automatically notify an installer when the sensed light intensity drops below a certain threshold level. The installer will go to the store to repair the luminaire.

Over time, the R&D product and service designers will come up with new functions that can be added to StoreSight. The store owner gets the possibility to add these functions to his contract by paying an extra rate. An installer will go to the store to upgrade the luminaires and if needed replace them with new luminaires.

After contract period

When a store will be refurbished and the lighting needs to be taken out, Signify will take the luminaires back to the warehouse. Here the luminaires can be cleaned and upgraded if needed.

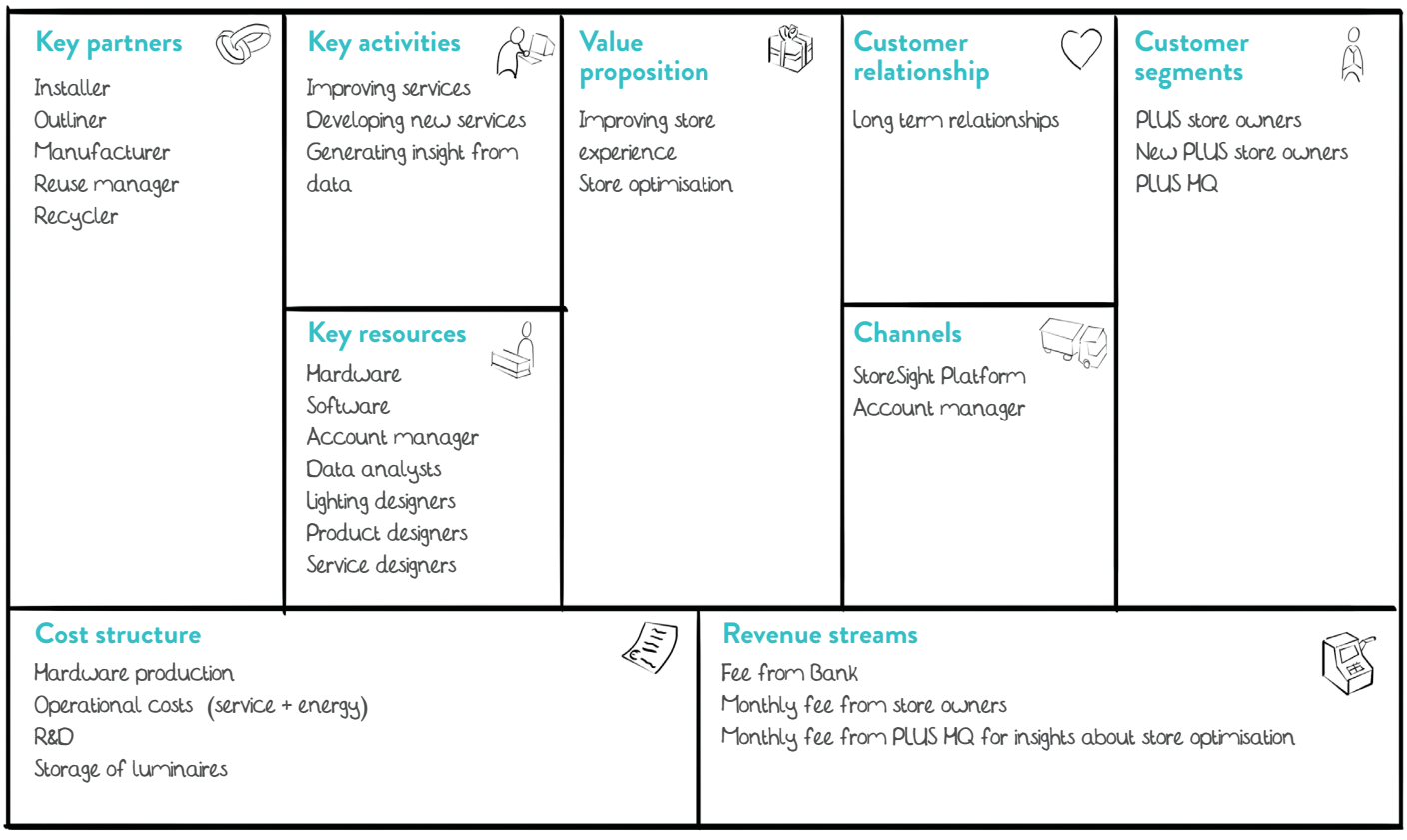
When the contract ends, the account manager tries to sell a new contract. If the store owner does not want a new contract, the luminaires are taken back for reuse in another contract. Because sensors have been constantly measuring the light intensity and burning hours of the luminaire, a prediction can be made about the remaining light intensity and lifetime of the luminaire. The price of the service will decrease over time if no new services are added by the store owner. This means that a store owner can, after a deep refurbish, decide to immediately implement new services in its contract. The old products can in this case be offered to another store owner as a cheaper service. This allows starting store owners to begin with lighting from 'older' store owners, which might be attractive to them since it is already costly to invest in a new store.

10.6 Costs

Financial costs

Figure 10.13 shows a business model canvas filled for the StoreSight concept. The offered value is in

Figure 10.13 Business Model Canvas StoreSight



this case defined as an improving store experience and store optimisation.

As can be observed from the figure, Signify requires some partners to be able to offer this value. The installer is the most important one here since this stakeholder could possibly also take on roles from other partners.

To build long term relationships by improving the PSS, the main activities of Signify itself is the improvement of the PSS. To do this a lot of human resources are needed (e.g. account manager, data analyst).

The platform acts as a main channel between Signify and its customers. As can be seen in figure 10.13 the headquarters is also added as a customer. This is because of the opportunity to sell the insights about store optimisation to the headquarters to improve the deisgns of their stores.

The main costs in this business model for Signify are the production of hardware, the operational cost and R&D. This means store owners, as can also be seen in the revenue box, pay a fixed rate per month and Signify will take care of all operational costs. Signify will pay partners, energy bills and storage.

This means Signify needs to keep these costs as low as possible and keep the energy usage for example as low as possible. It is also benifical for them if the system can stay the same for as long as possible.

Environmental costs

Since this concept is a result from Signify's willingness to become more sustainable, the environmental costs of this concept also need to be discussed.

Since StoreSight is still a concept, it is difficult to be very concrete about the amount of resources saved and added. Therefore a small explanation will be given about where StoreSight adds resources and where resources are saved.

StoreSight mainly saves resources by extending the economic lifetime of the trunking and luminaires through flexibility and allowing luminaires to be looped through additional lifecycles. Additionally, the fact that Signify pays the energy bills, will force them to optimize the energy usage of the system.

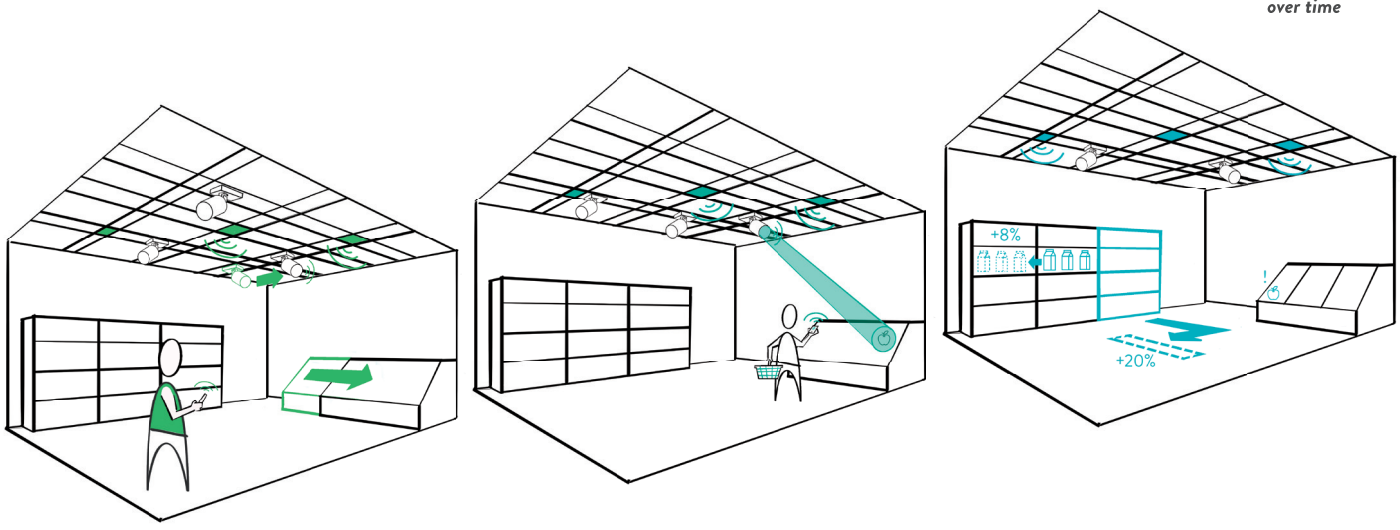
However, some of choices made to make the system future ready, also create more environmental impact. The sensor devices are an addition in terms of both materials and energy usage. The motorized luminaires will contain more parts than conventional luminaires and their movement also requires additional energy. The platform will use energy to process the data, which was not there before.

Overall, the environmental costs highly depend on how often the system requires upgrades and how much longer it will last than a contemporary system. Keeping in mind that Signify wants to add sensors and connectivity to the retail systems anyway, StoreSight will at least decrease impact of those systems by enabling upgrades of the sensors and the reuse of the luminaires.

Societal costs

It needs to be mentioned that this concept might also cause societal costs. The fact that this system could stimulate shoppers to buy more food, might in a country where 50% of the population is overweighted not be prefered. One way to deal with this could be to focus the store optimisation only on the space and energy usage of a store instead of boosting a store's revenues.

Figure 10.14 The evolution of StoreSight over time



10.7 The evolution of StoreSight

As said before, the result of the StoreSight PSS will evolve over time. The evolving character of the system elongates the economic lifetime of the hardware by making it resilient to future customer needs and technological possibilities. The roadmap in figure 10.14 will be used to explain how this result will evolve over time.

The first horizon: Enhancing attractiveness

As the title of figure 10.14 says, StoreSight will first focus on enhancing the attractiveness of the store. StoreSight will enhance the attractiveness of the store's ambiance and groceries through responsive lighting. When the store owner, shown as the person with the green jacket in figure 10.15, indicates the movement of interior elements in the store, the lighting will be adapted to these changes (green arrows). Enhancing the attractiveness of the stores ambiance and products through lighting is something Signify is already capable of. However, the fact that the lighting will adapt to changes in the floorplan is new. Also new is the fact that StoreSight is a circular 'as a service' proposition.

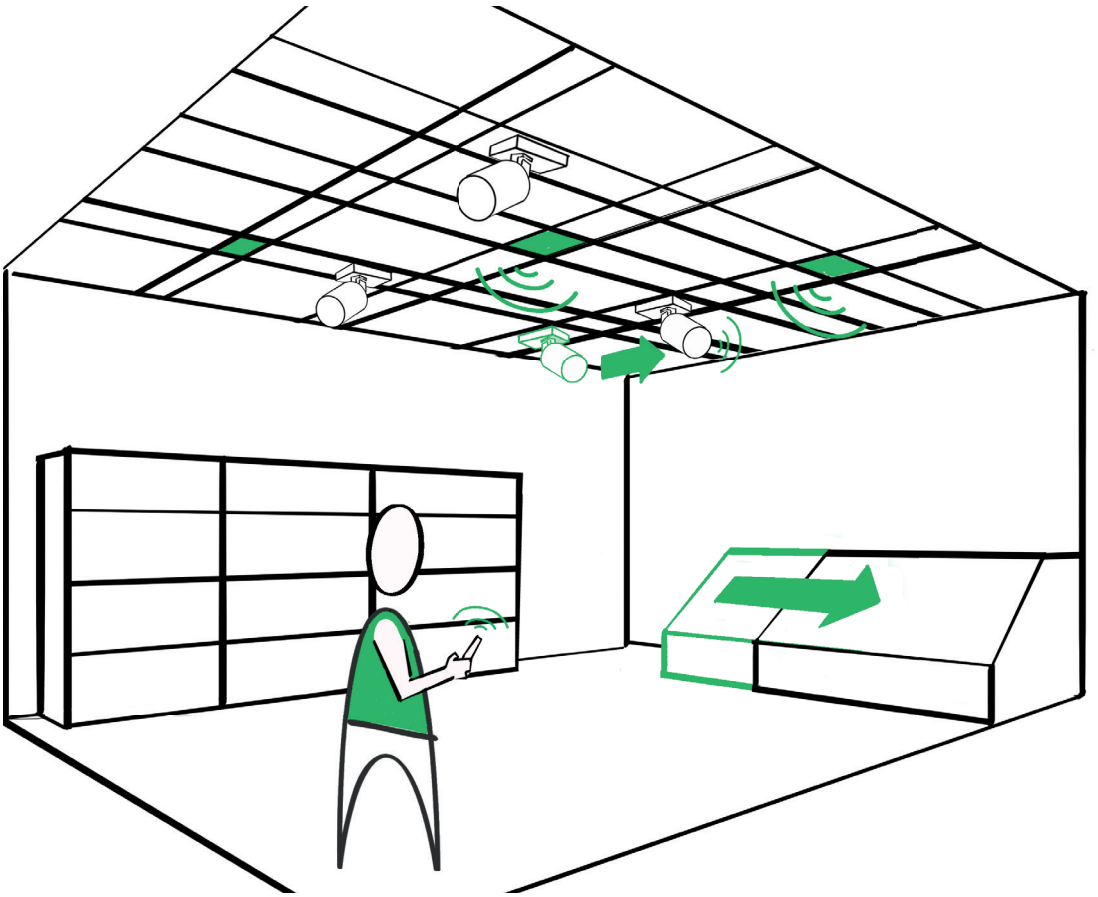
The second horizon: Enhancing convenience

As the title of figure 10.16 states, during the second phase StoreSight will enable the improvement of the shopping comfort. StoreSight will enhance the convenience of the store by providing indoor navigation, highlighting of searched products and enabling shoppers to request help from a staff member through the StoreSight shopper app. Additionally, the data from the Indoor Positioning System will be used to provide insights on how to increase the convenience of the store layout. The hardware can be upgraded to enable the technologies and looks needed during this horizon

The third horizon: Store optimisation

During the third horizon (fig. 10.17) the hardware of StoreSight will provide the backbone for a 'smart store'. The data gathered through the hardware will be stored on the online platform. By connecting the data from sales with the atmospheric parameters sensed by the sensing devices, the atmospheric parameters can be optimized in order to improve the conversion rate of the store. This data can also be used to optimise the opening hours of the supermarket. Additionally, by tracking groceries in the store trough cameras, services as counterless payment and theft prevention can be provided. Again the hardware can be upgraded to make it ready for the functions in the third horizon.

Figure 10.15 The First Horizon: Enhancing Attractiveness



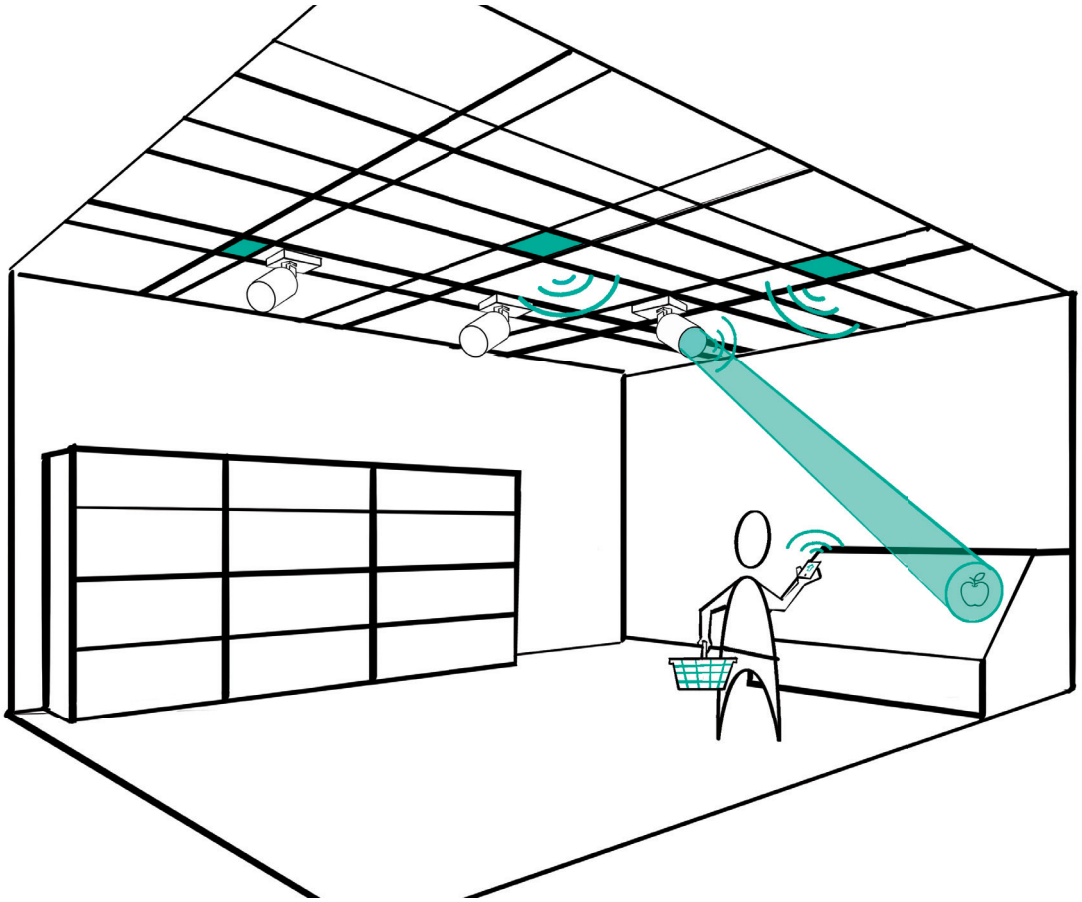


Figure 10.16 The Second Horizon: Enhancing Convenience

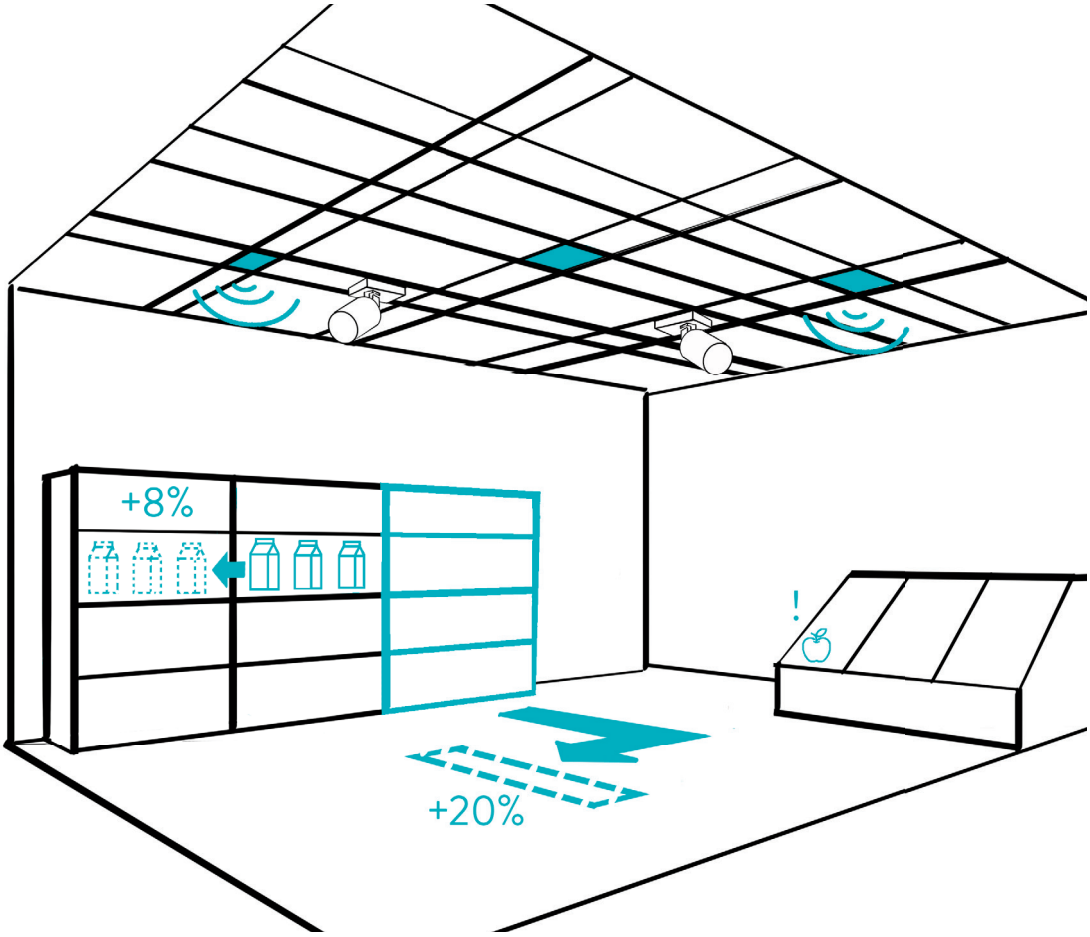


Figure 10.17 The Third Horizon: Store Optimisation

** this separate document is attached to the back of this report.*

Tactical roadmap
To provide more insight in the different horizons a tactical roadmap was made (separate document*). On top, the white pictures show the different horizons as explained before. A small row (NOW) is added to show which products and developments are already available at Signify that can be used as basis for other developments.

At the right edge of the roadmap the vision is shown: 'efficient supermarket through an intelligent & circular lighting grid'. The visual visualizes this by showing how different items are connected to an digital platform though an upgrading lighting grid. It also shows the fact that these luminaires will be reused and circulate from store to store by using the information on this digital platform.

On the left edge of the roadmap the different layers of the roadmap are shown. These are separated under desirability, viability and feasibility. The desirability part is important for the retailers and marketeers within Signify. It includes which customer values are addressed during the different phases. Additionally, it includes the different functions that enable these values to be addressed.

Under the desirability, the viability layer can be found. This layer does not only include the financial viability (business model), but also how the circularity of this concept creates value.

At the bottom of the roadmap the feasibility layer shows all resources that are needed to enable the layers above (viability & desirability). It shows which services are provided by the partners during which horizon. Secondly, it shows which software applications need to be developed by the service designers. Thirdly, it provides insights in the what requirements for the hardware at each point in time. It shows which insights are needed to enable the offered functions. It shows which data is needed to generate these insights. It also provides insights in which data should already be gathered to enable future functionalities. Finally, it shows which additional resources Signify needs to make all improvements mentioned above possible.

First Horizon
The customer value layer shows that the first, as explained before, the enhancement of the stores attractiveness. This will lead to enhancement of the shopping comfort in the second horizon. Combining both will finally lead to improvement of the store's experience. In the third horizon store optimisation is addressed by boosting sales and operational efficiency.

In the layer below, functions, it can be seen that adaptive lighting is added to functionalities that currently already exist (activity based lighting and product based lighting). If the white dotted line is followed to the bottom of the roadmap, the resources that enable this function can be found. As can be seen nearly at the bottom of the line, this function requires an up-to-date store layout and the exact location of the luminaires. To get insights in the location of the luminaires, as explained before, fixed sensor devices are needed. To be able to re-outline the luminaires remote controllable luminaires are needed. An application is needed that allows the retailer to update the store layout and the outliner should control the repositioning of the luminaires.

When going back to the functions layer, after adaptive lighting, appearance updates can be found. As can be seen in the NOW horizon, Signify is already able to offer this functionality through the telecaster luminaire.

As can be seen, the circularity of the luminaires in the first horizon is mainly focused on extending the useful life of the luminaires. This focus on the extension of lifetime continues until the end of the second horizon. At the end of the first horizon, the circularity layer states 'responsive maintenance'. This means installers will get a notification ones a luminaire does not work anymore. If the connected dots are followed, it can be seen that data about the light intensity is required to do this.

Second Horizon
On top of the second horizon the customer value layer states, as explained before, 'increase shopping comfort'. To increase the shopping comfort, the system will offer, as can be seen in the 'functions' layer, staff navigation, shopper navigation, product localization, predictive staff commands, a help function for shoppers, product highlighting, fast in-store internet, rates and routes from peers and in the end, counter free checkout.

Staff and shopper navigation can currently already be offered with the IPS system, as can be seen in the NOW horizon. Since IPS does not fit in the first horizon, it is placed in the second horizon. PLUS store owners might not immediately be interested in these functions, but the expectation is that they will be so in 2 to 5 years from now. This can be found on top of the second horizon bar.

If you look at the line connected to 'product localization' in the functions layer, it can be seen that it ends up in a blueish bar. If this bar is followed to the left of the roadmap, it ends up at 'product recognition'. These blueish bars show how insights as 'product recognition' are developed over time. To create this product recognition, cameras are needed that capture images of products in the store. If these images are combined with an up-to-date shelf layout, the system can learn to recognize certain products in the store. This can for example

be used to automate the store layout indication and in the end of the second horizon to enable a counter free checkout. Amazon has already proven a similar system is technically feasible (The Guardian, 2018).

Also the recognition of failure causes requires the system to learn which sensor values relate to which failure causes. In horizon two (circularity layer) the system will be able to predict which maintenance is required before a luminaire breaks down.

Also the predictive staff commands (function layer), require some data to make predictions. If the line from predictive staff commands is followed downwards, it ends in the 'in-store behaviour' bar. In the first horizon motion sensors could also be the same cameras as for the product recognition and save data about movements in the store. In the second horizon, the system will be able to use this to predict when the staff is needed, at for example a counter. As the line also shows, the software, in this case the staff app, requires an update.

At the end of horizon two, which is in about 5 to 7 years from now, when the first contracts end, Signify should be able to reuse the luminaires in other stores. This allows Signify to offer contracts with used luminaires that can be slightly cheaper. Moving downwards along the line, it can be seen that reverse logistics, luminaire passports, new luminaires, the remaining lifetime of these luminaires, their photometrics and a storage facility need to be in place.

Third horizon

An important insight this roadmap tries to bring across is that the functionalities offered in the third horizon require insights that ask for long-term data collection.

Theft prevention (function) requires the system to recognize 'normal' behaviour of shoppers and the different products. By prevention of theft, the profit margin of the supermarket will increase. An increasing profit margin allows Signify to base their prices on the profit margin and profit themselves also from this.

Also 'atmospheric parameter optimisation', which basically relates to the use of atmospheric parameters as sound, light and smell to increase the conversion rate, might result in an increase of a supermarkets profit. Since this part, as discussed before, might also cause societal impact, Signify should be a bit careful with this. On the other hand, this can be used to save energy because also the energy usages of other systems in the store can be optimized. This could have a large impact on energy usage in general. To illustrate, supermarkets count for 3% of UK's electricity usage. Reasearchers have shown that IoT enabled systems can decrease the energy usage of a supermarket with up to 20% (Heiselberg et al., 2016).

The last function on the roadmap is 'shelf layout optimisation'. If the system knows how the different factors affect the sales of products, this could be connected to the place of products in the shelfs. These insights could be sold to head-quarters of supermarkets. These insights could also be used to let grocery brands (e.g. Coca Cola) pay for the lighting on a specific spot. Currently brands already pay the supermarket for their spot in the shelf. Better spots are more expensive. These insights allow Signify to provide lighting that is beneficial for a certain type of products. The supermarket could let the brands pay for this improvement. This increases the profit margin of the store and as a result the fee that Signify will get.

PART IV: VALIDATION

This part provides a retrospect of the whole project. First a concept evaluation will be presented that will lead to next steps for the StoreSight concept. Next, the limitations of this project will be presented. These will lead to insights for Signify. Thirdly, a personal reflection on this project will be given that will lead to recommendations for further research.

CHAPTER 11: CONCEPT EVALUATION

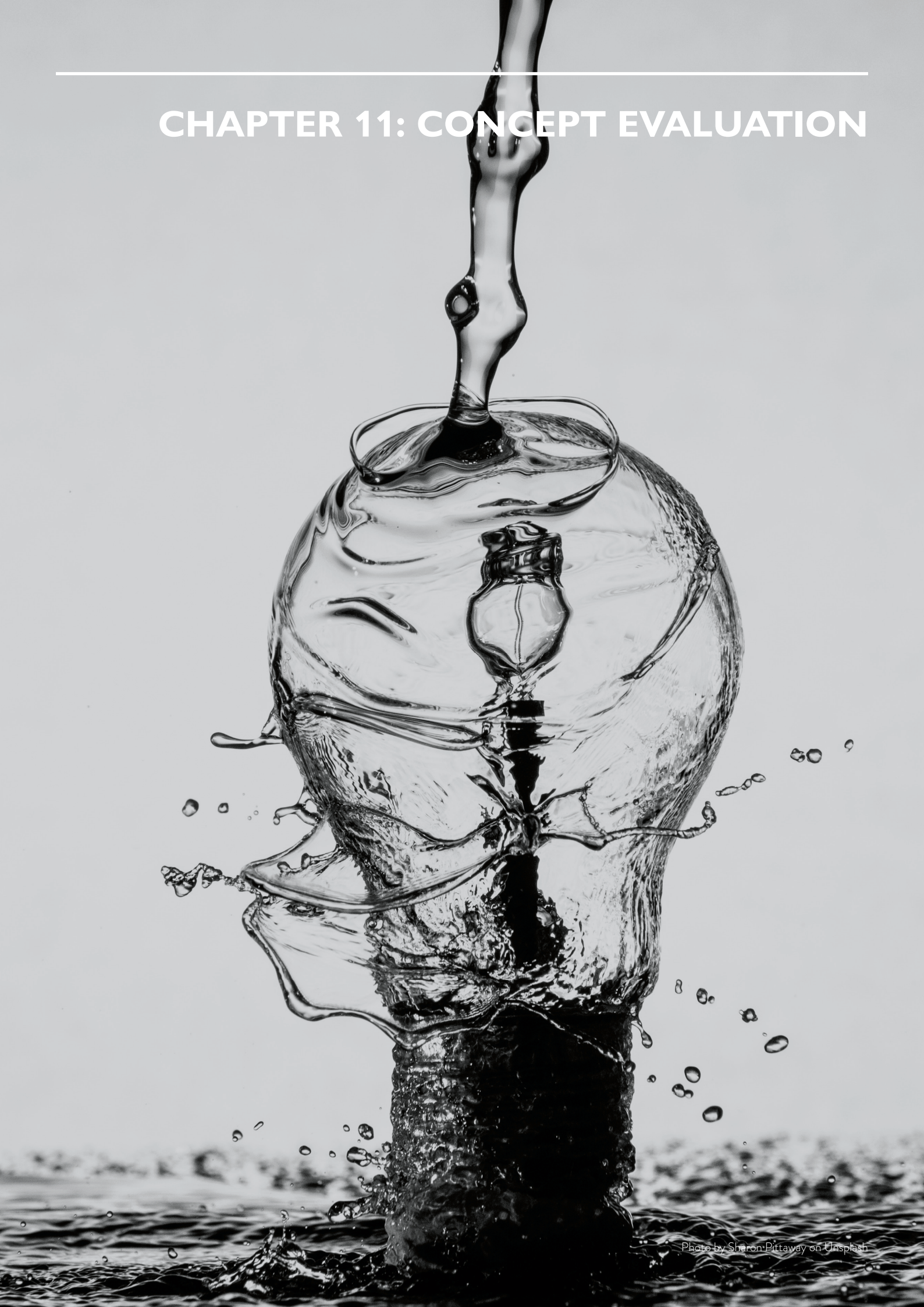


Photo by Sharon Pittaway on Unsplash

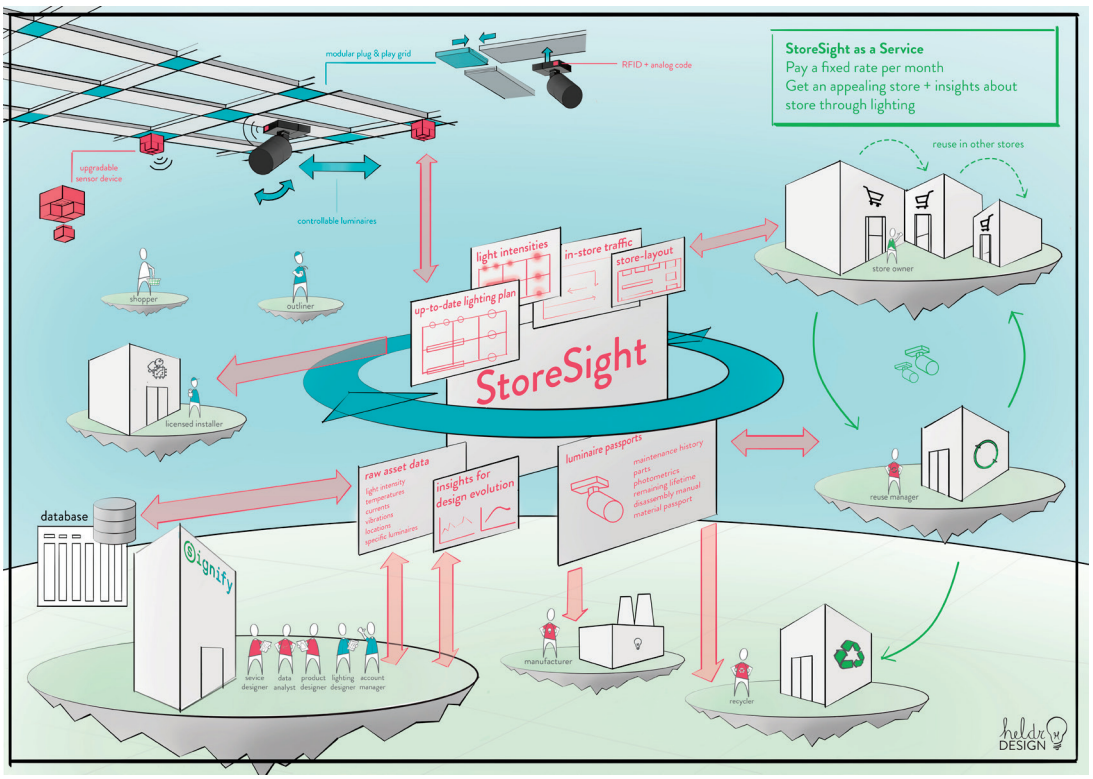


Figure 11.1 Overview used in the evaluation interviews

CHAPTER 11: CONCEPT EVALUATION

To evaluate the desirability, viability and feasibility of the final concept, interviews were held with six employees from Signify*, two entrepreneurs with a similar CE related platform and a machine learning engineer. During these semi-structured interviews, the concept was first presented using a figure with the different elements of the concept, as shown in figure 11.1. Afterwards questions about the efficacy of StoreSight where asked.**

* Key Account manager PLUS, Marketing Manager, Product manager, System manager, Customer insight expert and project manager LED platform

** Façade identification system (FIS) and circularise

Desirability: Do the stakeholders want this?

Questions related to the desirability of the concept were mainly relevant for the key account manager and the other employees from Signify. The employees indicated supermarkets are becoming more and more interested in circularity. This interest in circularity is mainly present in the Dutch and Nordic markets. Signify stated that circular lighting is something they have to be able to offer in the future, but they are uncertain about when. However, up until now this interest was mainly focused on the products supermarkets sell instead of the store itself. According to Signify's employees this is currently changing.

When asking more specifically about the desirability for PLUS, the employees indicated that the headquarters would be interested in this concept since it fits their brand identity. They saw, however, difficulties in making this offering operationally work because of the decentralized structure of PLUS. The headquarters of PLUS might, according to the employees, be interested in the circularity of the lighting. The storeowners. however. are mainly focusing on reducing cost as much as possible. The structure of PLUS makes it difficult for the headquarters to force store owners to choose a certain type of lighting. According to the employees the desirability of this concept for store owners also depends on the added value of the flexibility.

The employees indicated that they saw the value for other stakeholders as well. They doubted whether these added values were enough to make the stakeholders, and especially the installers, change their behaviour. The employees think installers could use these insights to make their job more efficient. They indicated they need more information about the goals of the installers to be able to assess their willingness to collaborate.

Viability: Should Signify do this?

The interviewees from Signify thought the profitability of this concept is mainly depending on who is going to pay for what. The employees stated that the fixed rate cannot be a lot higher than what store owners currently pay for their lighting. Higher costs would decrease the desirability of the concept. They saw, however, possibilities to let other stakeholders pay for the use of the data. They mentioned for example the that installers might be willing to buy the software to increase the efficiency of their opperations. Additionally, subsidies from the government could make the offering more attractive for all involved parties. The employees stated that subsidies also worked well to convince customers when LED was introduced. Overall they thought the concept had the potential to be profitable.

One interviewee was sceptical about the profitability of the concept, since it is often cheaper to throw a product away instead of repairing it. This last point was also mentioned by one of the Signify employees that mainly saw the financial value in reusing the luminaires without repairing them before reuse. There were also some employees that mentioned the opportunity of even selling them (second hand), when a contract period ended.

The Signify employees mentioned again that it would not be possible for Signify to own the hardware themselves and another financial construction had to be found to make this concept work.

Apart from the financial value, the concept could add value to the Signify and Philips brands. Signify's employees all agreed that the concept is in line with their current strategy and the brand identity. Some of them mentioned that what they currently are expressing verbally about their identity is maybe not always completely in line with the way they act internally. They saw this concept as an opportunity to put their money were their mouth is.

Overall the interviewees thought this concept would reduce the impact of their lighting on the environment. However, at this stage it is difficult to evaluate this impact. This requires some additional research.

Feasibility: Can Signify do this?

The interviewees from Signify all stated that this concept would be realisable before 2021. They indicated that they are already working on a similar platform. They questioned the necessity of motorized spots. They expected that currently available hardware would be able to perform the required functionalities. Additionally, they saw the cost that would come with these. They mentioned that their Maxos Fusion line would especially be suitable for this concept. They also mentioned the presence of sensors in their portfolio. These sensors are not combined into one device, but seperate devices that can be attached to any point in the Maxos Fusion grid.

However, one employee indicated that the tracking the light intensity with sensors to asses the remaining lifetime would be less accurate then calculating it. The calibration of the sensors has in previous project been proven to be hard.

One employee stated that mid 2019 most relevant types of retail luminaires are available as a CE ready. They also indicated that they are looking for collaborations with non-profit organisations like Madaster that try to build a publicly available database with material passports. To make sure it is always clear which materials their products contain. However, Signify is not yet working on a luminaire passport. The interviewed employees estimated that they were able to build these before 2021. The main bottleneck these interviewees saw, was setting up partnerships with the required stakeholders. Especially finding the right installer company to collaborate could be difficult according to them.

According to the machine learning expert too, the concept was feasible. It would require some thinking about how many data points to store and how to build analysis tools, but according to him this would be doable. He stated that it is mainly important to have a consistent dataset. Sensors are generating quite consistent data. He had some questions about the data entered by the stakeholders since people are less consistent in generating the required data.

Also the interviewee from the FIS thought the platform was a feasible concept. This was mainly based on the fact that he already build a working prototype with all kinds of data from different assets. He also stated that urban mining companies like NewHorizon are already using this kinds of information to offer more insights on the second hand building materials they offer.

Conclusion: What's next?

The employees indicated that they were, simultaniously to this project, working on similar concepts. They indicated that they are going to develop these further using the insights gained in this project. This means that StoreSight will probably not be implemented exactly as it is designed right now, but insights will be used.

CHAPTER 12: LIMITATIONS

Photo by Charles Etoroma on Unsplash

CHAPTER 12: LIMITATIONS

This chapter provides an overview of the limitations of this project. It discusses trustworthiness of the information, why certain choices were made and how this has possibly influenced the results of this design project.

12.1 Input

The information used in this design project was mainly constructed around qualitative interviews with Signify employees. This has a few important implications:

The oldest interviews are more than a year old. The information they contain, might therefore be outdated. Additionally, information provided in newer interviews can, due to changes in the company, have been become obsolete. However, by continously discussing the results with Signify, an attempt is made to take these changes into account.

The fact employees sometimes provided conflicting answers, indicates that employees do not have a common understanding about certain topics. Since all statements seemed reasonable it was difficult to define which statements would be most plausible. Altough the insights were discussed at multiple times with different employees, it is still not certain that no other understandings about these insights exist. It was mainly unclear which functionalities products and systems where already able to fulfil at certain points in time.

Signify's employees could not always be completely open about current developments in the field of CE, IoT and retail lighting. As a result, many ideas were generated that already existed. Additionally, this made sometimes hard to assess the feasibility of ideas. Ideas that seemed initially very unfeasible might have been feasible.

Finally, employees might have been biased to push their own vision on the topic. During this project an attempt was made to look at all possibilities in CE and IoT instead of what should be the solution according to Signify's employees. It is however possible that some opportunities remained undiscussed.

Since organising interviews with supermarket owners and headquarterss turned out to be difficult and time consuming, little input was used from the supermarket directly. A considerate decision was made to move on with the available information, instead of spending more time on getting responses from the headquarters and storeowners. Gained insights have not been validated with these external stakeholders themselves but with internal stakeholders from Signify with a lot of customer contact or knowledge.

12.2 Scope & definitions

This design project focused on lighting only. There are solutions imaginable that include the whole ceiling, other interior elements in the store or even the design of the building. It was decided that these concept were out of the scope of this project. These directions might have resulted in different solutions.

Finally, the way certain definitions are chosen has potentially influenced the results of this project. The way circular was framed required the final concept to be an as a service model. On the other hand, the definition of IoT was taken quite broadly to allow for less autonomous and wireless solutions, whereas some might argue that a local wired system cannot be referred to as IoT.

CHAPTER 13: PERSONAL REFLECTION

Photo by Redd Angelo on Unsplash

CHAPTER 13: PERSONAL REFLECTION

This chapter contains a reflection on some of my personal experiences during this project. These points will lead in some of the cases to recommendations for Signify or further research in the field of CE, IoT and design engineering

13.1 Process

In the beginning I was experiencing an information overload. Drawing giga maps, stakeholder maps, product journeys helped a lot to get grip on the information again. However, talking to all stakeholders individually resulted in needs and wants that seemed sometimes difficult to unite. I decided therefore to focus on the collaboration between these stakeholders.

At some point my designer intuition told me that it was time to get rid of the criteria for a moment and start ideating. I made a well thought out session plan and within a week I had lots of ideas. When converging, I tried to trust my intuition again instead of looking at the criteria I made. I wanted to show the diversity of ideas and was a bit blinded by whether the stakeholders would like these ideas. This mainly resulted in a focus on how profitable and easy to implement ideas would be for Signify.

When I went back to my criteria, I saw that some of the ideas were actually not able to match these. At that point I decided to combine the ideas. This resulted in the design of StoreSight.

During the process I noticed that Signify is relatively good at the Intergrated Product Design part (how to do it?). I noticed that when people are being vague I try to get concrete by asking "oke nice idea, but how are we going to do that?" When people are being very concrete, I try to understand why they need to do something or not. In this case, Signify was quite concrete about which technologies and products to use and therefore the strategic designer (What to do?) in me might have been triggered a bit more. I think it was in this case more important to show them why they should (or not) do certain things. In the end, I know that they are capable of finding a way to do it.

13.2 Short-term vs long-term

I noticed that in Signify's innovation culture quick wins are preferred above long-term earnings. I think this is hindering the development of use and result oriented PSS, that are mainly profitable on the long term. During the interviews I noticed that the interviewees interpreted the 'as a service' concept sometimes very differently: For some the idea of selling products would still be valid in an 'as a service' proposition. The employees were overall quite sceptical about 'as a service' models. They seemed to see more opportunities in a similar concepts were hardware is sold instead of 'used'. I think Signify is not the only company that is experiencing this, since it is in line with what Bet et al. (2018) said about the cultural barrier being the biggest. Result oriented service models can on the long term be very profitable, but for some reason investors do not see this yet.

During the project I was aware of the fact that it is difficult to predict how retail really looks in 10 years. By doing some research only an educated guess can be made. Also when it comes to IoT and big data, it is difficult to make forecasts about which data is needed in the future and which data is actually useful. These risks might also be one of the reasons why Signify prefers short-term investments over long-term investments.

13.3 Environmental & societal costs vs financial costs

Another point related to the short-term mindset of companies, is the fact that currently viability is often seen from a pure financial viewpoint. As a designer I think it can sometimes be hard for us to justify choices that decrease the impact on society and environment, but that increase the financial costs. You could argue that it is good for the image of the company, or to be prepared for legislation, but it is hard to make a comparison between these and the costs.

During my IPD courses I learned how to assess the environmental impact of embodied designs. During SPD, courses about sustainability were not mandatory. During this project I realised that decisions that affect the societal and environmental impact of products are made in the very early stages of the design process. The addition of sensors and connectivity could already been made during first ideation stages. At that point, it is hard to say something about the impact of these choices on your design, since the business model enabled by these sensors could make the impact of the sensors for example irrelevant.

CHAPTER 14: RECOMMENDATIONS

Photo by Laurentiu Iordache on Unsplash

CHAPTER 14: RECOMMENDATIONS

This chapter provides some conclusions on the project in the form of next steps in the development of Storesight, insights for Signify that go beyond the scope of this graduation project and recommendations for further research. The next steps are mainly based on the concept evaluation. The recommendations for Signify and recommendations for further research are based on the limitations in chapter 12 and personal reflection in chapter 13.

14.1 Next steps in the development of StoreSight

Signify indicated they are going to further develop (at least parts of) the concept. To improve the chance of success, a few insights in the next steps of StoreSights development are provided below.

Involve stakeholders in the design process
It is necessary to talk with all involved stakeholders. Especially additional insights in the needs and wants of the installers, the PLUS headquarters and the store owners are needed. Probably, trade-offs in the wants of multiple stakeholders have to be made. To speed up this process, it could be conductive to get all stakeholders around one table. This could lead to a fruitful negotiation. Additionally, the stakeholders should be involved in the further development of the concept.

Mak the PSS result oriented
The StoreSight concept is, according to Signify employees, quite similar to ideas that exist internally. It is, however, not completely the same. To make sure no optortunities of servitization remain untaken, Signify should redesign products, not let store owners buy the system, assign a stakeholder to take on the role of the reuse manager, and try to build a long term relationship instead of sell products.

Make the hardware roadmap ready
It is needed to evaluate which products are exactly needed and whether the current products are really able to fulfil all functionalities of the StoreSight concept. It is necessary to keep the ideas on the roadmap in this report and Signify's own roadmap in mind. Are the current products really able to deliver or adapt towards these functionalities? Or are these functionalities not required in 10 years?

Set up a data management plan
Additionally it is needed to evaluate which data is really required and how to best capture this data. Also validate this with the people that have to build models to analyse the data.

Experiment and iterate
Try to make this concept work in one store first and then scale it up. Since it is difficult to make accurate forecasts, try to keep the iterative character part of the concept. Make sure the whole offering stays adaptable. Keep improving the offering for every store. If this is not possible with in the current way Signify works, consider to build an internal start-up around this idea that allows for experimenting.

14.2 Recommendations for Signify

Encourage transparency and collaboration
Servitization requires stakeholder involvement. This project shows that circular propositions also require more collaboration. In collaboration openness and transparency is very important. During this project Signify could not always be completely transparent about their internal opperations and ideas. To be able to offer purposeful solutions through collaboration and partnerships, Signify might have to be more transparent.

Create a common understanding across segments
As already stated in the analysis part of this report the internal collaboration and communication can be improved also. Different interpretations of the current state and vision of the company make it hard to work towards one common goal. However some strategic goals are formulated regarding new services and business models, only clear goals exist regarding the environmental impact (e.g. CO2 emissions). Opportunities regarding new and circular business models remain untaken this way. It could be helpful to also formulate clearer goals regarding these (e.g. number of tested business models).

Explore opportunities IoT/CE for other segments
StoreSight shows that IoT creates multiple opportunities to improve the circularity of lighting. This project only focuses on retail. These opportunities should also be explored for other fields.

14.1 Further research

Communicating long-term benefits
To make CE work, efforts have to be made to to change the short-term oriented mindsets of companies. Currently, designers need very strong arguments to be able to convince companies to choose for a long-term oriented proposition over a short-term oriented one. By equiping designers with tools to communicate the long term benefits of their designs, they become able to change the mindset of their clients.

Comparing impact on people, planet and profit
Additionally, tools are needed to measure environmental and societal value in a way to make it equally important as financial value. Currently most companies only care about financial value since they are not directly affected by the other two. Legislation and subsidies play a role in making people and planet as relevant as profit to companies. However, it would be great if companies were intrinsically motivated to care about the environment.

The impact of IoT at early stages of concepts
Designers could use a tool that allows them to quickly assess the environmental impact of adding IoT to their ideas. For designers it is important to know which timespan and looping strategies could make this impact irrelevant to be able todecide whether they should use IoT to make their designs more circular. Product designers are able to conduct a LCA, but designers that mainly focus on earlier stages of the design process can only make very rough estimations. A design tool could be developed that makes designers aware of the benefits that IoT could have for their circular designs. This could be combined with a short assessment tool that allows designers to see whether adding IoT could be beneficial for the circularity of their designs.

Assessing the circularity of business models
More guidelines are needed for (business model) designers on when a proposition can be called circular. Now most guidelines focus on products and not on the whole product journey. These guidelines could be similar to examples as C2C certificates or energy labels. This way it is clear for designers which requirements they need to meet. This could also promote designers to design for at least one reuse cycle. Additionally, it becomes easier for customers and governments to assess and compare the circularity of companies and their propositions.

Investigating the effect of financial partners
It should be investigated whether the existence of a lease bank or financing company effects the way service providers treat their products in circular models.

REFERENCES

Baines, T. S., Lightfoot, H. W., Evans, S., Neely, A., Greenough, R., Peppard, J., ... & Alcock, J. R. (2007). State-of-the-art in product-service systems. Proceedings of the Institution of Mechanical Engineers, Part B: *journal of engineering manufacture*, 221(10), 1543-1552.

Bet, B. et al. (2018). Barriers and Best Practices for the Circular Economy. Retrieved on 26-03-2018 from http://hdl.handle.net/1765/105039

Van den Berg, M. (2014) Product Design for a Circular Economy: A case study towards a circular luminaire. Retrieved on 06-04-2018 from: uuid:523db269-2c95-4566-bd69-eeb83b466774

Boehm, M., Thomas, O., 2013. Looking beyond the rim of one's teacup: a multidisciplinary literature review of product-service systems in information systems, business management, and engineering design. *J. Clean. Prod.* 51, 245e 260.

Bressanelli, G., F. Adrodegari, M. Perona, and N. Saccani. 2018. "Exploring How Usage-Focused Business Models Enable Circular Economy through Digital Technologies." Sustainability 10 (3): 639.

Circle Economy (2018) master circular business with the value hill. Retrieved on 16-05-2018 from: https://www.circle-economy.com/master-circular-business-with-the-value-hill/#.WvwSwEiFOUk

Circulatenews.org (2018) Philips Provides Light as a Service To Schiphol. Retrieved on 17-07-2018 from: https://circulatenews.org/2015/04/philips-providing-Light as a Service-to-schiphol-airport/

CIU (2018) investeren in de circulaire economie: over waarde creëren met de value hill. Retrieved on 16-05-2018 from: https://www.ciu.nl/investeren-in-de-circulaire-economie-over-waarde-creeren-met-value-hill/

Curry, A., & Hodgson, A. (2008). Seeing in multiple horizons: connecting futures to strategy. *Journal of Futures Studies*, 13(1), 1-20.

Dutch Government (2017a.) Transition to a circular economy. Retrieved on 13-12-2017, from https://www.government.nl/topics/circular-economy/transition-to-a-circular-economy

Dutch Government (2017b). A Circular Economy in the Netherlands by 2050. Retrieved on 10-01-2018 from: https://www.government.nl/documents/policy-notes/2016/09/14/a-circular-economy-in-the-netherlands-by-2050

Emerce (2017) Infographic: de supermarkt van de toekomst. Retrieved on 12-04-2018 from: https://www.emerce.nl/nieuws/infographic-supermarkt-toekomst

EMF. (2015). Towards the Circular Economy: Economic and business rational for an accelerated transition.

EMF (2016). Intelligent assets: Unlocking the circular economy potential.

EMF (2018) Circular Economy System Diagram. Retrieved on 31-03 -2018 From: https://www.ellenmacarthurfoundation.org/circular-economy/interactive-diagram

Geissdoerfer, M., Savaget, P., Bocken, N. M., & Hultink, E. J. (2017). The Circular Economy–A new sustainability paradigm?. *Journal of Cleaner Production*, 143, 757-768.

GESI and Accenture (2016) #SystemTransformation: How digital solutions will drive progress towards the sustainable development goals.

GfK (2018) PLUS 'Meest maatschappelijk verantwoorde supermarkt'. Retrieved on 23-07-2018 from: https://www.duurzaam-ondernemen.nl/gfk-plus-meest-maatschappelijk-verantwoorde-supermarkt/

Guardian (2018) Amazons first automated store automated opens to public. Retrieved on 09-10-2018 from: https://www.theguardian.com/business/2018/jan/21/amazons-first-automated-store-opens-to-public-on-monday

Heiselberg, P. K. (Ed.) (2016). CLIMA 2016 - proceedings of the 12th REHVA World Congress: volume 1. Aalborg: Aalborg University, Department of Civil Engineering.

HGB (2018a) Circular business models. Retrieved on 31-03-2018 from: https://kenniskaarten.hetgroenebrein.nl/en/knowledge-map-circular-economy/circular-business-models/

HGB (2018b) Circular business models. Retrieved on 19-05-2018 from: https://kenniskaarten.hetgroenebrein.nl/en/knowledge-map-circular-economy/circular-business-models-2/

HGB (2018c) what are the environmental benefits? Retrieved on 31-03-2018 from: https://kenniskaarten.hetgroenebrein.nl/en/knowledge-map-circular-economy/ce-benefits-the-netherlands/

Iamsterdam (2018) Light as a Service – Schiphol leads the way in circular lighting. Retrieved on 17-07-2018 from: https://www.iamsterdam.com/en/business/news-and-insights/circular-economy/Light as a Service-schiphol-leads-the-way-for-circular-lighting

Ingemarsdotter, E. et al. (in Press) Circular solutions enabled by the Internet of Things: a categorisation

interbrand (2018) Best Global Brands 2017 Rankings. Retrieved on 21-08-2018, from https://www.interbrand.com/best-brands/best-global-brands/2017/ranking/

Kirchherr, J. W., Hekkert, M. P., Bour, R., Huijbrechtse-Truijens, A., Kostense-Smit, E., & Muller, J. (2017). Breaking the Barriers to the Circular Economy.

LightNOW (2018) Philips lighting to change name to signify Retrieved on 11-04-2018 from: http://www.lightnowblog.com/2018/03/philips-lighting-to-change-name-to-signify/

Lusch, R. F., Vargo, S. L., & O'brien, M. (2007). Competing through service: Insights from service-dominant logic. *Journal of retailing*, 83(1), 5-18.

Mentink, B. (2014). Circular business model innovation: a process framework and a tool for business model innovation in a circular economy.

Nielsen (2015). Green generation: millennials say sustainability is a shopping priority. Retrieved on 30-11-2017, from http://www.nielsen.com/us/en/insights/news/2015/green-generation-millennials-say sustainability-is-a-shopping-priority.html

Nudurupati, S. S., Lascelles, D., Yip, N., & Chan, F. T. (2013). Eight challenges of the servitization. In Proceedings of the Spring Servitization Conference (Vol. 2013, pp. 8-14).

Oliva, R., & Kallenberg, R. (2003). Managing the transition from products to services. *International journal of service industry management*, 14(2), 160-172.

Pagoropoulos, A., D.C.A. Pigosso, and T.C. McAloone. 2017. "The Emergent Role of Digital Technologies in the Circular Economy: A Review." Procedia CIRP 64. The Author(s): 19–24.

Philips lighting (2018a). Annual report 2017. Retrieved on 11-04-2018 from: http://www.lighting.philips.com/static/2017/philips-lighting-annual-report-2017.pdf

Philips lighting (2018b). Food and large retailers. Retrieved on 11-04-2018 from: http://www.lighting.

philips.com/main/systems/system-areas/food-large-retailers

Philips lighting (2018c). Unlock the extraordinary potential of light. Retrieved on 16-01-2018 from: http://www.lighting.philips.com/main/services/circular-lighting

Philips lighting (2018d). Managed Services. Retrieved on 11-04-2018 from: http://www.lighting.philips.com/main/services/managed-services#managed_services_http://images.philips.com/is/content/PhilipsConsumer/PDFDownloads/Global/Services/ODLI20170905_001-UPD-en_AA-7035_Philips-Managed_Services_Digi_WTO_01_digital-version.pdf

Philips lighting (2018e) Philips lighting introduces lifi broadband data through light. Retrieved on 11-04-2018 from: http://www.newsroom.lighting.philips.com/news/2018/20180316-philips-lighting-introduces-lifi-broadband-data-through-light

Philips lighting (2018f) Taking a circular lighting approach. Retrieved on 11-04-2018 from: http://www.futureoflight.philips.com/home/design/taking-a-circular-lighting-approach

Philips lighting (2018g) Light as a Service rekentool. Retrieved on 23-07-2018, from: http://www.lighting.philips.nl/systemen/aanbod-van-pakketten/winkels-en-horeca/light-as-a-service-retail#rekentool

Philips Retail Lighting (2018) RetailScene 2. Retrieved on 23-05-2018 from: http://images.philips.com/is/content/PhilipsConsumer/PDFDownloads/Global/ODLI20151117_004-UPD-en_AA-retailscene-issue-2.pdf

PLUS (2018) Maatschappelijk verantwoord ondernemen. Retrieved on 23-07-2018, from: https://www.plus.nl/info-verantwoord/maatschappelijk-verantwoord-ondernemen?gclid=Cj0KCQjw3v3YBRCOARIsAPkLbK6a1KOS5DMDxE1PBOBnFEOe6wxZddw1epTS42SBq5ozCjHpmMu9DdIaAmaaEALw_wcB

K. Hellek, T.C. McAloone, V. Avlonitis, A. Garcia i Mateu, J.B. Andersen, K. Mougaard, L. Neugebauer and J. Hsuan (2013) PSS Tool Book: A workbook in the PROTEUS series. Retrieved on 18-04-2018 from: http://www.proteus.dtu.dk/-/media/Centre/PROTEUS/Dowloads/PROTEUS-workbook-series-PSS-Tool-Book.ashx

Ritzén, S., & Sandström, G. Ö. (2017). Barriers to the circular economy–integration of perspectives and domains. Procedia CIRP, 64, 7-12.

Roozenburg, N. and Eekels, J. (1998, 2nd ed.) Product Ontwerpen: Structuur en Methoden, Utrecht: Lemma.

Tukker, A. (2004). Eight types of product–service system: eight ways to sustainability? Experiences from SusProNet. Business strategy and the environment, 13(4), 246-260.

Tukker, A. (2015). Product services for a resource-efficient and circular economy–a review. *Journal of cleaner production*, 97, 76-91.

Turley, L. W., & Milliman, R. E. (2000). Atmospheric effects on shopping behavior: a review of the experimental evidence. *Journal of business research*, 49(2), 193-211.

Unilever (2017). Report shows a third of consumers prefer sustainable brands. Retrieved on 30-09-2017, from https://www.unilever.com/ news/Press-releases/2017/reportshows-a-third-of-consumers-prefersustainable-brands.html

VPRO tegenlicht. (2015) het einde van bezit. Retrieved on 17-07-2018 from: https://www.npostart.nl/vpro-tegenlicht/08-11-2015/VPWON_1232897

Whitmore, A., Agarwal, A. and Da Xu, L. (2015) 'The Internet of Things—A survey of topics and trends', Information Systems Frontiers, 17(2), pp. 261–274. doi: 10.1007/s10796-014-9489-2.

TU Delft
&
Signify