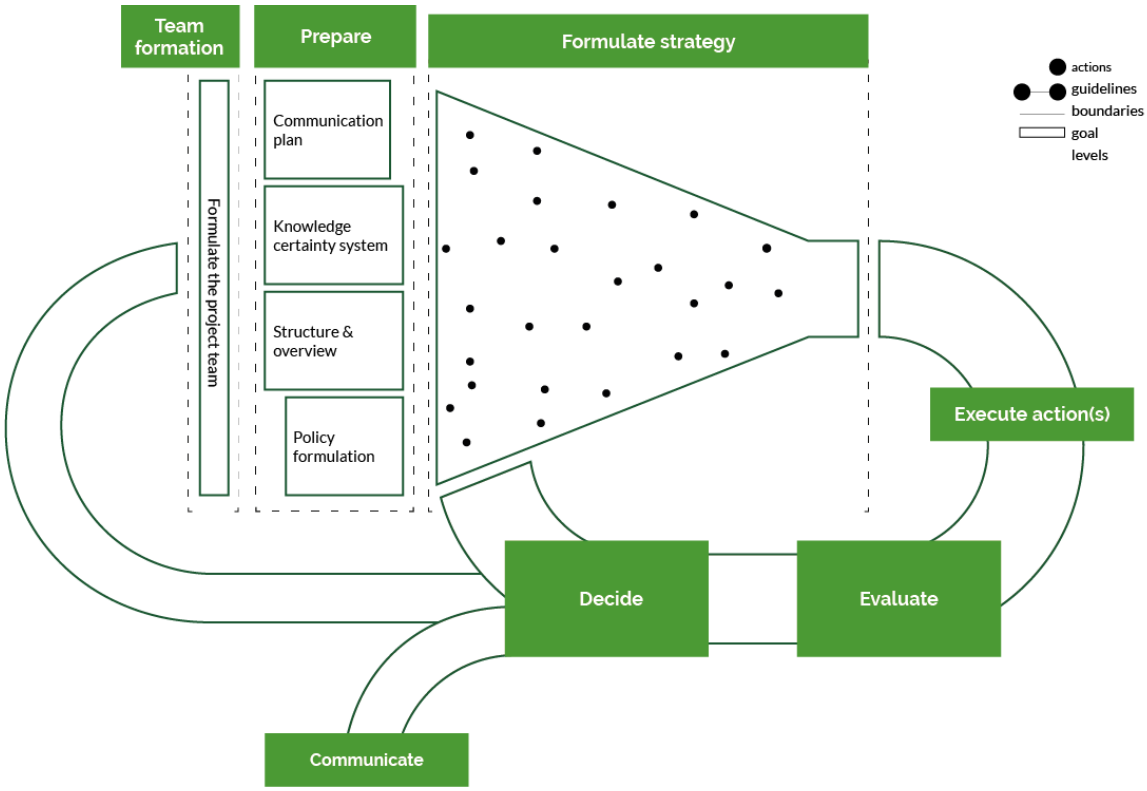
A framework for strategic sustainable development implementation by SMEs

INCORPORATING LIFE CYCLE THINKING AND TRIPLE BOTTOM LINE CORPORATE SUCCESS.



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Acknowledgements

I would like to thank the people that helped me during the process of this master thesis project. First of all, I would like to thank Bert van Lieshout for providing me with the opportunity to execute the master thesis project at Themans. Due to the Covid pandemic, it was impossible to meet each other in person before the start of the project, for which I would like to thank him for the trust he had in providing me with the opportunity and the trust he gave me during my master thesis.

I would like to thank Ilanit Lutters-Weustink for the guidance during the project, the many conversations on the thesis project, the process, the structure of the report, the mental support, and the friendly question about how I was doing and how everything was going.

I would like to thank the employees at Themans for their contributions to the project's implementation and the friendly welcome at their company. Special thanks to the research and development team.

Finally, I would like to thank my family and friends for their mental support during the project. I enjoyed the research and the challenge and look forward to show all of you the results.

Enjoy the reading.
Max

Table of Contents

List of abbreviations

ALU	Aluminium
BOM	Bill of materials
BOP	Bill of processes
B2B	Business to business
CE	Circular economy
CIMM	Continuous Improvement Maturity Model
CSDD	Corporate Sustainability Due Diligence directive
CSR	Corporate Social Responsibility
D4S	Design for Sustainability
EPR	Extended Product Responsibility
EPD	Environmental Product Declaration
EM	Environmental Management
FSSD	Framework for Strategic Sustainable Development
ILO	International Labour Organization
KPI	Key Progress Indicators
LCA	Life Cycle Analysis
LCM	Life Cycle Management
LCC	life Cycle Cost
LCI	Life Cycle Inventory
LCSA	Life Cycle Sustainability Analysis
LCT	Life Cycle Thinking
LSS	Lean Six Sigma
MCDM	Multi-Criteria Decision-Making process
MVO	Maatschappelijk Verantwoord Ondernemen (CSR)
NPD	New Product Development
OECD	Organization for Economic Cooperation and Development
OEM	Original equipment manufacturer
PDCA	Plan-Do-Check-Act
PDP	Product Development Process
ROI	Return On Investment
SCM	Supply Chain Management
SDG	Sustainable Development Goals
SLCA	Social Life Cycle Analysis
SME	Small & Medium Enterprise
SWOT	Strengths-Weaknesses-Opportunities-Threats
TBL	Triple Bottom Line
3BL	Triple Bottom Line

Definition list

Small and medium enterprise
This report uses the Dutch definition of an SME. In the Netherlands, an SME consist of ten to fifty (small) or fifty to two hundred fifty (medium) employees (Ministerie van economische zaken en klimaat, 2021). This report focuses on the small companies within the SME statement.

Normative level management
Normative level management refers to: “Questions of vision and mission of a company and of the fit between sustainability engagement and organizational culture are in focus of the normative management level.” (Rupert J Baumgartner, 2014).

Strategic level management
Strategic level management refers to: “Developing an effective corporate sustainability strategy is part of the strategic level.” (Rupert J Baumgartner, 2014).

Operational level management
Operational level management refers to: The implementation of the sustainability strategy in the different corporate functions is part of the operational level.” (Rupert J Baumgartner, 2014).

Sustainable development
Sustainable development is development by humanity within the biosphere’s boundaries (the capacity to absorb the effects of human activities). Following the (Karl-Henrik Robèrt et al., 2013) principles of sustainability: “operational sustainability principles would aim to eliminate our contribution to … :

- … systematic increases in concentrations of substances from the earth's crust,
- … systematic increases in concentrations of substances produced by society,
- … systematically physical degradation of nature,
- … conditions that systematically undermine people’s capacity to meet their needs”.

Corporate mission
This report uses the following definition of corporate mission: reason why the company exists

Corporate vision
This report uses the following definition of corporate vision: A long term goal of the company

Summary

The importance of sustainable development within companies is widely acknowledged in the literature and legislative institutions (Department of Economic and Social Affairs, 2001; United Nations Department of Economic and Social Affairs, 1987). However, most research is focused on large corporations and multinationals for regulations, systems and methods. Small and medium enterprises (SMEs) get less focus within literature and legislation. As SMEs are often intertwined with multinationals as partners, further research on the applicability of sustainable development to SMEs is of interest.

Themans hang & sluitwerk BV is a small design and dealership company of door fitting products within the Dutch business-to-business (B2B) door fitting market. Due to changes within the market and internal motivation stated by the managing director, they are trying to incorporate sustainable development within their company. This thesis project examines the possibility for Themans to include sustainable development within their company. Aiming to obtain a normative and strategic level management framework to obtain sustainable development for Themans hang & sluitwerk BV. This framework allows Themans employees. Additionally, this thesis report researches the applicability of the developed framework for similar small and medium enterprises.

The analysis of the corporation Themans and its context, together with the literature study, identified the requirements necessary to obtain sustainable development for an SME. This analysis with the list of requirements resulted in a framework aiming to accomplish the triple bottom line divided ecological, social and economic success goals for the company and including life cycle thinking within the company.

The seven phases of the framework are: project team formulation, preparation, strategy formulation, execute actions, evaluate actions, decide, and communicate. The framework's normative and strategic parts, the project team formulation, preparation, and strategy formulation, were implemented at Themans via workshops and brainstorming sessions to identify possible alternations required for execution by Themans employees.

These multiple sessions resulted in a collaboratively established sustainable development mission and vision. Moreover, a set of one-hundred-and-forty-five sustainable development actions were collaboratively formulated. Twenty actions could be discarded from the one-hundred-and-forty-five actions since they provide an increased risk for the company. Eighteen other actions were identified and labelled as risky since they potentially provide a risk for the company.
The developed framework applies to other SMEs, provided they comply with specific requirements such as B2B, circular economy tech cycle products, and more.

The course of the assignment and the reorganisation at Themans provided difficulties for finishing the prioritisation of the framework. Therefore, the resulting one-hundred-twenty-five actions require further prioritisation. The thesis ends with the recommendation to execute the seven steps of the framework in its completeness by Themans with full dedication to give their corporate transition towards sustainable development a head start.

Chapter 1 Introduction

The importance of sustainable development is widely acknowledged within literature, corporations, and politics. For example, current developments in sustainability principles provide an increased corporate responsibility. New regulations (for example, the 'Corporate Sustainability Due Diligence Directive' (CSDD) (Justice and Consumers, 2022)) provide a necessity for an expanded corporate paradigm on its activities and product development to cope with the accompanying required corporate transition toward a sustainable corporation.
However, most legislations and literature reports focus on large companies and multinationals. Themans hang & Sluitwerk BV is a small design and dealership company of door fitting products within the business-to-business (B2B) door fitting market. Due to changes within the market and internal motivation stated by the managing director, they search for guidance to incorporate sustainable development. This chapter provides the project's research plan and introduces the case company, Themans hang & Sluitwerk BV.

1.1 Research plan

This section consists of the research question and the scope and planning of the research.

1.1.1 research question

The initial goal of this project was to solve a specific packaging sustainability problem which aimed to replace a single-use plastic bag holding the mounting kit (set of different sized bolts) of a door-fitting product-packaging combination by a more sustainable alternative. This sustainable packaging solution project would provide a narrow-scoped solution for the unsustainable development problem of the company. Refining the problem statement showed a lack of sustainable development strategy to tackle the broad-scoped unsustainable development problem within the company.
The project's goal, therefore, shifted to providing a normative and strategic level management framework to obtain sustainable development within the company.
Normative and strategic level management refers to: "Questions of vision and mission of a company and of the fit between sustainability engagement and organizational culture are in focus of the normative management level. Developing an effective corporate sustainability strategy is part of the strategic level. The implementation of the sustainability strategy in the different corporate functions is part of the operational level." (Rupert J Baumgartner, 2014).

Next to Themans Hang & Sluitwerk BV's transition to sustainable development, the potential application of the framework for SME companies, in general, is researched. This project thus aims to answer the following two research questions:

Primary research question: How can Themans hang & Sluitwerk BV evolve to become a sustainably developing company?

Secondary research question: How does the Themans hang & Sluitwerk BV corporate transition process towards sustainable development apply to other small and medium enterprises (SMEs)?

1.1.2 Scope and planning

The sustainable development level of the case company was at level zero at the start of the project. Level zero means no sustainability knowledge nor initiatives taken within the company concerning sustainability, next to this master thesis project. This project provides an introduction to the topic of sustainable development.

The project's scope is broad due to the width of the topic of sustainable development. Next to ecological sustainability, social and economic sustainability are incorporated.

The project provides a normative and strategic management level framework. It, therefore, identifies the sustainable development interpretation of the case company and facilitates the strategy formulation for sustainable development incorporation within the company. It does not facilitate the implementation of the strategy in corporate structures.

The planning of the thesis project consists of four segments (Figure 1)

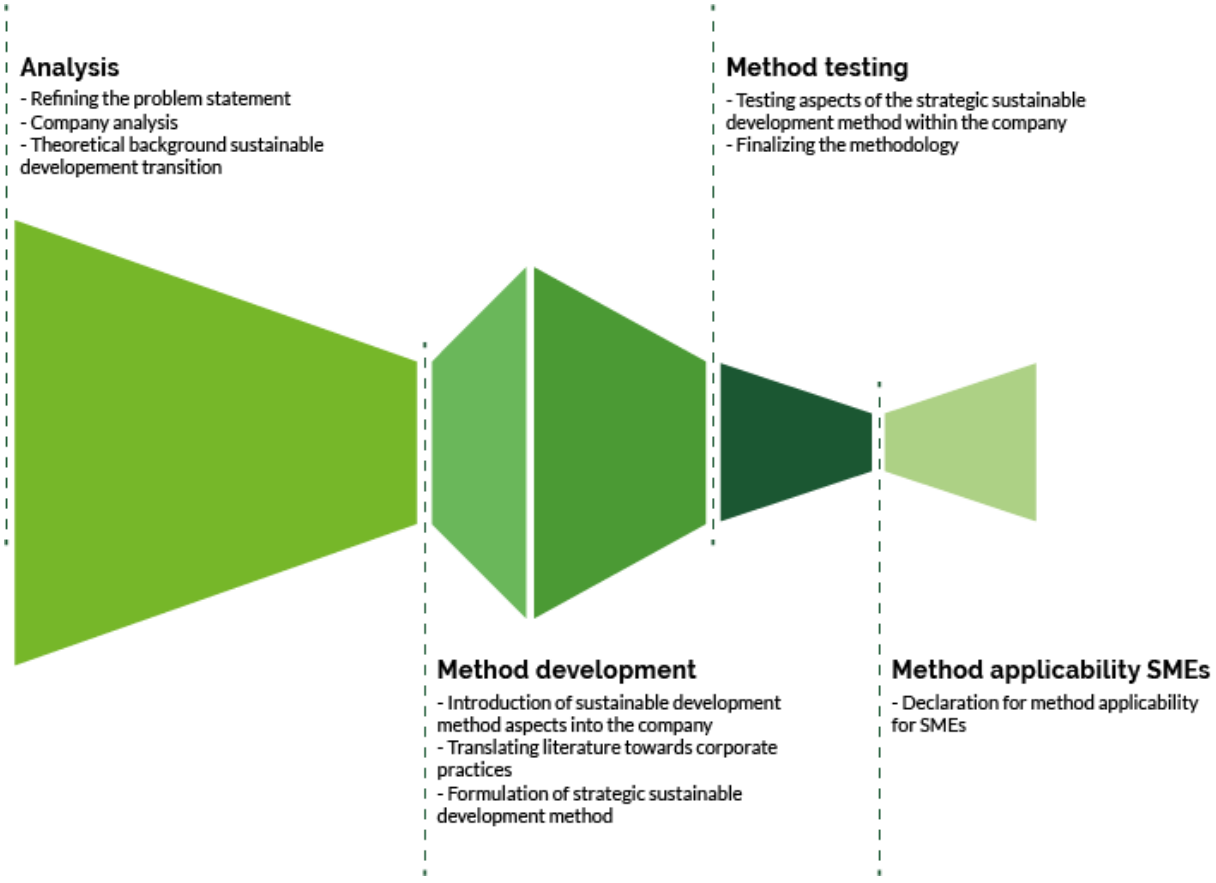


Figure 1 divergence, convergence planning master thesis project

1.2 Introduction case company: Themans hang & Sluitwerk BV

This section introduces the company Themans by elaborating on its characteristics and its context. The section consists of:

- The history of Themans (section 1.2.1)
- the market and supply chain conditions (section 1.2.2)
- the product portfolio (section 1.2.3)
- the current sustainable development state (section 1.2.4)

1.2.1 History of Themans

The case company Themans hang & Sluitwerk BV (further referred to as Themans) originated in 1928 as a business-to-business (B2B) dealer of high-quality door-fitting products. Door fittings is an umbrella term indicating all aspects surrounding the in-place keeping and locking of a door or window.
In 2006 the company evolved into a dealer & design company incorporating two own brands; S2 and ANSA, to the company (Themans hang & sluitwerk BV, 2019). Including two own brands required: inclusion of an internal R&D department, alternations to the purchasing department, and additional production partners.

In 2020, Themans included an internal assembly line in its corporate structure. Adding the assembly line reinsures the company's flexibility, allowing it to define the final product form at the last moment within the manufacturing process, which is an essential aspect of its strategy.
Including the internal assembly line addition of 2020, Themans counts around twenty employees (Table 1), classifying Themans as an SME in the Netherlands. The small size and structure of the company contribute to flexibility due to the short communication lines and quick corporate actions.

Themans is a daughter company of the umbrella company Nauta. The relationship with the umbrella company allows some functions required for Themans functioning to be executed externally by Nauta; human research, marketing, and data analysis.

Table 1 Corporate overview Themans

Function	Employee(s)
Management	1
Sales	4
Purchaser	1
Stakeholder relations	2
Product manager	1
Product development	2
Logistics & Warehouse	2
Assembly	5

1.2.2 Themans' market & supply chain conditions

Themans is active in the B2B metal retail & build domain within the door fitting processing industry in the Netherlands and Belgium. The market segment to which Themans delivers its product can be categorised at the low end of the market. This conservative market segment is driven by quality, security and brand history and requires a broad product portfolio for complete-solution-offering and ease of search from their suppliers. Themans complies with the market segment demands by including a broad set of door-fitting product types within their portfolio. To accomplish the broad portfolio, Themans offers own-brand products, external-brand products, Original equipment manufacturer products (OEM), and Reverse OEM products.

The different offerings and the company's size require Themans to have a broad upstream supply chain. Due to the company's size, production is outsourced, creating an upstream supply chain. One Asian partner company dominates the upstream supply chain. The dominant position of the partner is because the partner provides translation of product designs for production, connects Themans to a production partner within Asia, and has a long-term bond with Themans.

The downstream supply chain exists out of multiple chains separating Themans from its final user. Metal retailers and door-fitting processers are the direct customers of Themans, from which feedback and other inputs provide incentives for new product development. From the direct customers, little incentive for sustainability could be derived. A questionnaire was sent to gauge the importance of sustainability from the direct customers. The findings were a one out of thirty-response rate and no stated importance for sustainability (Appendix 1).
The customers of the metal retailers and door-fitting processors, further called indirect customers, are the buyers of the products and sometimes also the installers of the products. Then, there are the product users, both individual households and public or industry buildings. Within the current situation, direct contact with indirect customers or users is not part of the R&D process.

1.2.3 Product portfolio

The product portfolio of Themans exists out of: Hinges, Multi-point lock systems, Locking systems, Door fittings, Profile cylinders, Window fittings, Door closer, Anti-panic fitting, Stainless steel door fittings, and Sills (Figure 2). Including OEMs and external brands makes the revenue per product category highly skewed towards the door fittings (Aluminium and Stainless Steel). The door fittings provide approximately eighty per cent of the revenue. The hinges are the second largest selling product group, and the third is the locking system group. The product category door-fittings consist of approximately forty-five own brand products and an unknown amount of OEM products.

To all products within the portfolio, the following characteristics are applicable:

- The products exist primarily from aluminium or stainless steel and have a relatively long lifespan.
- The products do not require an external energy source for use.
- The design of the products is guided and restricted by standardized measurements due to the larger context of use.

- The products have a long brand/ aesthetic value (the managing director gave the example that some products are already sold for 15 years without alternations).
- Among the products within the portfolio, high similarities occur within the production processes of the products.
- The use frequency and long lifespan of the product make the products high-performance products.

Based on the product characteristics, Themans employees assume that the products require minor alterations to become sustainable.

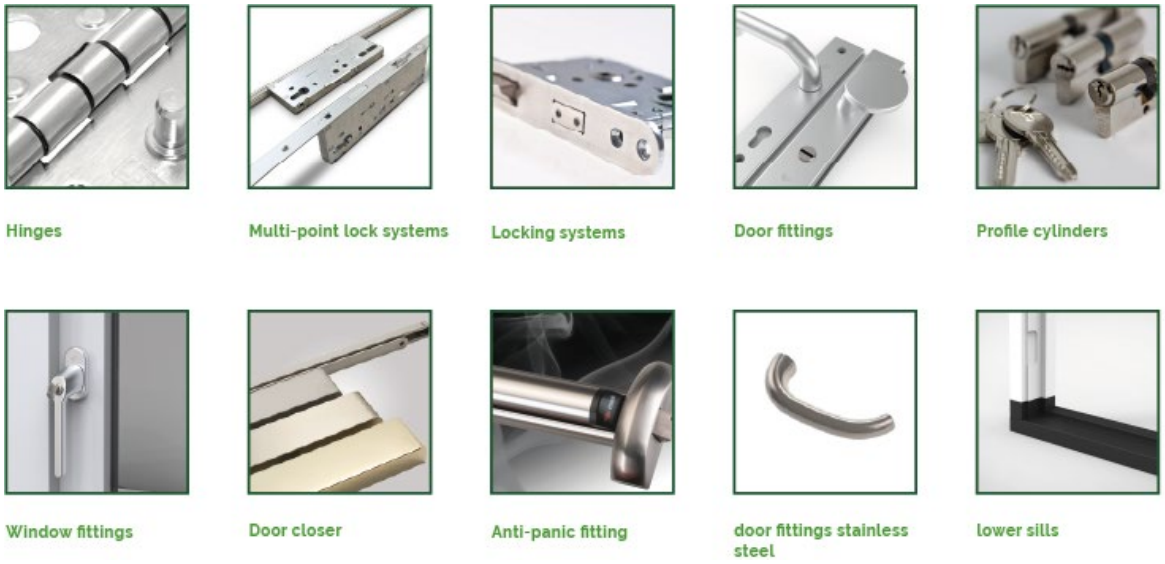


Figure 2 overview of the product categories within the portfolio of Themans

1.2.4 The current sustainability state of Themans

The current structure, initiatives, and applied methods (new product design method, purchasing method) at Themans do not indicate a specific focus on sustainability. The company's managing director showed environmental awareness with the statement that the current way of working could no longer be substantiated within the current sustainability paradigm and that the company should aim to reduce its negative effects on the world. Additionally, Themans perceives pressure to transition towards more sustainable practices from their investment companies and large customers.

However, the lack of experience concerning incorporating sustainability within company actions and the lack of knowledge concerning the topic shows no current actions for incorporating sustainable development. Within the company, employees have different opinions on the impact and contribution of the company on sustainability. The motivation of employees within Themans ranges from motivated employees willing to alter the company's direction towards sustainable development to employees who find the topic difficult and see obstacles in the way.

Within the current situation, the industry-provided environmental product declaration (“cradle-to-grave” type EPD) is used to communicate the general environmental impact profile of Themans products. These EPDs provide impact focus areas (the life cycle phase, which provides the most

impact) for the product categories (Table 2) (Example EPD see APPENDIX 2). All no-power-source-requiring products create the most impact in the production and transportation phases. These phases include the production and transport of raw materials, product manufacture and packaging materials. The company does not execute a more specific product impact assessment themselves. The information required for this assessment is currently not available by the company.

Table 2 product category EPD overview

Product category	Product type	Life span EPD	Life cycle phase with the highest impact
Hinges		30 years	Production stage & transportation >building site
Multi-point lock systems *seen as a general locking system; no specific EPD found	Locking systems	30 years	Production stage & transportation >building site
Locking systems	Press locks	12 years	Production stage & transportation >building site
	padlocks	10 years	Production stage & transportation >building site
	Window locking system	30 years	Production stage & transportation >building site
	Locking systems	30 years	Production stage & transportation >building site
Door fittings (ALU)		10 years	Production stage & transportation >building site
Profile cylinders		10 years	Production stage & transportation >building site
Window fittings		10 years	Production stage & transportation >building site
Window locking systems		30 years	Production stage & transportation >building site
Door closer		30 years	Production stage & transportation >building site
Anti-panic fitting		30 years	Production stage & transportation >building site
Door fittings (Stainless steel)		10 years	Production stage & transportation >building site
Handles (Stainless steel)		10 years	Production stage & transportation >building site

So from the introduction of the case company could be concluded that the intent for sustainable development is available at the company. However, until now, no action has been undertaken.

Chapter 2 Theoretical background sustainable development

This chapter provides the theoretical basis for formulating the strategic sustainable development framework for Themans. The set-up of this chapter is based on the primary research question: How can Themans hang & Sluitwerk BV evolve to become a sustainably developing company? Three phases of the corporate transition process were derived from the research question: the current corporate situation, the transition process, and the desired future state (visualised at the top of (Figure 3)). The current corporate situation is partly described in section 1.2 (Introduction case company: Themans hang & Sluitwerk BV).

The theoretical background is therefore structured as follows:

- The desired future state: The desired future state section shows the translation process from generic worldview sustainability to corporate sustainable development goal statements (section 2.1).
- The transition process: The transition process section describes the general process of corporate transition and explores multiple processes and methods that could facilitate the transition toward the company's desired sustainable future state. (section 2.2).
- Small-and-medium enterprise limitations and opportunities for the sustainable development transition process; This section explores the limitations and opportunities for SMEs to implement sustainable development. It provides essential characteristics of SMEs, which should be taken into account for the development process of the framework (section 2.3)

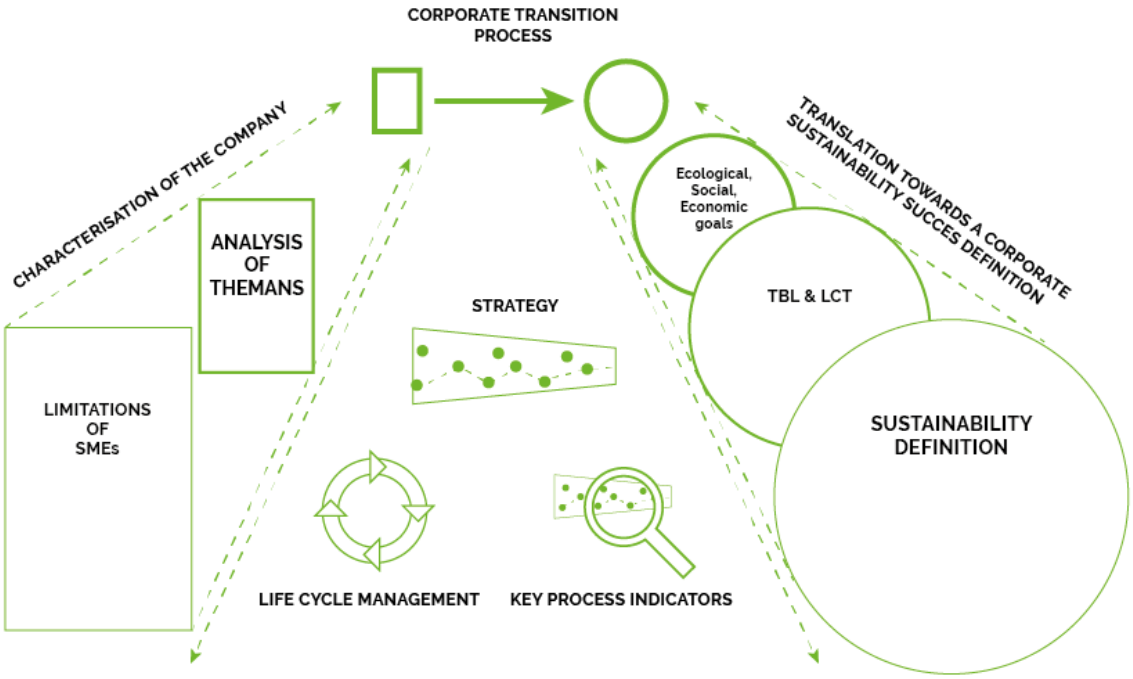


Figure 3 Overview research plan theoretical background

2.1 Sustainable development desired future state

For use during the transition process, the definition of sustainable development for the case company should be clear. This section translates the definition of sustainable development towards a corporate applicable sustainable development definition. Furthermore, this section uses triple bottom line (TBL) to translate the corporate applicable sustainable development definition into; ecological, social, and economic goals. Last, the section includes life cycle thinking (LCT) to ensure that impact of the complete life cycle of the products is taken into account.

2.1.1 Definition of sustainable development

Sustainability and sustainable development are defined from multiple viewpoints within the literature due to the uncertain nature of the matter. The uncertain nature results in various definitions, from the biological essentials (Robert Costanza et al., 1995); sustainability means avoiding extinction and living to survive and reproduce. The sustainable development definition of international policy-making is “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (Gro Harlem Brundtland, 1987). Where sustainable developments are time-dependent facilitators required to facilitate future needs, and the substance of needs is time depended (Abraham Harold Maslow, 1943; Manfred Max-Neef et al., 1992).

The 2030 agenda (Department of Economic and Social Affairs, 2001; United Nations Department of Economic and Social Affairs, 1987) provides a more detailed translation of seventeen sustainable development goals (SDGs). The seventeen goals and their indicators are categorised within five differentiated areas of importance: People, Planet, Prosperity, Peace, and Partnership (Figure 4). The goals provide a translation for governments to move in a more sustainable direction. For understanding purposes, the division into smaller pieces could make sustainable development easier to understand.

Figure 4 Overview of SDGs (Department of Economic and Social Affairs, 2001)

However, for corporations, the SDGs can still provide difficulties since the target group of the SDG translation is governments. A more depictive formulation, therefore, is the principle-based definition of what is not sustainability (obtained from agreements of scientists from different fields)(Karl-Henrik Robèrt et al., 2013). This principle-based definition states sustainable development: We live in the biosphere; within the biosphere, there is a quick system between plants and animals, which is in a dynamic balance. This system is open for energy but closed for material (from thermodynamics, the first and second law). The lithosphere provides a slow, balanced system based on geological cycles providing earth's crust materials. These agreements create the basis for the statement of sustainability. The (Karl-Henrik Robèrt et al., 2013) principles of sustainability state: "operational sustainability principles would aim to eliminate our contribution to … :

- … systematic increases in concentrations of substances from the earth's crust,
- … systematic increases in concentrations of substances produced by society,
- … systematically physical degradation of nature,
- … conditions that systematically undermine people's capacity to meet their needs".

Sustainable development is thus development by humanity within the biosphere's boundaries (the capacity to absorb the effects of human activities). Reducing the effects of human activities is, therefore, the aim of the principles.

The principle-based characteristic of the Karl-Henrik Robert definition provides a more timeless use of the definition, in combination with the use of a negative, making it easier to understand for non-familiar readers. This definition can thus best be used within corporations to clarify the general statement of sustainable development.

Next to difficulties in understanding the topic, the correct translation towards corporate sustainable development is additionally complex due to the interrelated nature between local contributions and biosphere impacts (Carlos Alberto Ruggerio, 2021). The interrelated nature provides difficulties for specific effect isolation for companies. The following section describes the translation of the sustainable development definition into corporate goals.

2.1.2 Triple bottom line

The triple bottom line (TBL) provides an expansion of the corporate criteria of success to include and operationalize ecological, social and economic sustainability within business actions (Hanan Alhaddi, 2015; John Elkington, 1997).

- Ecological sustainability refers to not compromising the environmental resources of future generations. For example, within this aspect of sustainability, the focus lies upon efficient usage of raw materials and energy recourses, minimizing the negative effects produced by the company.
- Social sustainability refers to the company's added value to its community or all involved stakeholders. Within this aspect, sustainability criteria focus on fair business practices concerning human capital and human rights.
- Economic sustainability refers to the economic added value of the company. Although often misinterpreted as the company's financial success, economic sustainability refers to the added prosperity of its surrounding system (John Elkington, 2018). Within the original concept of the triple bottom line, the bottom lines were depicted as three areas that overlap (Figure 5), creating share zones where actions directly influence multiple aspects of sustainability.

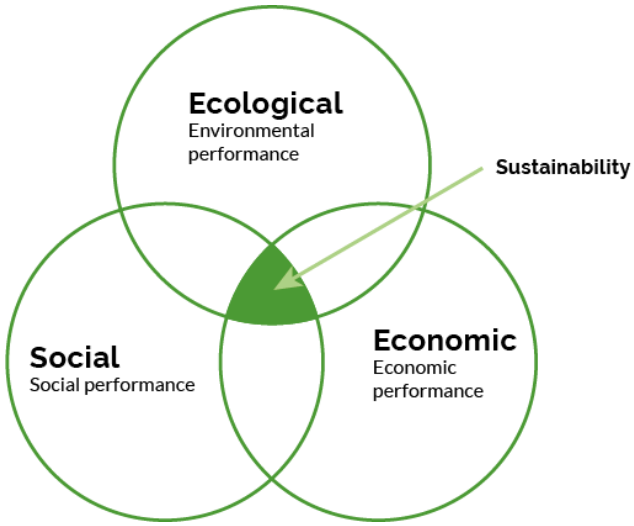


Figure 5 triple bottom line (John Elkington, 1997)

A risk of the TBL is that companies interpret the divisions in isolation, overseeing the interrelations of the three paradigms (Carol A. Adams et al., 2008). More recent research indicates, although taking into account the interdependencies, a more dependent “wedding cake” relation between the three aspects of sustainability (Andreas Obrecht et al., 2021) (Figure 6).

The SDGs (United Nations Department of Economic and Social Affairs, 1987) can also be categories within the division of the triple bottom line (Figure 6). Allowing translation from global goals and indicators towards corporate goals and indicators of success with the TBL as a corporate support tool to expand the paradigm of business.

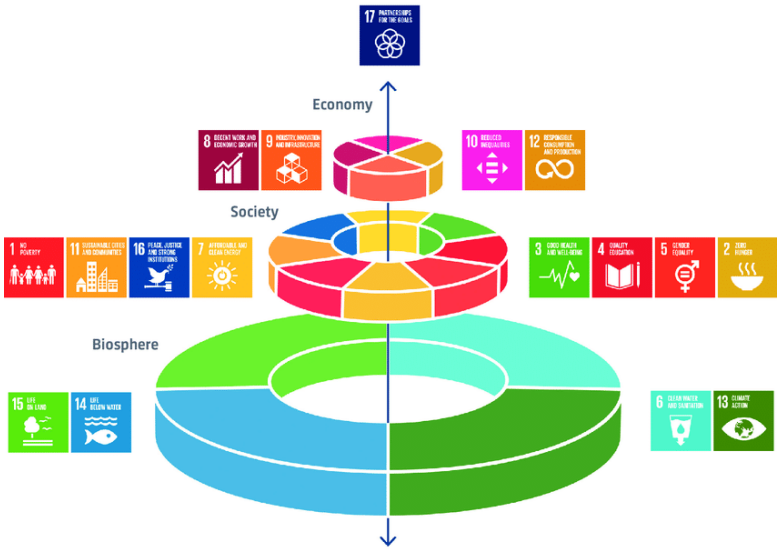


Figure 6 Wedding cake prioritisation of sustainability development goals (Andreas Obrecht et al., 2021)

Research also provides corporate sustainability goals. However, a disbalance is in place concerning the three aspects of sustainability (Figure 7) (H. Afshari et al., 2022). The following three sections will elaborate on the current visions of the expanded success criteria. However, some aspects of sustainability are more elaborately researched than others, namely ecological sustainability.

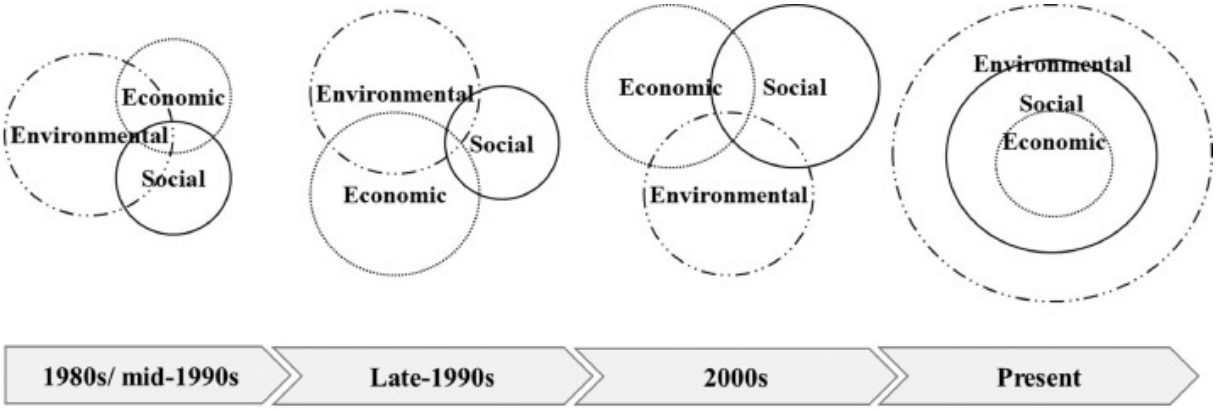


Figure 7 Research focus over the years concerning the three areas of triple bottom line division of corporate success (H. Afshari et al., 2022)

2.1.2.1 Ecological success goal; Circular economy

The current economic incentive model is a “take-make-dispose” linear system. Here finite resources are extruded from the earth at a rapid large scale, altered into products, and discarded after use. The (Karl-Henrik Robèrt et al., 2013) principles of sustainability indicate that this system contributes to the four unsustainability statements instead of eliminating our impact.
Circular economy is a goal that focuses on designing out waste, building strength by incorporating diversity, using renewable sources (energy and material), thinking in systems instead of products, and focusing on feedback mechanisms that reflect actual costs, including costs outside the scope of the financial realm (Ellen Macarthur Foundation, 2015).

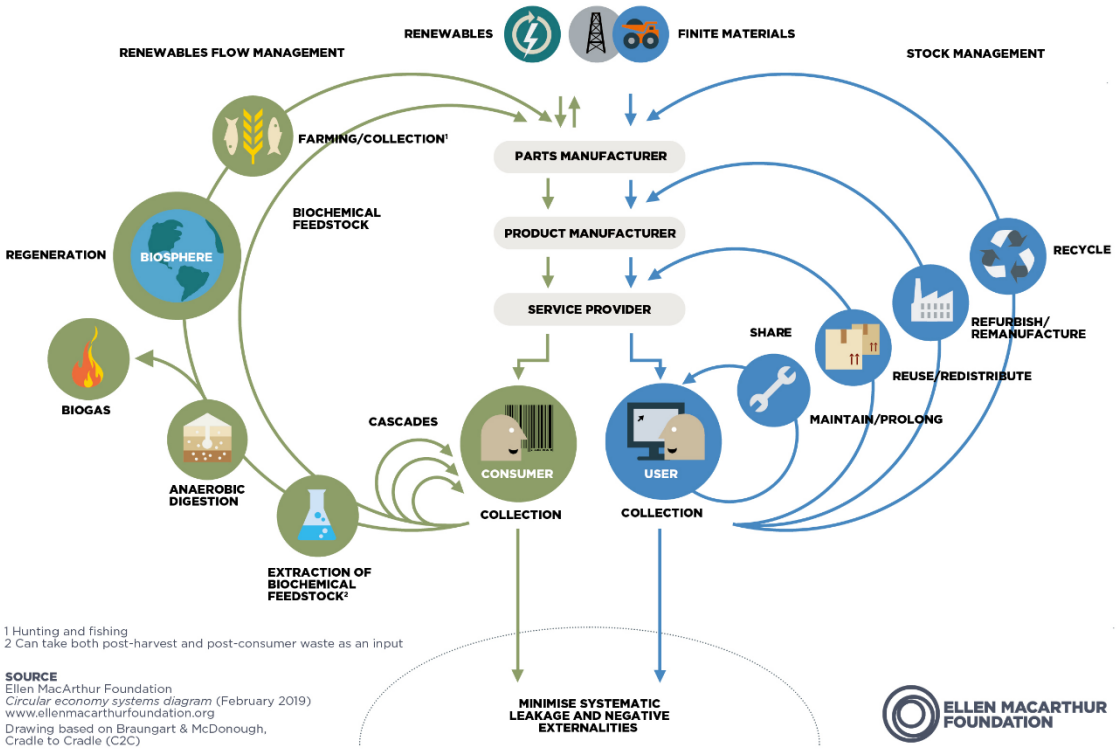


Figure 8 The outlines of a circular economy (Ellen Macarthur Foundation, 2015)

The circular economy outline differentiates two loops: the biological and technical cycles. Both cycles aim to maintain the product's value for as long as possible (Figure 8). The biological cycle can regenerate into the biosphere, whereas the technical cycle cannot. Products within the technical cycle should therefore be maintained within the cycle for as long as possible. From the top, inputs to the system should be as pure as possible to increase the efficiency of the regenerating loops and to maintain the quality of the products to ensure a long cycle time. A long cycling time (time per cycle times the number of cycles) reduces the need for materials, energy, and labour for new product creation. The product value decreases due to the use of the product. Cascade use of the product allows diverse reuse, maintaining product value for longer. The inner loops (closest to the user) maintain most product value, whereas the product value at the outside loop is only based on its material properties.
In line with the outline of a circular economy, (Marcel C Den Hollander et al., 2017) states two critical aspects of CE to be:

- **The product lifetime**, specifically within the lifetime, the use cycle of a product, and the moment in which the product is not obsolete (did not lose value yet). Here the lifetime of a product should be as long as possible to simulate a material closed loop flow closely.
- **The recovery of resources** should aim to reserve or recapture the highest level of the product's value.

The circular economy model goes even further, aiming to close the linear system and "… to ultimately decouple global economic development from finite resource consumption." (Ellen Macarthur Foundation, 2015).

The 9R's, or R-ladder

The 9R's, or R-ladder, provide an extension to the outline of a circular economy (Figure 9 & Figure 10), applying more categories and including multiple strategies to implement circularity starting from the design phase (Arne Remmen et al., 2007; Departement Klimaat en Energie, 2021; José Potting and Aldert Hanemaaijer (eds.) et al., 2018). The R-ladder includes a hierarchy among the options to close the loop from the most impactful strategy (R0) to the least impactful strategy (R9). (José Potting and Aldert Hanemaaijer (eds.) et al., 2018) states that there is a negative relationship between a strategy within the 9R-ladder and the environmental effects of the production phases of the product. So the higher the 9R-ladder level, the lower the ecological impact.

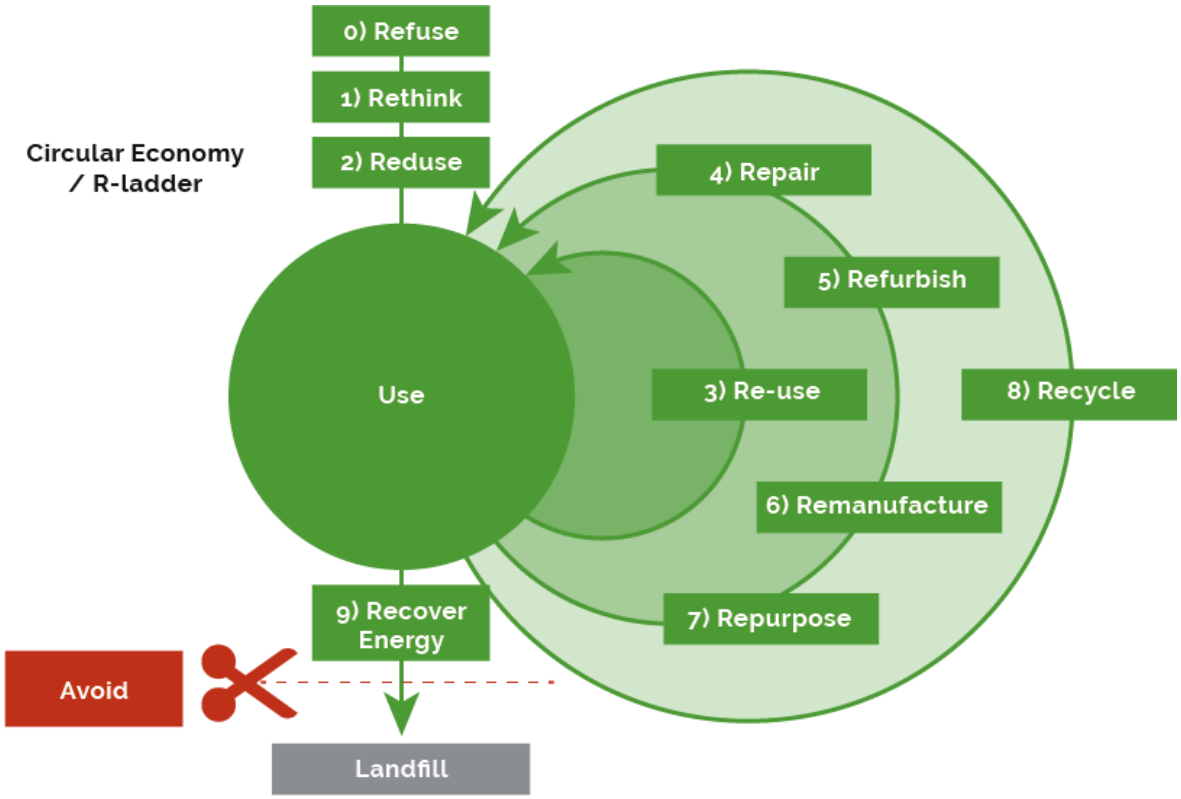


Figure 9 9R-ladder graphic based on (José Potting and Aldert Hanemaaijer (eds.) et al., 2018)

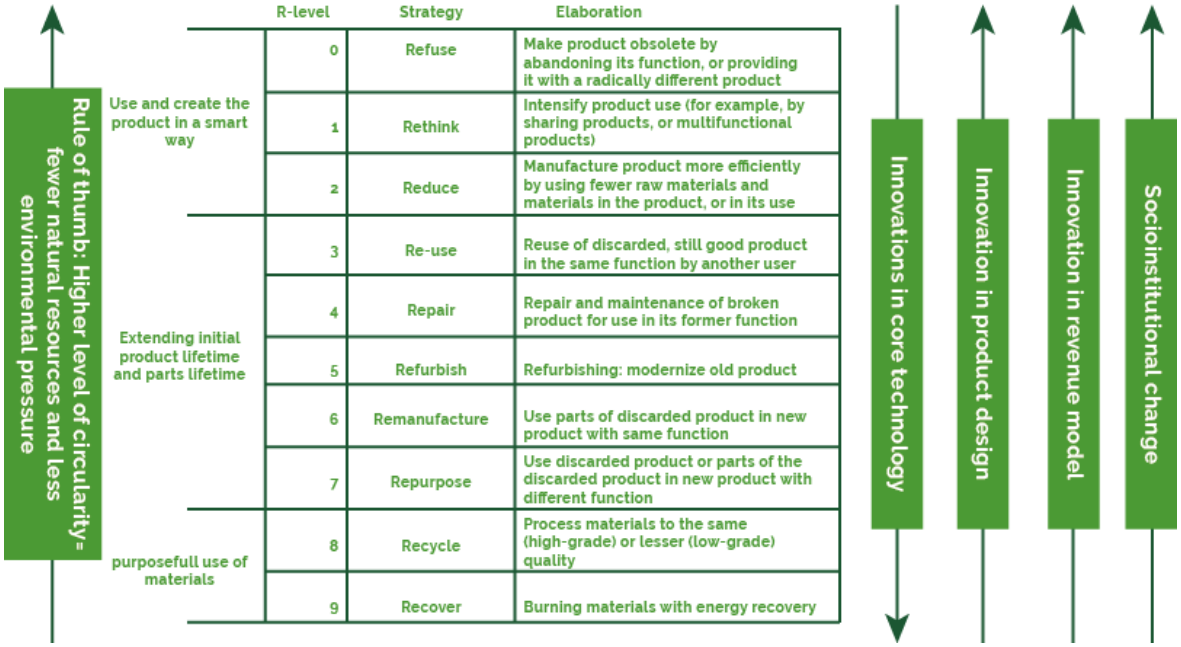


Figure 10 9R ladder model based on (José Potting et al., 2017)

The circular economy model requires rethinking corporate value creation to maintain the utility and value of the offering. Here the company should: “Preserve and enhance natural capital by controlling finite stocks and balancing renewable resource flows.”, “Optimize resource yields by circulating products, components, and materials at the highest utility at all times in both technical and biological cycles.” And “Foster system effectiveness by revealing and designing out negative externalities.” (Ellen Macarthur Foundation, 2015).

However, the implementation of CE does not apply to all product types. Products that experience rapid technological innovations counter the long-lifetime aspect of CE. Here the innovations devalue the products fast, for which the overall environmental impact could be higher with the implementation of design for CE (Marcel C Den Hollander et al., 2017). A circular economy goal for this type of product developing companies could create a risk of greenwashing since the design for CE products can be less sustainable when discarded after use. Additionally, a higher level of circularity does not always provide fewer environmental effects. For example, due to sharing, the ease of availability could create unnecessary use of products (José Potting and Aldert Hanemaaijer (eds.) et al., 2018).

Product modularity

Design for modularity is a product architecture strategy focusing on product architecture breakdown in independent units. The decision for modular design and its benefits (upgrades of products, adaptations of parts, modifications, easy product assembly and disassembly, product variety increase, economy of scale benefits, production time reduction) as a sustainable design strategy depends on environmental impact per life cycle step (Monique Sonego et al., 2018). (Figure 11) shows the benefits and limitations associated with a modular product architecture.

In line with the 9R ladder, modularity (dependent on the use of interfaces) facilitates easier recycling, reuse, and remanufacturing, allowing for upgrades (refurbish) and repair (Figure 11).

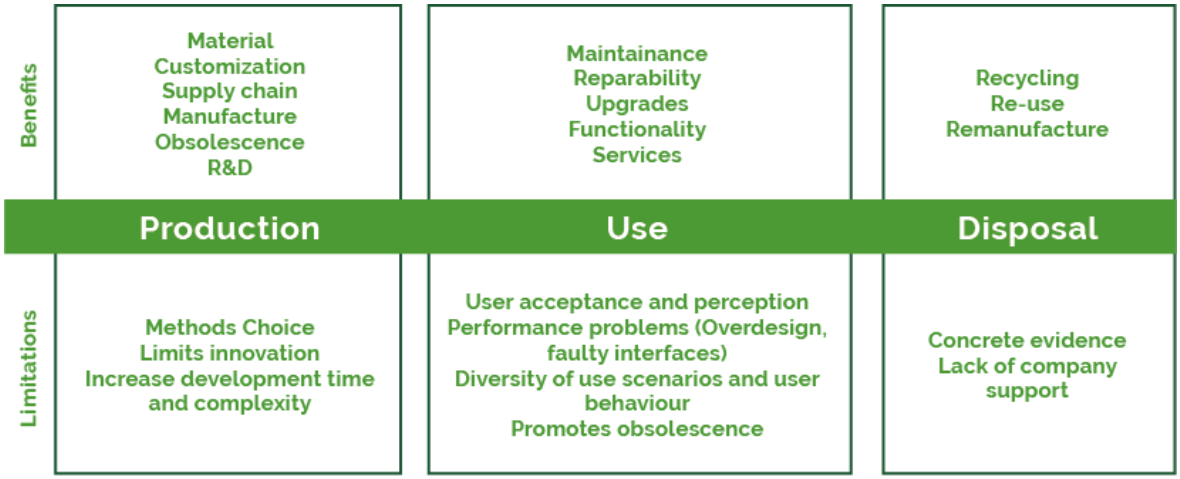


Figure 11 Benefits and limitations of modularity per stage of the product life cycle phase. (Monique Sonego et al., 2018)

Products within the portfolio should fit the modular design requirements to overcome the limitations of modularity, like overdesign (Figure 11). However, combining the benefits of modular design with the 9R ladder shows high potential for modular design within the ecological sustainability goal.

2.1.2.2 Social success goal; Maslow's hierarchy of needs

Social sustainability is a relatively new research focus topic (H. Afshari et al., 2022). The social sustainability-oriented SDGs shown in (Figure 6) are no poverty, zero hunger, good health and wellbeing, quality education, gender equality, affordable and green energy, sustainable cities and communities, peace, justice and strong institutions. This shows an interdependency on the ecological sustainability aspect for certain goals. Additionally, few social specific independent globally acknowledged goals are found.
One of the reasons is that social sustainability is more culturally dependent, which can be visualised by the different legislations applicable in different countries. The differences provide possible different social goals depending on the location of the appliance.
Companies often base their social sustainability policy on international agreements to overcome cultural differences (Amfori BSCI, 2021; Aleksi Kivinen, 2022). The international acknowledged guidelines;

- The United Nations Guiding Principles on Business and Human Rights (UNGPs) (United Nations Human Rights office of the high commissioner, 2011),
- The Gender Dimensions of the UN Guiding Principles on Business and Human Rights (United nations development programme, 2019)
- The OECD/OESO guidelines (OESO is the translation of the Dutch government of the OECD)(Ministerie van buitenlandsezaken, 2014)

all are based on companies complying with the declaration of human rights (United Nations, 1948) and the fundamental human rights principles within the working environment (International labour organization, 2019a).

Additionally to the thirty human rights articles, the international labour organisation (ILO) provides five fundamental principles out of eight fundamental conventions; "freedom of association and right to collective bargaining" (conventions No. 87, No.98), "elimination of all forms of forced labour" (conventions No. 29, No.105, No. 138), "abolition of child labour" (convention No. 182) and "elimination of employment discrimination" (No. 100, No. 111), "safe and healthy working environment" (International labour organization, 2019b).

H. Afshari et al. classify social sustainability indicators within four groups; Human rights and social life (with one-hundred-sixty-two indicators); legal, political and government (twenty-two indicators); occupational related (one-hundred-thirty-two indicators); business-related (one-hundred-three indicators) (H. Afshari et al., 2022). The indicators range from health and safety indicators to well-being and happiness, expanding the social sustainability goal beyond human rights-related indicators.

The social sustainability goal could thus be interpreted as corporate compliance with international and local legislations. However, human needs can exceed human rights. Maslow's hierarchy of needs prioritises needs in which both human rights are stated, and more internal needs like psychological and self-fulfilment needs are included (Figure 12) (Abraham Harold Maslow, 1943). However, criticism of Maslow's hierarchy of needs showed that the requirement of sequential bottom-up fulfilment of the pyramid does not apply to all situations (Saul McLeod, 2007). The differentiation could be used as a goal statement for social sustainability to aim beyond compliance to human rights toward the highest level of human needs since the overall hierarchy is not false.

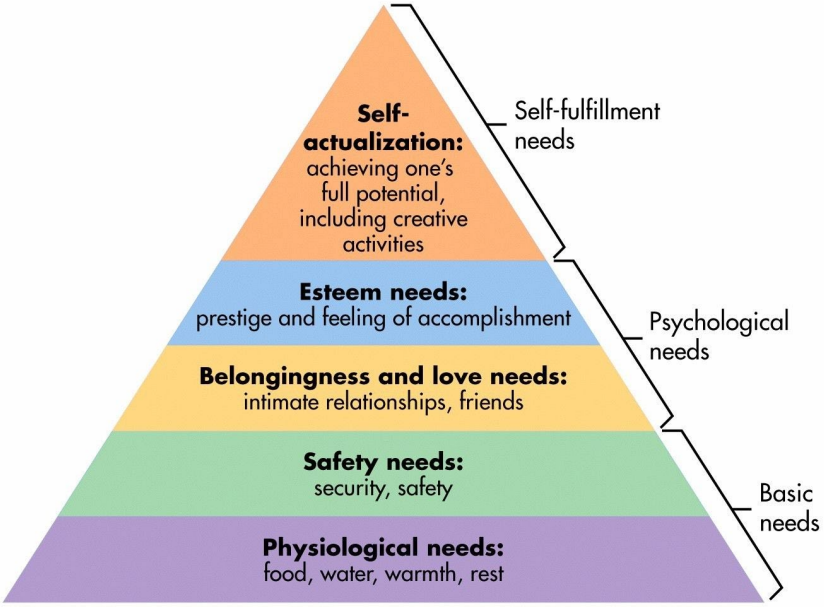


Figure 12 hierarchy of human needs (Saul McLeod, 2007)

2.1.2.3 Economic success goal; economic resilience

Economic sustainability refers to the company's added prosperity to its surrounding system (John Elkington, 2018). The addition, providing economic prosperity to its surrounding system is often neglected within literature ((Figure 13) Dow Jones sustainability index, Global reporting initiative, and Bansal (2005) do not indicate economic prosperity goals for the surrounding system of the companies).

Table 4. The Three Dimensions of Corporate Sustainability.

	Dow Jones Sustainability Index	Global Reporting Initiative	Bansal (2005)	Kolk, Hong, and van Dolen (2010)
Economic	1. Corporate governance 2. Codes of conduct/compliance, corruption, and bribery 3. Risk and crisis management 4. Customer relationship management 5. Innovation management	1. Economic performance 2. Market presence 3. Indirect economic impacts	1. Established government relations 2. Reduced costs of inputs 3. Reduced costs for waste management for same level of outputs 4. Used waste for revenue 5. Differentiated product on environmental performance 6. Created spin-off technologies	1. Employee compensation 2. Donation/community spending 3. Local sourcing/local hiring/taxation

Figure 13 example indicators of economic sustainability by literature (Ivan Montiel et al., 2014)

Economic sustainability also requires a broader paradigm to include the interdependencies between the three bottom lines. For example, M. Z. Hauschild et al. states that the environmental impact is based on population size, economic activity per capita and eco-efficiency (M. Z. Hauschild et al., 2004). Further, due to the population size and economic activity, the eco-efficiency should increase by a factor ten within fifty years to obtain sustainable development. It, therefore, suggests that companies should aim for a service business model instead of a product to overcome the limitations of product strategies in line with ecologic sustainability.

On the same basis of environmental impact, it could be concluded that continuous economic activity per capita growth is not possible within the planet's boundaries.

Tim Jackson states a need for redefining economic sustainability to prosperity due to the current dilemma of economic growth; where, on the one hand, growth in the current form is unsustainable due to the environmental boundaries, and on the other hand, de-growth in the current situation is unstable due to protentional unemployment and recession risks (Tim Jackson, 2009). Additionally,

he suggests twelve steps from a macro, governmental view to transition towards a sustainable economy or to obtain a resilient economy which can sustain the required environmental and social transformations. These steps reform the current economy towards an environmental impact, including one; improving current jobs and sharing jobs to overcome unemployment.
Based on an economic sustainability goal from the triple bottom line view slightest theoretical basis is found.
However, economic resilience instead of growth provides a recurring topic, especially for SMEs, since these significantly contribute to the economic development of their surrounding communities (Angappa Gunasekaran et al., 2011), for which this could be seen as the goal.
Stefanie Beninger et al. state that a company's capacity for anticipation and adaption are the two key aspects of economic resilience (Stefanie Beninger et al., 2020). Anticipation refers to risk management involving the awareness of impactful events or critical forces. Adaptation refers to avoiding and responding to unfortunate situations.

A company's capacity for anticipation and adaption are part of risk management. H.C.Theisens et al. provide an example of risk management with the help of a risk matrix (Figure 14) (H.C.Theisens et al., 2020). Here the probability and severity of risk are scored. Risk management aims to identify, assess and mitigate risk to reduce the probability of occurrence or the severity of the effect.

Probability	Negligible 1	Minor 2	Moderate 3	Major 4	Catastrophic 5
5 Almost certain	Moderate 5	High 10	Extreme 15	Extreme 20	Extreme 25
4 Likely	Moderate 4	High 8	High 12	Extreme 16	Extreme 20
3 Possible	Low 3	Moderate 6	High 9	High 12	Extreme 15
2 Unlikely	Low 2	Moderate 4	Moderate 6	High 8	High 10
1 Rare	Low 1	Low 2	Low 3	Moderate 4	Moderate 5

Figure 14 risk matrix based on (Gulsum Kaya, 2018)

2.1.3 Life cycle thinking

The triple bottom line translated the sustainability definition into a three-division of corporate sustainable development goals. For sustainable development, the impact of the company should be taken into account, and the complete product lifecycle as well. Life cycle thinking (LCT) is a paradigm which takes into account impacts generated within the entire lifetime of a product (Figure 15) (Arne Remmen et al., 2007; Shahjadi Hisan Farjana et al., 2021). Life cycle thinking transforms the current gate-to-gate paradigm, which only considers a part of the product's life cycle in a cradle-to-grave paradigm. The lifecycle phases of a product are product-specific and, therefore, can differ. Generally, the phases are raw material extraction, production, transportation, use, and disposal.

The complete life cycle view emphasizes the importance of design decisions since these initiate effects for the whole product life cycle. This way of thinking also enlarges the possibilities for the designing company to enhance the sustainability of the products at multiple levels.

Due to the possibilities for the designing company, a shift in accountability and responsibility is also noticeable. Current developments in sustainability principles provide increased demanded corporate responsibility. New regulations, for example the 'Corporate Sustainability Due Diligence Directive' (CSDD) (Justice and Consumers, 2022), although not applicable to SMEs yet, show impact responsibility placed on the designing company. The life cycle thinking paradigm provides insight into the risk of shifting the impact towards a different chain within the supply chain instead of reducing the risk. Additionally, it shifts the focus towards a value-maintaining paradigm instead of a value-decreasing over time paradigm.

Traditional environmental management focuses on increasing the efficiency and sustainability of the company's facility (own chain). Life-cycle-thinking guards companies from possible blindsight from this gate-to-gate paradigm since a product's overall sustainability impact could be negatively affected by efficiency improvements in one of the chains. The gate-to-gate paradigm could thus lead to shifting the impact of the product towards a different chain within the complete product life cycle, resulting possibly in so-called "greenwashing" (unsubstantiated sustainability claims).

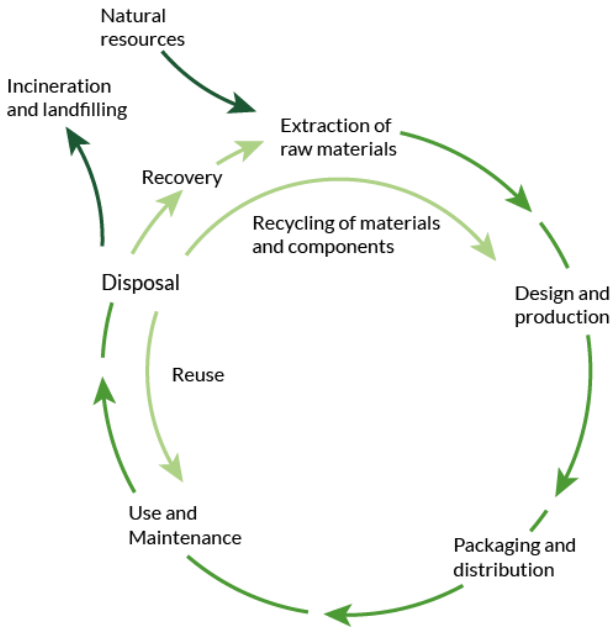


Figure 15 representation of life cycle phases as part of life cycle thinking (Arne Remmen et al., 2007)

Life cycle analysis (LCA)

Sustainability assessment tools facilitate the translation of product life cycle data into information. Life cycle analysis (LCA) is a product impact assessment methodology that combines the quantitative product effect data to assess a product's effects on its surroundings, taking into account all life cycle steps of the product (Mark AJ Huijbregts et al., 2017). "Many companies stated that LCA draws attention to the areas in which improvement is needed, makes comparison of different alternatives easier, and allows tracking changes between product generations" (Jussi Nygren et al., 2010). The LCA methodology consists of four phases; Goal and scope definition, Inventory analysis, Impact assessment, and Interpretation (International Organization for Standardization, 2006) (Figure 16). Currently, the LCA is limited to ecological effects. Alternations to the LCA focus on one of the three bottom lines: LCC (life cycle cost), LCSA (life cycle sustainability analysis) and SLCA (social life cycle analysis).

Executing a LCA requires, however, a lot of time and costs. Companies, therefore, often use it only on benchmark products.

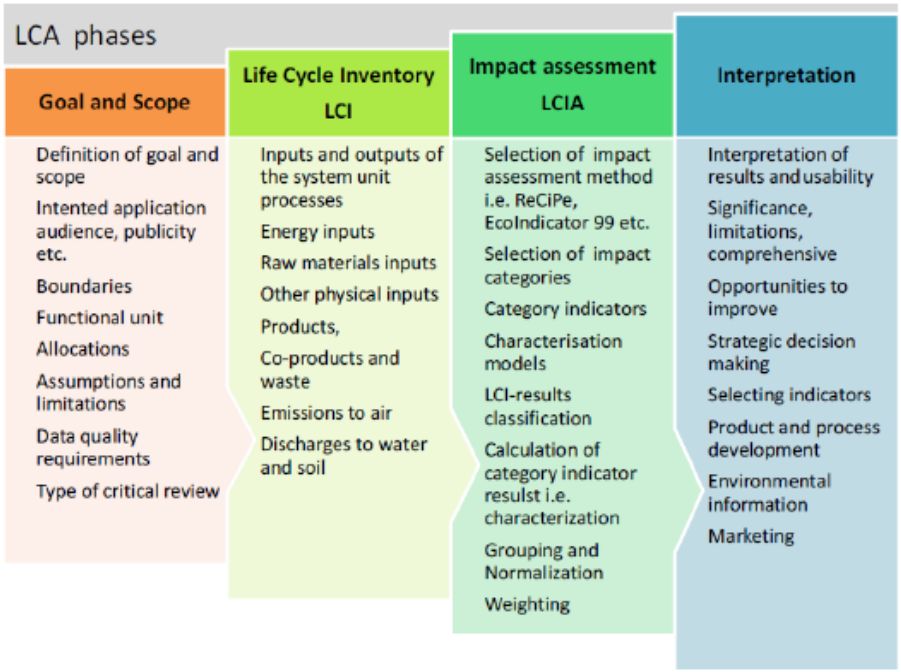


Figure 16 Life cycle assessment phases (Juhani Heilala et al., 2014)

So LCT facilitates the minimization of a product's harmful environmental effects (by design for the whole life cycle) while maximizing the product's social and economic value throughout the products life cycle (Arne Remmen et al., 2007), providing corporations with an enlarged paradigm to undertake sustainable development activities within the complete product life cycle. Executing a life cycle assessment can then identify improvement areas within a product's life cycle, although costs and time requirements for executing an LCA can provide difficulties for the company.

2.2 The transition process

A corporate transition process overlaps the gap between the current and the future desired state. The transition towards sustainable development can use various supporting methods within different management levels (normative, strategic, operational). This section uses a top-down management approach to obtain frameworks, methods and systems to guide the transition process up to a normative and strategic level. The transition process incorporates the TBL goal statements and LCT within the SME.

2.2.1 The levels of a transition process

Dual pyramid model; transition approach for sustainable development

The strategic plan hierarchy identifies the different strategic levels involved with a company's transition (Bambang Purwono et al., 2014) (Figure 17). A top-down strategy formulation approach should be used to transition corporations, starting with a mission and vision. The reason for the order is to obtain top-down motivation and resource allocation for the execution of the project.

Figure 17 Alternation of Strategic planning hierarchy (Bambang Purwono et al., 2014)

The top-down approach ensures that all employees strive for the same goal. The aim is, however, to let bottom-up approaches take over the process implication after top-down initiation. Thus the input for the hierarchy should be obtained via bottom-up feedback, as also suggested by the dual pyramid model for change management (H.C.Theisens et al., 2020).

Effective change management

Thomas G Cummings et al. identify five corporate transition management activities to facilitate corporate transition management (Figure 18) (Thomas G Cummings et al., 2014).

1. The motivation for change needs to be initiated at the company—the internal and external drivers-for-change need to be identified to state the incentive and pressure for change. The gap between the current and desired state needs to indicate the size of the required transition process. Furthermore, individual views on the change should be identified to understand the company's starting point and manage expectations. It also identifies protentional resistance to change.

2. A vision provides a goal for the change process. The vision states a detailed future state and combines the future state with the company's core ideology to bridge the aspects of the change and the company together.
3. The change requires support from individuals within the company. For support, it is essential to know the stakeholder's role, power within the company, and opinion on the change.
4. The transition bridges the current and desired state of the company. This state requires planning to facilitate a clear roadmap for the company. The planning should not only include actions to help continue the change process but also actions to initiate and maintain motivation. Furthermore, it is crucial to understand that the change requires learning new skills. Managers often underestimate the time it takes to implement new skills or change to a different goal too quickly, making the new skills obsolete (Thomas G Cummings & Christopher G Worley, 2014).
5. The change process requires continuous effort to sustain momentum. These efforts are both of a financial and corporate resources nature as from a motivational and learning speed nature. From the change agents, the continuous effort requires to overcome the resistance of other employees. It is important to include support systems for the change agents to ensure the momentum of the change transition. Additionally, the change's momentum must align with the company's and its employees' frequency. Moving in line with the own frequency can take away resistance.

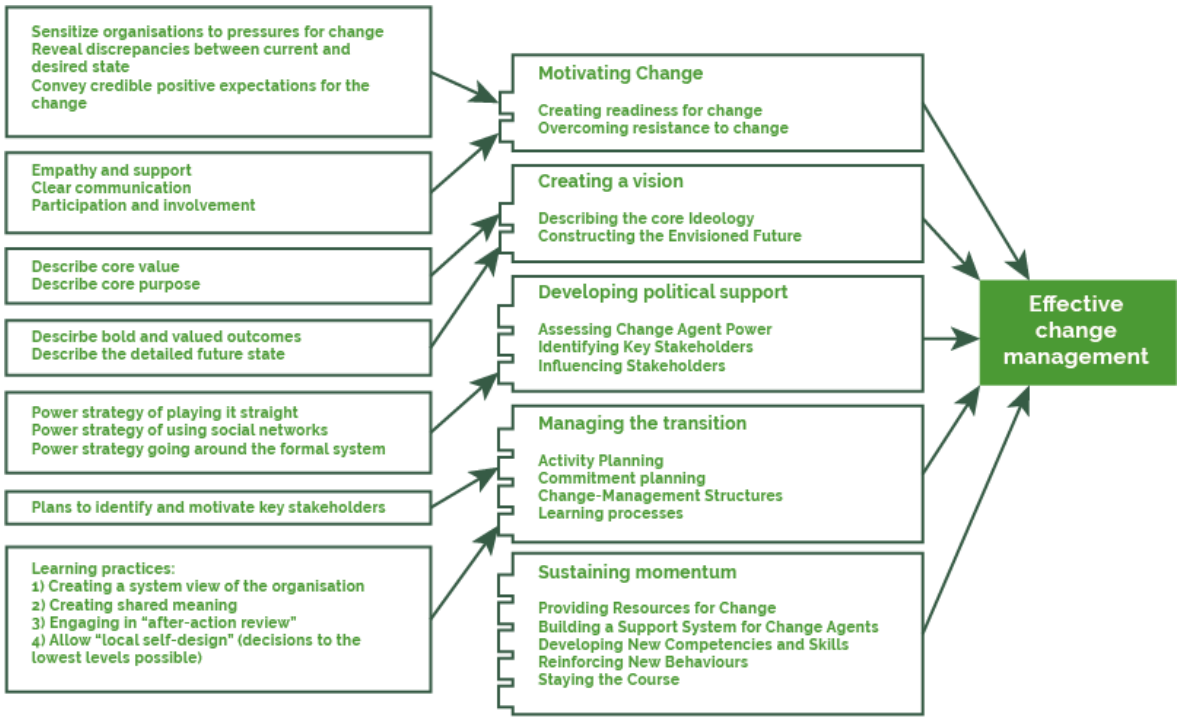


Figure 18 Aspects of effective change management, adapted from (Thomas G Cummings & Christopher G Worley, 2014)

The transtheoretical model

Within the effective change model, the employee-level view on change should be identified to understand the starting point and expectations of the company.

James O. Prochaska et al. state six stages of personal behaviour change, which could be used to explain employee-level views on the change (Figure 19) (James O. Prochaska et al., 1997). Defining the stage of the employees within the company could provide the angle for approaching the company's transition process. A successful change ensures maintenance and avoids termination of the behaviour change.

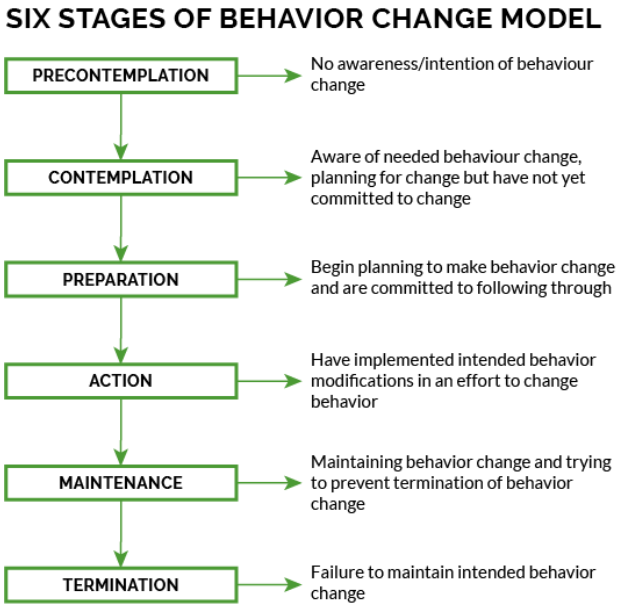


Figure 19 Six stages of the transtheoretical model (Zachary Pope et al., 2014)

So, the corporate transition field provides two levels to take into account during the transition process. The management process stresses the importance of corporate motivation; vision creation; support allocation; planning of activities, commitment, and learning processes; and sustaining the momentum by resource allocation, personal development, reinforcing new behaviours and staying on course for the corporate transition process.

At the employee level, the behavioural change stage could indicate the employees' motivation for the transition process and their expectations from the process. As motivation is identified in all layers of the transition process as an essential aspect, the motivation stage within the company's employees is important to understand for implementing a transition method.

2.2.2 Sustainable development strategy

A strategy directs a transition process by providing a prioritized overview of actions from the current state of a company towards a desired future state. Generally, a strategy consists of a success statement, the current state of a company/system and a sequence of prioritized actions. (G.I. Broman et al., 2017) provides a framework for strategic sustainable development (FSSD) based on a principle-based definition of sustainability (Karl-Henrik Robèrt et al., 2013), system thinking, back-casting, and a five-level model. The strategy formulation uses a back casting technique from the principle-based goal or vision statement. This back casting technique facilitates the initiation of a sustainability transition process without the specific need for in-depth starting knowledge (G.I. Broman & K.H. Robèrt, 2017). Since, due to the use of the principle-based definition of sustainability, less knowledge of the consequences of corporate actions in relation to the overall world sustainability impacts is required.
Furthermore, the required knowledge level grows in line with the company's transition, as indicated by the funnel shape (Figure 20). The results of the actions sharpen the system boundaries for further actions, resulting in a practical way of obtaining knowledge on company-specific sustainability.

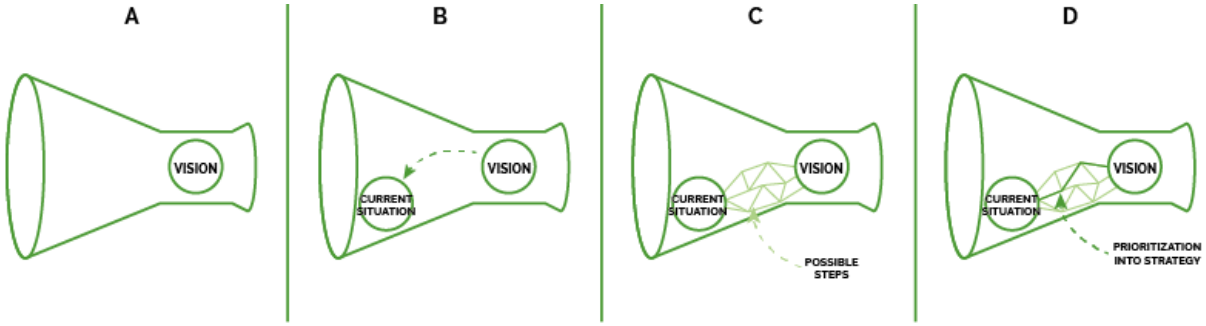


Figure 20 framework for strategic sustainable development (G.I. Broman & K.H. Robèrt, 2017)

The framework for strategic sustainable development provides a procedure (ABCD) to formulate a sustainability strategy (G.I. Broman & K.H. Robèrt, 2017) (Figure 20):

- Stage A: Educate participants (maximum of fourteen participants) on sustainability in general, sustainability translation for the company, and the funnel principle of the strategy. Furthermore, this phase focuses on formulating a vision of success.
- Stage B: Analyse and asses the company's current situation regarding the vision of success (based on the principles). This phase deals with the question, where is the company's current state within the funnel?
- Stage C: Identify possible solutions using back casting from the vision, and use creative processes to generate solutions and opportunities implied by the gap between the vision and the current situation.
- Stage D: Apply strategic guidelines to provide prioritization among the possible solutions to formulate a feasible strategic plan. The prioritization is based on the sustainability principles (Karl-Henrik Robèrt et al., 2013)

The framework for strategic sustainable development provides difficulties for corporations to translate the definition into guidelines for actions individually. This is because the prioritisation and feasibility testing are based on the principle-based definition of sustainability. The FSSD does not provide information on prioritisation factors within the strategy but leans on counsellor education

sessions to obtain knowledge on their prioritisation system. Finally, the FSSD prioritises ecological sustainability over social and economic sustainability.
Due to the limitations of the FSSD, the impact effort method and the multi-decision-making process are researched.

Impact effort matrix Lean Six Sigma (LSS)
Lean six sigma (LSS), a corporate methodology aimed at facilitating continuous learning within companies, states an impact effort matrix for decision making (H.C.Theisens et al., 2020).
This matrix divides actions into four categories based on their impact on the company's goal and the effort required to execute the actions (Figure 21). Prioritization within this matrix focuses on executing actions with high impact and low effort first. Additionally, it states to plan actions with high-impact-and-high-effort and with low-impact-and-low-effort. Finally, it states to discard actions with low-impact-and-high-effort. The matrix can thus provide a prioritization of actions. However, to obtain a prioritization matrix oriented toward the inclusion of sustainable development, the impact should include a sustainability impact score for the actions.

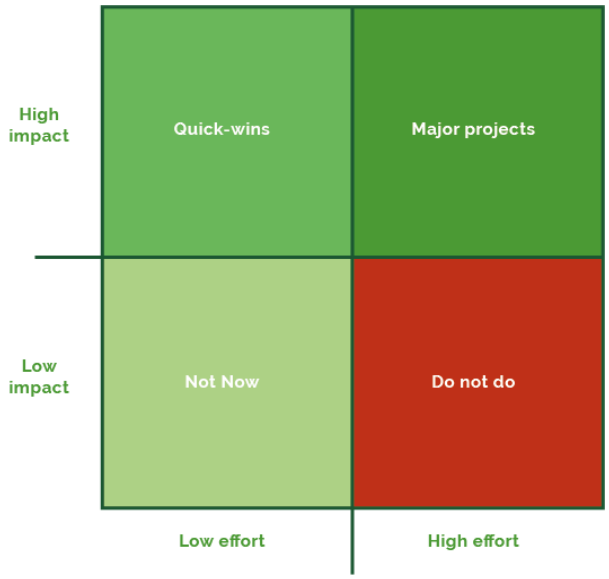


Figure 21 impact-effort matrix for lean prioritizing projects based on (Lean six sigma academy B.V., 2020)

Multi-Criteria Decision-Making
Another method to obtain prioritization is multi-criteria decision-making (MCDM). A multi-criteria decision-making process can guide the prioritisation process by highlighting the trade-offs and subjectivity, increasing the transparency of the decision (A. Veldman, 2014). Generally, a multi-criteria decision analysis follows the next steps:

1. The problem should be defined, and alternatives should be generated.
2. The criteria to make a comparison between alternatives possible should be identified. The criteria should do all alternatives justice and achieve the problem-solving goal.
3. Value judgements on the relative importance of the criteria should be identified. The relative importance refers to the prioritization among the criteria.
4. Inferior alternatives should be eliminated from the comparison to increase the speed and reduce the effort of comparison.
5. Determine the performance of alternatives for the criteria
6. Select the final alternative(s)

Often misunderstood assumptions about MCDM are that it will generate the “right answer”, an objective answer or take the pain out of decision making (A. Veldman, 2014). The assumptions are not accurate. MCDM provides answers closest to the values stated by the decision maker and is subjected to the subjectivity of the decision maker.
Unreliable knowledge can decrease the confidence of the value judgements. Including input from multiple sources (theory, consensus of experts, observations and the model) can counter this problem. (Lund University Centre for Environmental and Climate Research, 2015)

Thus, this section states that the corporate transition process should use: a backcasting technique from the vision level to create the strategy, prioritisation factors, solutions to obtain the vision statement, and a prioritisation/ decision-making procedure. The section further identifies knowledge certainty and transparency as beneficial factors of the strategy process.

2.2.3 Life cycle management

"Life Cycle Management (LCM) is a product management system aiming to minimize environmental and socioeconomic burdens associated with an organization's product or product portfolio during its entire life cycle and value chain." (Arne Remmen et al., 2007). The system provides a broad overview of the aspects of companies' sustainability incorporation and monitoring. It lists all practices from sustainability policies and strategies, systems, concepts, tools and information models (Figure 22). The overview is broad. Dependent on the company's characteristics, a combination of the LCM aspects can be selected to create an adapted LCM system.

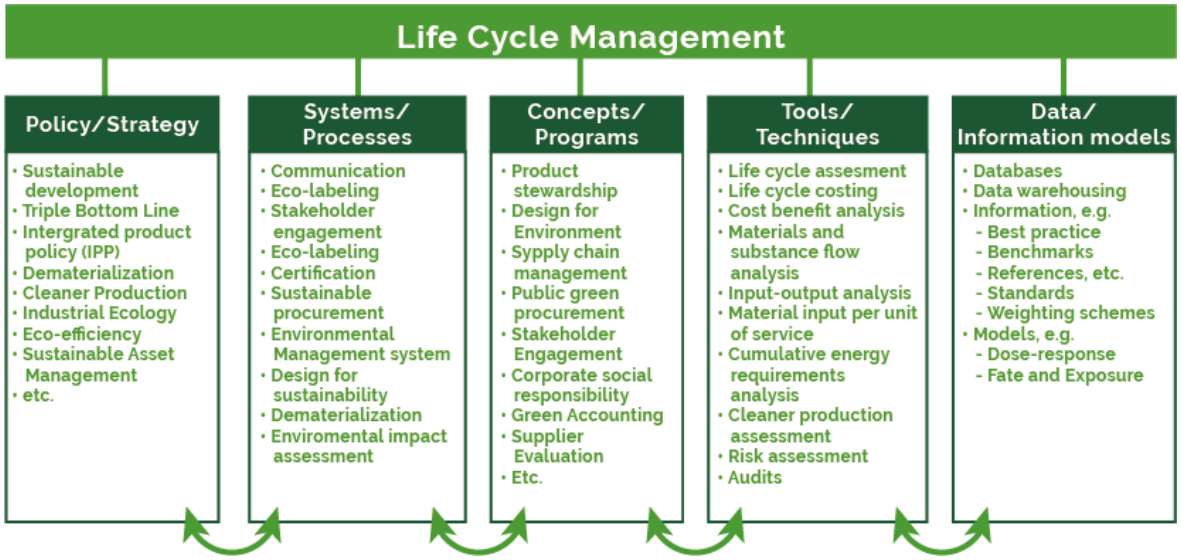


Figure 22 overview of data models, tools, programs, systems and strategies included as part of LCM based on (G. Sonnemann et al., 2015)

Continuous improvement: Plan Do Check Act

A company's policy is the starting point for LCM implementation. A policy shows the company's ambition. The ambition expressed within the company's policy statement should indicate the commitment toward the continuous improvement cycle as stated in an ISO management framework to initiate the transition (Tom Tibor et al., 1996). Furthermore, it should indicate the commitment towards a product improvement beyond the manufacturing level towards a complete life cycle improvement. The commitment also indicates sufficient active participation and management resource allocation toward the LCM (Arne Remmen et al., 2007).

LCM aims to collect, structure and disseminate product-related information to inform decision-makers and to provide continuous improvement (Arne Remmen et al., 2007). Companies often face difficulties initiating the sustainability transition due to a so-called 'first-time-right' burden. Continuous improvement reduces this first-time-right dogma to overcome initiation difficulties. The PDCA (plan-do-check-act) method, therefore, functions as a backbone of the LCM system to maintain momentum (ISO, 2015)(Arne Remmen et al., 2007):

- Plan: This phase covers the analysis of company and environmental characteristics and formulates goals and actions to obtain the goals.
- Do: this phase contains executing the actions stated in the plan.
- Check: This phase is about monitoring and measuring the results/ effects of the executed actions.
- Act: This phase covers evaluating the executed actions and the accompanying effects. It focuses on the alignment of the effects with the overarching company goals. A decision is

required in this phase to continue the current actions and focus on a different topic or to alternate the current actions.

The aim to inform decision-makers about the best capabilities is facilitated by including all company functions, the supply chain, and all stakeholders during the product's life cycle (Arne Remmen et al., 2007) (Figure 23). An important note here is the crucial role of internal and external communication in the process as the driving force for continuous improvement (Arne Remmen et al., 2007)

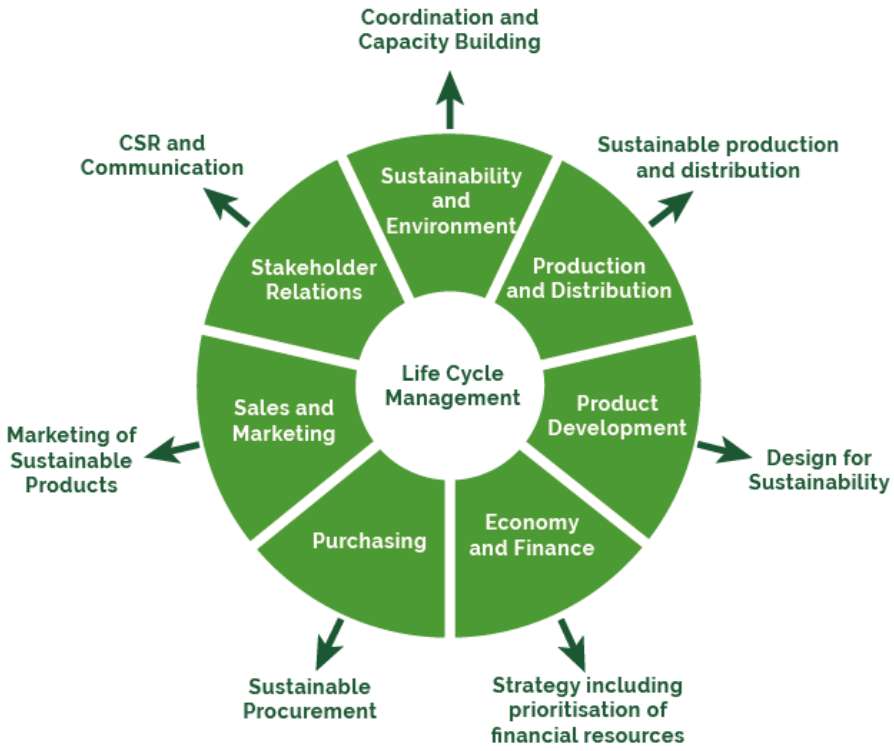


Figure 23 company functions involved with life cycle management (Arne Remmen et al., 2007)

Continuous improvement: maturity model Lean six sigma

Lean six sigma facilitates decision-making focused on the efficiency and effectiveness of the company by providing tools and techniques for continuous improvements (H.C.Theisens et al., 2020). The principles of lean six sigma are to minimize waste and optimize processes by focussing on the core value creation of the company and the alignment of the core value creation with perceived customer value. The techniques and tools provided provide additional guidance for efficient and effective development of the company. Lean six sigma's continuous improvement maturity model (CIMM) (Lean six sigma academy B.V., 2020) provides an overview of improvement methods both on the organisational level and the process level to facilitate a continuous improvement-oriented corporation (Figure 24), in line with the continuous improvement mentioned within LCM.

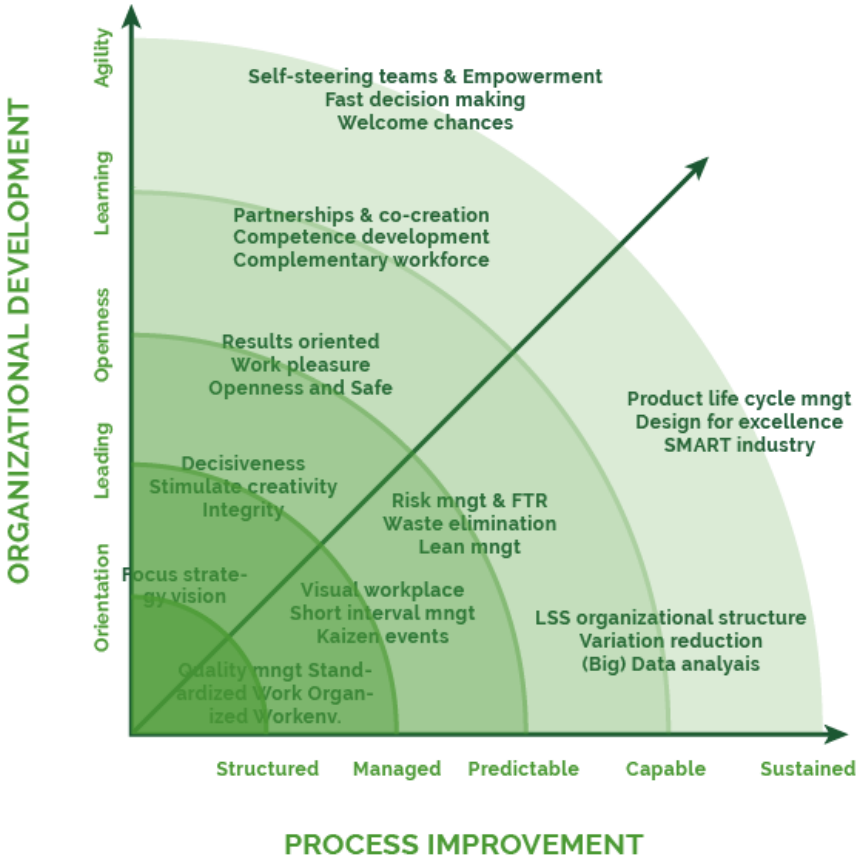


Figure 24 continuous improvement maturity model based on (Lean six sigma academy B.V., 2020)

The organisation development side of the CIMM provides five sequential levels; Orientation, leading, openness, learning, and agility. The ordered overview of tools and techniques provided by lean six sigma can provide additional support for the transition process towards sustainable business operations.
A pitfall for lean six sigma could be the applicability for non-producing companies since the system is oriented towards an in-house developing and producing cooperation. SMEs with limitations might only be able to use the generalised features of lean six sigma.

Continuous improvement: benchmarking
Benchmarking is a process of assessing the highest standards of excellence within the market and identifying opportunities for improvements within the company (Khurrum S Bhutta et al., 1999).
(MRM Crul, 2009) states a ten-step benchmarking program: setting objectives, product selection, functional unit & system boundaries, focal areas, parameters, disassembly session, results, improvement options, prioritization options, and implementation. This benchmarking program aims to compare the sustainability impact performance of the company with the market's “best practices” (MRM Crul, 2009). Benchmarking thus aims to provide knowledge to improve the company's practices internally.

2.2.4 Sustainability communication

As mentioned in section 2.2.3 (Life cycle management), continuous sustainability improvement within a company depends on communication on progress to all stakeholders (Arne Remmen et al., 2007). Internally a formal communication plan should provide clear communication and motivation within the company. Externally multiple ways of communication can provide additional value to the company next to continuous improvement. Sustainability certification is a potential tool for external communication; sustainability marketing.

Certification

Vinod Kumar et al. predict that sustainability becomes more and more a moral obligation within marketing strategy (Vinod Kumar et al., 2012). Three types of sustainability marketing can be differentiated (Joya A Kemper et al., 2019):

- product-related sustainability marketing,
- sustainable lifestyle and behaviour change marketing,
- reformative sustainability marketing (stating a need for institutional and normative change)

The success of marketing depends on the fit between the company and the marketing strategy.

Part of a sustainability marketing strategy can be sustainability certification. Certificates aim to provide stakeholders with third-party information on the sustainability claims of products, reducing the uncertainty of the stakeholders (Nicole Darnall et al., 2014). Certificates can lead companies towards sustainable actions by the requirements stated for the certificate. However, more and more research states that due to the number of certificates and their different framing of sustainability, the credibility and impact of certificates are reduced (Olivier Boiral et al., 2018; Alice M. M. Miller et al., 2015). Therefore certificates might cause greenwashing if companies solely focus on certifications instead of focusing on the company's complete sustainability performance (Olivier Boiral et al., 2018)

Additionally (Nicole Darnall & J Alberto Aragón-Correa, 2014) states the three limitations of one-dimensional certificates to be: limited framing of sustainability due to the number of sustainability attributes (requiring multiple certificates to cover all aspects of sustainability), possible misguidance on overall sustainability performance due to framing (greenwashing), competition within certificates with differing requirements to obtain the certificate.

Certification can be of added value when a certificate has both authority and credibility. Credibility is obtained by: "scientific rigour, inclusiveness, transparency/openness, impartiality/ independence and impact" (Alice M. M. Miller & Simon R. Bush, 2015). Additionally, it should be required by the stakeholders and should alter employee behaviour to provide real internal motivation and impact instead of only external incentives (Olivier Boiral et al., 2018).

Benchmarking

Benchmarking could be used as a marketing tool in case of a favourable comparison between the company's performance and other competitors (Tim Stapenhurst, 2009). Benchmarking is also used to overcome difficulties in LCA result communication, to overcome the lack of a reference frame (Bruno Menezes Galindro et al., 2019). Benchmarking allows the comparison of LCA results between competitors within the market to provide a reference frame.
A potential pitfall of benchmarking is unintended comparison with own market active products, which could lead to parasitism. Using time-depended-versions within the portfolio allows sustainability progress communication via benchmarking between market active and passive product versions without the possibility of product protentional profit parasitism.

2.2.5 Design for sustainability

The design of a product decides around eighty per cent of the product's sustainability impact (Shamraiz Ahmad et al., 2018). The transition towards a sustainable developing corporation could therefore start with a transition at the product design level by including a sustainable design system like D4S or obtaining aspects of the system.

Design for sustainability (D4S) is a system or process that guides sustainable innovation by incorporating TBL sustainability and LCT within the design and product innovation process (MRM Crul, 2009). This system includes product design guidelines based on impact information from multiple perspectives; climate change, reduced biodiversity, deforestation, ecosystem destruction, and depletion of available freshwater (MRM Crul, 2009).

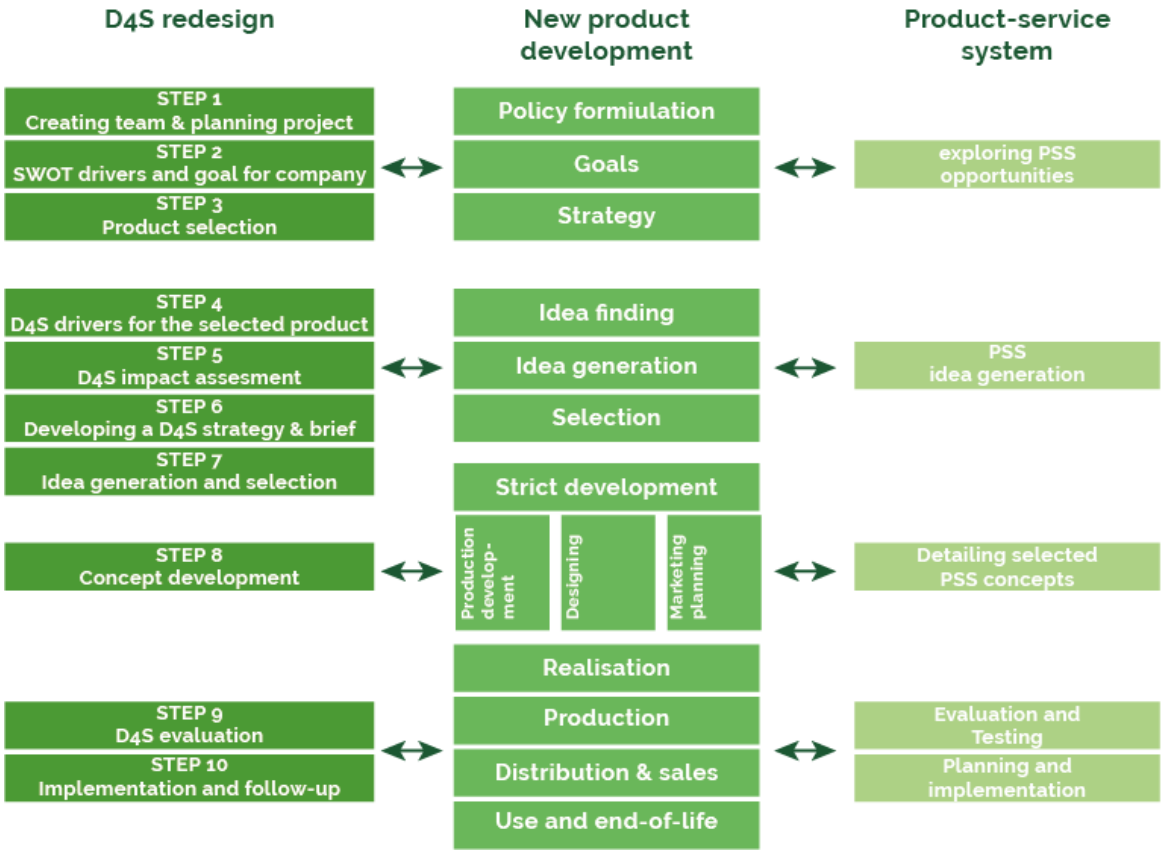


Figure 25 overview of approaches within Design for Sustainability based on (MRM Crul, 2009)

D4S provides approaches for both incremental (redesign) and radical (new product development, product-service system) innovation (Figure 25). Guiding the approaches are the impact-reducing strategies categorised as follows (complete list see (Appendix 3 and Appendix 4)):

1. Select low-impact materials
2. Reduce the use of materials within the product-packaging system
3. Optimization of production techniques
4. Optimization of the distribution system
5. Reduction of impact during use
6. Optimize the social and economic benefits of manufacture

7. Optimize the initial lifetime of the product
8. Optimization of the end-of-life system
9. (Only for radical innovation) Meet user needs with a different product or service
10. (Only for radical innovation) Develop a hybrid product
11. (Only for radical innovation) Exploiting new technological opportunities.

The social and economic sustainability aspects are only represented within one impact-reducing strategy (number 6). A pitfall of the D4S system is the skewed inclusion of the TBL, dominated by environmental sustainability. The skewed focus within the literature on the TBL topics can explain this pitfall.

The approaches for incremental (redesign) and radical (new product development, product-service system) innovation differ due to the difference in available data and the project's sustainability improvement level. With incremental innovation, most data on the current product can provide input for the re-design process. However, the redesign does not include rethinking alternatives for the materialisation of the function. Instead, it focuses on refining the current solution.
The radical innovation process is more uncertain but allows for sustainable improvement up to business model alternation for the company.

Important note: overlap between the two approaches is the inclusion of the added value of the company and the alignment with the company's mission. Both approaches start by focusing on the added value of the company's offering since this is the core that provides value for their customers and thus should be maintained.

The design for sustainability (D4S) system provides concrete guidelines for sustainable innovation.

2.3 Small-and-medium enterprise limitations and opportunities for the sustainable development transition process

Small and medium enterprises in the Netherlands consist of ten to fifty (small) or fifty to two hundred fifty (medium) employees (Ministerie van economische zaken en klimaat, 2021). Since the implementation of sustainable development within SME companies is different from implementation within larger companies, alternations are required for implementation by SMEs (C. Mortimer, 2011).
This report focuses on the small companies within the SME statement.

The field of SME is highly heterogeneous due to different factors; technological level, market relations, and competitors' strategies (Alexander Kaufmann et al., 2002). Generalization is, therefore, difficult other than based on size-related issues.
From an internal perspective, SMEs have in comparison to larger companies (Alexander Kaufmann & Franz Tödtling, 2002):

- Limited human and financial recourses,
- Lack of time,
- Limited marketing & commercialization abilities,
- Are more dependent on adaptation to customer demand

Additionally, concerning the implementation of LCM, (Helene Seidel-Sterzik et al., 2018b) state as possible implementation influencing factors for SMEs: “Influence of the manager, environmental culture, lack of resource availability, lack of future orientation, lack of knowledge on environmental issues, market requirements, geographical separation of production and consumption, awareness of own environmental issues and communication/information sharing”.

From an external perspective, the relationship and thus influence of the SME within its supply chain is characterized by a relatively more minor authority position related to the smaller sales percentage the SME represents for the partner company. This section elaborates on the limitations and opportunities of SMEs to incorporate sustainable development.

2.3.1 Internal SMEs' limitations

The company’s culture indicates the motivation and commitment to the transition. A corporate culture not supportive of sustainable development implementation will decrease the possibility of successful implementation of sustainability systems (Helene Seidel-Sterzik et al., 2018b). Within SMEs, corporate culture depends on leadership and knowledge within the company (Helene Seidel-Sterzik et al., 2018b). The influence of leadership within an SME is especially high due to the limited number of employees and the company's structure. The company's leadership manages the commitment or effort for the transition (Thomas G Cummings & Christopher G Worley, 2014). The development or prevention of a sustainable development supporting culture within the company also depends on the company’s leader (Helene Seidel-Sterzik et al., 2018b).

Corporate culture can also influence documentation and data quality within SMEs. Due to the culture and ease of communication among the small number of employees within SMEs, less often formal procedures for operation and communication are adequately used compared to larger companies (C. Mortimer, 2011). The poor documentation reduces the transparency of the decision-making since arguments cannot be evaluated (Gilbert Silvius et al., 2022).

Sustainability systems require documentation of additional product and process data, for which the lack of documentation culture can complicate implementation (C. Mortimer, 2011).
The reactivity, instead of proactivity among SMEs to incorporate improvement programs, provide additional difficulties in altering the corporate culture to introduce sustainable development (Helene Seidel-Sterzik et al., 2018a).

The knowledge basis on which corporate culture is partly based provides the less motivational-related and more accuracy-related side for the required sustainability culture. Awareness of the topic is required to make the correct alternations to the culture (Helene Seidel-Sterzik et al., 2018a). However, research states multiple limitations to knowledge inclusion within SMEs. Compared to multinationals, knowledge gaps within SMEs arise due to fewer co-operations between SMEs and knowledge institutions (Alexander Kaufmann et al., 2001). SMEs lack employee training, while employee training is proven highly effective for small SMEs' innovation capacities (Irem Demirkan et al., 2021).
The consequences of the knowledge gaps indicated in SMEs are limitations for implementing new procedures. For example, the lack of knowledge provides concerns about the capacity to obtain quality data (G. Sonnemann et al., 2015). Additionally, prioritising actions on new aspects, for example, the environmental impact, provides uncertainties due to the lack of knowledge of the SME decision maker (Helene Seidel-Sterzik et al., 2018b). At the strategic level, SMEs show “less awareness of international trends and less future focus” (C. Mortimer, 2011).
Thus, SMEs should co-operate with support organisations and knowledge centres to implement the transition process towards sustainability incorporation. Sector or regional support can provide the financial and human resource capacity to implement sustainability within the company (G. Sonnemann & M. Margni, 2015).

Adisa Azapagic states departments that should be involved in the project: “finance, Human resources, Environment H&S, Logistics, Production, Purchasing, Sales/commercial”, led by the sustainability management team (Adisa Azapagic, 2003)(Arne Remmen et al., 2007).
SMEs miss some departments within their company. However, partners can provide the required knowledge—cooperation with partners in a multidisciplinary team that can overcome the missing links.

To implement complex processes, some work method techniques like ‘the reversed assignment’ (instead of solving something, think what would make it worse) could be used to reduce the perceived complexity (Sasja Dirkse-Hulscher et al., 2007).

Financial limitations also guide the transition process towards sustainability for SMEs. Costs provide a critical barrier to executing projects within SMEs (Craig M Parker et al., 2009). The cost barrier results in SMEs aiming more often for projects with high commercial viability, leading to significant short-term financial success (Linda Condon, 2004; C. Mortimer, 2011).
The importance for SMEs of the high commercial viability of projects makes for less radical innovation selection (Tino Woschke et al., 2017) and more innovation within the known domain (Elco Van Burg et al., 2012). Implementation of sustainability becomes difficult since strategies and projects are often long-term, uncertain and difficult to quantify (Marc J. Epstein et al., 2001), which is contrary to SMEs' decision-making priorities. Strict allocation of financial resources for sustainability innovation can provide a solution for the implementation of sustainability within SMEs and shows the company's commitment to the transition (Arne Remmen et al., 2007). Furthermore, an approach focused on the inclusion of cost-efficiency could provide a better SME-suited solution (G. Sonnemann & M. Margni, 2015).

2.3.2 External SMEs' limitation

The limited facility resources force small companies to work together within supply chains to cope with a lack of, for example, production capabilities. This provides a dependency on the supply chain for the transition towards sustainable development incorporation. For SMEs to make the transition, cooperation within the supply chain is required (Arne Remmen et al., 2007). For cooperation between the supply chain partners, a common goal should be established, and long-term oriented relation-building should be aimed to facilitate trust (Arne Remmen et al., 2007).
Documented agreements like a code of conduct (Amfori BSCI, 2021) facilitate clear responsibility division between partners and provide a basis for cooperation. Additionally, transparency and information sharing between partners facilitate the necessary trust that cooperation can build. However, SMEs tend to share less information with their partners (Helene Seidel-Sterzik et al., 2018b). Transparency between business partners requires strategic considerations balancing protecting intellectual property and cooperation. Transparency in partner communication and actions allows for certainty for the partner company, increasing the likelihood that partners comply with the agreements.

A close geographical location eases cooperation. Cooperation with other companies could provide an opportunity. For example, other 'western' customers from a supplier also need to comply more and more with sustainability legislation. Here cooperation with supplier customers could provide the size and resources to influence the supplier to comply with, for example, a code of conduct or implementation of a production information system.

In summary, SMEs have limitations and influencing factors for implementing the transition process towards sustainable development due to their characteristics. These limitations are of multiple resource natures (human, financial, time, marketing abilities, knowledge, structure systems), a higher dependency on customer demand, a higher dependency on leadership, a higher dependency on the supply chain, and a higher orientation towards short financial success.
To overcome the limitations, a framework for sustainable development implementation for SMEs should focus on:

- Ensure top-down commitment for the transition by management to ensure motivation to change.
- Focus on alignment of the framework with documentation and data quality systems within SMEs
- Include multiple perspectives within the project by a multidisciplinary group and cooperation with partners and experts to overcome the knowledge gap
- Aim to balance high commercial viability actions and more long-term oriented actions
- Cooperate with partners to overcome the size limitation within the supply chain and to grow together towards sustainable development.

Chapter two provided the theoretical background for the transition process toward sustainable development for a SME. Section 1.2 (Introduction case company: Themans hang & Sluitwerk BV) provided research on the case company Themans. Together these chapters provide the analysis for this project. Chapter three will summarise and derive requirements for the method from this analysis.

Chapter 3 Literature guidelines

The previous chapters provide insights into developing a sustainable development transition framework for Themans. This chapter summarises the most important findings (section 3.1). It then translates the analysis' insights into requirements for developing the framework for Themans (section 3.2).

3.1 Summary theoretical background

The theoretical research identified the three phases of corporate transition towards sustainable development for Themans: the current situation, the transition process, and the company's desired future sustainable development state.

The current situation

The current situation of Themans shows management in the contemplation phase, showing the intent to transition toward sustainable development; however no current action. The lack of market incentive, a sustainable product assumption and a knowledge gap on the topic explain the lack of current action.

The SME classification of Themans identifies resource limitations, top-down commitment, documentation and data quality systems, sustainable development knowledge gap, short-term financial success focus, and dependency on the supply chain partners as the most influencing aspects for sustainable development incorporation.

The transition process

Two company levels are involved in the transition process: the management system and individual employee levels. Top-down; The mission, vision, goals, strategy, guidelines, program, budgets, and procedures are identified as the corporate transition subjects for strategy formulation and implementation. The corporate transition strategy provides transparency in the process but is subject to the objectivity of the decision maker. The implementation of the corporate transition process requires continuous improvement (PDCA, CIMM, benchmarking) driven by progress communication as crucial. The external progress communication could use certification. However, the risks outweigh the benefits. Guidelines from D4S can be used as part of education material to guide action generation for the strategy.

The company's desired future sustainable development state

The "principles of sustainability" (Karl-Henrik Robèrt et al., 2013) will allow constructive internal communication on sustainable development. The TBL goals: Circular economy (ecological success), meeting the levels of the hierarchy of human needs (social success), economic resilience (economic success), and the inclusion of LCT, provide the desired future sustainable development state.

3.2 Guidelines method

The complete list of requirements from the literature is due to its size, placed in the appendix (Appendix 5). This section shows overarching guidelines for the method development obtained from the requirements list. The overarching guidelines can, however, not be used instead of the requirements list since the interrelated nature of the requirements.

Guideline 1) The framework should overcome the SME case company's limitations, align with the case company's capabilities and focus on the case company's opportunities for sustainable development.

- An example of SME limitations is the knowledge gap concerning sustainable development.
- An example of the case company's capabilities alignment is the lack of a marketing department, limiting sustainability commercialisation for the framework.
- An example of the case company's opportunities is collaborating with other western producers' customers to obtain more power for specific actions within the supply chain.

Sections 2.3 and 1.2 provide more in-depth explanations for guideline 1.

Guideline 2) The framework should establish top-down incorporation of sustainable development in a continuous transparent improvement process.

Top-down incorporation is necessary to ensure management commitment and resource allocation. Continuous improvement allows initiation and refinement of sustainable development within the case company along the way. External progress communication is required to ensure refinement leads to improvement.

Section 2.2 provides more in-depth explanations for guideline 2.

Guideline 3) The framework should establish the incorporation of circular economy, meeting the levels of the hierarchy of human needs and economic resilience, as the case company's goals for sustainability and establish LCT as the new paradigm for all product-related activities.

Incorporating all three dimensions of sustainable success statements (TBL) within the SME ensures no isolated sustainable development view and provides the benefit of executing interdependent sustainable development actions, which contribute to more than one dimension of sustainable corporate success.

Section 2.1 provides more in-depth explanations for guideline 3.

Chapter 4 Method development

This chapter describes the development of the framework for sustainable development incorporation for Themans, based on the analysis summarised in the requirements and guidelines of chapter 3.
First, section 4.1 explains the framework overview and shows the seven phases. Then per phase, the approach and the implementation at Themans of the phases are elaborated (section 4.2 - 4.8).

4.1 Framework Overview

(Figure 26) shows the framework overview. The overview shows a prioritizing shape (formulate strategy phase) which shows guidance of the framework towards a sustainable development vision. The overview also shows a cyclic shape, facilitating continuous improvement to continue the sustainability improvements within the company beyond the first strategy formulation. Phase seven, “communicate”, drives the framework's improvement cycle.

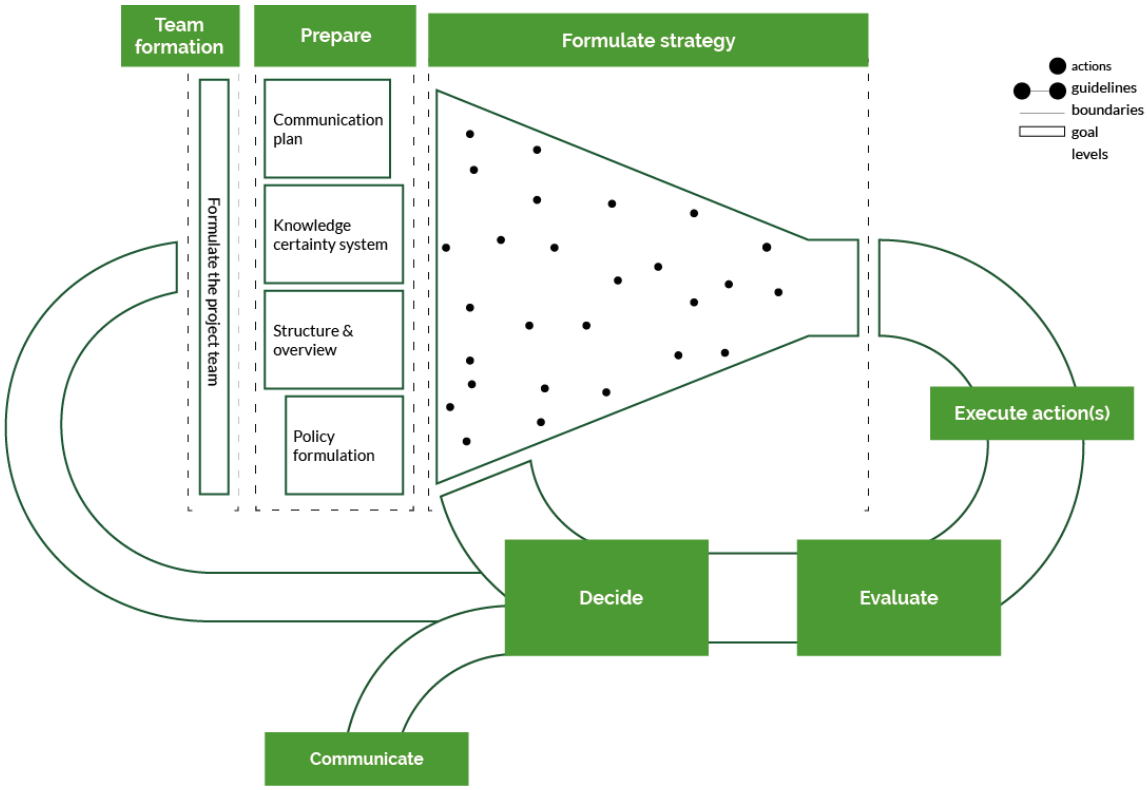


Figure 26 The method for successful implementation of sustainability within Themans

The seven phases of the framework are:

1. Project team formation (section 4.2)
2. Prepare (section 4.3)
3. Formulate strategy (section 4.4)
4. Execute actions (section 4.5)
5. Evaluate (section 4.6)
6. Decide (section 4.7)
7. Communicate (section 4.8)

(section 4.2 - 4.4) provide the normative and strategic levels of the framework. (section 4.5-4.8) provide operation-level steps, execute action(s), evaluate, decide, and communicate. Elaboration on these parts is out of the project's scope. However, the steps indicate the following

- Execute action(s): refers to executing the strategy's actions
- Evaluate actions: refers to comparing the expected and final results
- Decide: refers to the decision point, where it can be decided to continue or stop with the current action and switch to another action, depending on the evaluation's outcome. Additionally, in case of a future situation in which the current normative and strategic part of the framework is not successful anymore. It should be decided to re-do the whole framework project.
- Communicate: refers to the update of external parties on the company's progress. Updating the progress is mandatory for each action(s) cycle.

4.2 Project team formation

The project team formation aims to obtain a multidisciplinary team to provide a broad basis of different inputs to tackle the project from multiple knowledge fields. This section shows the aspects of the project team formation approach and the implementation at Themans.

4.2.1 project team formation approach

The initiative taker forms the project team. The basis of the project team formation is a stakeholder analysis. The stakeholder analysis should provide the crucial stakeholders to include within the project team. The goal is a multidisciplinary team, providing inputs from all life cycle steps of the product. After forming the project team, allocate resources to the team (employee time, financial resources).

Project team formation procedure

1. List all stakeholders involved with the transition of Themans towards sustainable development (including all life cycle steps of the products).
2. Prioritise all stakeholders in four categories using the power-interest graph (Mark S. Reed et al., 2009)). Based on the power to direct the process and the interest in the outcome of the process:
    - Key players: High power, High interest
    - Subjects: Low power, High interest
    - Context setters: High power, Low interest
    - Crowd: Low power, Low interest
3. Select project team members from the 'Key players' and 'Subjects' categories. The main body of the project group could also consist of the 'Subjects' stakeholder group, given that resources for the project are allocated by 'Key players' (often management).
4. Question the completeness of the set of stakeholders: is the current set of partners sufficient for the aimed future goal?
    - Potential overlooked partners for the transition towards sustainable development are: potential disposal companies, potential recycling companies
5. Analyse the team members' behaviour change stage via a conversation on the sustainable development project topic.
6. State the multidisciplinary project team
7. Allocate time resources for the multidisciplinary project team and financial resources to execute the framework

Procedure advises

Knowledge gaps on all levels can provide difficulties to the project. To overcome the knowledge gap, the project initiator should consider ensuring a multidisciplinary set of employees, to obtain a broad set of inputs. Especially for SMEs, it is advised to include partners for phases of the framework since they have a more dependent position in their supply chain. The inclusion of partners provides input on product life cycle aspects, which are outside of the scope of the company itself. The benefit of including partners can potentially be three folded:

- Partners provide can provide product-specific expertise outside the scope of the SME
- The inclusion of partners can motivate partners to reduce their impact
- The inclusion of partners allows more easily for collaborations among the supply chain

Collaborations with experts and knowledge institutions on a specific sustainability topic or process could also provide input to the project to overcome knowledge gaps. Experts can provide insight into unknown topics for SMEs. A possible hindrance of expert input could be the limited knowledge of or familiarity with the company, which could require a translation towards the company-specific application of the experts' advice.

Due to limited time among Themans employees, it is advised to create the following layer construction for the project team:

- A small multidisciplinary core: consisting of experts on all life cycle stages of the products.
- A multidisciplinary experts layer, incorporating specific knowledge experts (on the processes or the topic of sustainable development) who are invited for expert guidance during steps of the method and updated on other phases.

For the framework project, it is advised to define the project's scope clearly, what is within it and what is not. Moreover, it is advised to initiate planning for the project's duration. This step allows a more specific allocation of resources to the project.

Resource allocation

Resource allocation is a crucial tool for motivation and execution of the sustainable development strategy project within the strategy development phase of the method. The strategic project can be initiated by allocating both financial and time-related resources. It is advised to allocate resources based on the scope and planning of the project. The significant resources which should be considered are:

- Employee working hours.
- Education costs (consisting of, among other things; Expert costs, knowledge corporation costs, and external guidance costs)
- Financial resources for the implementation of the framework (facilitating execution of actions)

4.2.1 project team formation: Implementation at Themans

(Appendix 6) Shows the executed stakeholder analysis. The stakeholder analysis is composed of input provided by the company. From the stakeholder analysis and conversations with management, the following project team was formed:

- Management (1 employee)
- R&D department (2 employees)
- Purchasing department (1 employee)
- Product management department (1 employee)
- Customer service department (2 employees)
- The master thesis student

Important to note is the consideration at the company not to include external parties within the project teams' core due to perceived risks. The risk basis is the uncertainties due to the company's limitations in meeting potential expectations resulting from partners participating in this project. For this reason, the external relations department employees were also excluded from the project team core.

For the expert layer of the project team, the production partner company and Nauta could be contacted to obtain knowledge on specific topics.

Finally, no specific resource allocation was stated (specific amount of time, financial resources). The project team members were informed about the project and were informed on possible meetings during the course of the thesis assignment.

4.3 Prepare

Following the 'project team formulation' phase is this 'prepare' phase. The 'prepare' phase aims to generate motivation, knowledge and resources for the transition process of Themans. Four preparation steps: communication plan, knowledge certainty, structure & overview, and policy formulation facilitate the preparation. This section will cover the four steps following the previously mentioned order (section 4.3.1 – 4.3.4). Each section provides advice for the approach and implementation at Themans.

4.3.1 Communication plan

The communication plan involves internal and external stakeholders in the project. The communication plan is vital within the project, where it helps to overcome communication difficulties and maintain continuous improvement.

4.3.1.1 Communication plan approach

A communication plan lets the company structure the why, how, and how often aspects of communication per stakeholder group (extern and intern). The communication plan aims to provide the right information to the right people.

Communicate the right information

The communication plan is a continuation of the project team formation. The responsibility or role of a note taker is included within the project team to ensure notes of meetings and brainstorming sessions are taken to communicate the right information. Good notes and summaries of brainstorm sessions also allow the involvement of more distant participants.

The project team should create a centralised place to allow information to be available for all project team members. The centralised place ensures transparency and retrieval of project activities and helps to update and thus involve project members.

Communicate information to the right people

The communication plan organises which people to inform or contact and at which moments of the project. Advised is to formulate in the first project meeting the communication plan, containing the following aspects:

- Audience; Whom do we inform during the project, obtained from the stakeholder analysis
- Frequency; How often is this stakeholder group informed
- Medium; Via which medium is the stakeholder contacted
- Purpose; What is the purpose of the communication

Communication to external stakeholders like customers is required at least annually (a year report of the executed sustainability actions) to ensure the continuation of sustainability improvements within the company.

4.3.1.1 Communication plan Implementation at Themans

During the master thesis project, communication was mostly done via face-to-face contact, workshops, brainstorm sessions, meetings, phone calls, and email. The thesis project is an iterative

and, therefore, less structured process, for which it was not possible to include a structured communication plan.
Meetings were announced face to face and via email to ensure the information on the date and time were correctly transferred. During the meetings, notes and pictures were taken for reference of the meetings. After brainstorming sessions, the session's findings were shared with the project team.

Additionally, the project did not establish a centrally accessible place of information. The company uses a multitude of programmes to communicate information. Its advised to make a 'team-sheet' within Microsoft Teams to facilitate centralised information and progress tracking (Figure 27). Microsoft teams is a programme already used for structuring multiple processes within Themans.

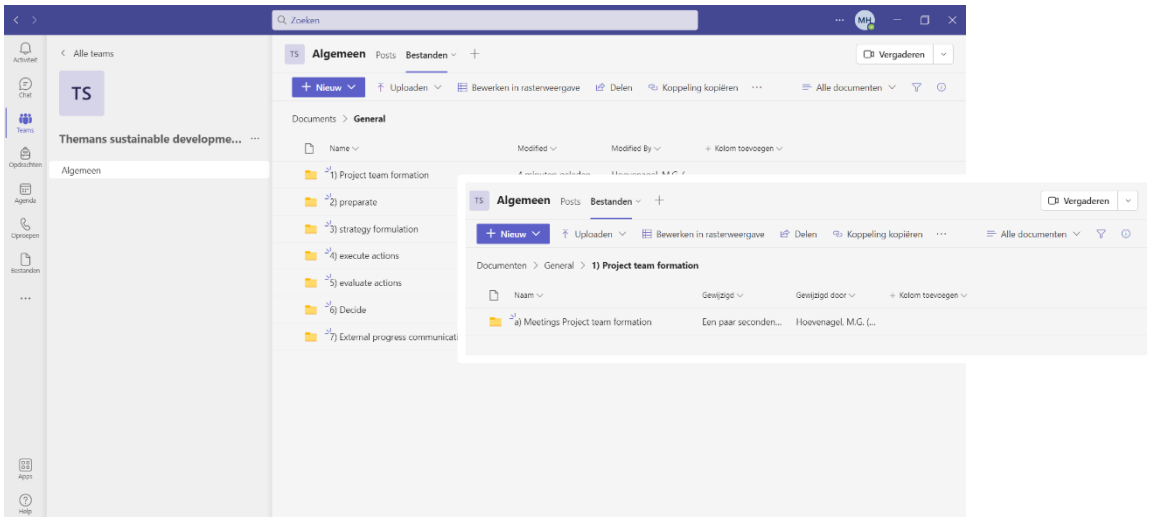


Figure 27 example of a centralised place for project information (within the programme Microsoft teams)

4.3.2 Knowledge certainty system

The knowledge certainty system aims to continuously evolve the company's knowledge to cope with the increasing difficulty of creating successful sustainable development actions per cycle. It, therefore, also helps reduce the prioritisation step's subjectivity. Creating a knowledge certainty system is too large to include in this project. This project, therefore, states the knowledge certainty aspects advised to include in a knowledge certainty system.
The project team formation states the importance of expert input and multidisciplinary teams. This step, therefore, focuses on the required knowledge for the involved team members.

4.3.2.1 knowledge certainty approach

An education system helps ensure that the required knowledge is at the required team members. The education system should take into account:

- Education focus (obtained from (Roberto Rivas Hermann et al., 2020))
- Teaching-learning approaches (obtained from (Roberto Rivas Hermann & Marilia Bonzanini Bossle, 2020))
- Themes (obtained from (Roberto Rivas Hermann & Marilia Bonzanini Bossle, 2020))
- External collaborations (obtained from (Roberto Rivas Hermann & Marilia Bonzanini Bossle, 2020))
- Continuously improvement of the basic level of knowledge within the project group.

Education focus

The project team core and the expert layer at Themans should be acquainted with the same knowledge base for the project to facilitate constructive discussion. Due to the designing nature of Themans, it is advised to have all R&D employees educated on sustainable development themes. Internally, the project team members can educate other employees to practise their knowledge and educate the other employees.

The principle-based definition of sustainable development should be familiar to all employees to facilitate constructive discussions and understanding of non-project team employees.

Teaching learning approaches

The teaching approach depends on the characteristics of the project members. Roberto Rivas Hermann & Marilia Bonzanini Bossle state nine examples of education approaches (Roberto Rivas Hermann & Marilia Bonzanini Bossle, 2020):

- Experimental learning
- Problem-based learning
- Project-based learning
- Reflective learning
- Peer assessment
- Interdisciplinary learning
- Blended learning
- Affective learning
- Holistic learning

The team members' education level and working methods are indicators for aligning the education approach to the company. For Themans project members, an active, practical, problem-based, and

project-based education approach worked best. Workshops and brainstorms with a problem or goal statement were used to create project-based problem-solving.

Themes

The first cycle of this framework requires education on the following themes:

1) The principle-based definition of (Karl-Henrik Robèrt et al., 2013) provides general knowledge on what sustainability and impact reduction are
2) Triple bottom line and its goals TBL opens up the paradigm by the division into ecological, social, and economic and ensures capturing all aspects of sustainable development for the company.
3) Life cycle thinking and its translation into LCA Life cycle thinking extends the opportunities for actions within the company and ensures that actions generated by the company do not redirect the needle, the impact, to a different chain within the supply chain.
4) Design for sustainability D4S guidelines help the project team members translate the principle-based definition into sustainable development strategies.
5) CSR (MVO in dutch (Rijksdienst voor Ondernemend Nederland, 2018)) Helps project team members translate the principle-based definition into social sustainable development strategies.

External collaborations

Collaborating with knowledge institutions and universities (experts, students) is advised to include new knowledge in the education system continuously. An external research company's assessment of the current situation of a benchmark product could also help retain insights for Themans on their product, its sustainability and the assessment methodology requirements.

Continuously improved basis level

The cyclic structure of this framework requires continuous improvement of the knowledge level of the project team members and the company. Every cycle, the required knowledge level for new sustainable development action generation increases. The education system should meet the increase in required knowledge level. It is advised to continuously improve the education level of the project team members and within the company. Additionally, it is strongly advised to educate the project team members and involved employees before executing a cycle of this framework.

4.3.2.2 knowledge certainty Implementation at Themans

The knowledge certainty system for this continuous improvement framework was too large for this project and out of the project's scope (the cycles after the initiation). This section, therefore, states the educational session executed during this project.

This project applied three types of education. First workshop sessions were given to all project team members on the topics:

Workshop The principle-based definition of sustainability (Karl-Henrik Robèrt et al., 2013) (Appendix 7): A workshop was executed with all seven project team members, explaining the principle based-definition with the help of illustrations provided by (Alexandre Magnin, 2013b) (Alexandre Magnin, 2013a).

Workshop Triple bottom line (Appendix 8): A workshop was executed with all seven project team members, explaining the triple bottom line and practical translation of the triple bottom line by an assignment for all members. The assignment was to indicate which indicators they use for decision-making for their tasks and to place these indicators within the three divisions of the triple bottom line. The result was a range of different answers and showed different motivation levels within the company.

Workshop Life cycle thinking and life cycle assessment (Appendix 9): A workshop was executed with all seven project team members, explaining the Life cycle thinking and practical translation of life cycle thinking by an assignment to make with all members an LCI of a product. The assignment created discussions on life cycle steps and identified to the employees that the company did not know all information on the product life cycle steps.

Second, the project implemented two project-based approaches via

- **Project CSR (Appendix 10);** was executed by two members of the project team (Management and Purchasing department) and an external member of Nauta within multiple meetings. The results of these sessions were education on what risks to identify concerning CSR within the supply chain (primarily focused on social sustainability) and a code of conduct for Themans and its suppliers.

- **Project D4S re-design (Appendix 11);** was executed by three members of the project team (R&D department and Purchasing department) within multiple meetings. The results of these sessions were education on design for sustainability (primarily focused on ecological sustainability) and actions to improve the sustainability of the 'ALU voordeurbeslag PC92 BI/BU (40mm)' door fitting product.

Third, the project aimed to cooperate with a regional company called Auping. Auping changed to sustainable development more than eleven years ago and was contacted to inspire and explain to Themans what the transition required for Auping. Unfortunately, this collaboration could not be established due to the corona situation.

4.3.3 Structure and overview

The structure and overview pillar concerns the company's ability to incorporate additional product and process sustainability information within its procedures and systems to allow retrieval and communication on its sustainable development progress.

4.3.3.1 Structure and overview approach

The additional product data required for sustainable development monitoring and communication requires more strict notions during procedures. This preparation pillar assesses the current working methods and systems available at the company and advises on structuring systems.

Assess the current situation

LCM states that data and information systems are the driving force for all other life cycle management systems (Guido Sonnemann et al., 2015). it is advised to analyse the company's current data structure and notification capabilities. This analysis should research to following topics:

- Standardized procedures; do the current processes within the company follow a standardized procedure? Standardised procedures can positively influence collecting and documenting product data since they structure the processes. SMEs can be less organised, which causes incompleteness of the product data. It is, therefore, important to incorporate standardized procedures within SMEs to ensure consistency.
- Increased system capacity; are the corporate systems capable of including additional product data? The additional data should be visualised within the corporate systems in a structured overview. For the structure, the systems should be able to incorporate new product data to prevent the scattering of product data over multiple systems.
- Complete life cycle product data; are there gaps in product life cycle data of the products? It is advised to execute a LCA meeting on the company's current monitored data and to locate product data gaps.

Data and information management

The data collection capacity of the company facilitates the company in obtaining information on the sustainable development progress of the company. Variations in data provide different difficulty levels to collect or transform the data into information (Figure 28).

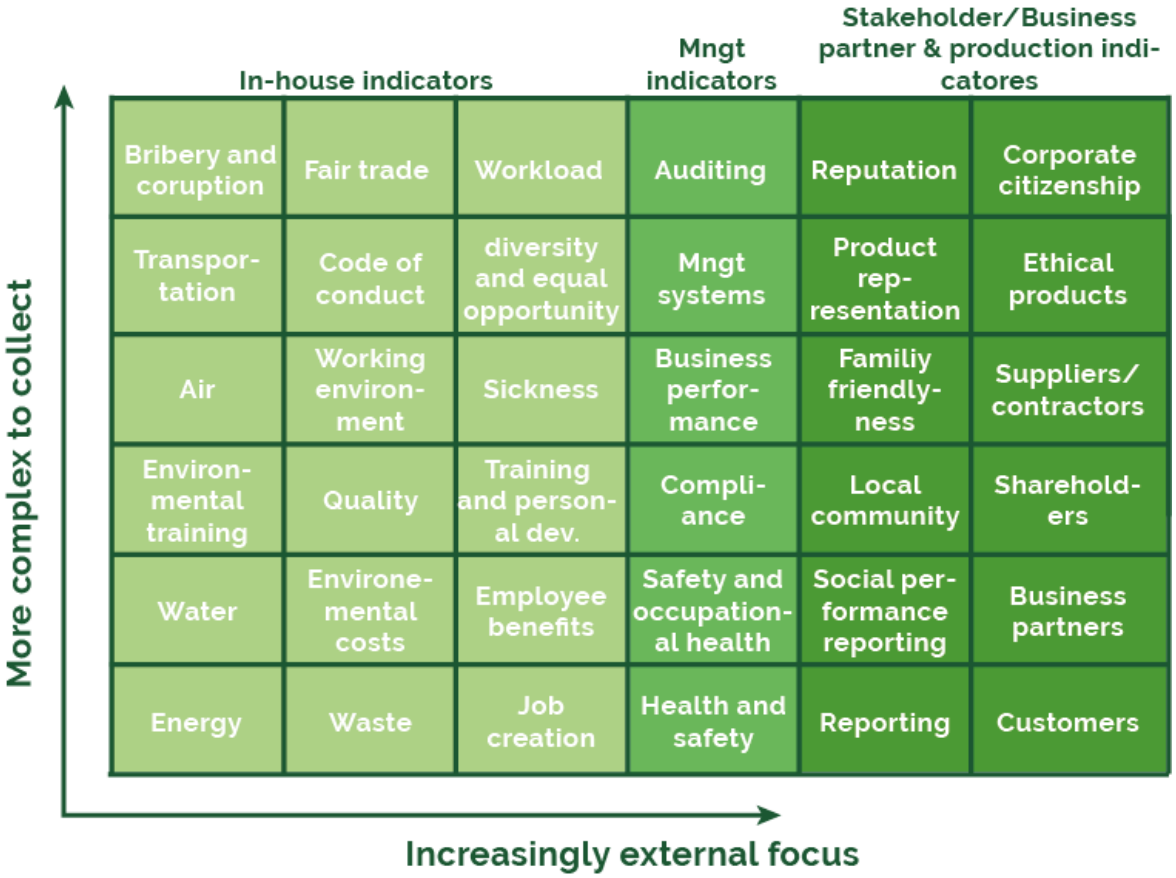


Figure 28 complexity of sustainability indicators (Justin J. Keeble et al., 2003)

The continuous improvement aspect of the framework tackles the multiple difficulty levels through an action execution procedure (section 4.5). This procedure addresses translating the action's goal into measurable outcome data. Thinking ahead to the actions outcome data, allows the company to create capacity in their systems to document the data. The product indicator should then be standardized within the company to ensure a uniform data file of all products.

For example, the hypothetical action “reduce the amount of packaging material of the PC92 32mm ALU 5001906617” is translated to its indicators for data collection (Table 3).

Table 3 indicators for the "reduce the amount of packaging material of the PC92 32mm ALU 5001906617" action

PC92 32mm ALU 5001906617 V1 product packaging combination:	PC92 32mm ALU 5001906617 V2 product packaging combination:
Packaging materials	Packaging materials
Packaging production processes	Packaging production processes
Packaging production location	Packaging production location
Packaging unfolded dimensions (length, width, thickness)	Packaging unfolded dimensions (length, width, thickness)
Packaging empty weight	Packaging empty weight –

These indicators allow communication and monitoring of the action's effect by the difference in the amount of used packaging material and the packaging material's characteristics.

Using the product category identification of (appendix 4), the required product data for impact assessment are; "Materials; manufacturing systems, factors affecting the life of the product (generally for this category, extending the product life reduces environment impact)" (MRM Crul, 2009).

Portfolio management
The product portfolio provides a top-down structure and overview to the product data systems. Monitoring progress over time requires a comparison between product characteristics over time. This requires structuring products within the internal product portfolio in versions dependent on sustainable development intervention.

4.3.3.2 Structure and overview implementation at Themans

The structure and overview system (portfolio management) is out of the project's scope since, during the project, the new product manager already executed a structure and overview revision at Themans. The product manager function is relatively new at Themans and implies structuring and managing the product data concerned with the product portfolio. To avoid double work and maintain focus on the aim of this project to facilitate a framework for sustainable development incorporation, this project limits the structure and overview implementation to the analysis of the current situation.

The current new product development processes (Appendix 12) show standardised processes. However, unstructured interviews with employees state that not all steps and information are filled into the systems. This creates concerns for a sustainable development situation which requires consequent documentation. Unfortunately, obtaining a view account of this system was not possible, for which it was not possible to investigate the system's current situation in detail.
For this framework pillar, the product manager should be the gatekeeper, ensuring consequent documentation of product data within the company's systems.

During the project, an LCA workshop was given, showing insight into product life cycle gaps. This workshop identified the material extraction, production, and end-of-life phases as knowledge gap phases. These are black boxes for the company and should be analysed for action generation within this or a future cycle.

4.3.4 Sustainability policy formation

Policy formulation means, in this report, a top-down mission, vision, goals, generation and translation (section 2.2.1). The policy formulation communicates and guides the strategy formulation and, thus, the company's direction. This pillar assesses the current sustainability policy and helps formulate a policy when this is missing within the company.

4.3.4.1 Sustainability policy formation approach

The company's mission is its culture and position basis for the company (John Pearce, 1982). It is formulated based on the input of both internal and external drivers. The vision is a long-term goal that orients the company toward its ideal position within its competitive landscape (Shannon A Bowen, 2018). This section analysis the current situation and inputs to generate a sustainable development policy. Furthermore, it facilitates advice in formulating the policy for the company.

Top-level commitment analysis

Policy formulation is executed top-down, for which it shows top-level commitment. To assess top-level-commitment, it is advised to analyse the company's sustainable development policy and usage. Resource allocation is an other indicator of top-level commitment and should, thus, for sustainability-oriented projects be analysed.

The sustainable development policy goal

The policy development's goal is to include the LCT and the success statements of the TBL sustainability paradigm within the company's mission and long-term oriented vision. Policy documentation, communication and translation into the strategy and company's activities should then facilitate active use. Active policy use is crucial for transparency and argument-based discussions on the topic.

The sustainable development policy process

Within Themans, management consists of a single person. Here the personal view toward sustainable development would dominate the whole SME policy. To reduce the subjectivity and possible usage rejection, a multidisciplinary team (including management) should brainstorm on the aspects and formulation of the policy. The brainstorming sessions should cover the basics of developing a mission and vision statement (as stated by (John Pearce, 1982)). After the brainstorming sessions, the company employees should be allowed to suggest alternative formulations for the policy. The multidisciplinary team decides whether to include the alternatives or not.

Sustainable development policy inputs

The basis for the formulation of the policy are the following inputs:

- Current policy & resource allocation analysis
- Market analysis
- Stakeholder analysis
- Legislation analysis
- SWOT analysis

Market, stakeholder, legislation, and the opportunities and threats of the SWOT analysis provide the company's drivers. The strength and weaknesses of the SWOT analysis ensure the incorporation of the company's core competencies.

Embody active use of sustainability policy
Active use of the mission and vision a partly obtained by employee influence during the process. Additionally, translation of the mission and vision into corporate processes is advised. Within this framework, this is obtained by:

- Translation of the mission and vision into goals for the strategy
- Translation of the mission and vision into prioritisation indicators (see Section strategy formulation)
- Translation of the mission and vision into evaluation processes
- Resource allocation

For the active use of the mission and vision statement, the mission and vision statement should be undisputed since they should guide all processes within the company, top- down and should thus be used in all cases and not in a cherry-picking way.

4.3.4.2 Sustainability policy formation implementation at Themans

Within the project, first, the inputs were researched. Combining the stakeholder analysis (APPENDIX 6), the internal and external drivers identification from the D4S project (APPENDIX 11), the market analysis (APPENDIX 14), the legislation analysis and the opportunities and threats in the market showed costs and profit to be the dominant drivers of the project. The market does not demand sustainability, nor does legislation in the current situation. However, changing legislation could be identified as the second driver of the project.
The individual analysis provided the following insights:

- The stakeholder analysis (APPENDIX 6) provided a prioritised list of stakeholders and identified the involved stakeholder groups.
- The legislation analysis (appendix 13) provides the following essential findings of the legislation research:
    - Corporate sustainability due diligence directive (CSDD) proposal legislation states human rights and environmental impact responsibility for the whole upper supply chain to the selling company. Starting with multinationals, this makes selling corporations in Europe responsible for human rights violations and environmental impact problems due to the production of their product or service. Indicated is a later introduction to SMEs based on their influence on their supply chain. Additionally, this is a driving force since banks providing investments started requiring documentation of corporate social responsibility.
    - "Wet Zorgplicht Kinderarbeid" in the Netherlands is a proposed law stating that selling corporations should prevent child labour within their upper supply chain to the best of their capabilities.
    - 'Bouwbesluit 2012' states requirements for almost energy-neutral new house delivery and limited impact on the environment while building a new house.

  Thus, the legislation analysis shows an increasing focus on sustainability impact within upcoming legislation. Providing requirements in the future for Themans.
- The allocated resources findings show no allocation of resources to sustainable improvement projects. The thesis assignment was also stated to be the first sustainable improvement project for the company.
- The market analysis (APPENDIX 14) shows that the market segment in which Themans is active is highly focused on cost-price and quality marks. Here SKG is the current dominant

quality mark. For sustainability, no quality mark is yet incorporated by the market, although competitors show some incorporation of ISO (14001 and 9001) and cradle-to-cradle certification. Additionally, statements on competitors' websites show the introduction of SDG to some of the competitors' companies. However, the method of implementation could not be retrieved from the competitors.

- The SWOT analysis (APPENDIX 15) states the strengths, weaknesses, opportunities and threats of Themans. Here the SWOT showed, among other things, the strength and opportunities of Themans to be the flexibility and speed with which the company can respond to the changing market. The accompanying weakness of the company is the lack of structure and documentation during its activities. The lack of structured procedures does allow them to react quickly. However, retrieving information on the process and created product data is challenging.
  Another interesting weakness, in line with section 4.3.3.1 (Structure and overview approach), was the broad portfolio and customer specialisation. Here no direction seems to guide the processes, making Themans focused on facilitating specific solutions for specific customers instead of creating products for a broader range of customers. This focus is also visual in the lack of a market research department within the company and could create a dependency on the current customers. A high dependency on current customers creates threats for the company.

Second, the current policy of Themans was analysed. The marketing department of partner company Nauta created the current vision and mission statement of Themans (Figure 29). Nauta did not involve Themans employees, nor did it properly communicate the statements with Themans. The creation process results in a lack of awareness and resistance to using the mission and vision statement (obtained from statements made during the second brainstorming session for the new mission and vision formulation).
Additionally, Themans has a commercial strategy, a ten-year plan, called the Themans train. The company's current strategy will not be documented within this thesis, but the company's focus is to obtain a specific revenue target by increasing the amount of sold products. The case companies' strategy includes no specific plan concerning sustainability.

Mission in Dutch	Translated mission to English
S2 staat voor hang- en sluitwerk producten die voor en met de bouwer ontwikkeld zijn. We zijn niet alleen leverancier van een product, maar nodigen onze klanten letterlijk en figuurlijk uit aan onze tekentafel om gezamenlijk zorg te dragen voor verbeteringen en nieuwe oplossingen. We durven daarbij te investeren in duurzame (maatwerk)producten sterk gericht op eenvoud van montage. Dit in combinatie met functioneel bedieningsgemak en een subtiel gevoel voor detail maakt dat S2 past in ieder interieur en een geliefd merk is in de bouwketen en bij de eindgebruiker.	S2 stands for hardware products developed for and with the builder. We are not just a supplier of a product, but invite our customers literally and figuratively to our drawing board to jointly take care of improvements and new solutions. We dare to invest in sustainable (customized) products with a strong focus on simplicity of assembly. This combined with functional ease of operation and a subtle sense of detail makes S2 fit into any interior and a popular brand in the building chain and with the end user.

Vision in Dutch	Translated vision to English
S2 wil de betrouwbare partner zijn voor de hele bouwketen. Van de verwerker in de timmerindustrie, ijzerwaren vakhandelaar, projectinrichter tot aan de aannemer of zzp' er op de bouwplaats. Dit doen we door intensief samen te werken en de verwerker te ontzorgen met innovatieve en universele totaaloplossingen op het gebied van hang- en sluitwerk passend bij het element (kozijn, raam, deur). Met de duurzaamheidsambitie om in toekomst bij het productieproces gebruik te maken circulaire materialen.	S2 wants to be the reliable partner for the entire construction chain. From the processor in the carpentry industry, hardware dealer, project designer to the contractor or self-employed person on the construction site. We do this by cooperating intensively and relieving the processor with innovative and universal total solutions in the field of hinges and locks appropriate to the element (frame, window, door). With the sustainability ambition to use circular materials in the production process in the future.

Figure 29 Vision and Mission statement Of Themans by Nauta

Third, a sustainable development policy was formulated (APPENDIX 16). Two brainstorming sessions were executed to obtain the mission and vision statement (and core values). During these sessions, the number of participants from the project team was three. Management was not able to be part of the brainstorming. The mission and vision were, however, sent for feedback to management. Unfortunately, management could not provide feedback on the mission and vision. The brainstorming sessions used a preparation assignment to obtain individual statements of the mission, vision and core values since it was thought that this assignment would create a safe starting space to reflect on the personal thoughts on the mission and vision of the Themans by the employees. One participant filled in the preparation assignment, for which the first brainstorming session was altered to include an individual and group part.

Findings of the sessions:

Mission in Dutch	Translated mission to English
"Bij S2 geloven we dat duurzaam bouwen zonder in te leveren op kwaliteit, veiligheid of gemak mogelijk is. Daarom streven wij naar het ontwikkelen van continue innovatieve betrouwbare totaal oplossingen geoptimaliseerd voor de hang & sluitwerk verwerkingsindustrie. Met ons brede assortiment aan hang & sluitwerk en onze service helpen wij de verwerkingsindustrie om de juiste oplossing te vinden."	"At Themans, we believe building sustainably can be without compromising on high quality, high safety, ease of use. Therefore we aim to continuously develop innovative, quality, complete solutions optimised for the door fitting processing industry. With our broad assortment of door fitting products and our service, we aim to help our customers to find the right solution."

vision in Dutch	Translated vision to English
“Dé Duurzame totaal oplossing worden voor de verwerkingsindustrie”	“Becoming thé sustainable complete offering company of door fittings for the door fitting processing industry.”

The mission and vision, as stated within these sessions, do not mention the specific TBL corporate success goals. Instead, a more vague sustainability statement is used within the formulation. However, the sustainable claim refers to the TBL success division shown during the translation brainstorming session (APPENDIX 17) from the mission and vision into goals and indicators. The mission and vision translation resulted in the following division into four sustainable development goals:

- Ecological sustainable development goal
- Social, sustainable development goal
- Economic sustainable development goal
- Commercial viability

4.4 Formulate strategy

The company's strategy shows a roadmap of actions to obtain the company's sustainable development goal. The strategy formulation exists out of three phases, which will be elaborated on in the following sections:

- Action generation phase (section 4.4.1)
- Action prioritisation phase (section 4.4.2)
- Action plan formulation (section 4.4.3)

4.4.1 Action generation phase

The action generation phase is a divergence phase, which aims to generate as many actions to obtain the goal as possible. This section covers the approaches to guide action generation and the implementation at Themans.

4.4.1.1 Action generation phase approach

The action generation phase is a divergence phase which aims to formulate a large, diverse set of options to solve a problem or obtain a goal. The success of idea generation depends on a combination of a clear topic description, the contributors set and the techniques used for idea generation.

Clear topic description

The most important for the brainstorming sessions is the clarity of the goal for which actions or solutions should be generated. For the sustainability strategy formulation this is based on understanding what sustainable development is for the company and how the company can reduce its impact. Translating this to the topic per session for the idea generation sessions is also essential. It is advised to undertake an idea generation session per the applicable life cycle step of the product(s). The applicable life cycle steps of the products can be identified using (Appendix 4).
Per life cycle step, actions for the three divisions provided by the triple bottom line should be considered to ensure all aspects of sustainability are included.

The contributors set

For this step within the framework, it is advised to invite the expert layer to participate in their expertise life cycle session (see section 4.2.1 project team formation approach). All contributors should be educated on the topic. To contribute within the action generation session, knowledge of the principle-based sustainability definition (Karl-Henrik Robèrt et al., 2013), life cycle thinking and the triple bottom line is strongly advised (see section 4.3.2.1 knowledge certainty approach).

An external guide could best guide the action generation sessions. The reason for external guidance is the current knowledge gaps applicable at Themans and the importance of participation of Themans employees. The guide of the action generation sessions should know brainstorming techniques and group dynamics and should have had the same education as the project team.

Techniques for idea generation

For the idea generation, it is suggested to execute brainstorming sessions consisting of an educational basis and topic clarification part and a brainstorming part. During these sessions,

workshop techniques can generate more input from the contributors (Sasja Dirkse-Hulscher & Angela Talen, 2007). Example techniques from (Sasja Dirkse-Hulscher & Angela Talen, 2007) are:

- The golden rules technique: provides a base set of rules for the workshop and allows correction of contributors if they provide counterproductive inputs. This rule clarifies "the rules of the game" to all contributors.
- Individual post-it brainstorm technique: activates all contributors and causes all of them to deliver ideas instead of a small group.
- The opposite goal brainstorm technique: applies to contributors with little familiarity with the topic. This technique switches the goal one-hundred-eighty degrees and allows contributors to generate ideas to increase the company's negative impact. Increasing a negative is often easier than reducing one. It then makes it more insightful for participants on how to decrease the impact.

Requirements actions

Not all actions apply to the prioritisation process. Some requirements are therefor listed to guide the process:

- The level of detail of the actions should be specific. SMART is not required for the actions since this is not time efficient. However, the action's goal and details should be specific for communication and to find potential dependencies.
- The actions should be independent. The prioritisation method filters out actions on the impact and effort, not their dependency or independency. The system can potentially filter out the dependent actions due to an increased economic risk they portrait with little certainty on ROI and high effort. However, specific prioritisation of independency of the actions is not filtered out and could thus cause difficulties. For this reason, it is advised to include only independent actions within the set.

4.4.1.2 Action generation phase Implementation at Themans

No external parties were included except the master thesis student to guide the process for the idea generation.

The impact profile overview (APPENDIX 4) (MRM Crul, 2009) classified the necessary product lifecycle steps. The product portfolio of Themans exists out of passive products. Passive products have the following impact profile: "Then the key impact areas will be in the materials extraction/processing, manufacturing and end of life. Use-phase impacts will be low. With the side note: watch for maintenance inputs for use phase (e.g., cleaning).".

The sustainable design responses then focus on: "A1: Selection of low impact materials, A2: Materials use, A3: Packaging, B1: Production and manufacturing, B2: Distribution and transport in all phases of the product life cycle: logistic distance, mode and efficiency, C1: Improve the social and economic benefits of manufacturing, D1(high priority): Extending initial product lifetime, D2: End of life systems"(APPENDIX 3).

The categories stated in the overview were intended to structure the brainstorming sessions. However, due to time competition between this project and another corporate project, little available time forced it into one brainstorming session with three out of seven contributors. These brainstorming sessions included multiple applicable life cycle stages (APPENDIX 18). The three techniques were used in the workshop to increase the amount of input. These techniques were

helpful, and the participants enjoyed the brainstorm. The outcome of the brainstorming was thirty-five actions.
An individual brainstorming technique called the snowball email (Sasja Dirkse-Hulscher & Angela Talen, 2007) was then used to increase the limited amount of thirty-five actions. This email led to a second brainstorming session with two out of seven contributors and a contributor from outside the project team. This guided session led to a specification and expansion of the actions, obtaining 145 actions (for the whole list (see excel file), for an example of the action list, see (Table 4)).
Important note, some contributors from the project team stated that they had no previous experience with brainstorming. The golden rules helped them to clarify what was asked of them.

Table 4 snapshot of the generated actions list

Number	Actions description
4	Aluminium veiligheidsbeslag 40mm re-design for disassembly & repair
24	CET re-design using recycled materials
46	Make upstream supply chain packaging using recycled materials
49	Package door fittings more efficient; using fewer materials and less air transport
76	Change production location towards Europe
98	Glijlagerscharnieren offer refurbisching on product
131	agree/apply to a Code of conduct for transport partner I
142	create a yearly education budget per employee at Themans for them to allocate (in agreement)
146	Use a second source in Europe for the CET

4.4.2 Action prioritisation phase

Prioritising actions is a multi-criteria-decision-making process in which actions are ranked based on their scores for specific indications of sustainable developmental success for the company. The action prioritisation phase scores the value of the generated actions, providing an order of best actions to execute.

4.4.2.1 Action prioritisation phase approach

The action prioritisation method depends on a combination of indicator translation and weighing the indicators (derived from section 2.2.2 Multi-Criteria Decision-Making).

Indicator translation

The used indicator set within the prioritisation method depends both on the accurate translation of the corporate success statement and the usability requirements of use.
For usability, the method should ensure SMEs can execute the method with their resource limitations (little required knowledge, little required time, little costs). The indicator set should also cope with the uncertainties associated with the development nature of the actions. (Figure 30) provides the set of criteria for the usability of the prioritisation method.

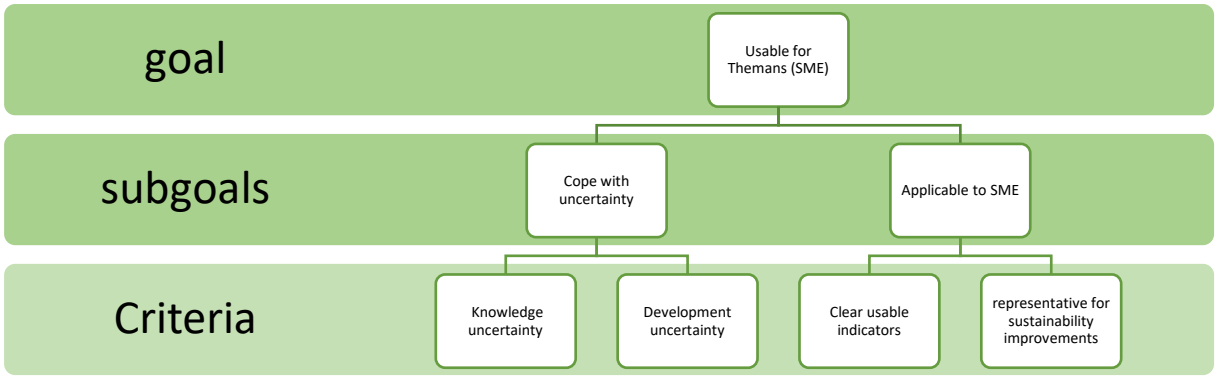


Figure 30 Goal for the usability of the prioritisation model for Themans

The corporate success statements are already introduced in the analysis (section 2.1.2). For accurate translation of these into indicators, a brainstorming session is advised. The translation session starts with the corporate mission statement and translates these into corporate success statements. The translation should then be done further into indicators for assessment of potential actions. The indicator set should:

- Cope with the uncertain nature of predictions
- Cope with the time pressure in which it should be usable
- Aim for a small set of indicators representative of the complete picture (for speed of use)
- Be easy to understand for the user
- Work with ordinal data with a quantitative nature or representation

Prioritisation of indicators into weighing formula

Part of the prioritisation method is weighing the prioritisation indicators. The weighing is based on subjective value judgements on the importance of indicators. Creating a criteria tree is advised to visualise the perceived importance of the indicators.

For the efficiency of the prioritisation method, the prioritisation of indicators should also identify the independent and dependent indicators. Prioritising actions first on independent indicators allows for efficient discarding of actions. It is advised to make a flow chart of the dependencies between indicators to show how to tackle the prioritisation process and reduce the required time for the process.

4.4.2.2 Action prioritisation phase Implementation at Themans

For the ease of use and reproduction of the prioritisation within Themans, the prioritisation is shaped into an impact-effort diagram for decision-making with sustainable development actions as subjects.

Derived from the theoretical analysis and the brainstorming session ‘mission and vision translation to corporate success goals and indicator’ (APPENDIX 17), the prioritisation formula exists out of:

- Ecological sustainable development goal (Ecological impact factor)
- Social, sustainable development goal (Social impact factor)
- Economic sustainable development goal (Economic impact factor)

- Commercial viability factor
- SME limitations and Themans specific limitations (stated as the corporate effort)

The prioritisation of Themans' success goals and the usability criteria for the prioritisation model result in the following prioritisation formula combination:

Equation 1 The ROI formula

$$\frac{(\boldsymbol{FV} - \boldsymbol{C})}{\boldsymbol{C}} \times \mathbf{100\%} = \boldsymbol{ROI}$$

Equation 2 The sustainable development impact-effort formula

$$\frac{(\boldsymbol{Ef} + \boldsymbol{Sf} + \boldsymbol{Ecf}) \times \boldsymbol{Impact\ Size}}{\boldsymbol{Corporate\ effort}}$$

The prioritisation process contains depended indicators, for which the dependency is shown in (Figure 31). The execution of the second prioritisation equation for the actions is dependent on the result of the first equation, the ROI formula, as shown in (Figure 31).

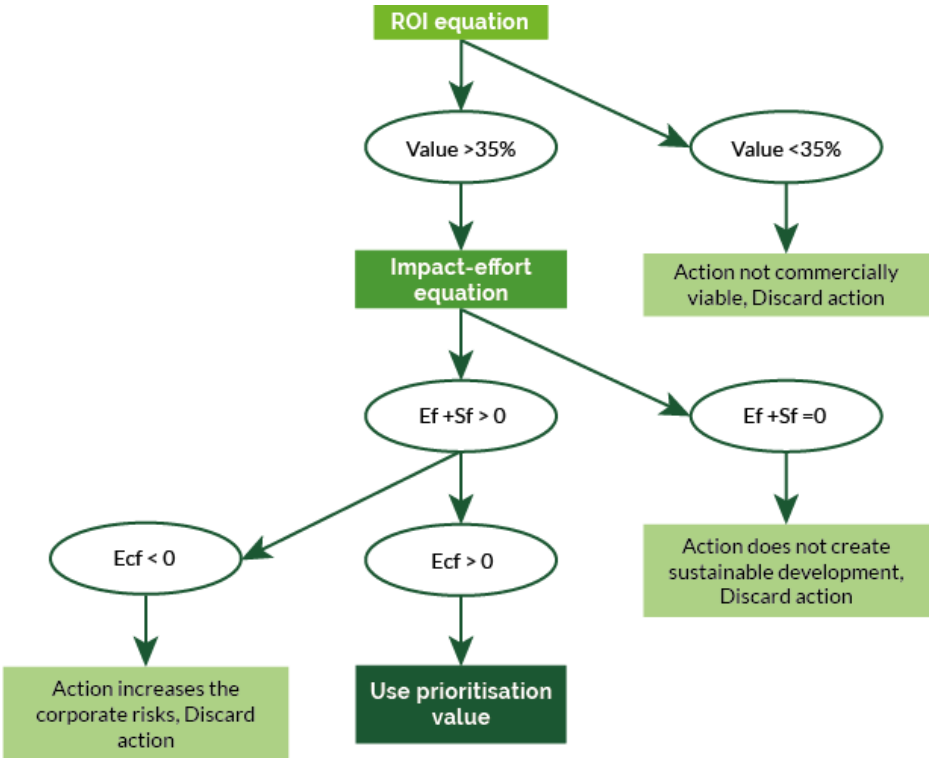


Figure 31 Dependency of prioritisation indicator values

This section continuous by explaining the scoring method per indictor group, starting with the ROI factor.

ROI Factor

The ROI factor indicates the commercial viability contribution of the action. This factor is used since it indicates the commercial viability without the need for a market acceptance indicator (which cannot be executed by Themans due to the lack of a marketing department and low interest in sustainability currently in the market). A minimum value of 35% ROI is used for this project at Themans. A value below 35% discards the action, reducing the time for prioritisation.

Ecological impact factor

The Ecological impact factor indicates the action's contribution to reducing the negative ecological impact of the company. For prioritisation, the 9R ladder is used. The 9R ladder is the best ecological success prioritisation option because:

- It works with the predictive nature of the actions
- It is time efficient due to the complete representation of sustainability for industrial products like the door fitting products of Themans
- It requires little effort to fill in,
- It allows for differentiation between high-impact and low-impact actions since the higher on the 9R-ladder, the lower the environmental pressure on the products production phases (José Potting and Aldert Hanemaaijer (eds.) et al., 2018).
- It focuses on the production phases, which aligns with the passive product portfolio.

The 9R-ladder score starts at zero (not applicable) and goes to the highest score, 'refuse' (ten points) (Figure 32).

	Points	Strategy	Elaboration
Use and create the product in a smart way	10	Refuse	Make product obsolete by abandoning its function, or providing it with a radically different product
	9	Rethink	Intensify product use (for example, by sharing products, or multi-functional products)
	8	Reduce	Manufacture product more efficiently by using fewer raw materials and materials in the product, or in its use
Extending initial product lifetime and parts lifetime	7	Re-use	Reuse of discarded, still good product in the same function by another user
	6	Repair	Repair and maintenance of broken product for use in its former function
	5	Refurbish	Refurbishing: modernize old product
	4	Remanufacture	Use parts of discarded product in new product with same function
	3	Repurpose	Use discarded product or parts of the discarded product in new product with different function
purposefull use of materials	2	Recycle	Process materials to the same (high-grade) or lesser (low-grade) quality
	1	Recover	Burning materials with energy recovery
	0	Not applicable	The action does not reduce the ecological impact

Figure 32 prioritisation scoring for the ecological sustainable development goal

Social impact factor:
The social impact factor indicates the action's contribution to reducing the negative social impact of the company. For prioritisation, Maslow's hierarchy of needs pyramid is used. The hierarchy of needs pyramid is the best social success prioritisation option because:

- It orients Themans to fill basic needs first, referring to, for example, a safe workspace in the whole supply chain.
- It provides prioritisation beyond human rights
- It overcomes measurability difficulties

The Maslow's hierarchy of needs scoring starts at zero (not applicable) and goes to the highest score, Self-fulfilment needs action, given that the psychological needs and basic needs are met in the applied situation (6 points) (Figure 33).

Points	Strategy	Elaboration
6	Self-fulfilment need action, given that psychological needs and basic needs are met in the applied situation	Self-fulfilment need action, given that psychological needs and basic needs are met in the applied situation
5	Psychological need action, given that the basic needs are met at the applied situation	Psychological need action, given that the basic needs are met at the applied situation
4	Self-fulfilment need action, given that basic needs are met in the applied situation	Self-fulfilment need action, given that basic needs are met in the applied situation
3	Basic needs action	Actions focussed on meeting human rights and food and safety needs for example: safety regulations, applying safety gear
2	Psychological need action	Actions focussed on enhancing the work-life balance and positive feed-back expressions
1	Self-fulfilment need action	Actions focussed on enhancing skills and meeting abilities of employees, helping them look for ways to advance their careers, facilitating good job fits.
0	The action does not reduce the social impact	The action does not reduce the social impact

Figure 33 prioritisation scoring for the social sustainable development goal

Economic impact factor:
The economic impact factor indicates the action's contribution to reducing the negative economic impact of the company. The risk matrix is combined for prioritisation with a classification of the action's expected profit. The risk matrix is the best economic success prioritisation option because:

- It results in risk avoidence
- It reduces the company's dependencies, contributing to the corporate aim to maintain flexibility.
- It contributes to resilience by identification of risks
- Risk avoidance is a long-term resilience indicator

However, it does not state a short-term economic impact indicator. The profit classification is, for this reason, included. The profit classification requires the profits of the actions to be ordered and split into five categories. This classification then indicates the short-term economic impact of the actions.
Together they do not provide a specific complete picture since sponsoring local sports clubs is omitted. This indicator was perceived as minimum contributing to the economic impact; thus, for simplicity and to limit fill-in time left out of the factor.

The scoring of economic sustainability impact requires identifying the current related social, ecological, and economic risks and predicting the risks' reductions or increases due to the action.
The risk matrix scoring starts at zero (no risk diversion) and goes to the highest score when an extreme risk is completely reduced (24 points) (Figure 34).

Probability	Severity: Negligible 1	Minor 2	Moderate 3	Major 4	Catastrophic 5
5 Almost certain	Moderate 5	High 10	Extreme 15	Extreme 20	Extreme 25
4 Likely	Moderate 4	High 8	High 12	Extreme 16	Extreme 20
3 Possible	Low 3	Moderate 6	High 9	High 12	Extreme 15
2 Unlikely	Low 2	Moderate 4	Moderate 6	High 8	High 10
1 Rare	Low 1	Low 2	Low 3	Moderate 4	Moderate 5

Figure 34 prioritisation scoring for the economic sustainable development goal

Impact size factor:
The impact size factor indicates the impacted area per product and the number of products. The size is required for the prioritisation formula since it shows the action's volume and, thus, its impact volume.
The scoring uses a five-category ordinal scale. This scale leaves room for uncertainty since predicting the number of products or the percentage within the product can be tricky (as acknowledged by the participants filling in the prioritisation model).

The percentage scoring starts at one (action applies to less than 20% of the product) and goes to the highest score; the action applies to more than 80% of the product (5 points) (Figure 35).

Strategy	Points	Elaboration
The action impacts a high percentage of the product	5	The action applies to almost all product parts (packaging included) >80%
The action impacts a relatively high percentage of the product	4	The action applies to <60% Action impact <80% of the product parts (packaging included)
The action impacts a conciderable percentage of the product	3	The action applies to <40% Action impact <60% of the product parts (packaging included)
The action impacts a relatively conciderable percentage of the product	2	The action applies to <20% Action impact <40% of the product parts (packaging included)
The action impacts a relatively small percentage of the product	1	The action applies to less then <20% of the product parts (packaging included)

Figure 35 prioritisation scoring for the impacted size within the product

The number of products scoring starts at one (the action applies to a relatively small amount of products) and goes to the highest score; the action applies to more than 80% of the product. The action applies to a large number of products (5 points) (Figure 36).

Strategy	Points	Elaboration	
The action impacts a high percentage of the product portfolio	5	The action applies to multiple product catagory	The action applies to all door fitting products
The action impacts a relatively high percentage of the productportfolio	4	The action applies to one product catagory	The action applies to all ALU 32mm doorfitting products
The action impacts a conciderable percentage of the product portfolio	3	The action applies to multiple product lines	The action applies to all ball bearing & Slide bearing hinges
The action impacts a relatively conciderable percentage of the product portfolio	2	The action applies to one product line	The action applies to the packaging of the
The action impacts a relatively small percentage of the product portfolio	1	The action applies to one or two products	The action applies to the PC92 28mm 5001135301

Figure 36 prioritisation scoring for the impacted number of products

Corporate effort factor
The corporate effort factor indicates the required effort to execute the actions. Effort for the company is split up into:

- Required time
- Required knowledge
- Required amount of employees
- Required technology
- Required financial means

For this, a Likert scale categorisation is used to translate qualitative ordinal data into discrete quantitative data. The best score for all indicators is one point since the corporate effort factor is the denominator of the equation (Figure 37, Figure 38, Figure 39, Figure 40, Figure 41).

1. Time factor During the project it was not possible to obtain a scoring mechanism for the time indicator. The time indicator is dependent on the percentage of the weekly available working hours per average action project team member. The percentages, which indicate the scoring, are dependent on the maximum allowed weekly working hours per average action project team member by the company. These percentages could unfortunately not be established in this project.

Strategy	Points	Elaboration
The action requires a small amount of time	1	The estimated average amount of labour hours per action project team member is less then .....% of its weekly working hours
The action requires a relatively small amount of time	2	The estimated average amount of labour hours per action project team member is .....% & ....%of its weekly working hours
The action requires a considerable amount of time	3	The estimated average amount of labour hours per action project team member is .....% & ....% of its weekly working hours
The action requires a relatively large amount of time	4	The estimated average amount of labour hours per action project team member is between .....% & ....% of its weekly working hours
The action requires a significant amount of time	5	The estimated average amount of labour hours per action project team member is more then .....% of its weekly working hours

Figure 37 prioritisation scoring for the time factor

2. Knowledge factor. The knowledge factor indicates the required investment to obtain the knowledge required for the execution of the action. Lack of knowledge can also provide more uncertainty and difficulties for the project.

Strategy	Points	Elaboration
The action requires a small amount of new knowledge	1	The company is highly familiar with the action's topic and has all the required knowledge
The action requires a relatively small amount of new knowledge	2	The company is very familiar with the action's topic and has around 60%- 80% of the required knowledge
The action requires a considerable amount of new knowledge	3	The company is moderately familiar with the action's topic and has around 40%- 60% of the required knowledge
The action requires a relatively large amount of new knowledge	4	The company is slightly familiar with the action's topic and has around 20%- 40% of the required knowledge
The action requires a large amount of new knowledge	5	The company is not at all familiar with the action's topic

Figure 38 prioritisation scoring for the knowledge factor

3. Required employees factor. The amount of employees at Themans is limited. If an action requires multiple employees from multiple departments, “normal work” might suffer from the lack of time. When the “normal work” suffers, this might damage the reputation.

Strategy	Points	Elaboration
The action requires a small number of employees	1	One or two employees are required to attend the action project
The action requires a relatively small amount of employees	2	A few employees are required to attend from no more than two departments' project
The action requires a considerable amount of employees	3	A few employees are required to attend from no more than three departments' project
The action requires a relatively large amount of employees	4	A few entire departments are required to attend the project, or employees from more than five departments are choired
The action requires a large number of employees	5	Of all departments, at least one employee is required to attend the project

Figure 39 prioritisation scoring for the ‘required employees’ factor

4. Required technology factor. The technology factor indicates the required investment to obtain the technology required for the execution of the action.

Strategy	Points	Elaboration
The action requires a small amount of new technological equipment	1	The company is highly familiar with the action's technology and has all the required technology
The action requires a relatively small amount of new technological equipment	2	The company is very familiar with the action's technology and has around 60%- 80% of the required technology
The action requires a considerable amount of new technological equipment	3	The company is moderately familiar with the action's technology and has around 40%- 60% of the required technology
The action requires a relatively large amount of new technological equipment	4	The company is slightly familiar with the action's technology and has around 20%- 40% of the required technology
The action requires a large amount of new technological equipment	5	The company does not have the action's required technology

Figure 40 prioritisation scoring for the required technology factor

5. Required financial means factor: During the prioritisation brainstorm session, it was mentioned that Themans tried to develop five new products (including redesigning packaging) per year. This value is used for the financial resources indicator. The financial resource indicator is dependent on the percentage of the R&D budget and the targeted R&D innovations annually.

Strategy	Points	Elaboration
The action requires a small number of Financial resources	1	The action requires close to zero <5% of the R&D budget
The action requires a relatively small amount of Financial resources	2	The action The action requires between the 5 % < Actions required finances en <10 % of the R&D budget
The action requires a considerable amount of Financial resources	3	The action The action requires between the 10 % < Actions required finances en < 15% of the R&D budget
The action requires a relatively large amount of Financial resources	4	The action The action requires between the 15 % < Actions required finances en <20 % of the R&D budget
The action requires a large number of Financial resources	5	The action requires more then 20 % of the R&D budget

Figure 41 prioritisation scoring for the required financial means factor

4.4.2.1 prioritisation results

It was not possible to complete the filling in process of the prioritisation model during the project. The attached excel file shows the overview of indicators and the partly filled-in data (M.G. Hoevenagel, 2022b).

The data that was provided allowed a discarding round of the actions based on their risk contribution or reduction (Figure 42). From the original 145 generated actions, 20 could be discarded since they provided an increased overall risk to the company. Eighteen were indicated as a potential risk since they contributed to a specific risk factor, but also reduced other risks. These were also discarded, but they could both potentially be used in a future state of the company. This left 107 Actions which should be further prioritised.

However, none of the actions were prioritised on their ROI performance since this data was not provided. The resulting action set is thus not representable for the actual action set for the company but does reduce the action set.

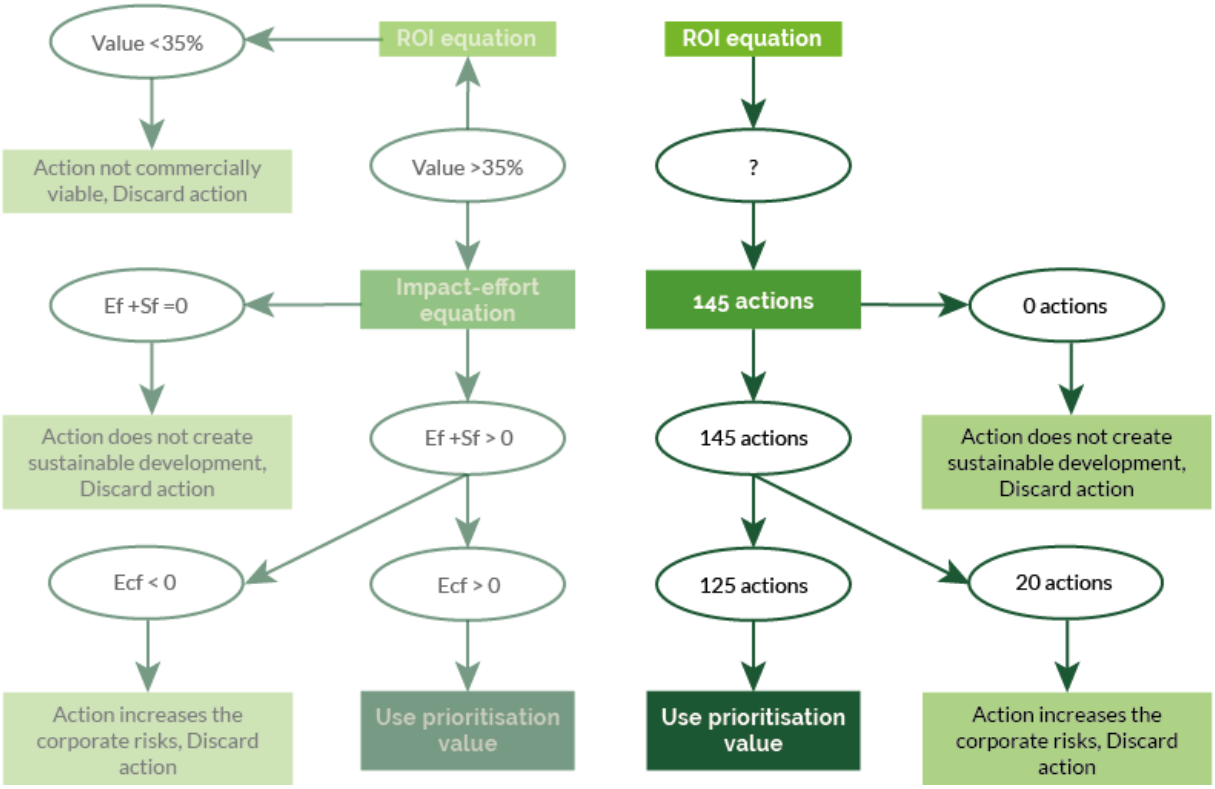


Figure 42 prioritisation decision tree project fill-in

4.4.3 Decide on actions to execute

Making an impact-effort matrix overview is advised to visualise the prioritisation (Lean six sigma academy B.V., 2020)(Figure 43). The impact-effort matrix indicates four categories of prioritised data:

1. Quick-wins (high impact, low effort); can easily be changed and should thus be executed first.
2. Major projects (high impact, high effort); require high effort and thus require planning.
3. Not Now (low impact, low effort); execute when high in resources; otherwise, other options are better, thus also require planning.
4. Do not do (low impact, high effort); avoid these options since they waste time.

The order of the four categories guides the order to execute the ranked actions. Additionally, it is advised to initiate pilot projects due to Themans' resource limitations to execute the actions. An important note for the pilot projects is to ensure the applicability of the execution of the action for its full impact size.

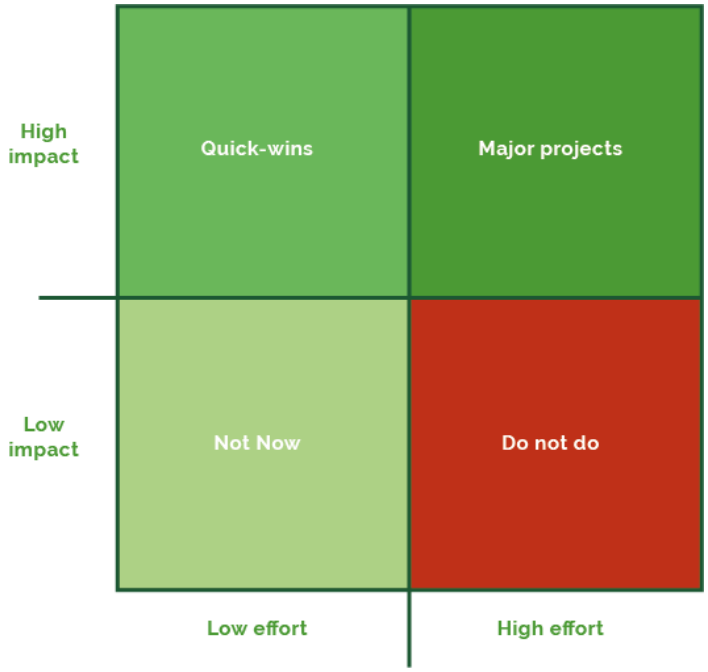


Figure 43 impact-effort matrix for lean prioritizing projects based on (Lean six sigma academy B.V., 2020)

This chapter illustrated the framework and elaborated on the normative and strategic management level parts. The next chapter will declare the use requirements for a SME.

Chapter 5 Declaration for generalisation of the method towards SME use

This chapter explores the possibilities and requirements for implementing the framework by a SME. It first declares the requirements for the usage of the framework. Second, it provides an implementation booklet for SMEs to implement the framework.

5.1 Declaration of framework use

This report focuses primarily on the implementation of the framework by Themans. For this reason, specific adjustments and made to the framework. This section lists the specification for implementation by Themans. The list of the specific adjustments provides the requirements of applicability for another SME.

The theoretical basis of the framework, the analysis of this report, focused on Themans' context. This focus can be seen in the characterisation of Themans and the translation of the desired future state toward Themans' applicable success goals.
The focus areas provide the following requirements to SMEs for the use of this framework:

- The company should be an SME; This framework is specified for SME use. The specification can be seen in, for example, disconnecting the ROI formula. This relation between the equations makes the sustainable development impact effort equation dependent on profit. The profitability of every project is more crucial for SMEs than for larger companies.
- The SME should be a B2B company with a customer relations department and customer relations analysis capabilities similar to Themans; Due to the marketing analysis capabilities of Themans, the prioritisation uses an ROI prediction formula based on their procedure to predict NPD success. A company with a higher customer relations analysis capability could better include a more specific VOC input for the commercial viability formula.
- The SME should produce products in the tech cycle of the circular economy outline; The prioritisation method uses the circular economy tech cycle to score the action's potential ecological impact reduction. The products designed or produced by the SME should thus fall within the CE tech cycle.
- The products of the SME should meet the requirements of CE; CE does not apply to all product types. Products that experience rapid technological innovations counter the long-lifetime aspect of CE and are thus not applicable to this framework.
- The SME employees should be in the contemplation phase or preparation phase; The framework provides information and helps structure a plan for sustainable development, which is most in line with these two phases.
- The SME should prioritise sustainable development; Without priority to sustainable development, the implementation of the framework will deliver few results and thus be of little value to the SME

When the SME meets these requirements, the framework can apply to them. They can therefore use the framework. However, it is advised to be cautious when applying the framework since translation toward the SME can be acquired.

5.2 SME implementation plan framework

The implementation plan and the prioritisation method of the framework are provided externally from this document. These documents can be used by SMEs to guide their transition process, given that the requirements are met (M.G. Hoevenagel, 2022a, 2022b).

Chapter 6 Conclusion & recommendations

This chapter reflects on the project and its accomplishments. It reflects on the project's success due to the framework's ability to incorporate the required topics and facilitate the required activities. It then reflects on the project's process, elaborating on the strengths and weaknesses of the project execution and recommending activities to improve the project's process in the future. Finally, it recommends further research based on this project's findings.

6.1 Conclusion

The project's goals were to provide a normative and strategic management level framework for Themans to obtain sustainable development within the company and to establish the application requirements of the framework for SME use. The project's analysis phase provided a requirements list for the sustainable development framework (APPENDIX 5). Based on the listed requirements, the following concluding statements can be made on the framework's successfulness in directing Themans on a normative and strategic level toward sustainable development.

Successfulness framework in directing Themans toward sustainable development

The framework successfully incorporates the sustainable development desired future state topics to a Themans appropriate level. The principle-based definition, translations of the TBL, and LCT are all included in the framework. However, the TBL incorporation is not entirely complete due to decisions during translation.

- The economic sustainability translation toward the economic success goal for Themans does not prioritise on the triple bottom line indicator supporting actions by the company for the local community. The framework uses in stead risk management for resilience and independence since these are more applicable to the current situation at Themans. To maintain the simplicity and efficiency of the prioritisation method this indicator is not added as an independent indicator.
- The economic sustainability translation toward the economic success goal for Themans excludes a specific voice-of-customer input (VOC), limiting the commercial viability factor's power in prioritising sustainable development actions since it lacks a market value for sustainable development actions. However, it is in line with the market response to this research and the limited voice-of-customer capabilities of the company.

The transition process from the current to the desired state within this framework successfully facilitates the generation and prioritisation of sustainable development actions as stated in the requirements. However, the transition process has one crucial dependency that this framework can not ensure, motivation. The transition process within this framework initiates multiple alternations to the current working method of the company. For the success of the overall framework, motivation and commitment are crucial. The framework does stress the importance of resource allocation, leadership and the top-down approach (formulating a mission and vision) to establish commitment. However, on the individual employee level, it does identify but does not cope with the range of different behaviour change stages. It thus primarily provides the jump from preparation to action and secondary provides the jump from contemplation to preparation.

The Themans employees show a range of behaviour change stages, with the majority in the contemplation stage, for which employee level commitment and motivation are the dependencies for successfully implementing the framework.

The project suffered because of the different prioritisation choices during the course of the project. The course of the project first raised the motivation within the company. However, due to the reorganisation, the priority and motivation of a part of the company changed. The change in prioritisation showed in the low attendance during brainstorming sessions. The low attendance reduced the power of the project since not all steps could be executed in the intended way, and not all steps could obtain broad multidisciplinary inputs.

The project identified the characteristics and limitations of Themans and included these into the framework (via, for example, the corporate success goals). The implementation of the normative and strategic level framework parts showed successful implementation of parts of the framework by the participating Themans employees.
The characteristic limitations for Themans and SMEs in general, knowledge gaps and lack of documentation for the initiation toward sustainable development are outlined within this framework. The project covered the company's knowledge gap through education workshops, projects, and guided brainstorming sessions. However, the project could not entirely overcome the knowledge gap due to the lack of possible incorporation of external parties and the declining motivation. These factors reduce the power of the framework's implementation during the project and make the outcome more subjective to a small group of participants. The workshops did, however, seem to raise interest in initiating sustainable development implementation at the company by the participants.
The lack of documentation within the project provided difficulties since not all information could be easily obtained. The project could, therefore, not complete testing the implementation on the normative and strategic levels of the framework. Notes and pictures of the meetings and this report function as the documentation of this project.

Applicability and use for SME sustainable development.
The framework can guide other SMEs to initiate and guide their transition process toward sustainable development. However, due to the framework's development analysis specifications on Themans, SMEs should comply with the declaration of use within this report.

6.2 Recommendations

The dependency on intrinsic motivation and commitment (or prioritisation) is vital to the transition but also to the framework implementation. The company's prioritisation toward the re-organisation to become a brand made it difficult to state if the framework was successful since the current implementation could not always follow its procedures. During the project, the priority decreased due to the rising priority concerned with the company's restructuring. However, the project's course required increased priority from the company as the project progressed. For example, this resulted in the company being unable to provide all data required to fill in the prioritisation method during the project.
Prioritisation is, among other things, influenced by the employee level jump from contemplation to preparation and the lack of prompting external driving forces. To properly test the framework's functionality, the company is recommended to execute the framework in its completeness, with the highest prioritisation.

Recommendation for the execution of the complete framework:
Special attention should be focused on employees' different views on sustainable development. The dependency on individual employees within a small company is high, so first, the employees' views within the project team should be in the same direction.

For the project team, it is stressed to include representatives from the 'subject' and 'key player' groups of the stakeholder analysis and facilitate sessions in which the external partners are invited to think with on the sustainable development topics of Themans.

Generating more sustainable development actions per product life cycle phase is recommended, since the larger project group will be able to provide more specific and relevant actions.
Requesting external guidance or expert help to guide these sessions is further recommended since a large group should all work together toward one goal.

From the execution of the framework's complete normative and strategic management levels, it is recommended to identify the required actions for Themans. The required actions go beyond sustainable development actions since preparation actions are required first.

As a statement of proactivity, Themans could request an external third party to execute a sustainability benchmark (based on a LCA) of their best-sold door fitting product. The benchmark will show the current sustainability state of the product. The benchmark will educate the company on the assessment, provide new data for the best-sold product, and can later showcase the progress made with the sustainable development actions (if the same product is assessed again).

6.3 Further research

This section uses the results and conclusions of this report to identify required areas for further research. The section covers further research to complement the framework. Further research complements the current framework and suggests alternations for future use of the framework.

Complementing research

The framework requires systems, currently not yet in the correct form at the company, referring to a continuous improvement education and portfolio-based structuring system. It is advised to research the required shape of these systems further.

Further research on procedures for the operational level steps of the framework is also advised. Themans has procedures for, among other things, NPD and evaluation of projects. Giving substance to the operational steps is advised to be further researched.

Since these further research topics are quite specific and have a clear scope, the execution could be done as a graduation assignment in combination with a knowledge institute.

Future framework improving research

The lack of a voice-of-customer input (VOC) limits the commercial viability factor's power in prioritising sustainable development actions since the value of sustainability improvements within the market is not directly incorporated into the formula. This is in line with the market response to this research and the limited voice-of-customer capabilities of the company. However, for the continuous improvement of the company and the system, it is advised to incorporate a VOC indicator within the formula's future commercial viability factor. H.C.Theisens et al. suggest the KANO model and the VOC analysis to identify the voice of customers (H.C.Theisens et al., 2020). Including this input requires the company to include a marketing department capable of obtaining the input data.

Additional research on the economic sustainability factor of corporate resilience is required. In recent history, Covid provided research focus on corporate resilience, but the topic of resilience is not yet broadly researched in literature. The economic resilience indicators could therefore be revised to represent economic resilience better when additional research is done.

Lastly, within Themans, a question arose: which sustainability quality mark could provide an external party guiding the sustainable development improvement process and make sustainable development immediately commercially marketable?

This project avoided advising sustainability quality marks for Themans since a strategy focused on obtaining and maintaining a quality mark makes the company dependent on the quality mark and is no long-term guide. Furthermore, the door fitting market has no dominant quality mark like the wood industry (FSC) (APPENDIX 14). A quality mark could then direct the company towards sustainability requirements for a mark that the customer would not recognise. Additionally, it could mean no education on the topic and no continuous sustainable development improvements by Themans, but only stated adjustments to maintain the quality mark, which provides a green-washing risk.

The marketing quality of the quality marks is thus excluded from the project. In a further stage of sustainable development incorporation, the marketing value of quality marks could be researched for usability by the company.

Appendix

Appendix 1) questionnaire sustainability customers

Duurzaamheidsenquête Themans hang & sluitwerk BV

Beste mevrouw/meneer, voor mijn afstudeeropdracht voor de studie Industrial Design Engineering doe ik een project op het gebied van duurzaamheid en verduurzaming voor het bedrijf Themans hang & sluitwerk BV. Deze vragenlijst is onderdeel van het project en heeft als doel om de huidige vraag naar verduurzaming (vraag 1 t/m 8) en de toekomstige vraag naar verduurzaming (vraag 9 t/m 15) voor Themans hang & sluitwerk BV in kaart te brengen.
De verkregen data is uitsluitend bedoeld voor mijn onderzoek en zal geanonimiseerd worden gecommuniceerd met Themans hang & sluitwerk BV.

Ik wil u vooraf graag bedanken dat u de moeite heeft genomen om deze vragenlijst in te vullen.

Max Hoevenagel
(student University of Twente)

1) Heeft u de vraag van uw klanten naar duurzame producten zien toenemen, gelijk zien blijven of zien afnemen?
   ☐ Toenemen
   ☐ Gelijk gebleven
   ☐ Afnemen

2) Wordt de duurzaamheid van producten door u gecommuniceerd aan uw klanten?
   ☐ Ja (vraag 3)
   ☐ Nee (vraag4)

3) Op welke manier communiceert u over de duurzaamheid van producten naar uw klanten?

4) Op welke manier zijn duurzame producten een toegevoegde waarde voor uw bedrijf?

5) Hanteert u duurzaamheidseisen bij de inkoop van producten?
   ☐ Ja (vraag 6)
   ☐ Nee

6) Welke eisen op gebied van duurzaamheid stelt u bij de inkoop van producten?

7) Zijn er of komen er in de nabije toekomst regels of wetten op het gebied van duurzaamheid die op uw bedrijf van toepassing zijn en ook mogelijke gevolgen kunnen hebben voor Themans hang & sluitwerk BV?

8) Heeft uw bedrijf een budget gereserveerd voor verduurzaming van het bedrijf?
☐ Ja
☐ Nee

9) Heeft u binnen uw bedrijf een persoon of afdeling die gefocust is op het verduurzamen van bedrijfsactiviteiten?
☐ Ja
☐ Nee

Het begrip duurzaamheid kan opgesplitst worden in drie gebieden op basis van 'triple bottom line)'; economische welvaart, klimaat kwaliteit en sociale rechtvaardigheid. De volgende drie vragen gaan over de inzet van uw bedrijf op elk van deze drie gebieden.

10) Heeft uw bedrijf een strategie/doelstellingen geformuleerd op het gebied economische welvaart
☐ Ja
☐ Nee

11) Heeft uw bedrijf een strategie geformuleerd op het gebied van de kwaliteit van het klimaat (m.a.w. de ecologische impact van het bedrijf op haar omgeving)?
☐ Ja
☐ Nee

Voeg als mogelijk de strategie hieronder bij (denk hierbij aan bijvoorbeeld een strategie gebaseerd op ISO 14001 of ISO 26000, methodes als D4S, etc.)

1) Click Insert > Object... > From File...
2) Choose the PDF file from the pop-up window and press Insert.

12) Heeft uw bedrijf een strategie geformuleerd op het gebied van haar sociale impact. M.a.w. een strategie die in gaat op de sociale gevolgen van zowel de externe activiteiten van het bedrijf, als de interne mogelijkheden geboden aan de interne werknemers.
☐ Ja
☐ Nee

Voeg als mogelijk de sociale impact strategie hieronder bij (denk hierbij aan bijvoorbeeld een MVO bedrijfsstrategie)

1) Click Insert > Object... > From File...
2) Choose the PDF file from the pop-up window and press Insert.

13) Wat zou Themans hang & sluitwerk BV kunnen doen om mee te groeien in de lijn met uw duurzaamheidsstrategie?

14) Mag ik contact met u opnemen om de gegeven antwoorden door te spreken in een kort telefoongesprek of zoomsessie (15-30 minuten)?
☐ Ja
☐ Nee

15) Mag ik hiervoor uw telefoonnummer?

16) Heeft u een voorkeur voor een datum voor u zou uitkomen?
Click or tap to enter a date.

17) Ik wil u bedanken voor het beantwoorden van de vragen. Mocht u nog opmerkingen hebben over het onderwerp of de vragen dan kunt u deze hieronder kwijt. Nogmaals dank voor uw tijd.

Appendix 2) EPDs of Themans examples

Algemene Brancheverenigging VHS

Milieuprestatieverklaring

Nederlandse bijlage
Scharnieren

Behorend bij:

Owner of the Declaration	ARGE; European Federation of Associations of Lock and Builders Hardware Manufacturers
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-ARG-20160193-IBG2-EN
ECO EPD Ref. No.	ECO-00000411
Issue date	14.09.2016
Valid to	13.09.2021

Hinges
ARGE; European Federation of Associations of Lock and Builders Hardware Manufacturers

Deze bijlage is alleen geldig in combinatie met de bijbehorende ARGE EPD en voor producten geleverd door een licentienemer van de Algemene Branchevereniging VHS

THEMANS voor duitende oplossingen

Themans hang- en sluitwerk BV is als licentienemer van de Algemene branchevereniging VHS gerechtigd deze EPD te verstrekken

Algemene Brancheverenigging VHS

Algemene Branchevereniging VHS

Basis voor opname in de Nationale Milieudatabase (NMD)

LCA resultaten

Basisprofielen		Productie	Transport->bouw	Emissies	Onderhoud	Transport->afval	Afvalverwerking
Fase(n) EN 15804		A1 + A2 + A3 (+ A5)	A4	B1	B2	C2	C3 (+ C1, C4 en/of D)
Naam basisprofiel		VHS Scharnieren	VHS Scharnieren	VHS Scharnieren	VHS Scharnieren	VHS Scharnieren	VHS Scharnieren
Eenheid basisprofiel		kg	kg	kg	kg	kg	kg
Commentaar (optioneel)							
Ook opnemen in Processendatabase?		Nee	Nee	Nee	Nee	Nee	Nee
Abiotic depletion, non fuel	kg antimoon eq.	6,482E-03	1,948E-06	0,000E+00	0,000E+00	1,669E-08	1,696E-09
Abiotic depletion, fuel	kg antimoon eq.	4,255E-02	4,316E-03	0,000E+00	0,000E+00	3,699E-05	3,076E-05
Global warming (GWP100)	kg CO2 eq.	6,676E+00	5,889E-01	0,000E+00	0,000E+00	5,047E-03	4,167E-03
Ozone layer depletion (ODP)	kg CFK-11 eq.	4,337E-07	1,081E-07	0,000E+00	0,000E+00	9,262E-10	4,474E-10
Photochemical oxidation	kg ethyleen eq.	4,574E-03	2,678E-04	0,000E+00	0,000E+00	2,295E-06	9,539E-07
Acidification	kg SO2 eq.	7,392E-02	2,391E-03	0,000E+00	0,000E+00	2,049E-05	1,730E-05
Eutrophication	kg PO4- eq.	1,021E-02	4,062E-04	0,000E+00	0,000E+00	3,481E-06	1,943E-06
Human toxicity	kg 1,4-dichloorbenzeen eq.	4,106E+00	2,486E-01	0,000E+00	0,000E+00	2,131E-03	4,389E-04
Fresh water aquatic ecotox.	kg 1,4-dichloorbenzeen eq.	1,109E-01	7,939E-03	0,000E+00	0,000E+00	6,805E-05	1,986E-05
Marine aquatic ecotoxicity	kg 1,4-dichloorbenzeen eq.	1,711E+04	1,008E+02	0,000E+00	0,000E+00	8,642E-01	2,202E+00
Terrestrial ecotoxicity	kg 1,4-dichloorbenzeen eq.	1,421E-01	9,606E-04	0,000E+00	0,000E+00	8,233E-06	9,565E-06
Total renewable energy	MJ	12,47062289	0,112159765	0	0	0,000961369	0,008266175
Total non renewable energy	MJ	93,80670354	9,128021767	0	0	0,078240187	0,093805576
Total Energy	MJ	106,2773264	9,240181532	0	0	0,079201556	2,517310011
Water, fresh water use	m3	0,088222281	0,001721134	0	0	1,47526E-05	3,14525E-05
Waste, non hazardous	kg	6,081649303	0,46808481	0	0	0,004012156	0,001332237
Waste, hazardous	kg	0,58733358	0,00569704	0	0	4,88318E-05	0,000295652

Opmerkingen:

1. *Bij opname in de NMD is rekening gehouden met een levensduur van 30 jaar*
2. *Er is een conversiefactor van 0,613 toegepast (gewicht/stuk)*

Appendix 3) Characterisation of product impacts based on product characteristics in combination with the specific design focus approached (MRM Crul, 2009)

Product type / characteristics		Typical impact profile	Knowledge focus (data you will need to gather for your product)	Most relevant D4S responses (the references link to Table 3-2 above)
1. An active product ? Does your product consume energy in order to function? If so what kind of energy (the critical issue is CO2 produced, but there are other aspects of pollution from energy production and distribution). You could consider 'water' as well as energy in this question, if it is appropriate to your product category.	**(A) YES**	It is highly likely that the most significant impacts for your product occur in the 'use-phase', from its energy (or water) consumed during use. NOTE: Even if the energy already comes from a renewable source or if the water is recovered wastewater you can still improve these features. Please consider the 'passive product' next below.	- lifetime and use patterns; -product operation (where energy is used); -the kind of energy sources (their greenhouse gas contribution); - overall power consumption; - efficiency of key components (e.g. motors).	B 3(i); (ii); (iii) (energy/water focus) E1, E2 and E3 (Lower priority: A2(i) and D2.)
	(B) NO (Passive product)	Then the key impact areas will be in the materials extraction/processing, manufacturing and end of life. Use-phase impacts will be low. *Caution:* watch for maintenance inputs for use phase (e.g. cleaning).	Materials; manufacturing systems; factors affecting the life of the product. (Generally, for this category, extending the product life reduces environmental impact).	A1 A2 A3 B1 B2 C1 D1 (High priority) D2
2. A mobile product? Is your product mobile or transported when in use? (e.g. a car or a container)	**(A) YES**	The use phase is likely to be important as product mass will create indirect use of energy for transport. However, as mass is related to materials processing and end-of-life, impacts in these phases need to be considered as well.	Use patterns; product life, transport distances over life; materials choice; issues of product weight; energy or fuels used for transport; end-of-life disposal patterns.	A2 (i). B2 (i); (ii); (iii); and (iv) B3 (i); (ii); (iii) Consider inputs to the mobility/transport process C1
	(B) NO (Stationary product)	No conclusions. Examine other characteristics.		
3. A consumables product? Does your product require consumables to operate? (e.g. batteries; chemicals; inks, paper etc.). [Many such products will also be in group 1A Active Products (this table above).]	**(A) YES**	Impact profile similar to 1A Active Products above – the use phase of your product is important. However, in this case you have to consider the life-cycle of the consumable products as well. You may gain product improvement by specifying different consumables.	Use patterns; data on the consumables, their impacts, typical amounts consumed over total product life; alternative or substitute consumables.	B3 (i); (ii); (iii). (equal emphasis on reduction of consumable use, selecting low-impact consumables, substituting renewable consumables – e.g. rechargeable batteries) C1 E1 (i); (ii) E2 (i) E3 (i) (Lower priority: A2; A3; D2)
	(B) NO (Passive product)	Consider 1B Passive Products (this table above).		
4 A short-life product? Is your product a consumable, a non-durable, a use-and-dispose?	**(A) YES**	Impact profile will emphasise beginning and end-of-life.	Use patterns; total volumes of materials, end-of-life disposal patterns; materials choices to reduce impacts at manufacturing and end-of-life and to extend life.	A1; A2; A3 B1; B2 C1 D1 (Note: not appropriate if product is also a 1A [Active Product] or 3A [Consumable Product] type) D2

TABLE 3-3 ___ PRODUCT TYPE, IMPACT AND RESPONSE

Appendix 4) Design focus approaches (MRM Crul, 2009)

Product characteristics	Strategic focus	Questions about your product (dossier information)	D4S / improvement approaches	Notes on Environmental effects
A. THE USE OF MATERIALS IN THE PRODUCT	**1. Selection of low impact materials**	*Can you identify any sensitive materials?*	(i) Eliminate materials with sensitive origins (e.g. rainforest timber), from non-renewable sources, or from endangered habitats, etc; or from economies where issues of human rights, labour exploitation or questionable development policies are prominent. Remember that 'renewable' materials are not without impact; always check the source data. Consider the 'social value chain' in materials selection. Link to C below – Social and ethical issues in production, distribution, and use.	Biodiversity and social concerns reduced.
		Are any materials high in embodied energy (or embodied water if that is a scarce resource in your market)?	(ii) The total energy and/or water used to create a product can be 'embodied' in its materials - the energy and/or water which goes into processing its materials. Reducing this can become a selection criteria for alternative materials. *Note: Embodied energy can be (partially) recovered through reuse and recycling. However, even recycled materials have an embodied energy (from transport, recovery, reprocessing etc.).* Embodied energy and/or water is an important issue but, to be significant in the selection of materials, 'total energy' or 'total water' is not an ideal measure because what is important is the pollution associated with the **form** of energy or the total pollution of the wastewater. What you really want from this indicator is how 'dirty' the energy or water is resulting from the production process, as well as how much of the resource is embodied. There is a move in many markets to define the embodied 'greenhouse gas' in materials, which more accurately reflects the energy impact of a material. Expect such data to become more readily available. Where it exists it is a measure that should be used for selecting alternative materials (or alternative sources of the same material). *Note: in the case of embodied water, recycled water is better than fresh (potable) water.* Link to D2(iii) and D2(v) next (Product Life-time and end-of life recovery) – embodied energy can be (partially) recovered through re-use and recycling.	The total energy used to create a product can be 'embodied' in its materials (i.e. in the energy which goes into processing the materials). NOTE this is true for recycled materials as energy is used in recycling (recovery, transport, processing etc). Link to A1(iv) below.
		Is anything in your product toxic to humans and/or ecosystems?	(iii) Eliminate toxic materials (e.g. lead or mercury) and any surface processing or treatments that introduce toxics in manufacturing, or which contaminate recovered/recycled materials [Link to A1(iv) or next below].	This is a critical issue for end-of-life paths; elimination of the toxic material will always be a more robust strategy than recovery and reuse/storage (where accidents can and do happen).
		Are the materials in your product able to be recycled?	(iv) Try to use recycled material.	Re-use and recycling assist in viable waste recovery, and can also help to recover embodied energy, but energy is used in recycling as well (recovery, transport, processing, etc.).
		Are there any recycled materials incorporated in the product?	(v) Use recyclable materials. Where possible Link to D2 Product life-time and end-of-life recovery (v).	Use of recycled materials builds the market for re-use of materials at end of (first) life.
		Could anything in our product be made from biodegradable materials?	(vi) Use biodegradable materials, if materials cannot be recovered at end of life. However be sure that a material is actually biodegradable in practice; landfills and compost systems do not always have the right conditions for things to biodegrade. Also biodegradable materials can contaminate recycling waste streams unless clearly labelled and separated.	Use of biodegradable materials avoids end-of-life waste accumulation.
	2. Materials use	*What is its total weight?* *Has the weight been optimised?*	(i) Think about the weight and structural issues of each component separately and reduce total product weight. Link to D: Product life-time and end-of-life recovery. A reduction in weight may have negative impact on product life.	A reduction in total product weight reduces overall resource flows in the economy (de-materialisation), lower extraction and processing impacts (less material consumed), lower transport impacts (a decrease in fuel consumption (Link to B2 Distribution and Transport).

TABLE 3-2 APPROACHES FOR DESIGN FOCUS AND RESPONSE

46

A. THE USE OF MATERIALS IN THE PRODUCT		*How many different materials are used?*	(ii) Consider the reasons for all the materials. Are there structural reasons for each material? Reduce the number of different materials. Use composite materials only if they lead to substantial reduction in total weight and if they can be recycled or reused at end of life.	Reduced materials can alleviate end-of-life concerns by easing recycling, materials reuse, and disposal.
		How are components and different materials joined? Could other joining systems be used?	(iii) Avoid bonding materials together; use mechanical fasteners or geometric patterns that allow components to be 'snapped' together. (iv) Use composite materials only if they lead to substantial reduction in total weight and if they can be recycled or reused at end-of-life.	Improves ease of recycling (by avoiding composite materials) and end-of-life materials capture. Link to D: Product life-time and end-of-life recovery.
	3. Packaging	*What drives the packaging of the product? Safety, standards, image?*	(i) Aim to reduce material content and diversity of materials in packaging. Packaging is affected by product design, transport systems design, marketing, etc. as products may require packaging, for transport, for physical protection, to prevent tampering, and to advertise product (at point of sale). Whilst recognising these market limits, aim to reduce packaging materials.	Lower resource consumption (energy, materials, water).
B. THE USE OF RESOURCES FOR AND BY THE PRODUCT	**1. Production and Manufacturing**	*What are the key resource inputs?*	(i) Reduce inputs [Refer to product dossier or draw a simple flow chart of the manufacturing of the materials in the product and the product production itself.] Consider all inputs to manufacturing and processing of materials (including finishing and surfaces) and to the manufacturing of product components. Use new machinery, different processes, different process chain to reduce inputs and lower resource consumption (energy, materials, water).	Lower resource consumption (energy, materials, water).
		Are recovered resources, lower carbon energy sources or renewable energy already used in manufacturing the product? Are there opportunities for this?	(ii) Consider using renewable energy (or 'green power') or switch to lower carbon energy sources (e.g. from coal or oil to gas or biomass). (iii) Consider using recycled or recovered resources (e.g. water from one part of process as input to another).	Lower greenhouse gas emissions.
		What are the key outputs of pollution and waste? Can pollution and waste be reduced?	(iv) Consult the information in your dossier or draw a simple flow chart of the key outputs of pollution and waste. Carefully evaluate waste materials, resources and pollution. Reduce or reuse as much as possible through increased materials efficiency, etc. Identify potential uses for waste products in other manufacturing processes.	Reduce waste – increase materials efficiency.
	2. Distribution and Transport in all phases of the product life-cycle: logistics, distance, mode, and efficiency.	*What is the transport distance over the product's life-cycle?*	(i) Reduce transport distances; re-organise logistics of distribution to reduce total 'product-miles' (the sum of all transport distances of the product components and the products themselves).	Whatever form of transport used, energy is consumed, with waste heat and (usually) some pollution in proportion to distance travelled. By reducing transport distances, less energy is required and less pollution is emitted.
		How are products transported (what is the form or mode of transportation)?	(ii) Change transport mode to a more efficient or less polluting means (e.g. from truck to rail).	As noted above, whatever form of transport is used, energy is consumed, with waste heat and (usually) some pollution in proportion to distance travelled. Switching to a more efficient and less polluting mode of transportation will reduce energy required on behalf of transportation and generate less pollution is emitted.
		How efficient are the transportation systems?	(iii) Improve transport load efficiencies (higher utilisation rate).	Reduce resource use in transport. Less pollution is generated per product.
		Can the weight of the product and packaging be reduced?	(iv) Reduce weight of materials in the product as it is transported (see A2 (i) Materials use above).	Reduced weight requires less energy in the transportation of products and therefore less pollution.

B. THE USE OF RESOURCES FOR AND BY THE PRODUCT	**3. Impact in use**	*What resources does your product require to function during use?*	(i) Reduce resources consumed by the product during use (e.g. electricity, water, paper, ink, batteries) or substitute lower-impact resources. This segment of the resource-use can account for a large part of the total resources used throughout the product's life-cycle.	This can substantially reduce waste streams in the product life-cycle.
		Could your product use renewable energy? *If water is a significant issue in your market are there alternative sources of water that could be used (e.g. wastewater instead of fresh)?*	(ii) Use renewable energy when possible (e.g. solar energy to charge batteries). Also, use wastewater when possible.	For energy consuming products switching to renewable sources will reduce greenhouse gas.
		Can user behaviour affect the resource demands of your product in use? In what way?	(iii) Consider possibilities for low-impact user behaviour; could user behaviour and choice lower product use impacts? Provide users with appropriate information to promote the most efficient use of the product – through education, offering the product as a service (Link to E1: Meet user needs with a different product or service) with 'intelligent' feedback about implications of choices and operation (e.g. gauges, diodes or information screens). For many products, resource use depends on user behaviour, on operation processes, selection of options, etc (e.g. cars and dishwashers.)	Promoting consumer education to change user behaviour and influence consumer choice to reduce product impacts.
C. SOCIAL AND ETHICAL ISSUES IN PRODUCTION, DISTRIBUTION OF USE	**1. Improve the social and economic benefits of manufacture.**	*What social and ethical issues arise from production, distribution, and/or use? Do production and distribution conditions add to social and economic development? As part of this, how and where is the product manufactured (including components and materials)?*	(i) Ensure that components/materials are sourced from producers and/or markets with best practice social and labour conditions. Link to A1: Selection of low impact materials. (ii) Look for ways to provide a positive intervention to improve social and labour conditions. (iii) Review any ethical issues across product chain and seek resolution. These issues may be closely linked to a Corporate Social Responsibility (CSR) analysis or your company's CSR programme. There are valuable public sources that provide assistance in these initiatives. The following lists a selection of these resources: the UN global compact (http://www.unglobalcompact.org consult); Corporate Citizenship / Maplecroft Ethical Insight (http://www.maplecroft.com); local fair-trade sites (http://www.fairtrade.org.uk).	CSR can become a way of 'shaping' the design/innovation strategy of the company and has positive implications for image.
D. PRODUCT LIFE-TIME AND END-OF-LIFE RECOVERY	**1. Extending initial product lifetime**	*What is the average life of your product? How does this compare to other competing products? What determines the product life?*	(i) Make product more durable and reliable. Design for repair and/or refurbishment. Link to D1(iii) and D1(iv) below.	Making the product last longer reduces the material input and output flows by reducing the total number of products in use needed to deliver a given social result.
		Is there an aspect of 'fashion' about your product? Is that more than a veneer?	(ii) Product obsolescence can be driven by fashion not function. For products with some aspect of 'fashion', consider ways of changing product appearance without discarding the essential 'core' of the product (e.g. removable covers or shells) which could have a longer life. Link to D1(iv) below.	Decreases material flows (from total product to the 'fashion shell').
		Do users feel your product could age with them? Does it get more valuable as it gets older?	(iii) Consider ways of making product more valuable to the user with age (like an heirloom).	This could decreases material flows because fewer products are produced to fulfill function / user-needs.
		Can your product be conceptualised as a combination of 'long-life' and 'short-life' components?	(iv) Consider extending life of component parts rather than the whole product. Invest in quality and strength for those parts which can be reused or refurbished (e.g. removable head shaving razors). Link to D2(iv) (next page).	Decreases material flows.

D. PRODUCT LIFE-TIME AND END-OF-LIFE RECOVERY	**2. End of life systems.**	*How easy is product to disassemble?*	(i) Make sure all component parts and all materials are able to be easily disassembled at the end-of-life. This may require special tools, but it should be cost-effective (simplicity should be	This allows for capture of materials and components and their reuse where collection systems and the market exist and ultimately reduces resource consumption. Note: in whatever way this is done it will use energy (processing and transport).
		How easy is the product to reuse?	(ii) Design the product components (or the entire product) to be reusable at the end of its first life, either for the same purpose or alternative purposes. Components of a product should be able to be recovered and refurbished for reuse.	Reuse can avoid much of the energy costs of recycling products.
		Can the product be easily remanufactured?	(iii) Components or modules can be designed to be recovered and refurbished for reuse. Products can be considered as an 'assemblage' of components which can be either new or refurbished. Design initiatives should seek to increase the value of these components at the end-of-first life. Link to D2(iv) next below.	Can save significantly on energy and materials consumption.
		Can the product be designed as an 'assemblage of modules'?	(iv) *Modularisation*: Design the product as 'an assemblage of modules' which allows for reuse and refurbishment of modules. Examine modular design to allow for reuse of key high-quality components in future products. Ensure that the design evolution of the product can be based around some enduring high-quality components (able to be refurbished).	Necessary to achieve reuse/ remanufacturing.
		Can your product be collected at end of life to allow for reuse of components or recycling of materials?	(v) *Materials recovery:* Establish a recovery process that is practical and economic, such as returning the used product by post, or to a retailer, or through waste collection systems. As part of this, a framework should be established as to whom and in what fashion the materials will be recovered. As a final resort, after refurbishment and reuse, when ultimately the product or component has reached the end of all possible lives, then materials should be recovered for recycling.	Saves on the consumption of materials.
E. INNOVATION AND NEW PRODUCT STRATEGIES	**1. Meet user needs with a different product or service**	*Is the 'need' for the product – its value and utility – well understood? What is the 'service' the product provides?* *(NOTE: This has more than functional or technological dimensions – products also fulfill emotional and aesthetic and cultural 'needs')*	Clearly define the customer 'need' satisfied by the product and: (i) design a completely new product that meet that need with fewer adverse impact to the environment and society; or (ii) design a new set of products and services which together can meet that need, to fulfill that need with lower environmental and social impacts. Link to Chapter 7: Product-Service System design for a set of approaches to such services.	Various efficiency gains often on larger scales.
	2. Developing a hybrid product	*Could one product replace two or more existing products?*	(i) Combine the functions of separate products into one product to reduce the total number of products required to meet customer needs (i.e. phones with alarm clocks, answering machines, etc.).	Reduce the number of products required to meet customer needs and reduce materials and resource use.
	3. Exploiting new technological opportunities	*Are any new technologies or materials available which could provide the basis for innovation?*	(i) New technologies (e.g. photo-voltaic solar cells) can be the basis for a complete product innovation (Link to Chapter 6). New materials offer opportunities for new product ideas and innovation. (Link to E1 above).	Various efficiency gains often on larger scales.

Appendix 5) List of requirements derived from the theoretical background

Overview of the framework requirements obtained from literature		
	Desired sustainable development future state	**Requirement**
	Definition of sustainable development	The framework should provide an understandable definition of sustainable development to facilitate constructive communication among the participants.
	Triple bottom line	The framework should include all three dimensions of sustainable corporate success (ecological, social, economic) within the company
	Ecological success goal: Circular economy	The framework should guide the company toward the circular economy goal.
	Social success goal; Maslow's hierarchy of needs	The framework should guide the company toward the 'social human rights & needs' success goal.
	Economic success goal; economic resilience	The framework should guide the company towards the economic resilience goal.
	Life cycle thinking	The framework should include LCT to broaden the corporate responsibility paradigm during sustainable development activities.
	The transition process	**Requirement**
	The levels of a transition process	The framework should facilitate top-down implementation of sustainable development to ensure management commitment and active use of the sustainable development vision.
	The levels of a transition process	The framework should incorporate bottom-up feedback to ensure that implementation within the company is successful.
	The levels of a transition process	The framework should aim to overcome resistance to change within the participants
	The levels of a transition process	The framework should facilitate the creation of a clear sustainable development vision statement to motivate the participants to transition toward a sustainable developing corporation.
	The levels of a transition process	The framework should facilitate maintaining the transition's momentum by including an education system set-up.
	The levels of a transition process	The framework should stress the importance of structural resource allocation for maintaining the momentum of the transition.
	The levels of a transition process	The framework should take into account the participants' stage of behaviour change
	Sustainable development strategy	The framework should facilitate generating multiple actions toward the sustainable development success goals
	Sustainable development strategy	The framework should facilitate an assessment of the current situation
	Sustainable development strategy	The framework should provide a transparent prioritization system to differentiate actions' ability to contribute to the sustainable development success goals
	Life cycle management	The framework should facilitate continuous improvement within the company.

	Life cycle management	The framework should aim for implementation by a multidisciplinary team.
	Life cycle management	The framework should aim for implementation with the external help of experts and partners.
	Sustainable development communication	External sustainable development progress communication to all involved stakeholders should be part of the framework to maintain momentum.
	Design for sustainable development	The framework should aim to include sustainable development guidelines from D4S to assist action generation among participants.
	Small-and-medium enterprise limitations and opportunities for the sustainable development transition process	**Requirement**
	Small-and-medium enterprise limitations and opportunities for the sustainable development transition process	The framework should overcome resource limitations, characteristic for SMEs
	Small-and-medium enterprise limitations and opportunities for the sustainable development transition process	The action prioritization system should take into account the limitations for SMEs

Appendix 6) Stakeholder analysis

The large portfolio and multi-layered supply chain provide a large group of involved stakeholders. The stakeholder analysis provides an overview of the stakeholders at play, their interest and power concerning the transition process towards sustainable development within Themans (Figure 44) and their level of direct involvement or indirect involvement (Figure 45). (Mark S. Reed et al., 2009) provides a stakeholder division method with four groups depending on the level of interest and power (Figure 44); the key players, context setters, subjects and the crowd. Further specification of the stakeholders is shown by the use of this categorisation.

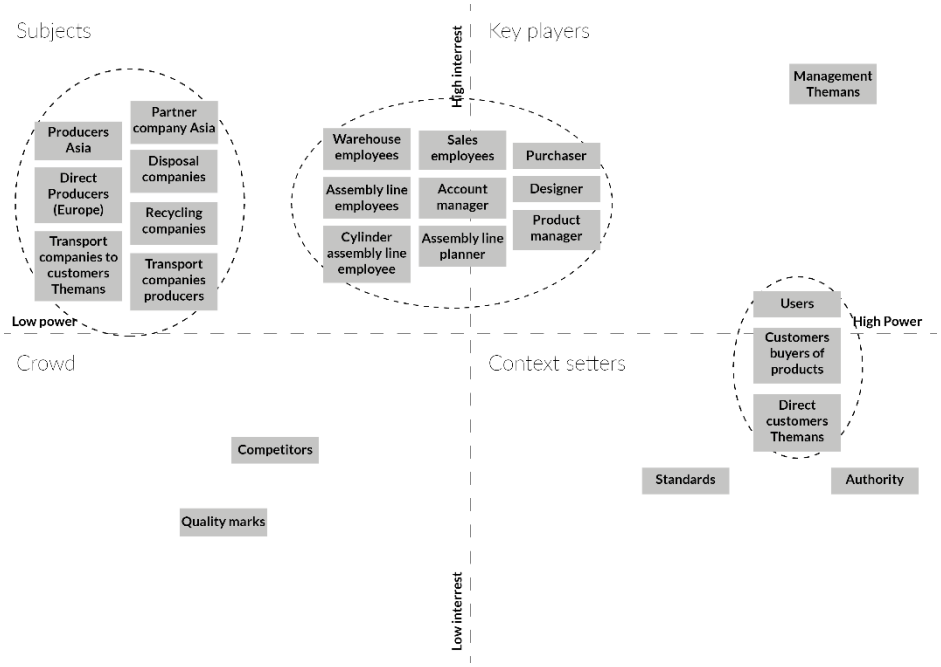


Figure 44 Power-interest stakeholders (Mark S. Reed et al., 2009)

Table 5 elaboration on stakeholders

Stakeholder group	Clarification	Classification	Short interest statement
Account manager	Employees at Themans	Subjects	Concerned with providing quality products with profit, and more and more with the companies sustainability impact (further referred to as Themans interest statement)
Assembly line employees	Employees at Themans	Subjects	Themans interest statement
Assembly line planner	Employees at Themans	Subjects	Themans interest statement
Authority	Dutch and European legislation	Context setters	Regulations to reduce the negative impact of companies
Competitors	Companies in the door fitting market	Crowd	Concerned with losing market share to Themans
Cylinder assembly line employee	Employees at Themans	Subjects	Themans interest statement
Designers	Employees at Themans	Subjects	Themans interest statement

Direct customers	Direct buyers of Themans products, mostly door industry and metal retailers	Context setters	Concerned with cost, profit alternations due to sustainable development
Direct producers (Europe)	Producers with direct contact with Themans	Subjects	Concerned with maintaining Themans as a partner and providing products with profit
Disposal companies	Downstream potential partners concerned with disassembling products	Subjects	Potentially providing services for Themans
Indirect customers	Customers of direct Themans customers, consisting of contractors, of door fitting installation projects	Context setters	Concerned with cost, profit alternations due to sustainable development
Management	Employees at Themans	Key players	Themans interest statement
Partner company Asia	Partner company providing all upstream supply chain actions for Asian produced products; design to production translation, producer contact, pre-selection and logistics to Themans	Subjects	Concerned with maintaining Themans as a partner
Producers Asia	Producers with indirect contact with Themans located in Asia	Subjects	Concerned with providing products with profit
Product Manager	Employees at Themans	Subjects	Themans interest statement
Purchaser	Employees at Themans	Subjects	Themans interest statement
Quality marks	Companies providing quality marks on quality, safety and sustainability	Crowd	Providing a service to Themans and informing customers of the decision-making process
Recycling companies	Downstream potential partners concerned with recycling products	Subjects	Potentially providing services for Themans
Sales employees	Employees at Themans	Subjects	Themans interest statement
Standards agencies	Organisations providing standards for the market	Context setters	Maintaining requirements for the market
Transport companies producers	Shipment companies	Subjects	Concerned with maintaining Themans producers and or Themans using their service
Transport companies to customers Themans	Shipment companies	Subjects	Concerned with maintaining Themans using their service
User	The user of door fitting materials	Context setters	Awareness and motivation are concerned with buying sustainable, high-quality products.
Warehouse employee	Employees at Themans	Subjects	Themans interest statement

The management of Themans has high power and interest concerning the transition process towards sustainable development. Employees at Themans can influence the process since the SME characteristic, in combination with the flat power hierarchy structure at Themans, allow this. However, the resources are located by the management of Themans, and the initiation of the transition process (in the form of this thesis project) was initiated by management at Themans. The theory states the importance of leadership involvement for motivation and resource allocations. Within the case company, the awareness concerning non-sustainable company efforts and intention to change the company efforts towards more sustainable efforts are acknowledged by management. (James O Prochaska et al., 2015) states this as a preparation stage towards implementing sustainability within the company. The management's interest at Themans is to act to the requirements of a quality mark to communicate the sustainability actions towards their market and have an external company to motivate the transition. Furthermore, in an unstructured interview, suggestions like; improving the packaging of the products by reducing the amount of plastic and excluding bolts, and finding out which coating is more sustainable, were suggested showing a specific detailed solution-oriented interest in the topic.

Important to note within the key players is the absence of interest from the customer. During the beginning of the project, a survey was spread among customers concerning their interest in sustainability and the value of sustainable development at Themans (Appendix 1). This survey was only answered by one of thirty customers, who responded to all questions with a negative answer concerning sustainable development interests.
Additionally, the nature of the product and the purchase process in which the end-user buys the complete door or house, including the door-fitting products, reduces the end user's authority (see directness of involvement by stakeholders Figure 45). Therefore, the customers of products (indirect buyers of Themans) are led more by cost, price and regulations. Current regulations focus on safety instead of sustainability. However, more and more regulations concerned with sustainability are addressed in common years. This, however, makes the customers' interest related to the authorities and standards within the market.

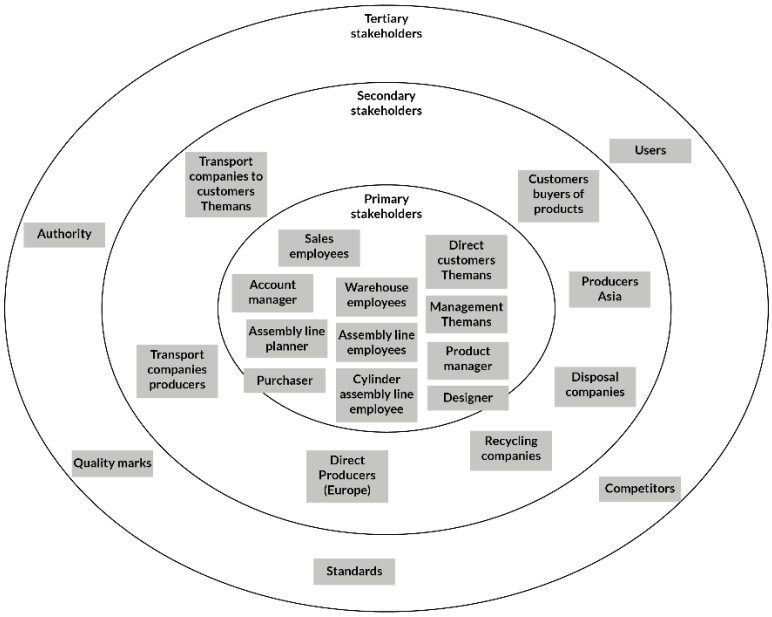


Figure 45 Involvement levels of stakeholders

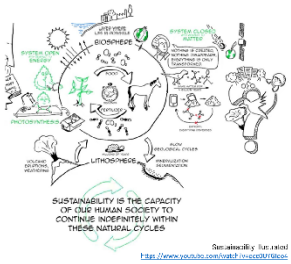
Appendix 7) The principle-based definition of sustainability (Karl-Henrik Robèrt et al., 2013)

This appendix shows an overview of the PowerPoint slides of the principle-based definition. This definition was repeated in multiple workshops and brainstorming sessions to introduce the aspects of the definition.

Wat is duurzaamheid?

(Karl-Henrik Robèrt,1989):

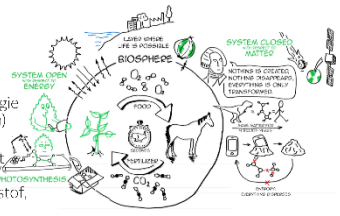
1. leven in de biosfeer
2. systeem
   1. Gesloten voor materie
   2. Open voor energy
3. Snelle en slome cycli in balans



Wat is duurzaamheid?

(Karl-Henrik Robèrt,1989):

1. leven in de biosfeer
2. systeem met planten en dieren in balans
   1. Systeem is open voor energie (1ste wet thermo dynamica)
   2. Systeem is gesloten voor materie (materie verandert alleen van vorm) & alles verspreid, versnippert tot stof, wat fotosynthese verhelpt

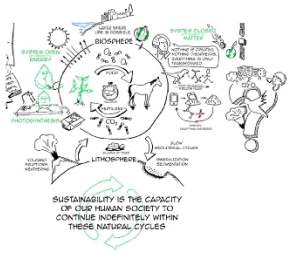


Wat is duurzaamheid?

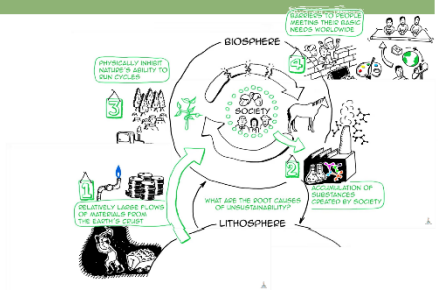
(Karl-Henrik Robèrt,1989):

1. leven in de biosfeer
2. systeem met planten en dieren in balans
   1. Open voor energie
   2. Gesloten voor materie
3. Snelle en slome cycli in balans

Dus duurzaamheid is de capaciteit van de mensheid om voor eeuwing binnen deze natuurlijke cycli te leven.

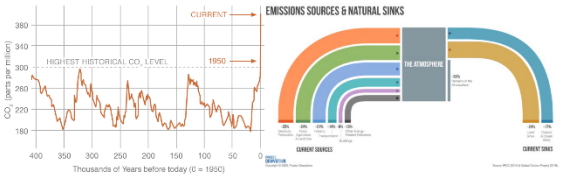


Wat is NIET duurzaamheid?

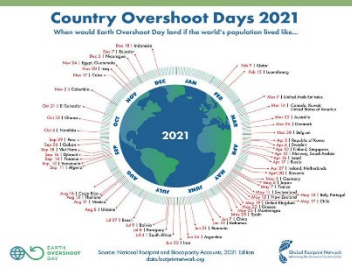


Wat is Niet duurzaam?

- Carbon emission sinks in nature



Waarom verduurzamen?



Appendix 8) Workshop Triple bottom line

This appendix shows an overview of the PowerPoint slides of the Triple Bottom Line and the assignment results. This division was repeated in multiple workshops and brainstorming sessions as an introduction.

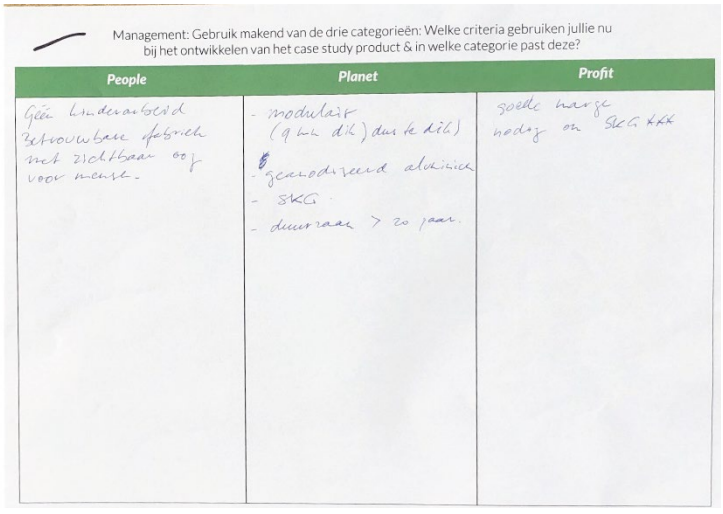


Figure 46 TBL assignment-Management

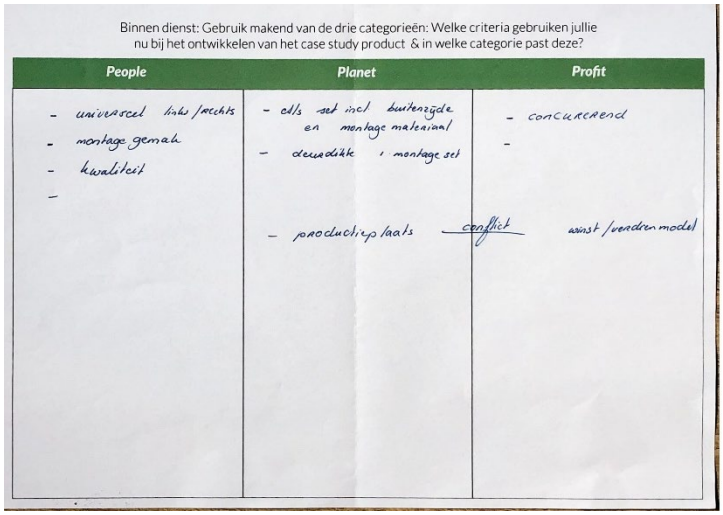


Figure 47 TBL assignment-Designers

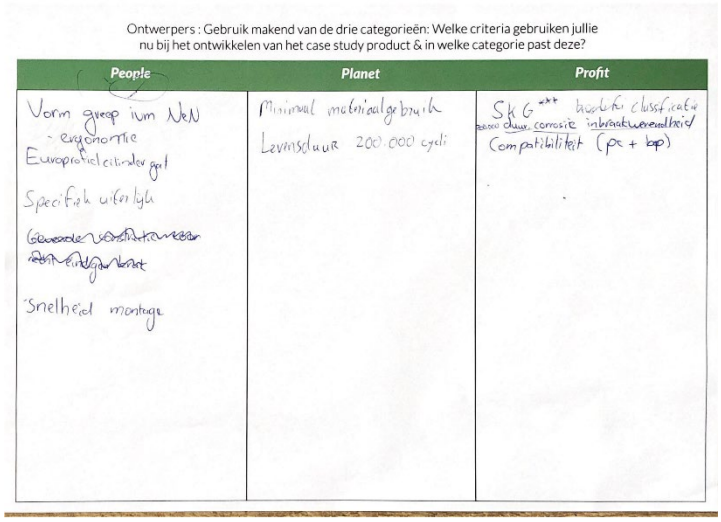


Figure 48 TBL assignment-Customer-service

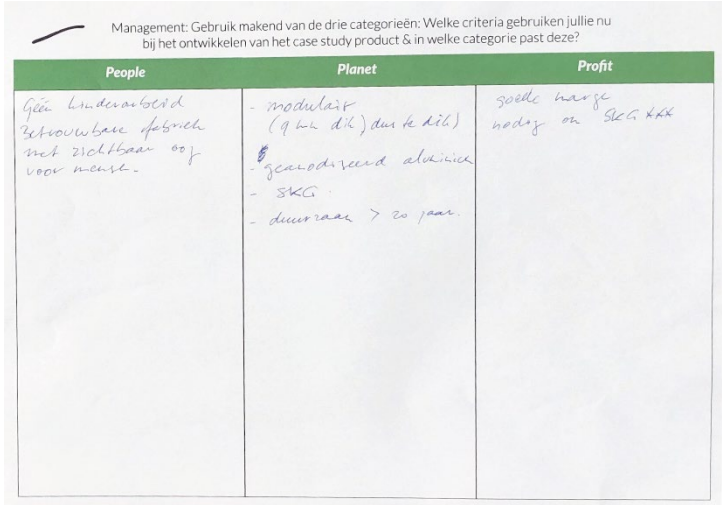


Figure 49 TBL assignment-Purchaser

Appendix 9) Workshop Life cycle thinking and life cycle assessment

This appendix shows an overview of the PowerPoint slides of the Life cycle thinking presentation and the assignment results. The LCT principle was repeated in multiple workshops and brainstorming sessions as an introduction.

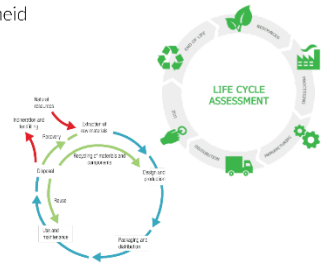
Nadenken over de hele levenscyclus van een product (LCT)

Een bredere verantwoordelijkheid en blik op het product

Flipover

Hoe breng je een product LC in kaart:

- Levens fasen in kaart



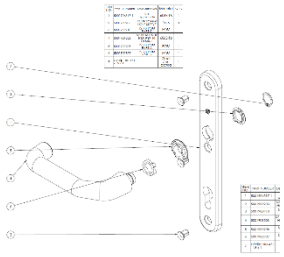
Nadenken over de hele levenscyclus van een product (LCT)

Een bredere verantwoordelijkheid en blik op het product

Flipover

Hoe breng je een product LC in kaart:

- Levens fasen in kaart
- BOM (bill of materials)



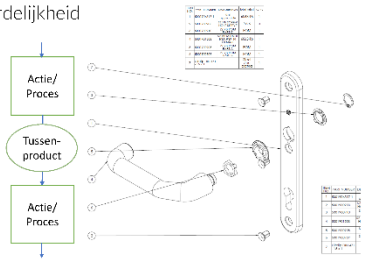
Nadenken over de hele levenscyclus van een product (LCT)

Een bredere verantwoordelijkheid en blik op het product

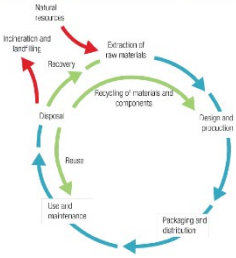
Flipover sheet

Hoe breng je een product LC in kaart:

- Levens fasen in kaart
- BOM (bill of materials)
- BOP (bill of processes)



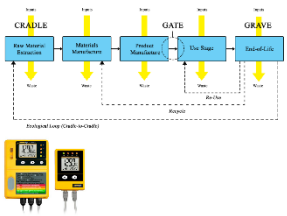
Nadenken over de hele levenscyclus van een product (LCT)



Meten van impact van producten (LCA)

LCA is life cycle assesment

- BOM en de BOP samen met milieu impact data van de effecten van de processen en materialen
- LCA maken is toevoegen van inputs; materiaal en energie outputs; product onderdelen & afvalstoffen aan processen (black boxes)

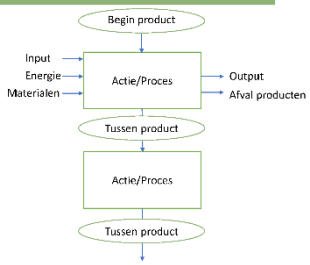


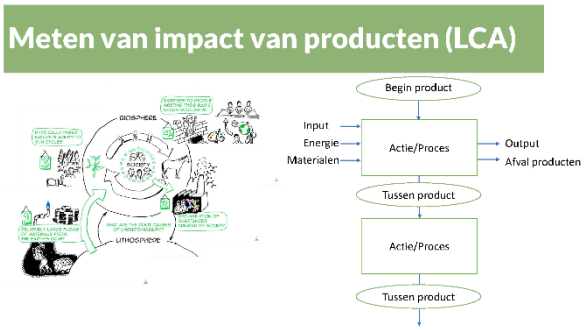
Meten van impact van producten (LCA)

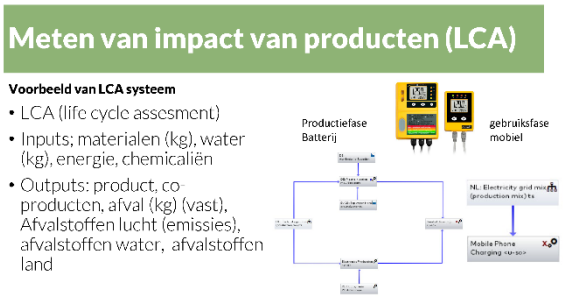
Flipover sheet Bill of processes

LCI maken is toevoegen van

- inputs: materialen, water, energie, chemicaliën
- Outputs: product, co-producten, afval (vast), Afvalstoffen lucht (emissies), afvalstoffen water, afvalstoffen land
- Voeg dit zo goed mogelijk toe aan het processen overzicht







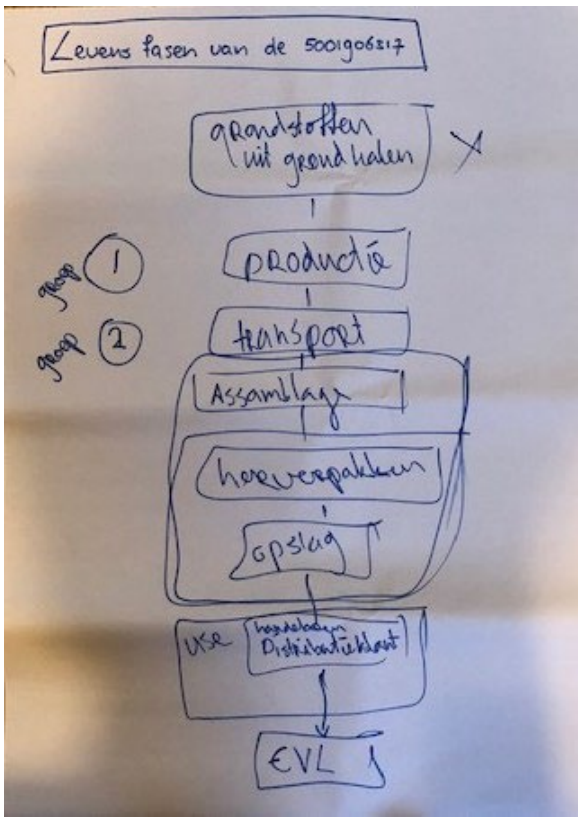


Figure 50 LCT assignment_Page_1

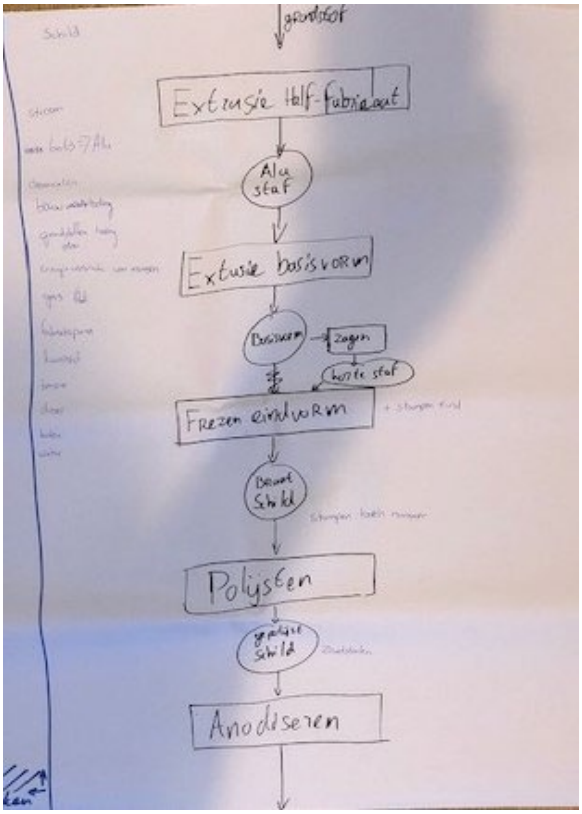


Figure 51 LCT assignment_Page_2

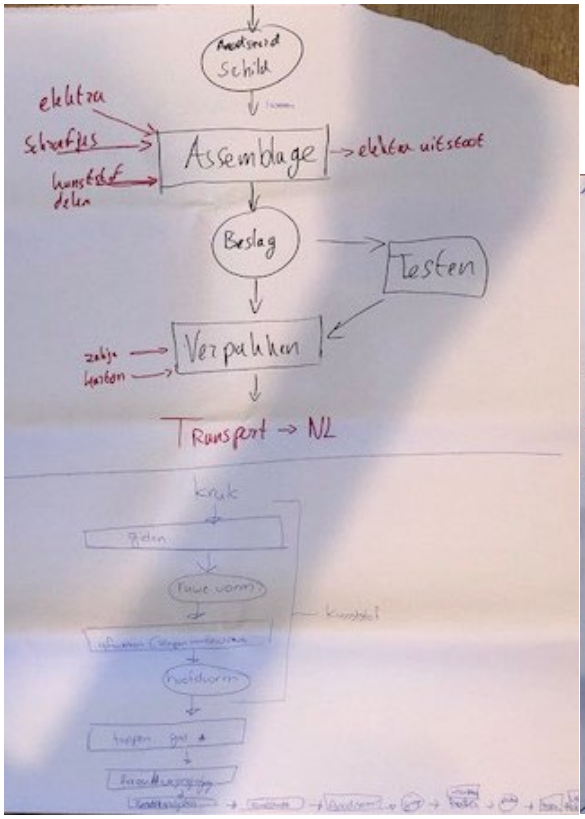


Figure 52 LCT assignment_Page_3

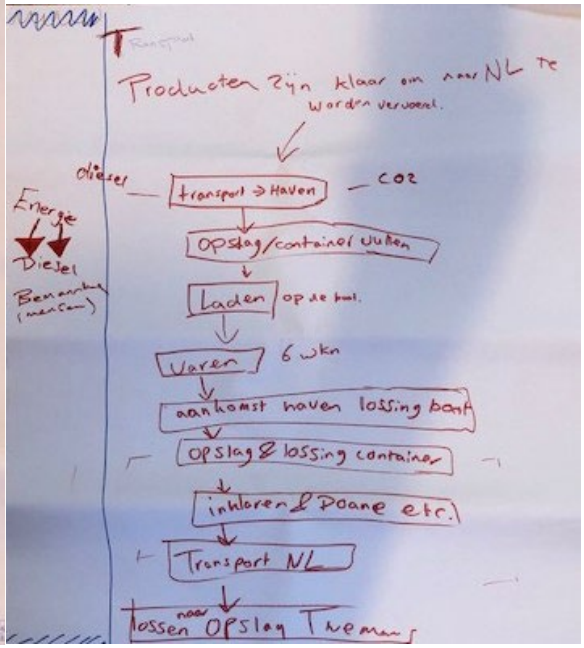


Figure 53 LCT assignment_Page_4

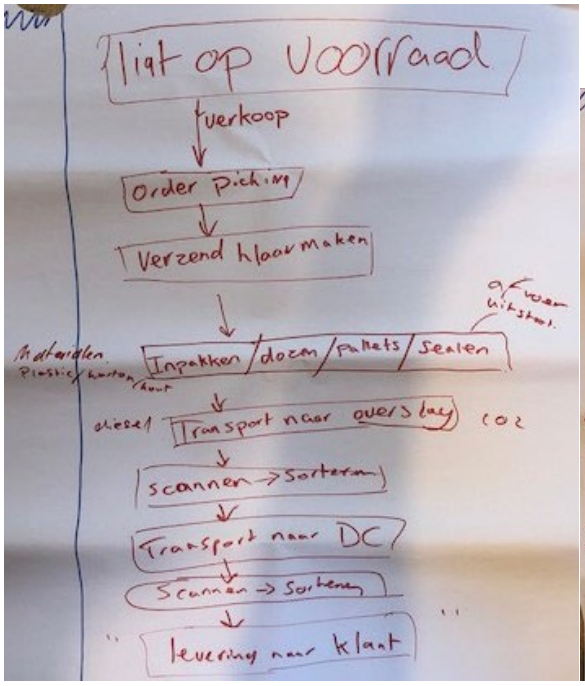


Figure 54 LCT assignment_Page_5

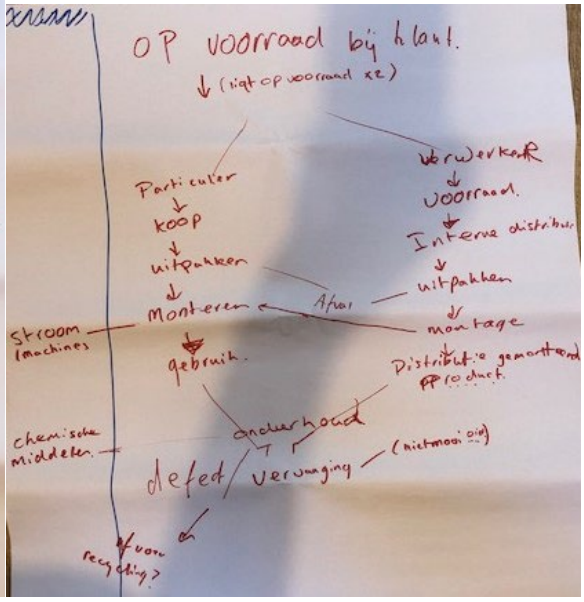


Figure 55 LCT assignment_Page_6

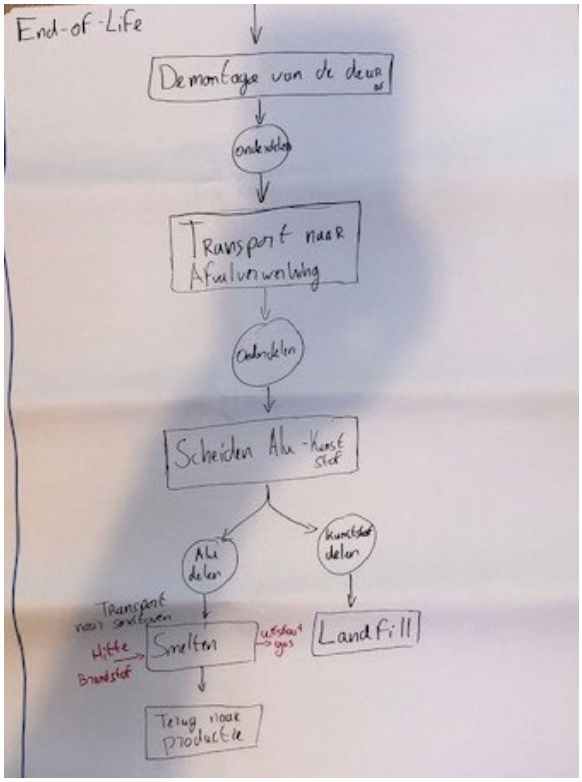


Figure 56 LCT assignment_Page_7

Appendix 10) CSR project: "STAPPENPLAN MVO-RISICOMANAGEMENT" (MVO NEDERLAND 2022, 2022) & Formulation of a Code of Conduct

The STAPPENPLAN MVO-RISICOMANAGEMENT

Not all steps could be executed during the project. The 'stappenplan mvo-risicomanagement' exists out of 8 steps which were introduced and discussed in multiple meetings:

1. Check the current CSR policy and actions
2. Identify the supply chain
3. Identify the risks
4. Prioritise the risks
5. Take action to reduce or take away the risk, together with supply chain partners
6. Incorporate the process into procedures and develop a complaints mechanism
7. Monitor progress
8. Communicate on policy and progress

The results

The steps resulted in the creation of a code of conduct (based on (Amfori BSCI, 2021; Ministerie van buitenlandsezaken, 2014; Aleksi Kivinen, 2022; International labour organization, 2019a, 2019b; United nations development programme, 2019; United Nations, 1948))

Stated agreements	Human rights article(s)	ILO principle
1. No child labour	4	No. 182
2. No bonded labour	4	No. 29, No.105, No. 138
3. Occupational health and safety	3	
4. Fair remuneration	1,23	No. 100, No. 111
5. Decent work hours	24	
6. Rights of freedom and collective bargaining	23	No. 87, No.98
7. Special protection of young workers		
8. no discrimination	1,2	No. 100, No. 111
9. no precarious employment		
10. ethical business behaviour		

The code of conduct agreements was then formulated into questions to inform at the three main suppliers of Themans if they could agree to these agreements. Two suppliers responded that they could. One had no time due to difficulties due to corona policies in the region.

The meetings resulted in a statement that the code of conduct could be brought to the suppliers during the next physical visit and could possibly be signed.

Additionally, ensuring compliance with the code of conduct was discussed. The code of conduct is a trust-based agreement, which causes difficulties concerning the compliance of the agreements by partners. For example, an authoritarian republic like China provides challenges, where enterprise union representation is entirely dominated by management and labour NGOs have restricted power (Tim Pringle et al., 2010). Alternatively, Tony's Chocolonely, a benchmark company on social

sustainability, discovered 1701 times child labour in their supply chain last year despite their efforts (Henk Hofstede et al., 2022).

(VNO-NCW et al.) provides causes for child labour; lack of schooling, culture, Globalisation and price pressure, and a geographical visualisation of countries where child labour is still found. So monitoring is required to ensure compliance with the code of conduct. Furthermore, independency is vital for the monitoring company to avoid conflict of interest or the appearance of it. Cooperation with NGO parties could full fill the role of an independent monitoring party.

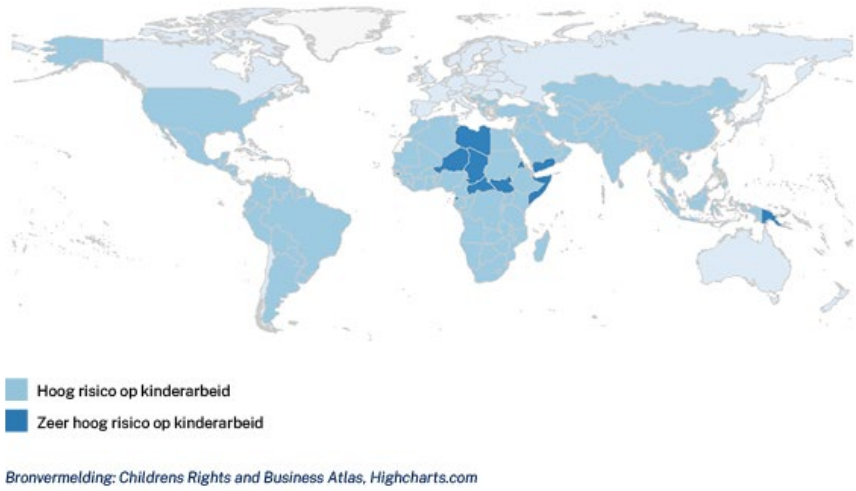
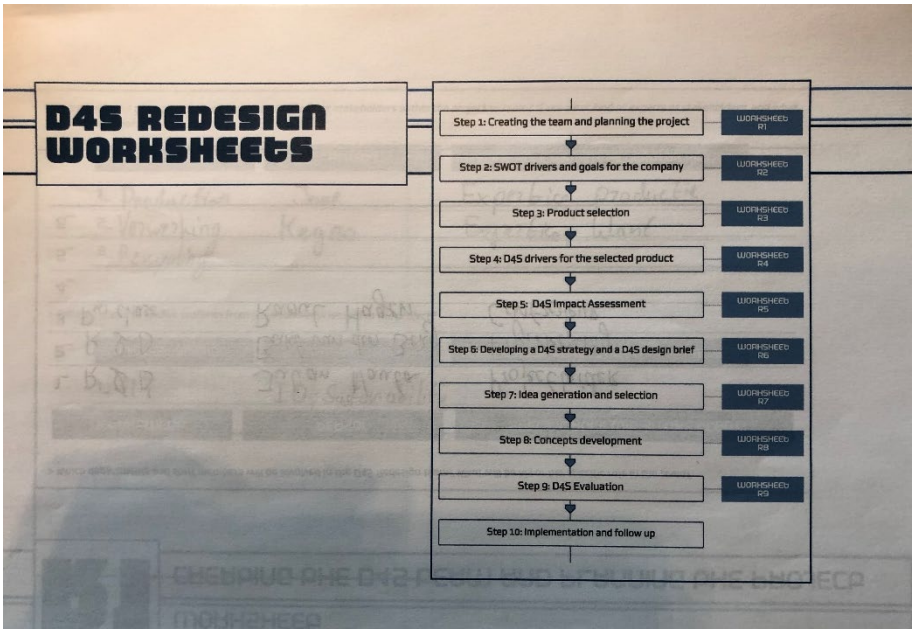
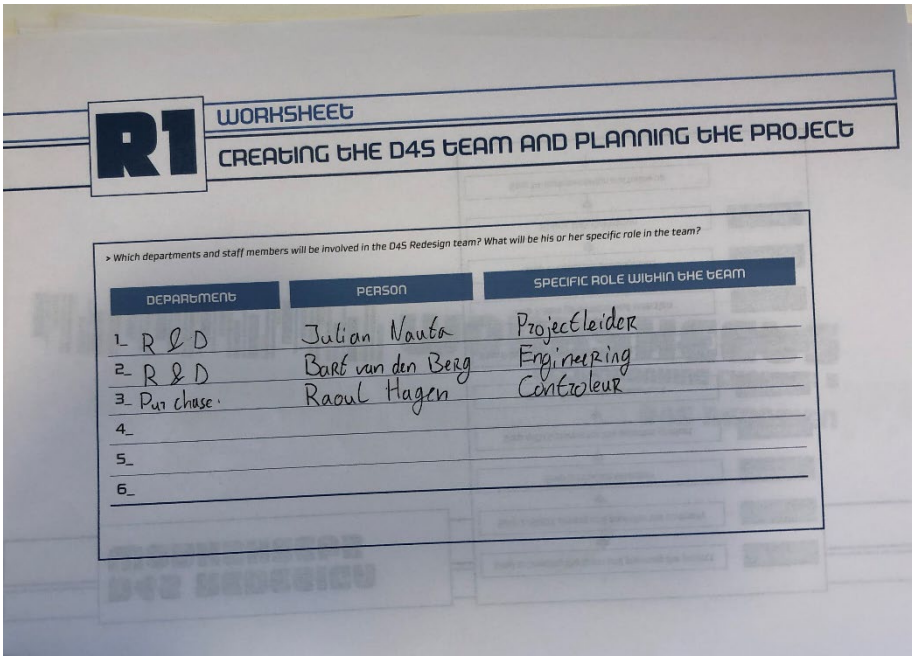


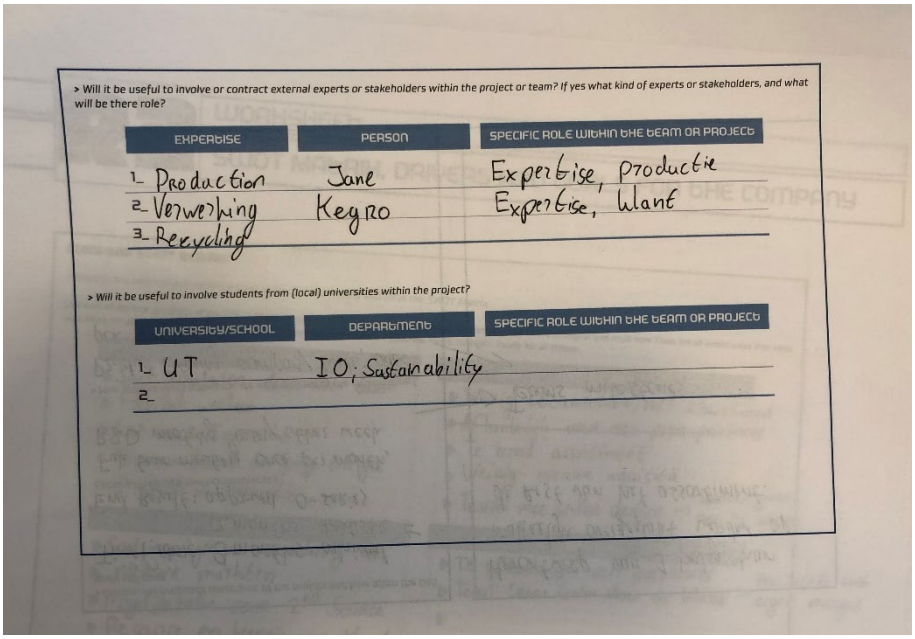
Figure 57 geographic child-labour risk identification overview (VNO-NCW et al.)

An independent Asian monitoring partner was researched during this project but not yet found.

Appendix 11) D4S re-design project (Arne Remmen et al., 2007)





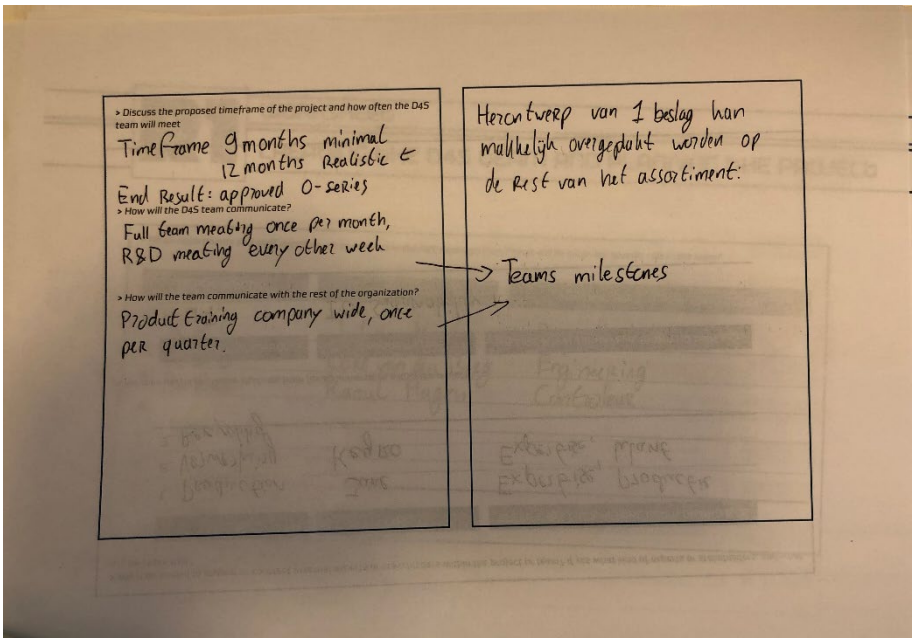


> Will it be useful to involve or contract external experts or stakeholders within the project or team? If yes what kind of experts or stakeholders, and what will be there role?

EXPERTISE	PERSON	SPECIFIC ROLE WITHIN THE TEAM OR PROJECT
1_ Production	Jane	Expertise, productie
2_ Verwerking	Keyro	Expertise, kunst
3_ Recycling		

> Will it be useful to involve students from (local) universities within the project?

UNIVERSITY/SCHOOL	DEPARTMENT	SPECIFIC ROLE WITHIN THE TEAM OR PROJECT
1_ UT	IO; Sustainability	
2_		



> Discuss the proposed timeframe of the project and how often the D4S team will meet

Time Frame 9 months minimal
12 months Realistic &
End Result: approved 0-series

> How will the D4S team communicate?

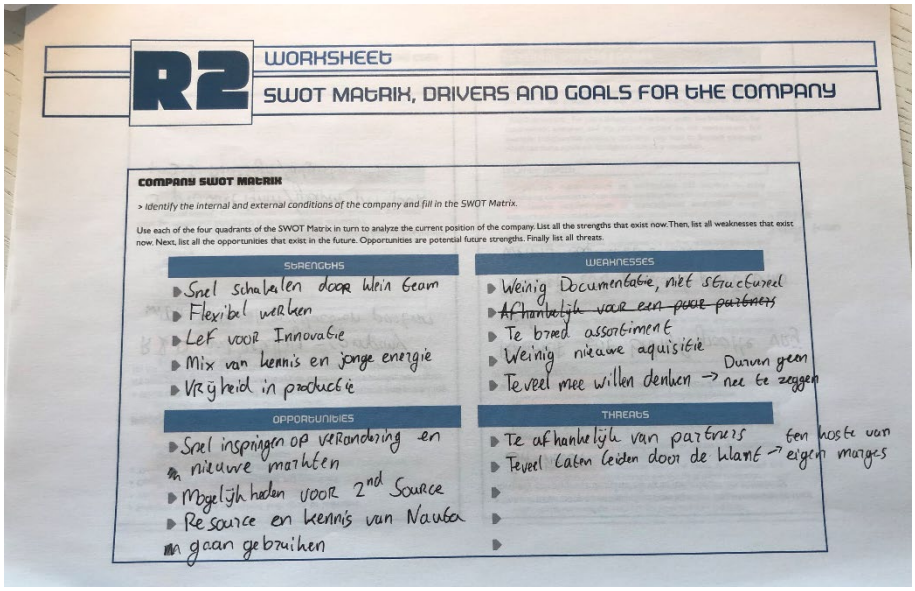
Full team meeting once per month,
R&D meeting every other week

→ Teams milestones

> How will the team communicate with the rest of the organization?

Product training company wide, once per quarter.

Herontwerp van 1 beslag kan mallhelijk overgepakt worden op de rest van het assortiment.



R2 WORKSHEET

SWOT MATRIX, DRIVERS AND GOALS FOR THE COMPANY

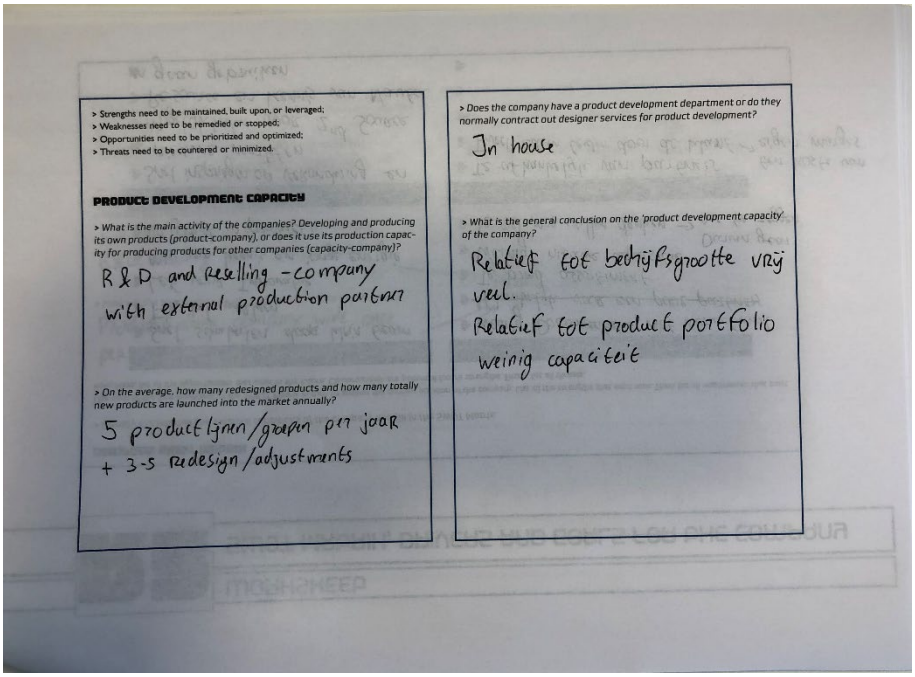
COMPANY SWOT MATRIX

> Identify the internal and external conditions of the company and fill in the SWOT Matrix.

Use each of the four quadrants of the SWOT Matrix in turn to analyze the current position of the company. List all the strengths that exist now. Then, list all weaknesses that exist now. Next, list all the opportunities that exist in the future. Opportunities are potential future strengths. Finally list all threats.

STRENGTHS	WEAKNESSES
Snel schakelen door klein team	Weinig Documentatie, niet structureel
Flexibel werken	~~Afhankelijk voor een paar partners~~
Lef voor Innovatie	Te breed assortiment
Mix van kennis en jonge energie	Weinig nieuwe aquisitie
Vrijheid in productie	Teveel mee willen denken → Durven geen nee te zeggen

OPPORTUNITIES	THREATS
Snel inspringen op veranderingen en nieuwe markten	Te afhankelijk van partners → ten koste van eigen marges
Mogelijkheden voor 2nd Source	Teveel Latem leiden door de klant
Resource en kennis van Navitas in gaan gebruiken	



> Strengths need to be maintained, built upon, or leveraged;
> Weaknesses need to be remedied or stopped;
> Opportunities need to be prioritized and optimized;
> Threats need to be countered or minimized.

PRODUCT DEVELOPMENT CAPACITY

> What is the main activity of the companies? Developing and producing its own products (product-company), or does it use its production capacity for producing products for other companies (capacity-company)?

R & D and Reselling - company with external production partners

> On the average, how many redesigned products and how many totally new products are launched into the market annually?

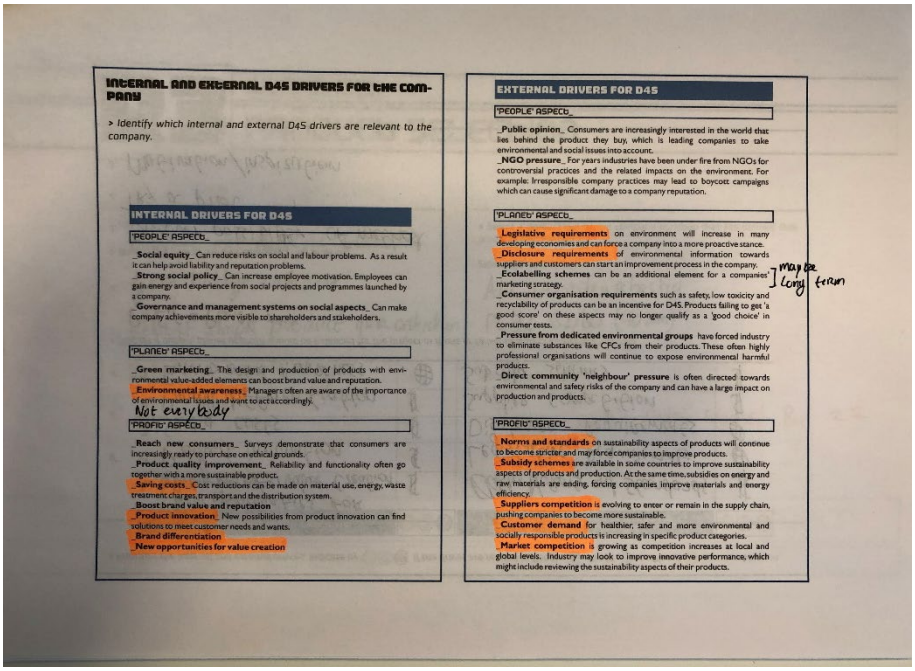
5 productlijnen/groepen per jaar
+ 3-5 Redesign/adjustments

> Does the company have a product development department or do they normally contract out designer services for product development?

In house

> What is the general conclusion on the 'product development capacity' of the company?

Relatief tot bedrijfsgrootte vrij veel.
Relatief tot product portfolio weinig capaciteit



INTERNAL AND EXTERNAL D4S DRIVERS FOR THE COMPANY

> Identify which internal and external D4S drivers are relevant to the company.

INTERNAL DRIVERS FOR D4S

'PEOPLE' ASPECT_

Social equity Can reduce risks on social and labour problems. As a result it can help avoid liability and reputation problems.
Strong social policy Can increase employee motivation. Employees can gain energy and experience from social projects and programmes launched by a company.
Governance and management systems on social aspects Can make company achievements more visible to shareholders and stakeholders.

'PLANET' ASPECT_

Green marketing The design and production of products with environmental value-added elements can boost brand value and reputation.
Environmental awareness Managers often are aware of the importance of environmental issues and want to act accordingly.
Not everybody

'PROFIT' ASPECT_

Reach new consumers Surveys demonstrate that consumers are increasingly ready to purchase on ethical grounds.
Product quality improvement Reliability and functionality often go together with a more sustainable product.
Saving costs Cost reductions can be made on material use, energy, waste treatment charges, transport and the distribution system.
Boost brand value and reputation
Product innovation New possibilities from product innovation can find solutions to meet customer needs and wants.
Brand differentiation
New opportunities for value creation

EXTERNAL DRIVERS FOR D4S

'PEOPLE' ASPECT_

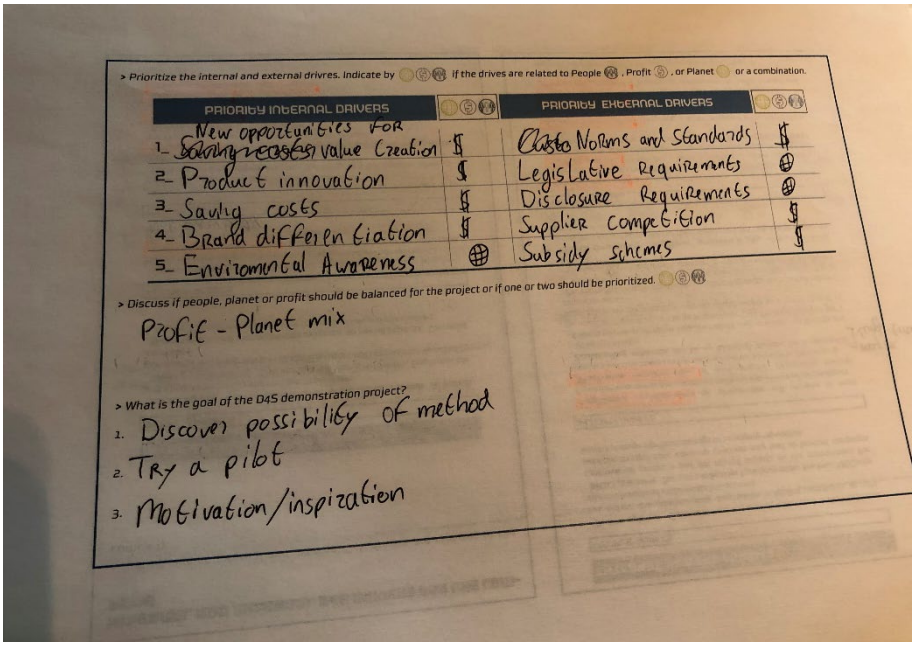
Public opinion Consumers are increasingly interested in the world that lies behind the product they buy, which is leading companies to take environmental and social issues into account.
NGO pressure For years industries have been under fire from NGOs for controversial practices and the related impacts on the environment. For example: Irresponsible company practices may lead to boycott campaigns which can cause significant damage to a company reputation.

'PLANET' ASPECT_

Legislative requirements on environment will increase in many developing economies and can force a company into a more proactive stance.
Disclosure requirements of environmental information towards suppliers and customers can start an improvement process in the company.
Ecolabelling schemes can be an additional element for a companies' marketing strategy.
] maybe long term
Consumer organisation requirements such as safety, low toxicity and recyclability of products can be an incentive for D4S. Products failing to get 'a good score' on these aspects may no longer qualify as a 'good choice' in consumer tests.
Pressure from dedicated environmental groups have forced industry to eliminate substances like CFCs from their products. These often highly professional organisations will continue to expose environmental harmful products.
Direct community 'neighbour' pressure is often directed towards environmental and safety risks of the company and can have a large impact on production and products.

'PROFIT' ASPECT_

Norms and standards on sustainability aspects of products will continue to become stricter and may force companies to improve products.
Subsidy schemes are available in some countries to improve sustainability aspects of products and production. At the same time, subsidies on energy and raw materials are ending, forcing companies improve materials and energy efficiency.
Suppliers competition is evolving to enter or remain in the supply chain, pushing companies to become more sustainable.
Customer demand for healthier, safer and more environmental and socially responsible products is increasing in specific product categories.
Market competition is growing as competition increases at local and global levels. Industry may look to improve innovative performance, which might include reviewing the sustainability aspects of their products.



> Prioritize the internal and external drivres. Indicate by 🌍💲👥 if the drives are related to People 👥, Profit 💲, or Planet 🌍 or a combination.

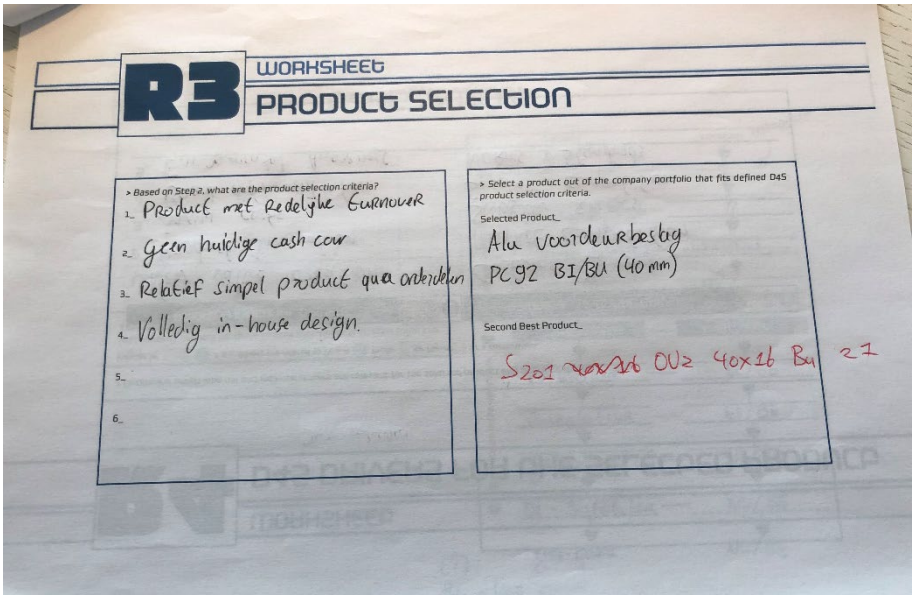
PRIORITY INTERNAL DRIVERS	🌍💲👥	PRIORITY EXTERNAL DRIVERS	🌍💲👥
1_ New opportunities for ~~Saving costs~~ value Creation	💲	~~Cost~~ Norms and Standards	💲
2_ Product innovation	💲	Legislative Requirements	🌍
3_ Saving costs	💲	Disclosure Requirements	🌍
4_ Brand differentiation	💲	Supplier competition	💲
5_ Environmental Awareness	🌍	Subsidy schemes	💲

> Discuss if people, planet or profit should be balanced for the project or if one or two should be prioritized. 🌍💲👥

Profit - Planet mix

> What is the goal of the D4S demonstration project?

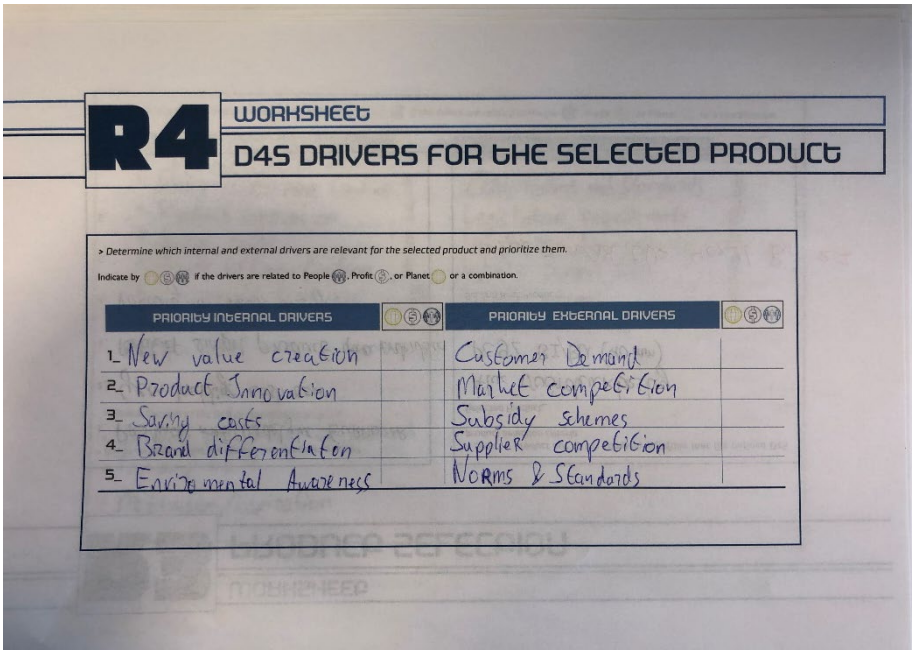
1. Discover possibility of method
2. Try a pilot
3. Motivation/inspiration



R3 WORKSHEET
PRODUCT SELECTION

> Based on Step 2, what are the product selection criteria?
1_ Product met Redelijke Turnover
2_ Geen huidige cash cow
3_ Relatief simpel product qua ontwikkeling
4_ Volledig in-house design.
5_
6_

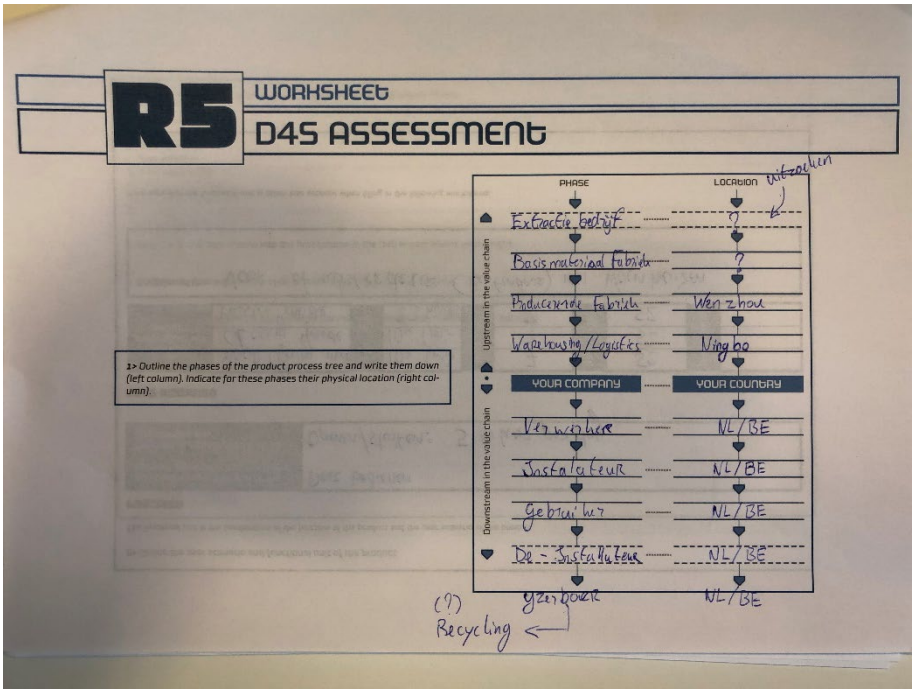
> Select a product out of the company portfolio that fits defined D4S product selection criteria.
Selected Product_
Alu voordeurbeslag
PC 92 BI/BU (40 mm)
Second Best Product_
S201 voorslot OU2 40x16 BU 27



R4 WORKSHEET
D4S DRIVERS FOR THE SELECTED PRODUCT

> Determine which internal and external drivers are relevant for the selected product and prioritize them.
Indicate by P S Pl if the drivers are related to People, Profit, or Planet, or a combination.

PRIORITY INTERNAL DRIVERS	P S Pl	PRIORITY EXTERNAL DRIVERS	P S Pl
1_ New value creation		Customer Demand	
2_ Product Innovation		Market competition	
3_ Saving costs		Subsidy schemes	
4_ Brand differentiation		Supplier competition	
5_ Environmental Awareness		Norms & Standards	



R5 WORKSHEET

D4S ASSESSMENT

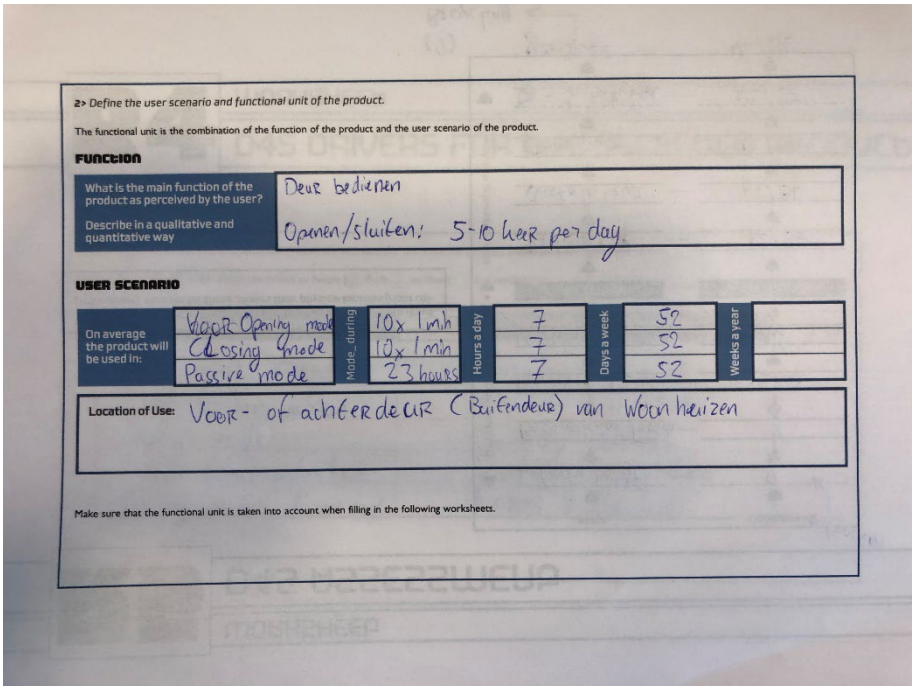
2> Outline the phases of the product process tree and write them down (left column). Indicate for these phases their physical location (right column).

PHASE	LOCATION
Extractie bedrijf	?
Basis materiaal Fabriek	?
Producerende Fabriek	Wenzhou
Warehousing/Logistics	Ningbo
YOUR COMPANY	YOUR COUNTRY
Verwijzher	NL/BE
Installateur	NL/BE
Gebruiker	NL/BE
De-Installateur	NL/BE
gezinboer	NL/BE

Upstream in the value chain

Downstream in the value chain

(?) Recycling



2> Define the user scenario and functional unit of the product.

The functional unit is the combination of the function of the product and the user scenario of the product.

FUNCTION

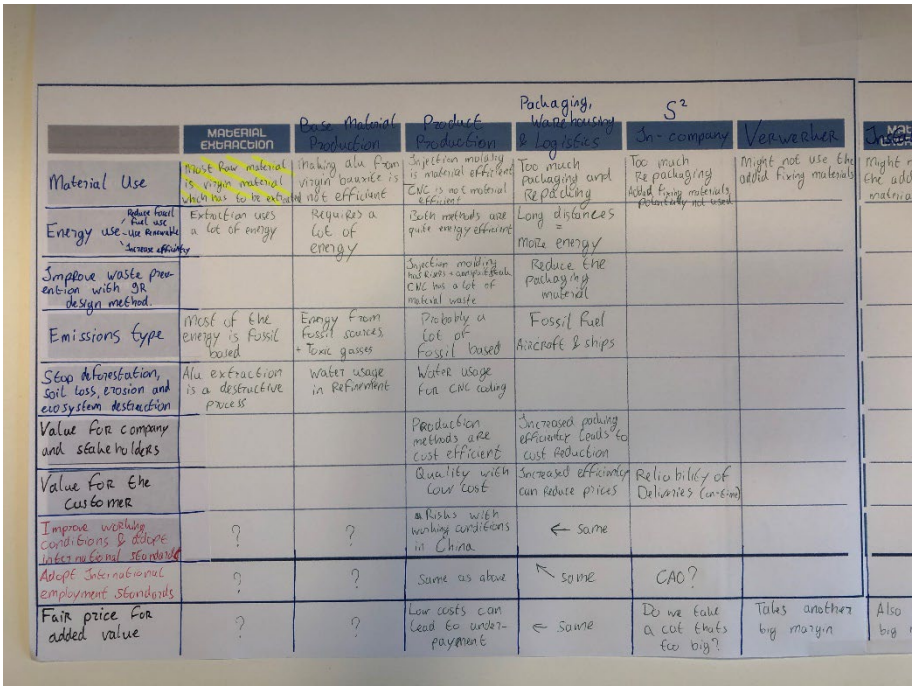
What is the main function of the product as perceived by the user?	Deur bedienen
Describe in a qualitative and quantitative way	Openen/sluiten: 5-10 keer per day

USER SCENARIO

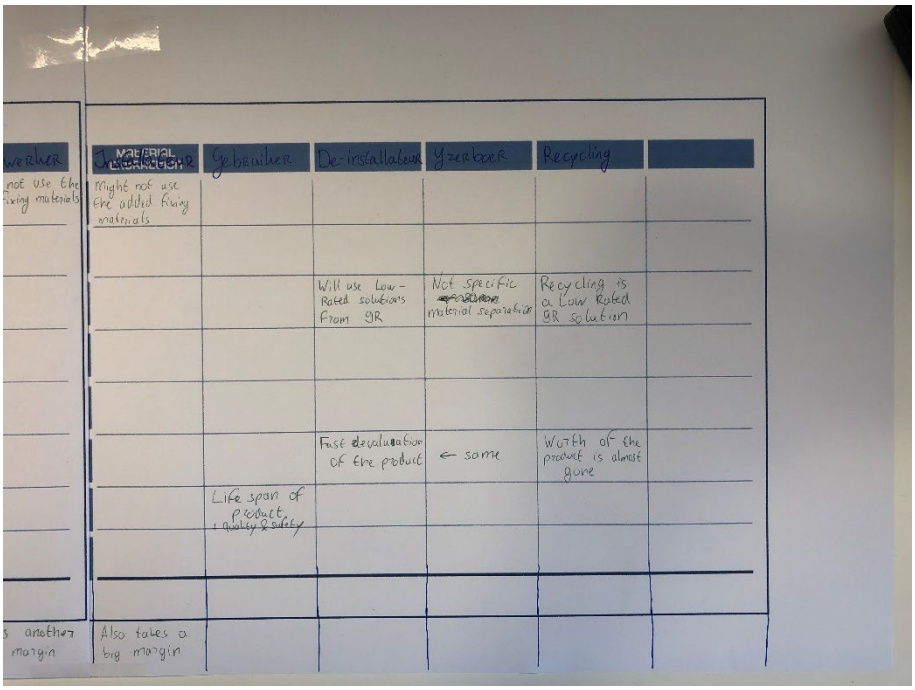
On average the product will be used in:	Mode during	Hours a day	Days a week	Weeks a year
Voor-Opening mode	10x 1 min	7	52	
Closing mode	10x 1 min	7	52	
Passive mode	23 hours	7	52	

Location of Use: Voor- of achterdeur (Buitendeur) van Woonhuizen

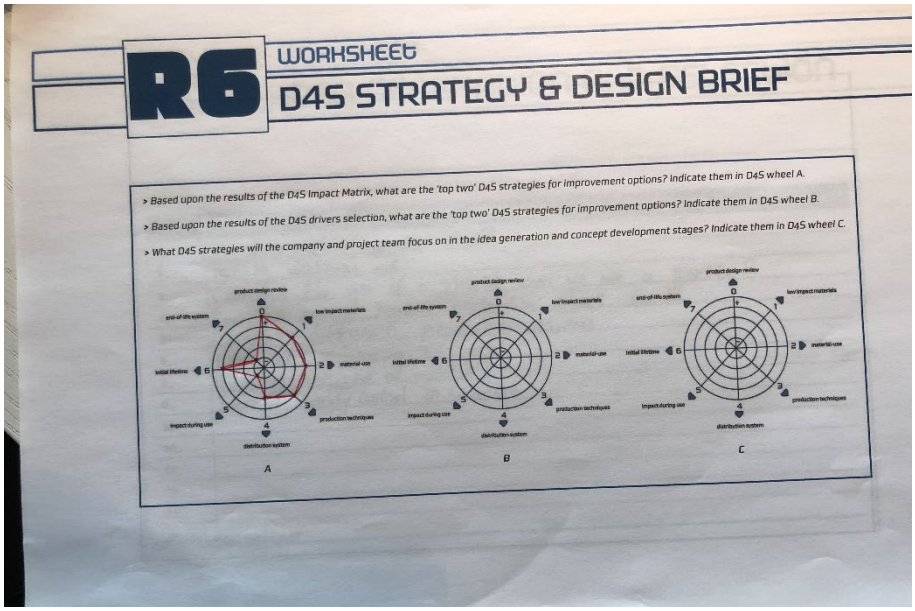
Make sure that the functional unit is taken into account when filling in the following worksheets.



	MATERIAL EXTRACTION	Base Material Production	Product Production	Packaging, Warehousing & Logistics	S² In-company	Verwerker
Material Use	Most Raw material is virgin material which has to be extracted	making alu from virgin bauxite is not efficient	Injection molding is material efficient CNC is not material efficient	Too much packaging and Repacking	Too much Repackaging Added fixing materials potentially not used	Might not use the added fixing materials
Energy use - Reduce fossil fuel use - Use Renewable - Increase efficiency	Extraction uses a lot of energy	Requires a lot of energy	Both methods are quite energy efficient	Long distances = more energy		
Improve waste prevention with 9R design method.			Injection molding has waste + sample defects CNC has a lot of material waste	Reduce the packaging material		
Emissions type	Most of the energy is fossil based	Energy from fossil sources + Toxic gasses	Probably a lot of fossil based	Fossil fuel Aircrafts & ships		
Stop deforestation, soil loss, erosion and ecosystem destruction	Alu extraction is a destructive process	Water usage in Refinement	Water usage for CNC cooling			
Value for company and stakeholders			Production methods are cost efficient	Increased packing efficiency leads to cost reduction		
Value for the customer			Quality with low cost	Increased efficiency can reduce prices	Reliability of Deliveries (on-time)	
Improve working conditions & adopt international standards	?	?	Risks with working conditions in China	← same		
Adopt International employment standards	?	?	Same as above	↖ same	CAO?	
Fair price for added value	?	?	Low costs can lead to under-payment	← same	Do we take a cut that's too big?	Takes another big margin



	MATERIAL EXTRACTION	Gebruiker	De-installateur	Verzamelaar	Recycling	
	Might not use the added fixing materials					
			Will use Low-Rated solutions From 9R	Not specific material separation	Recycling is a Low Rated 9R solution	
			Fast devaluation of the product	← same	Worth of the product is almost gone	
		Life span of Product + quality & safety				
s another margin	Also takes a big margin					



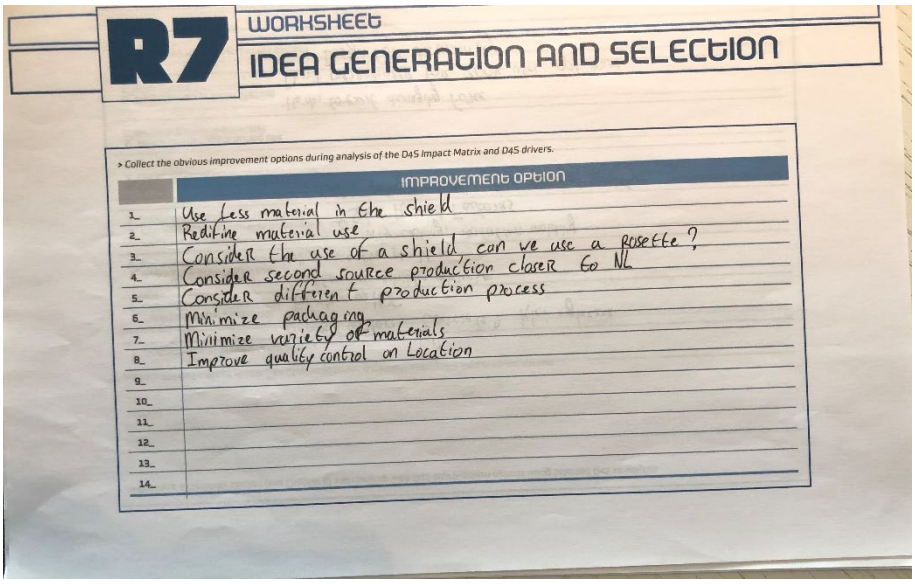
R6 WORKSHEET

D4S STRATEGY & DESIGN BRIEF

> Based upon the results of the D4S Impact Matrix, what are the 'top two' D4S strategies for improvement options? Indicate them in D4S wheel A.

> Based upon the results of the D4S drivers selection, what are the 'top two' D4S strategies for improvement options? Indicate them in D4S wheel B.

> What D4S strategies will the company and project team focus on in the idea generation and concept development stages? Indicate them in D4S wheel C.

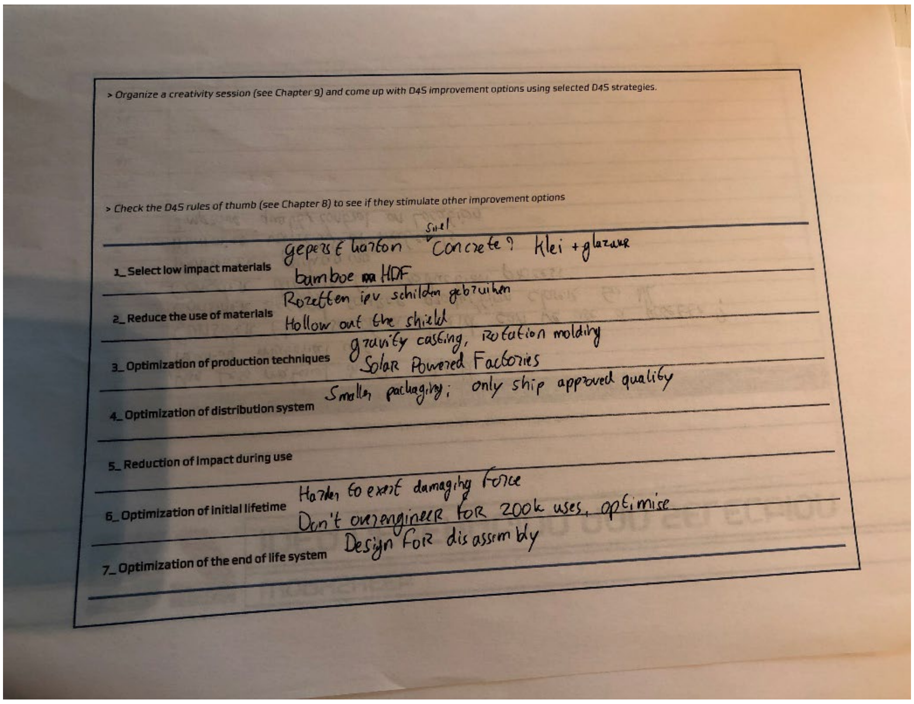


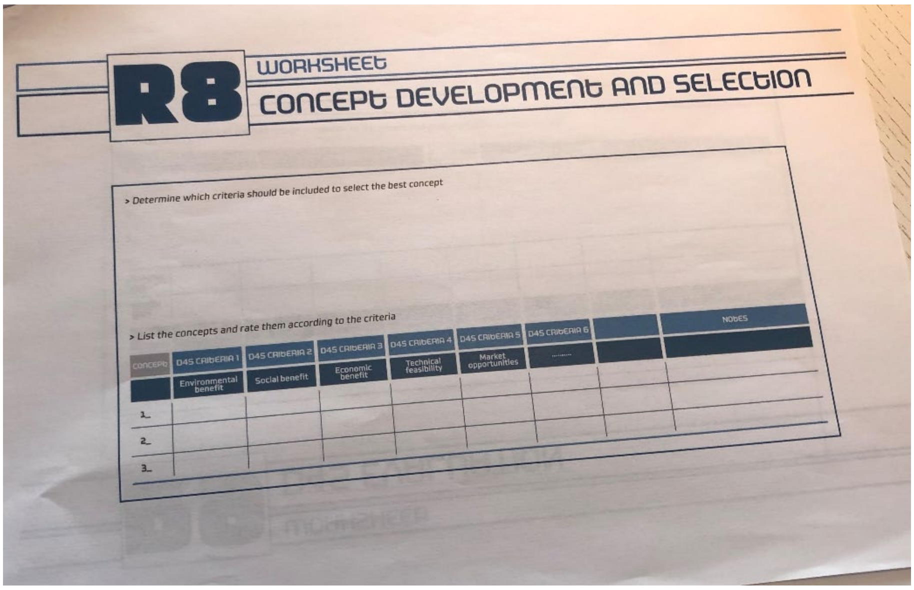
R7 WORKSHEET

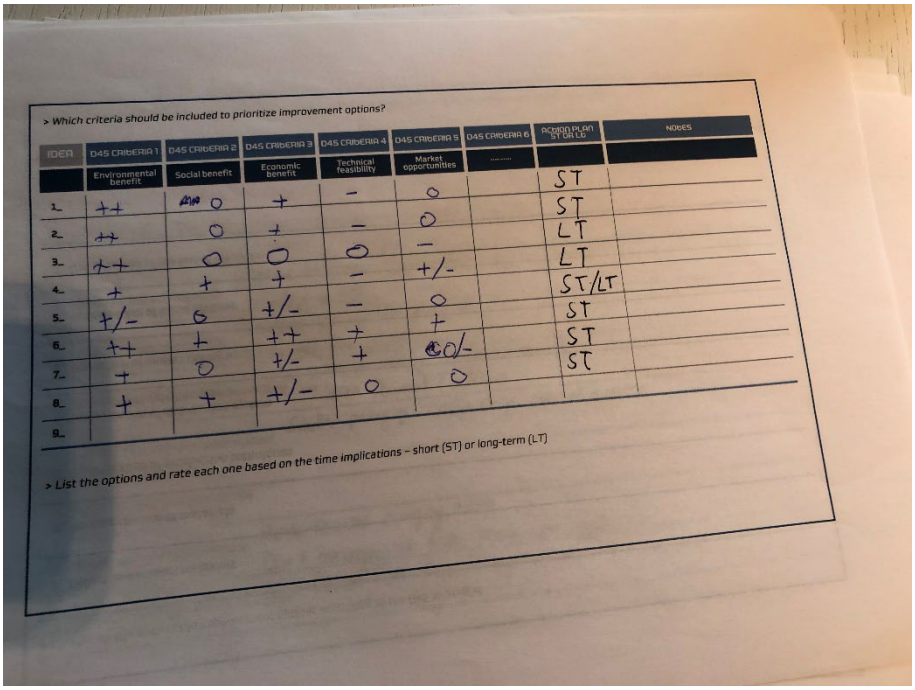
IDEA GENERATION AND SELECTION

> Collect the obvious improvement options during analysis of the D4S Impact Matrix and D4S drivers.

	IMPROVEMENT OPTION
1_	Use less material in the shield
2_	Redifine material use
3_	Consider the use of a shield can we use a rosette?
4_	Consider second source production closer to NL
5_	Consider different production process
6_	Minimize packaging
7_	Minimize variety of materials
8_	Improve quality control on location
9_	
10_	
11_	
12_	
13_	
14_	


> Organize a creativity session (see Chapter 9) and come up with D4S improvement options using selected D4S strategies.
> Check the D4S rules of thumb (see Chapter 8) to see if they stimulate other improvement options
1_ Select low impact materials
2_ Reduce the use of materials
3_ Optimization of production techniques
4_ Optimization of distribution system
5_ Reduction of impact during use
6_ Optimization of initial lifetime
7_ Optimization of the end of life system

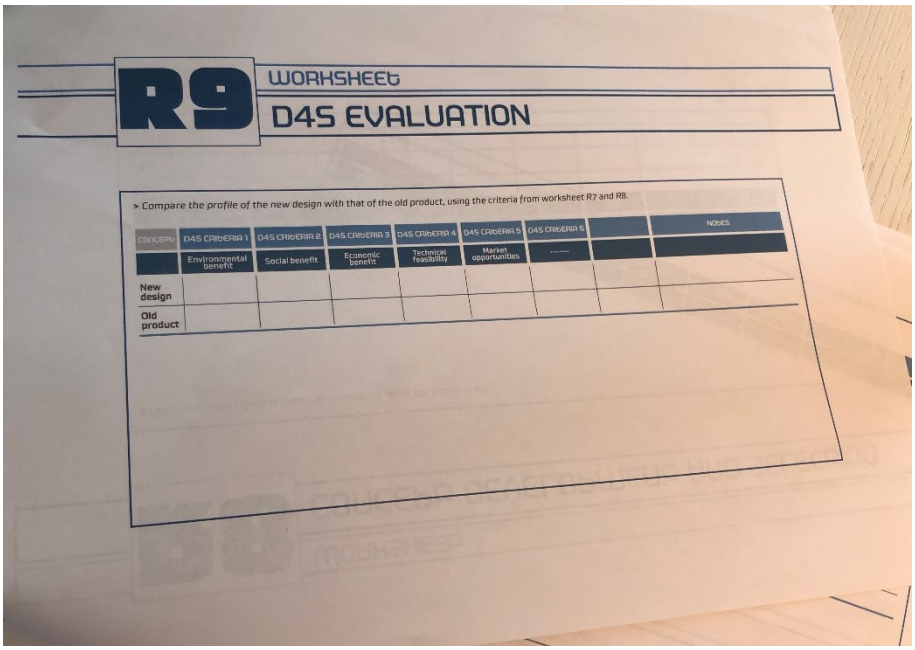

R8
WORKSHEET
CONCEPT DEVELOPMENT AND SELECTION
> Determine which criteria should be included to select the best concept
> List the concepts and rate them according to the criteria



> Which criteria should be included to prioritize improvement options?

IDEA	D4S CRITERIA 1	D4S CRITERIA 2	D4S CRITERIA 3	D4S CRITERIA 4	D4S CRITERIA 5	D4S CRITERIA 6	ACTION PLAN ST OR LT	NOTES
	Environmental benefit	Social benefit	Economic benefit	Technical feasibility	Market opportunities	.....		
1.	++	0	+	-	0		ST	
2.	++	0	+	-	0		ST	
3.	++	0	0	0	-		LT	
4.	+	+	+	-	+/-		LT	
5.	+/-	0	+/-	-	0		ST/LT	
6.	++	+	++	+	+		ST	
7.	+	0	+/-	+	0/-		ST	
8.	+	+	+/-	0	0		ST	
9.								

> List the options and rate each one based on the time implications – short (ST) or long-term (LT)



R9 WORKSHEET

D4S EVALUATION

> Compare the profile of the new design with that of the old product, using the criteria from worksheet R7 and R8.

CONCEPT	D4S CRITERIA 1	D4S CRITERIA 2	D4S CRITERIA 3	D4S CRITERIA 4	D4S CRITERIA 5	D4S CRITERIA 6		NOTES
	Environmental benefit	Social benefit	Economic benefit	Technical feasibility	Market opportunities	.....		
New design								
Old product								

Appendix 12) Current new product development and production process within Themans

This appendix shows an overview of the processes for NPD at Themans, starting with the R&D process.

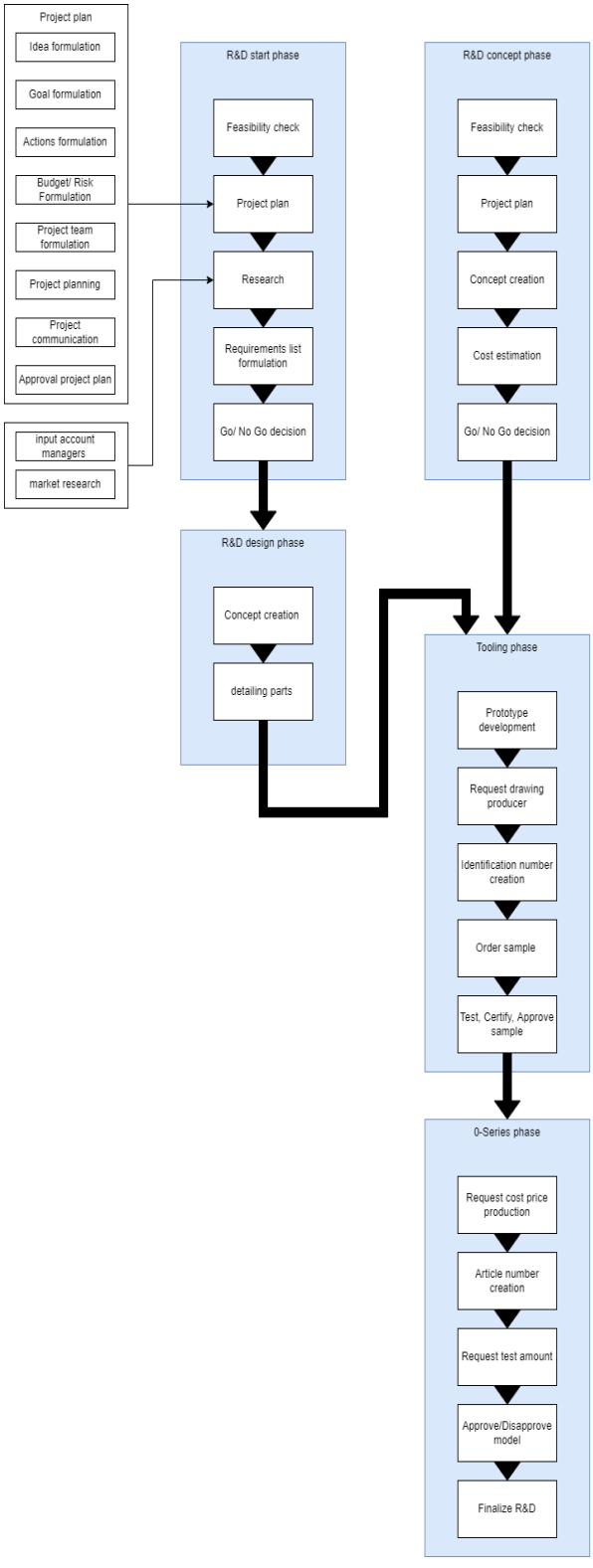


Figure 58 general product development process at Themans hang & Sluitwerk BV

Research and development process of Themans

The current product development process of Themans can be characterized as a stage-gate process with go/no-go decision-making. The process differs per project and designer but has a general structure (Figure 58). For the development of a short new product development process, the R&D process consists of three phases: the R&D concept phase, Tooling phase, and 0-series phase (Figure 58 starting point on the right side). For more elaborate innovative products, the R&D process consists of five phases: R&D start phase, R&D design phase, R&D concept phase, Tooling phase, and 0-series phase (Figure 58 starting point on the left side).

The current R&D process does not focus on the implementation of ecological sustainability. The certification for, among other things, SKG during the tooling phase brings quality requirements which are dominant in the current R&D process.

The current R&D process uses input from and cooperates with other departments like purchasing, stakeholder relations, and external production companies.
The stakeholder relations department (account managers) provides customer input, which initiates new product development. Purchasing is incorporated within the 0-series phase for the initial supplier selection. Here the external partner company in Asia (a producer selection company) provides a preselection of Asian producers able to produce the new product. Furthermore, they facilitate the final translation from design to the production process.

Current generalized production process

Themans outsources product manufacturing to direct and indirect suppliers. The suppliers provide little information on the specific circumstances of production, for which the specific production circumstances are perceived as a black box. As with the product impact of the product portfolio section, general statements can be obtained from the products. All products are manufactured mainly from virgin aluminium or stainless steel (obtained from partner company Asia), combined with multiple small plastic parts. The main metal body means that the raw material extraction processes are for all products roughly similar (Figure 59) (Figure 60). Most production is executed in Asia, for which its most likely that Australia and China are the raw material suppliers for the manufacturers (Table 6).

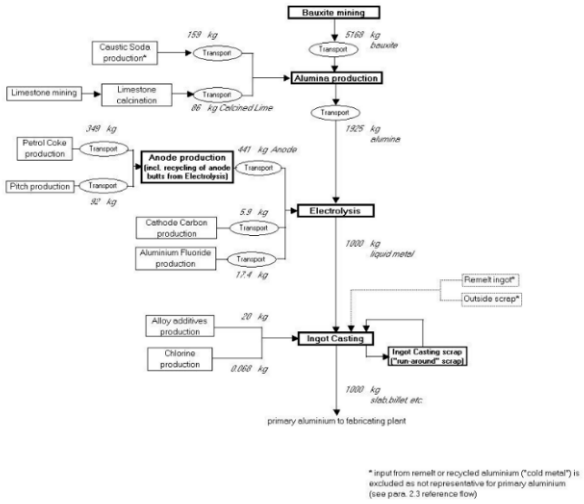


Figure 59 Life cycle inventory production process primary aluminium (International Aluminium Institute, 2003)

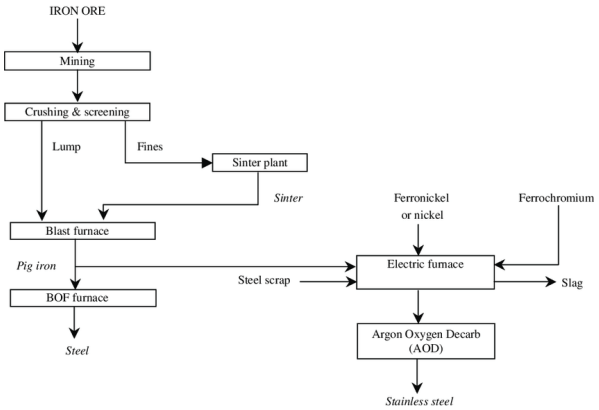


Figure 60 iron ore to steel and stainless-steel production (Terry Norgate et al., 2006)

Table 6 Top 5 iron ore and bauxite producing countries

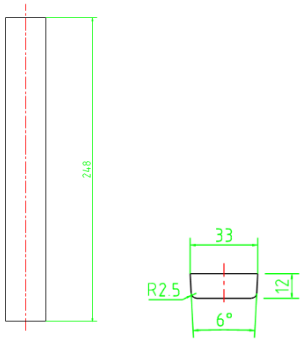
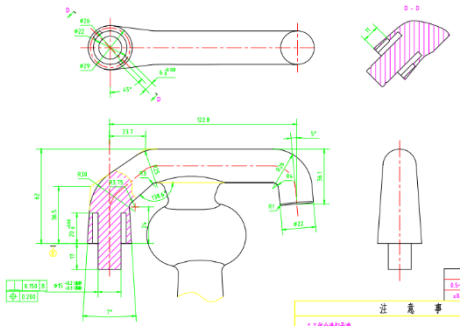
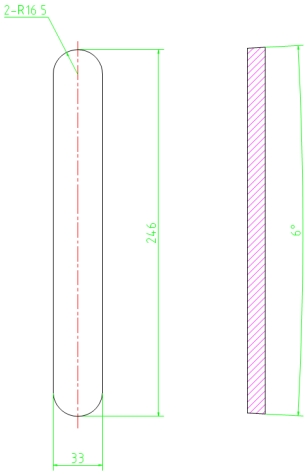
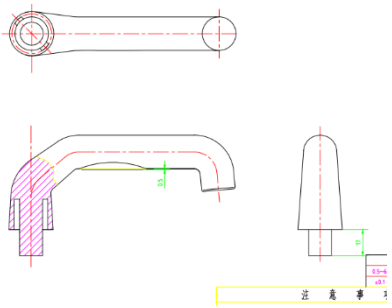
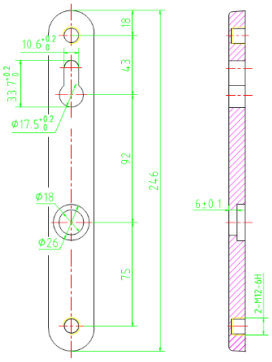
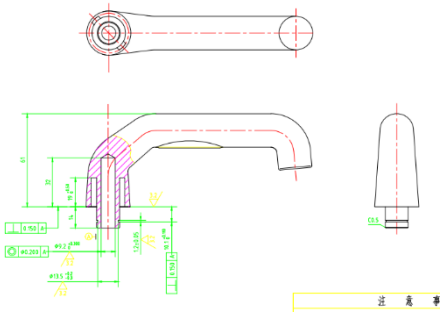
Top 5 Iron ore production countries (R. J. Holmes et al., 2015)	Top 5 Bauxite production countries (Hobart M. King)
1. Australia	1. Australia
2. Brazil	2. China
3. Russia	3. Brazil
4. China	4. India
5. India	5. Guinea

Specific manufacturing processes depend on product characteristics. However, Themans product portfolio contains products with a similar manufacturing process (Table 7). The door fittings generate the most profit for the company. A more specific example of an aluminium door fitting product (product code; 5001906617) and a stainless steel door fitting product (product code; 5201101100) are therefore shown in (Figure 59& Table 8) and (Figure 60 & Table 9).

Table 7 Production processes related to Themans product portfolio (verified by designers and production partner)

Manufacturing processes	Finishing processes
Cutting	Polishing
Gravity Casting	Anodising (Anodiseren/ verzinken)
Stamping	Lasered the logo
Milling	Electrolysation (plated, blue galvanize, yellow galvanize
Drilling	Sandblasting
lathing the slot of circlip	Powder coating
Stamping	
Extruded	
Tapping	
Injection moulding	
Punched	
Injection moulding	
Welding	
Turning	

Table 8 Production process door fitting product 5001906617 (verified by production partner in Asia)

Aluminium product 5001906617		
	Shield	Handle/Knob
Process 1	Cutting profile into the length for machining 	Gravity casting of the handle 
Process 2	Stamping the two round ends (R16.5) if it is a round shield 	Cut away the pouring head 
Process 3	Mill the holes 	Drilling the hole and lathing the slot of the circlip 

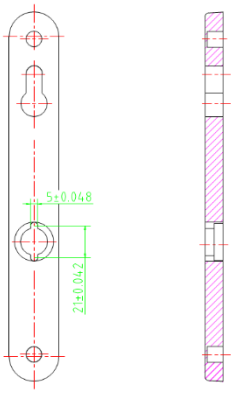
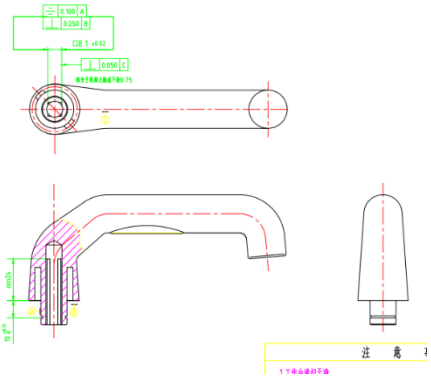
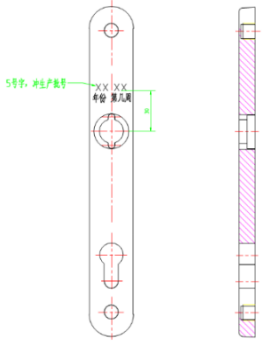
Process 4	Stamping the two ribs of the handle hole 	Stamping the hole of the spindle 
Process 5	Stamping the batch Number on the back 	
Process 6	Polishing	Polishing
Process 7	Sandblasting	Sandblasting
Process 8	Anodising	Anodising
Process 9	Assembly	Assembly
Process 10	Packing	Packing

Table 9 production process stainless steel door fitting product 5201101100 (verified by production partner in Asia)

Stainless steel product 5201101100		
	Bush	Handlebar
Process 1	Cutting and milling the end connection with the handlebar and drilling the fixation screw hole	Cutting into the length
Process 2	Welding plate to the end of the connection	Welding the two ends
Process 3	Welding coupling to the other end of the bush	Make screw hole with hot flow drilling
Process 4	Polishing	Polishing
Process 7	Assembly	Assembly
Process 8	Packing	Packing

Packaging process upstream

The use phases of the packaging are (manufacturing, transport, warehouse, transport, retail, transport, and use). The packaging is introduced at the end of the product manufacturing phase, creating the product packaging system which enters the Themans warehouse. Multiple layers of packaging are at play in the current product packaging combination. Transport from suppliers provides product packaging combinations in bulk (with secondary and tertiary packaging) or individually packaged (in primary, secondary, and tertiary packaging), depending on the purpose of the part (aesthetic of pure functional) (Figure 61). Due to current supply chain problems and increased energy costs, cost-focused efficiency initiatives are seen from the Asian suppliers, providing less air transportation and increasing the number of products within a sea container transport packaging.

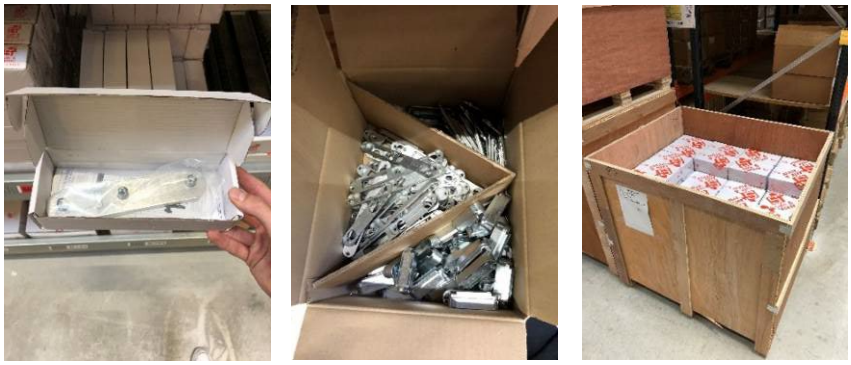


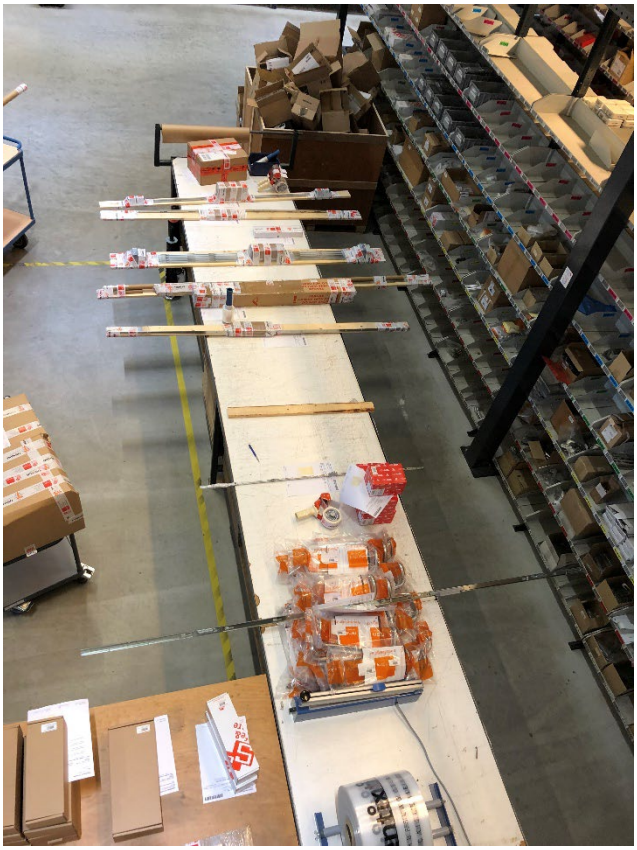
Figure 61 primary, secondary (bulk), tertiary packaging provided by suppliers Themans

However, the current product-packaging combination shows an unstructured packaging policy, where products are packaged in various primary packaging systems (Figure 62). The primary packaging uses a combination of cardboard and plastics to protect the product from structure collapse during transport and scratches.

Figure 62 Different product packaging combinations for comparable products

Packaging process down-stream

The warehouse employees at Themans transform, depending on the demand, the packaging of the products. Additionally, products from the assembly line are packaged before transport to customers. The product packaging use scenarios differ widely within the customer group. Obtained from build-sector customers, waste streams are produced due to the amount of additional protective plastic layers. The warehouse employees are looking for better solutions to improve the packaging systems. A previous master thesis assignment created a packaging system per door. Unfortunately the customer could not cope with the packaging alternation.



current purchasing process

The inclusion of two own designed brands in 2006 changed the supply chain and Themans' role within the supply chain. Suppliers would provide a complete designed and produced product in the original situation. The new situation creates additions to the supply chain in which the products are designed by Themans and produced by multiple suppliers. The current combined supply chain contains different routes depending on the product (Figure 63). The supply chain overview shows six chains: producer, middleman, Themans, direct customer, indirect customer, and user. The division between direct and indirect customers derives from the two customer types: a platform (metal retailer platform) and the timber industry. The platform provides an additional link between Themans and its products user.

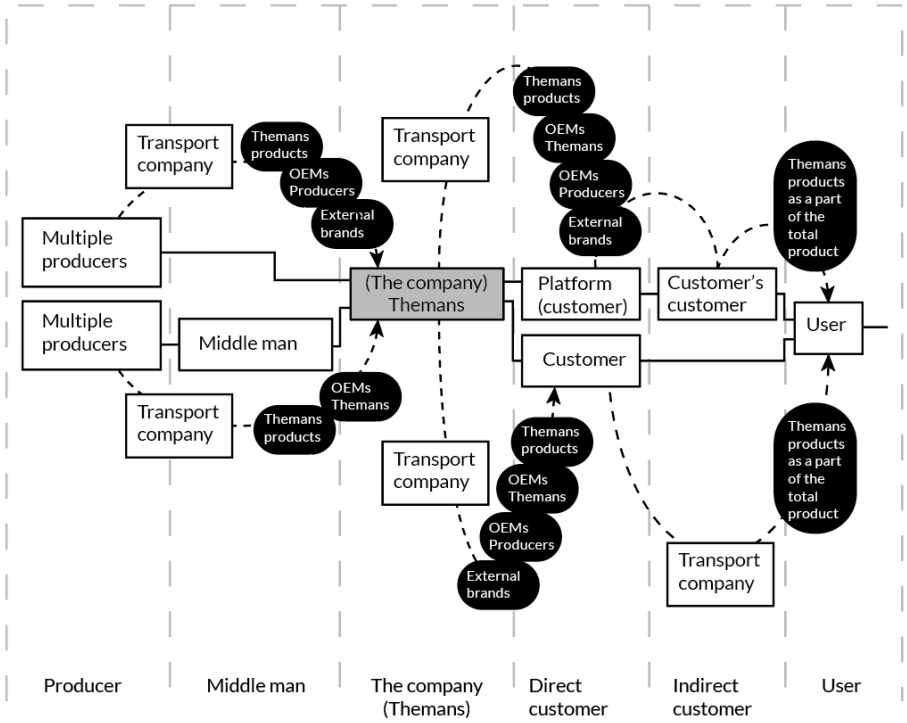


Figure 63 overview of the current supply chain of Themans and product movement among the supply chain

Using a simplified view of the supply chain allows for distinguishing four supply chain routes:

- the External brands
- the OEMs producer
- the OEMs Themans and Themans products produced in Asia
- the OEMs Themans and Themans products not produced in Asia

All supply chains exist out of: The producer, Themans, Direct and Indirect customers, The user, and transportation companies linking the links of the supply chain, except the in Asia produced products, which include an additional middle man chain.
The products designed by Themans provide more authority to Themans within its supply chain than dealership products.

In line with the four supply chain routes, alternations occur in the current supplier selection procedure (Figure 64). The supplier selection procedure overview applies to the time frame before

the COVID-19 pandemic when travelling toward suppliers was physically possible. The figure shows the current focus on quality criteria within the selection procedure of all products.

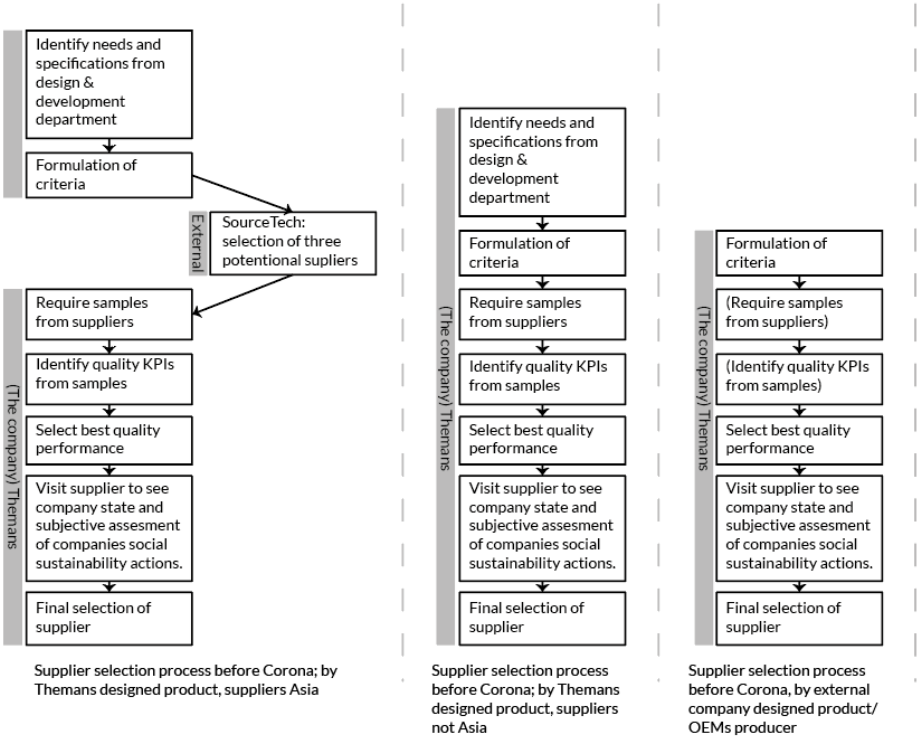


Figure 64 Supplier selection procedures at Themans

Assembly

Themans focuses on flexible manufacturing service, which strives to finalize the final state of the products to the end of the manufacturing line. The addition of the internal assembly line contributes to flexibility by shifting the final product form within the company. The assembly line provides jobs to employees with a distance from the labour market.

The newness and capacity of the assembly line make for a small in-house percentage of assembled products. For example, Mounting kit assemblies, door handle combinations, a specific product line and OEM packaging. The assembly line provides opportunities due to the company's increased authority in manufacturing and packaging.

It also provides challenges concerning the increased logistic complexity, where incorrectly manufactured parts obstruct the assembly of products and could decrease service.

Transport

The current type of transportation upstream Themans' supply chain exists out of truck-, boat- and when essential aeroplane transport. The downstream transport uses trucks to transport the products to the customers.

Appendix 13) Legislation, Norms & Standards analysis

Themans provides products dominantly to the Dutch market, but also the European market. Providing to both markets requires the company to comply with Dutch and European regulations. The authorities set the context in which Themans is allowed to operate.

Applicable European legislation door fitting products:

- Quality and safety legislation: The construction products directive (Construction Products Directive 89/106/EEC: CPD)
- Quality and safety legislation: The construction products regulation (Construction Products Regulation 305/2011/EU CPR)
- Norm EN-1906:2012
- Corporate sustainability due diligence directive (CSDD) (Justice and Consumers, 2022): An European directive proposal which will make the selling corporations of products and services within Europe responsible for violations of human rights within their production supply chain and environmental damage done due to the production of the products or services. It further states that corporations should do everything within their capabilities to prevent human rights violations and environmental damage in producing products or services. The directive intends to implement the directive first for Large multinational corporations. However, SMEs could also be included depending on their influence within their supply chain.

Applicable Dutch legislation door fitting products:

- Bouwbesluit 2012 (Minister voor Wonen en Rijksdienst, 2011a) states directives from multiple angles: …., safety, health, usability and chapter 5 states Technical build directive from the point of energy- and environmental sustainability:
    - (Minister voor Wonen en Rijksdienst, 2011b) States that a newly built house should be delivered almost energy-neutral, which some stated exceptions for specific buildings. However, This implies that door fitting products should contribute to the energy-neutral claim.
    - (Minister voor Wonen en Rijksdienst, 2011c) States that the materials used for building a new house should provide a limited impact on the environment.
    - (Minister voor Wonen en Rijksdienst, 2019) States that a user function should have a maximum environment score of 0,8 on the “Bepalingsmethode Milieuprestatie Gebouwen en GWW-werken”, which is based on (NEN, 2019). The calculation applies to the complete building. Based on the life cycle time of the building and based on the life cycle steps stated within (NEN, 2019), the impact of the building is scored.
- Door fittings: EN-1906
- Anti-panic fitting EN-179 and EN-1125
- (Ministerie van Buitenlandse Zaken, 2019) “wet zorgplicht kinderarbeid” states that a law is initiated that forces corporations in the Netherlands that sell products and services to do everything within their capabilities to prevent producing products or services by child labour.

As an extension of legislation, corporations have market standards to guide corporate actions. The standards are not compulsory. However, they are often required by customers to ensure quality. Standards like ISO norms 26000, 14001, and 9001 (ISO, 2015) (concerning sustainability, employee safety& health) are highly used by companies.

For circular economy: Extended Producer Responsibility (EPR) is increasingly used within the transition governance within holland and Europe towards a circular economy (A. Dimitropoulos et al., 2021). Here future legislation could insist that suppliers include an EPR report on all their products.

Appendix 14) Market analysis, sustainability focussed

Themans is active in the B2B door fitting market, specialising in door manufacturers and metal retail customers. Here they provide products at the top of the low-segment of the market. This segment of the market is highly cost-price and quality-mark oriented. The driving quality marks are CE, SKG-IKOB, and KOMO. These certificate providers test the products on their resilience to theft initiatives concerned with destroying the product. There are more and more quality marks for security and sustainability (cradle to cradle, ISO, GRI). When a quality mark is demanded by a large group of customers or when a large group of competitors applies it, the power of the mark grows. Within the current market, SKG is the dominant certificate for security. For sustainability, no dominant certificate is found within the market.

The potential shift of competitors towards sustainable development could influence the success and market share of Themans. The competitors have no direct power or influence on the actions of Themans. However, indirectly they can influence market trends and competitor actions. Therefore, the current state of competitors concerning their sustainability certificates and actions is researched to find possible trends (Figure 65).

Competitor data is obtained via the industry organisation VHS (Vereniging fabrieken van Hang- en Sluitwerk) within the Netherlands since almost all competitors are participants of the industry organisation. Additionally, competitors are obtained from the largest customer metal retail website. Data from competitors' appliance of sustainability quality marks and incorporation within the competitor's company is obtained from their websites and annual reports.

Among the competitors, little attention to sustainability is observed in marketing. Competitors showing interest in sustainability certificates focus on ISO (14001 and 9001) and cradle-to-cradle. Furthermore, competitors state the SDG of the UN as a lead in the sustainability strategy.

	Company name	Product branche	Communicates ecological sustianability certificates					Communicates social sustainability certifica				Actions				Quality marks			
			1	2	3	4	5	1	2	3	4	1	2	3	4	1	2	3	4
4	AMI		EPD	SKG-IKOB	Cradle to Cradle silver			ISO 9001				Sustainabi	Cradle to Cradle build group						
5	Ankerslot BV							MVO certi	Social workplace										
6	Artitec Wallebroek BV																		
7	ASSA ABLOY nederland BV																		
8	AXA stenman Nederland B.V.		SDG (susta	ESG	SASB standards			MVO standards				Measure c	External climate change and waterreports (CDP)						
9	BREUER & SCHMITZ GmbH & Co K		EPD	Cradle to (	MHC (mat	DoP						New buildi	Provide job e-bikes for employees			CE			
10	BUVA homecare systemen B.V.		EPD									use solar cells				SKG			
11	CESnederland B.V.																		
12	DOM Nederland															SKG	CE		
13	Dormakaba Nederland B.V.		EPD	EcoVadis gold medal (based on ISO 26000 and MVO)															
14	Dulimex B.V.							ISO 9001				Sustainabl	minimzing reduction of waste			SKG			
15	Elton B.V.		milieubarometer									Sustainability report							
16	EVVA Nederland B.V.							ISO 9001				Sustainability report (use GRI Global reporting initiative)							
17	FUHR Benelux B.V.																		
18	GU-Nederland B.V.																		
19	HMB profit locks & tools		SKG-IKOB (MVO certified)														CE	Politie keurmerk veilig wonen PKVW	
20	Hoppe Benelux		ISO 14001					ISO 9001									CE	ISO 50001	
21	Maco Beschläge Nederland B.V.		ISO 14001	Duitse Vereniging van Duurzaam Bouwen (D				ISO 9001	OHSAS 18001										
22	Mauer® Locking Systems		EPD																
23	Metafa Holland B.V.																		
24	Mul-T-Lock Nederland B.V.																		
25	Salto Systems BV		ISO 14001	SDG	ESG			ISO 9001	ISO 27001			Sustainabi	CSR strategy/ planning						
26	SecuProducts BV																		
27	SIEGENIA-AUBI KG																		
28	Ten Hulscher bv															SKG		Politie keu	NBR Nationale beveiliginsrichtlijn
29	Venster Techniek B.V.																		

Figure 65 Sustainability certificates and actions of competitors (competitors obtained from industry organisation VHS (Vereniging fabrieken van Hang- en Sluitwerk) participants, competitor data obtained from the competitors' website)

Appendix 15) SWOT Analysis

The SWOT analysis could be used for strategy formulation, aiming at how to improve the utilisation of the company's strengths and opportunities and how to minimise the weaknesses and threats for the company. The SWOT analysis can also be used as bottom-up input for formulating the vision and mission statement. Although the vision and mission statement might not be formulated yet, internal characteristics (strengths and weaknesses) of the company and external characteristics (threats and opportunities) can provide insight into the mission and vision of the company.
Internal characteristics are characteristics like price and quality. External characteristics are characteristics obtained from the market and customers.

A brainstorming meeting on all aspects of the SWOT (strengths, weaknesses, opportunities, threats) was executed, providing the following overview.

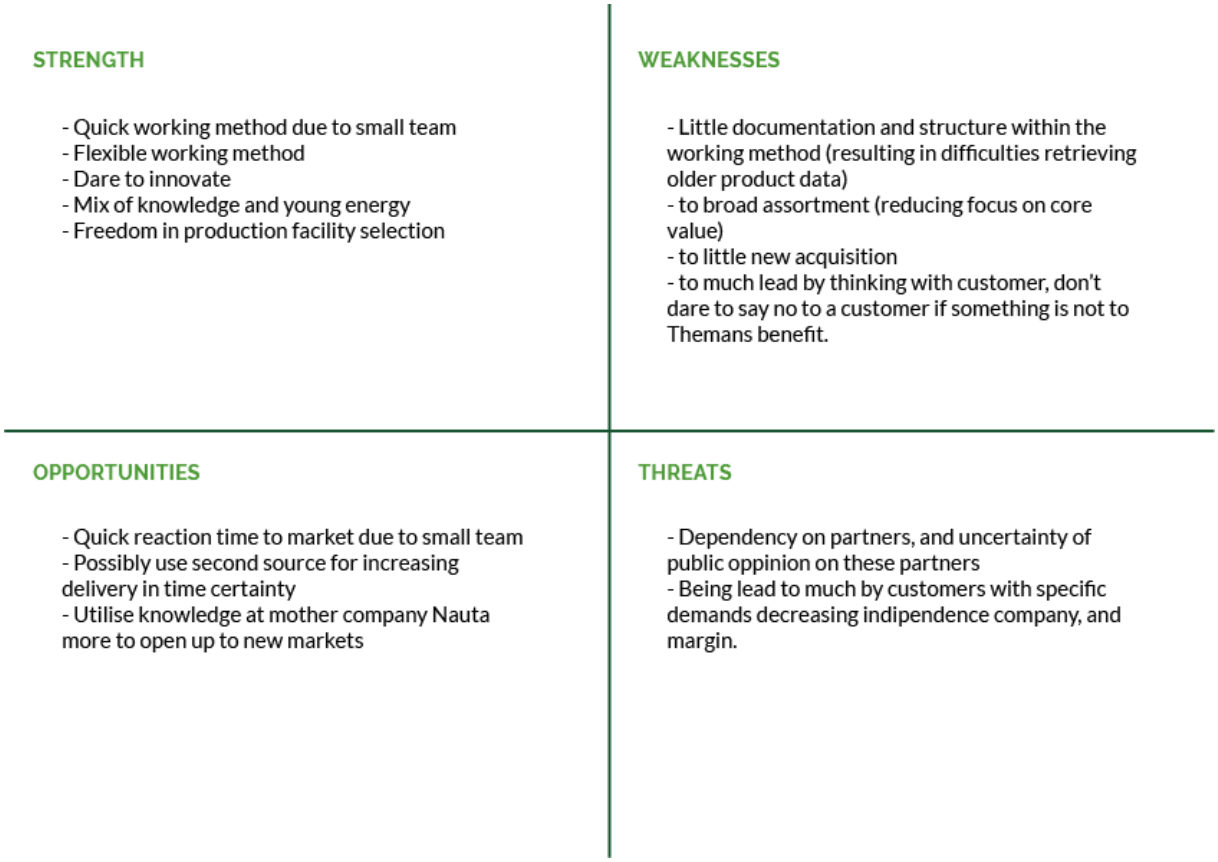


Figure 66 SWOT analysis Themans

Appendix 16) Workshop outcomes vision, mission, core values,

Mission statements

1. “To deliver flexible and sustainable door fitting products, specialised to facilitate the needs of the processing industry.”
2. “S2 should inspire processing partners and contractors/builders to build sustainably by providing innovative product solutions, high in quality securing the safety of the product.”

Figure 67 Generated individual mission statements Themans workshop

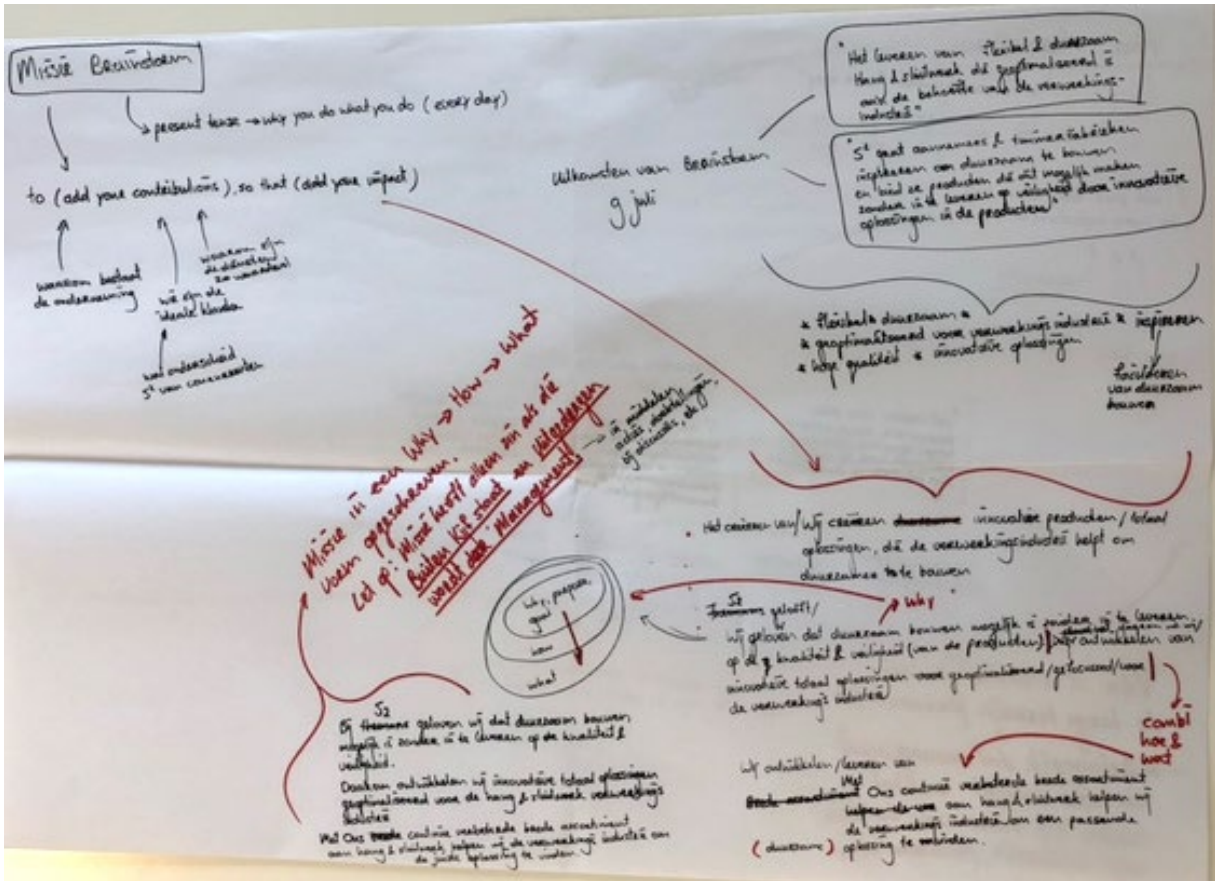


Figure 68 Formulation of a single mission statement combining the inputs of the participants of the workshop

Vision statements

1. “Make S2 the earth's friendliest supplier of safe & secure door fittings.”
2. “To deliver innovative and sustainable complete door fittings solutions for the Dutch processing industry.”
3. “Make S2 one of the first providers of sustainable home-safety solutions in the European new-house and renovation market.”

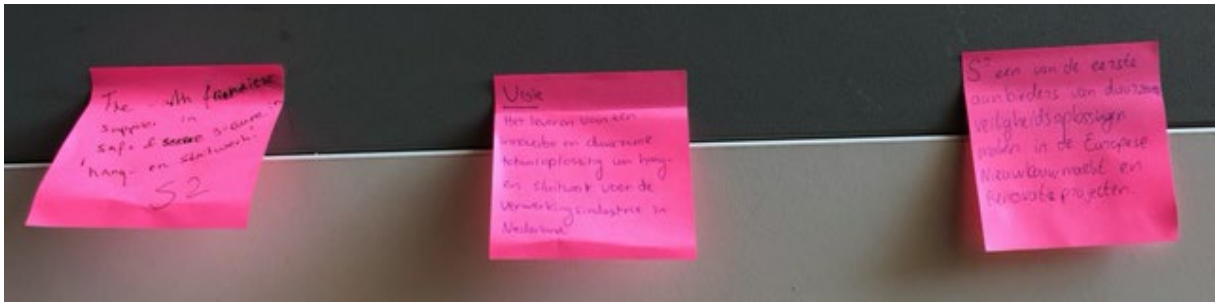


Figure 69 Generated individual vision statements Themans workshop

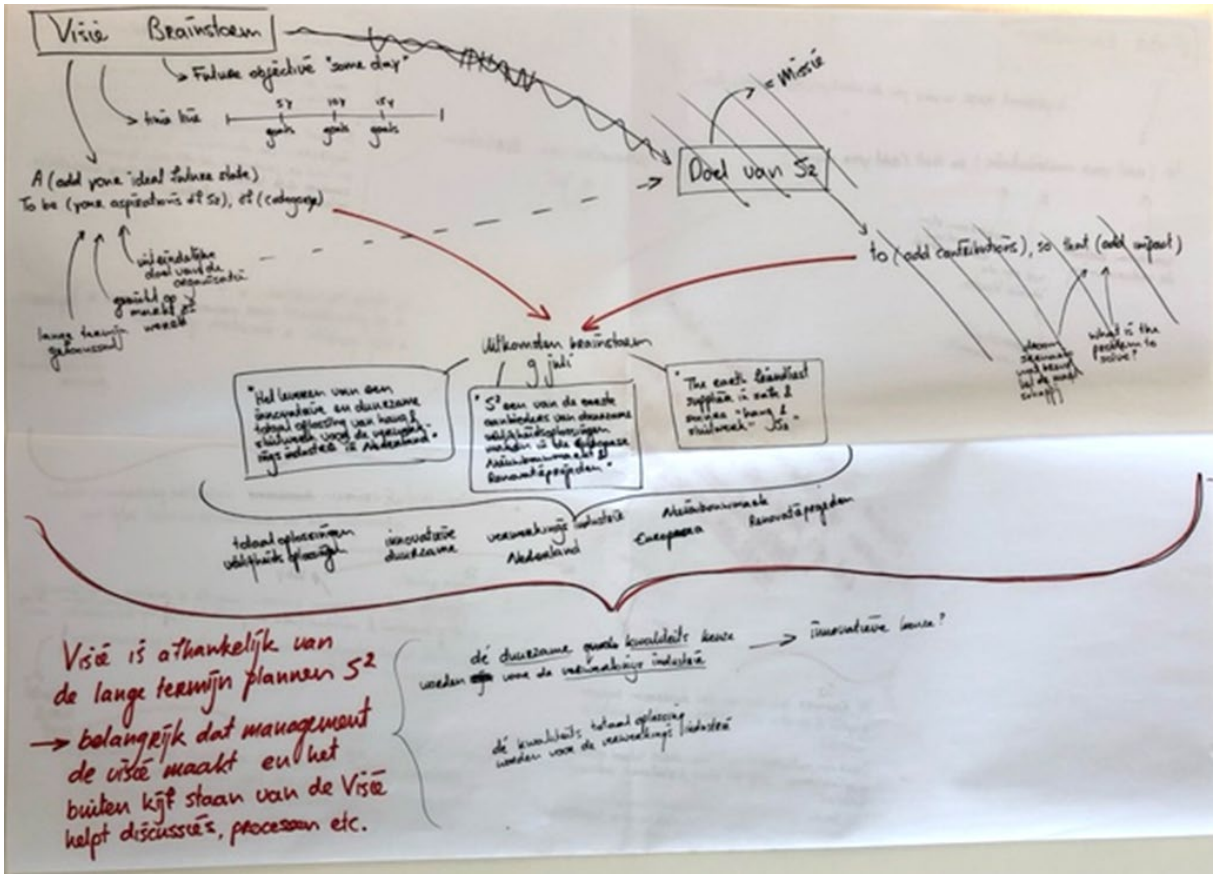


Figure 70 Formulation of a single vision statement combining the inputs of the participants of the workshop

Core values

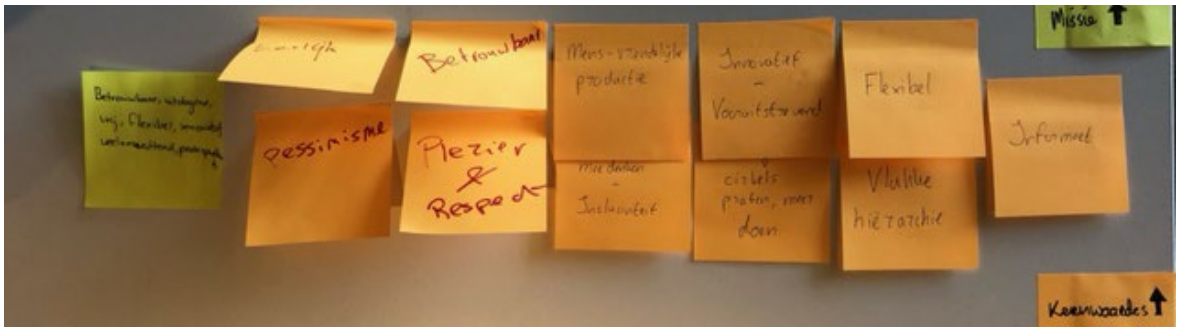


Figure 71 Generated core values for the company

1. Honest
2. Fun
3. Respect
4. Flexible
5. Informal
6. Inspiring
7. Trustworthy
8. Human-friendly production
9. Inclusive
10. Flat power structure
11. To think with
12. Innovative
13. Future-oriented
14. Pessimistic (participant thought the current core values were asked)
15. Focussed on doing

Appendix 17) Brainstorming session 'mission and vision translation to corporate success goals and indicators

This appendix provides an overview of the brainstorming session mission and vision translation to corporate success goals and indicators, based on the top-down approach (Figure 72). First, the assignment slides are shown. Second the results are shown (answers are in Dutch).

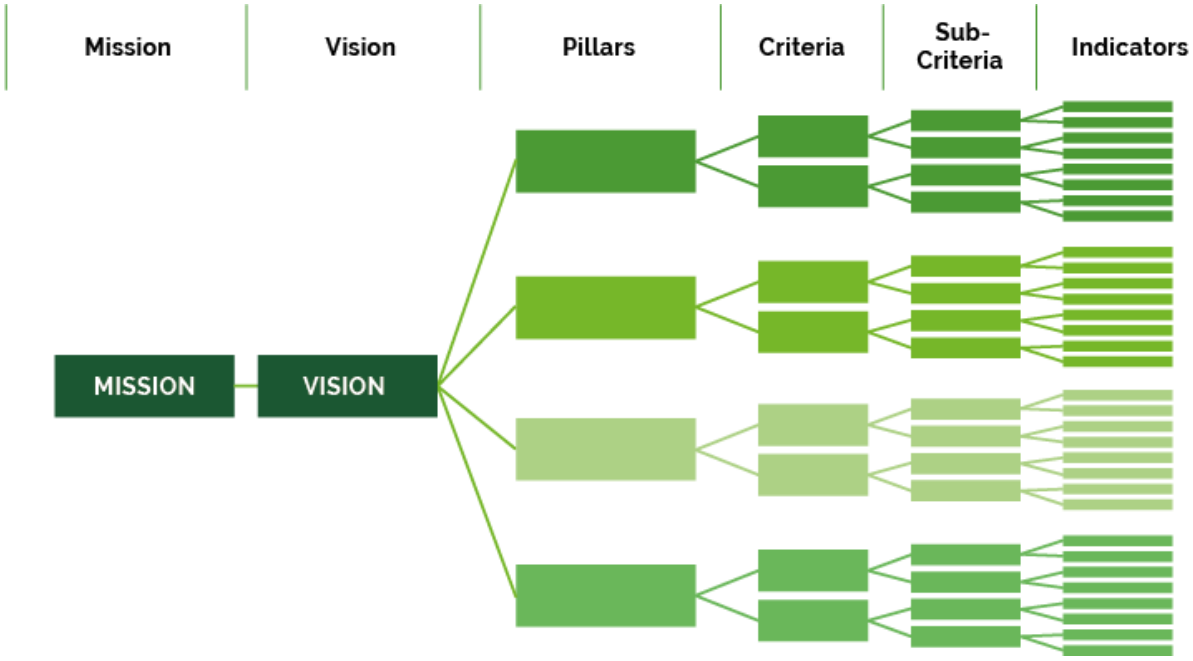
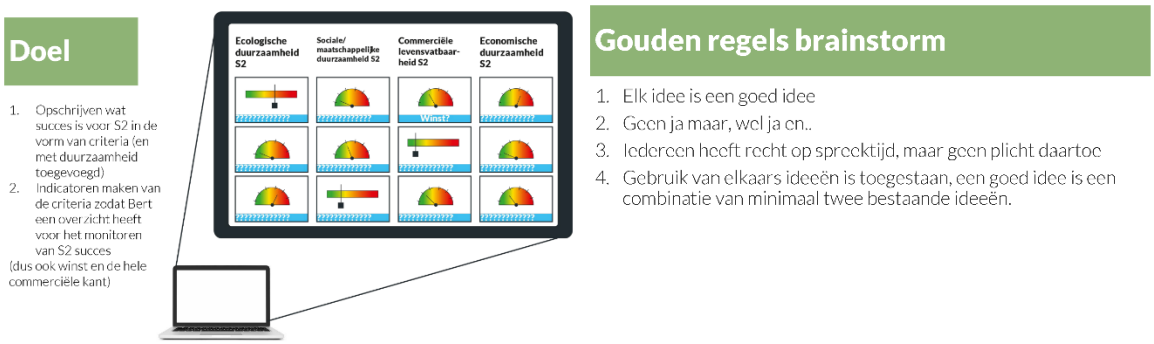
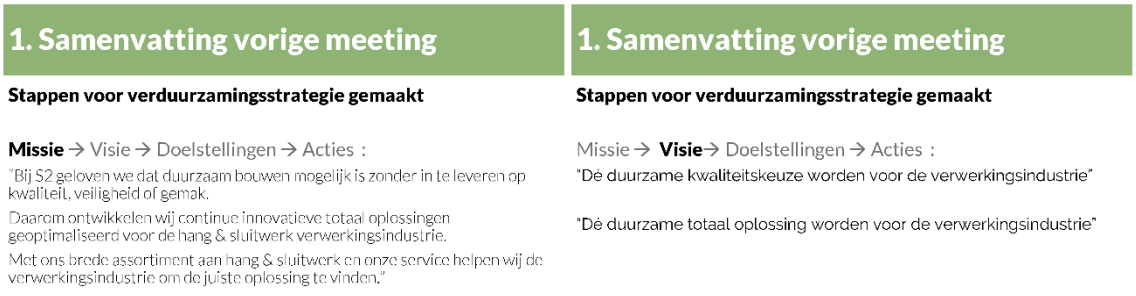


Figure 72 top-down translation from mission and vision toward indicators

Presentation slides and brainstorm guide.





1. Samenvatting vorige meeting

Stappen voor verduurzamingsstrategie gemaakt

Missie → Visie → **Doelstellingen** → acties :

Themans producten circulair maken, • De CET volledig recyclebaar maken, • duurzaam inkopen, • product portfolio meer lean maken voor besparen driedubbel werk, • minder nieuwe grondstoffen gebruiken, • gerecyclede materialen beslag lijn, • Energie neutraal kantoor/pand, • efficiënter verpakken, • efficiëntere transport, • Meer inzicht in mensen in de productie keten, ...

1. Samenvatting vorige meeting

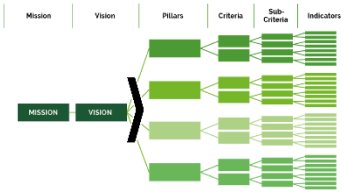
Stappen voor verduurzamingsstrategie gemaakt

Missie→ Visie → Doelstellingen → **Acties** :

Opstellen code of conduct • Modulair ontwerpen • design for maintenance and repair • Testen of refurbishen winstgevende opties bied • Terugvoer stroom en de assemblage lijn ontwikkelen • Product portfolio versimpelen • onderzoeken hoe inkoop gerecyclede materialen kan • meer contact met keten partners genereren • Gebouw beter isoleren • Zonne panelen toevoegen • Neutrale airco installeren • transport tussen productie stappen verminderen • Bulk transport vanuit China regelen • efficiëntere verpakking ontwerpen • Extra assemblage capaciteit opzetten • Analyseren huidige verpakkingen .....

2.1 Vaststellen hoofdpilaren vanuit Missie statement Themans/S2

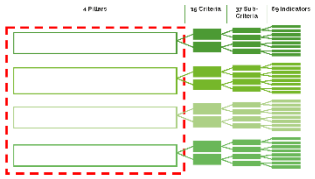
Vraag: Wat zijn de cruciale succes criteria voor succes voor Themans/S2?



2.1 Vaststellen hoofdpilaren vanuit Missie statement Themans/S2

Opdracht: brainstorm over de hoofdpilaren/ cruciale succes criteria groepen voor het monitoren van succes voor Themans/S2?

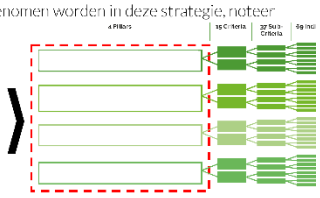
• 5 min: Lén categorie per post-it → Post-its clusteren



2.2 Selecteren van juiste pilaren om te gebruiken

Opdracht: discussieer welke hoofdpilaren (cruciale succes criteria voor het monitoren van succes voor Themans/S2) volgens jullie het belangrijkst/ alomvattends zijn voor Themans/S2 succes) en noem waarom

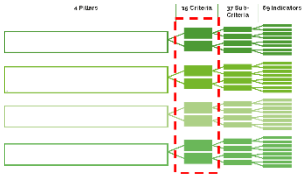
• 5 min: Welke pilaren moeten opgenomen worden in deze strategie, noteer argumenten bij de criteria



2.3 Brainstorm per pilaar zoveel mogelijk criteria voor het bereiken van de pilaar

Opdracht: brainstorm per pilaar, zoveel mogelijk succes criteria voor het bereiken van de pilaar voor Themans/ S2?

• 5 min: Lén criteria per post-it → Post-its clusteren



2.4 Selecteren van pilaar criteria om te gebruiken

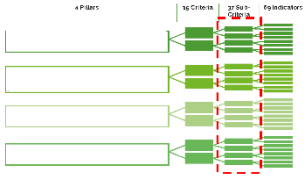
Opdracht: discussieer welke succes criteria volgens jullie het belangrijkst/ alomvattends zijn voor het bereiken van de pilaar criteria)

- 5 min: Welke criteria moeten opgenomen worden in deze strategie, noteer argumenten bij de criteria

2.5 Brainstorm per criteria zoveel mogelijk sub-criteria voor het bereiken van de pilaar

Opdracht: brainstorm zoveel mogelijk sub-criteria voor het bereiken van de criteria

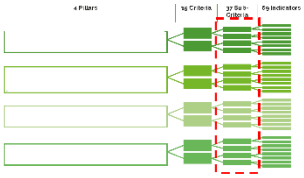
- 5 min: Lén categorie per post-it → Post-its clusteren



2.6 Selecteren van sub-criteria om te gebruiken

Opdracht: discussieer welke succes sub-criteria volgens jullie het belangrijkst/ alomvattends zijn voor het bereiken van de criteria)

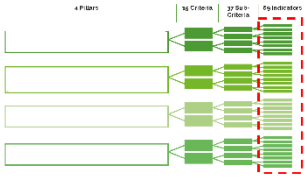
- 5 min: Welke criteria moeten opgenomen worden in deze strategie, noteer argumenten bij de criteria



2.7 Brainstorm per sub-criteria zoveel mogelijk indicatoren voor het bereiken van de pilaar

Opdracht: brainstorm zoveel mogelijk indicatoren voor het bereiken van de sub-criteria

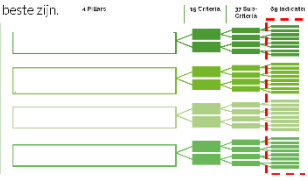
- 5 min: Lén categorie per post-it → Post-its clusteren



2.8 Selecteren van indicatoren

Opdracht: discussieer met je buurman/vrouw welke succes indicatoren volgens jullie het belangrijkst/ alomvattends zijn voor het bereiken van de sub-criteria)

- 5 min: Schrijf jullie begin letter op de meest belangrijke hoofdpilaren
- Argumenteer waarom deze indicatoren de beste zijn.



5. Verduurzamingsacties Themans BV

Voornemen:

5 min:

Naar aanleiding van deze sessie, wat zouden jij nu binnen drie weken kunnen doen met de inhoud van deze sessie?

Brainstorm results

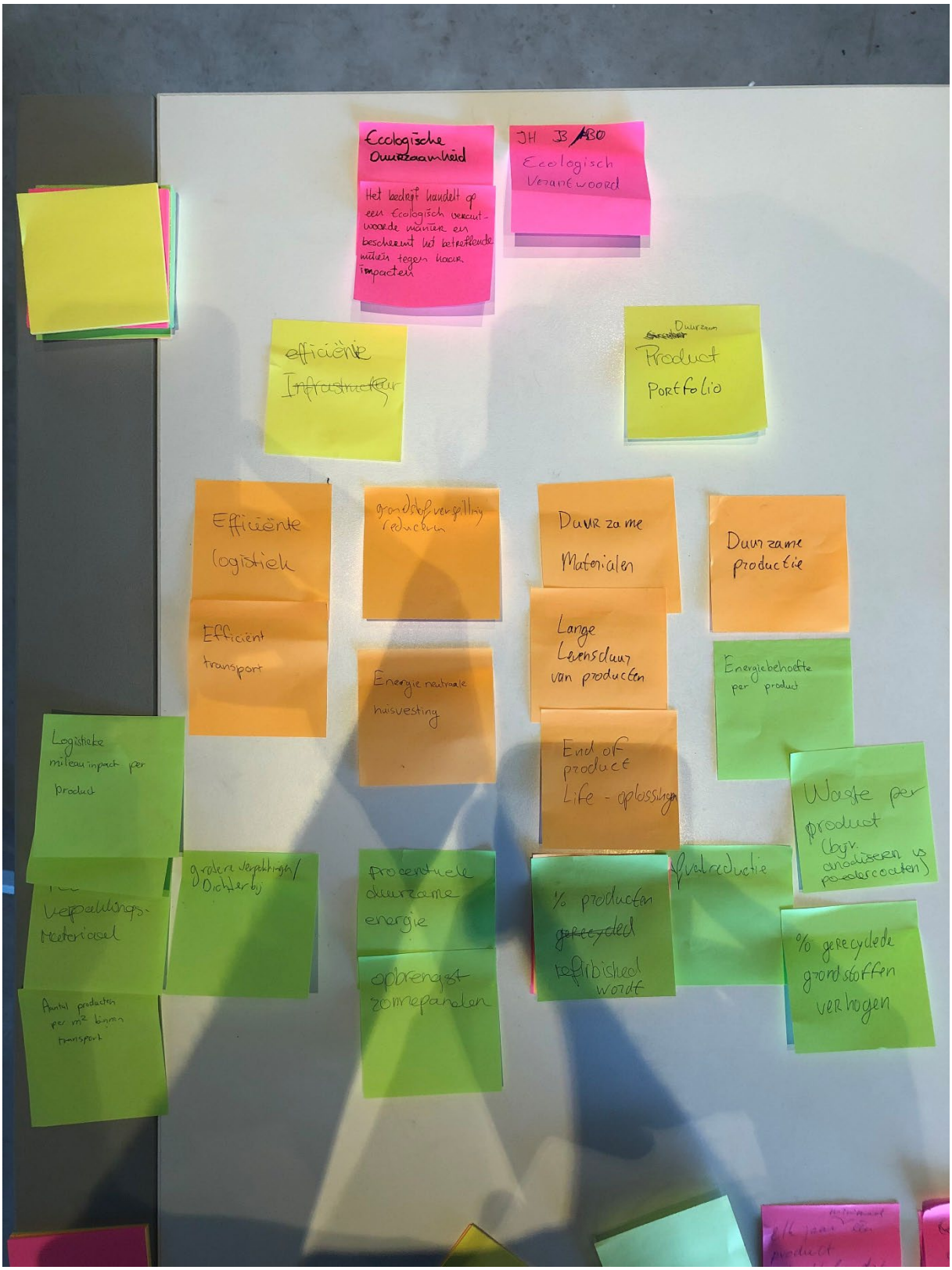


Figure 73 Overview of translation of mission and vision statement to sub goals and indicators

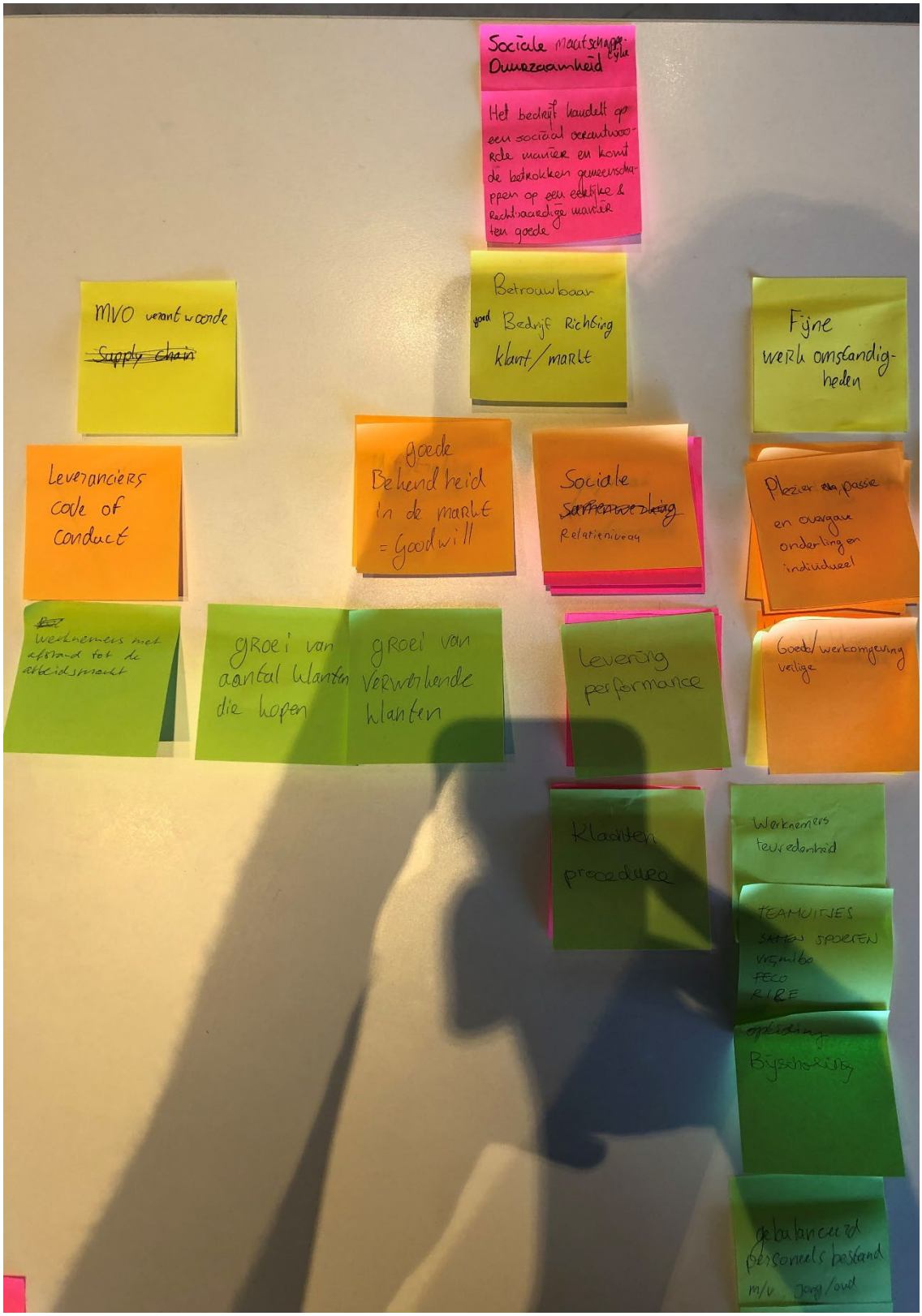


Figure 74 Overview of translation of mission and vision statement to sub goals and indicators

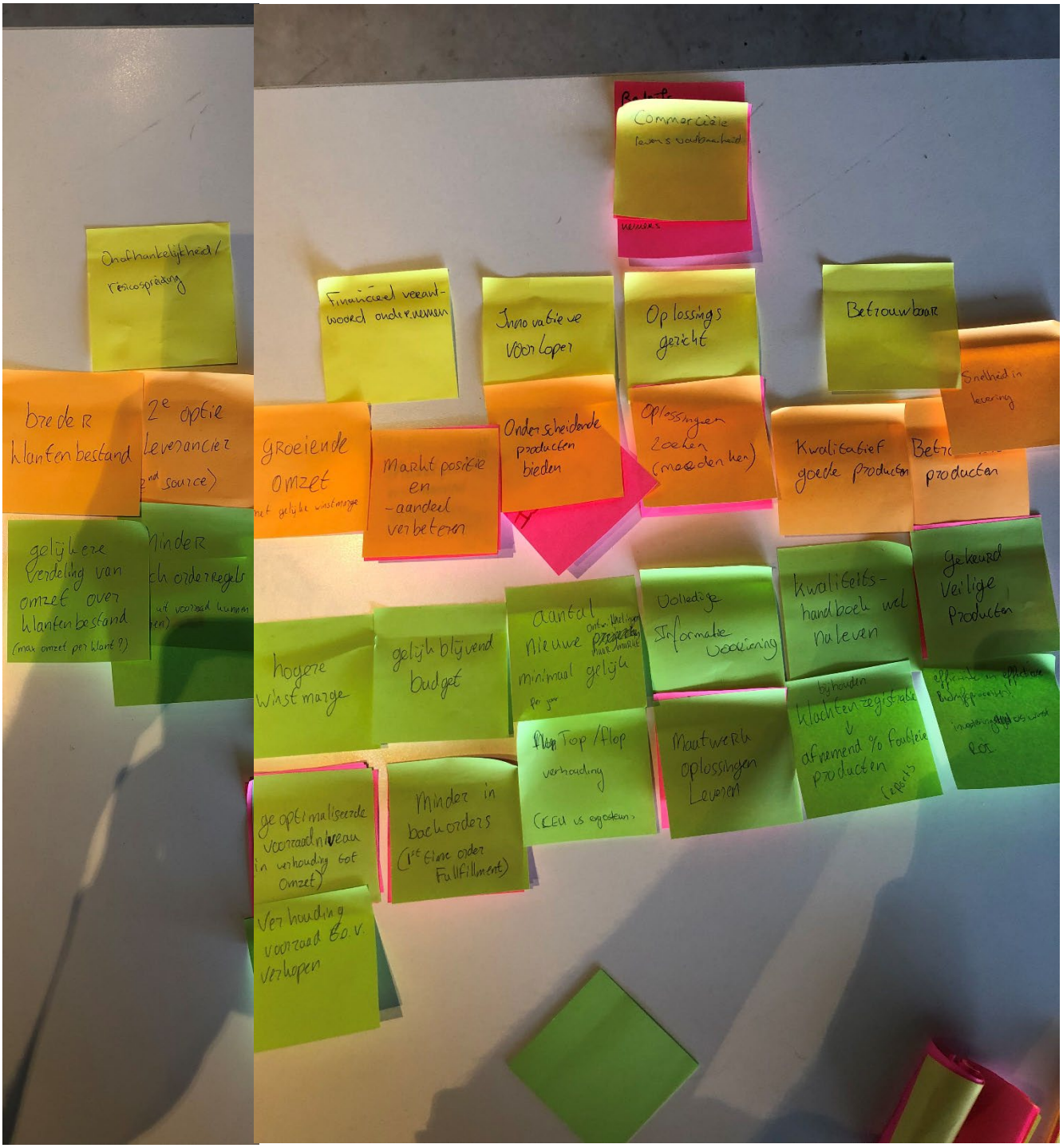


Figure 75 Overview of translation of mission and vision statement to sub goals and indicators

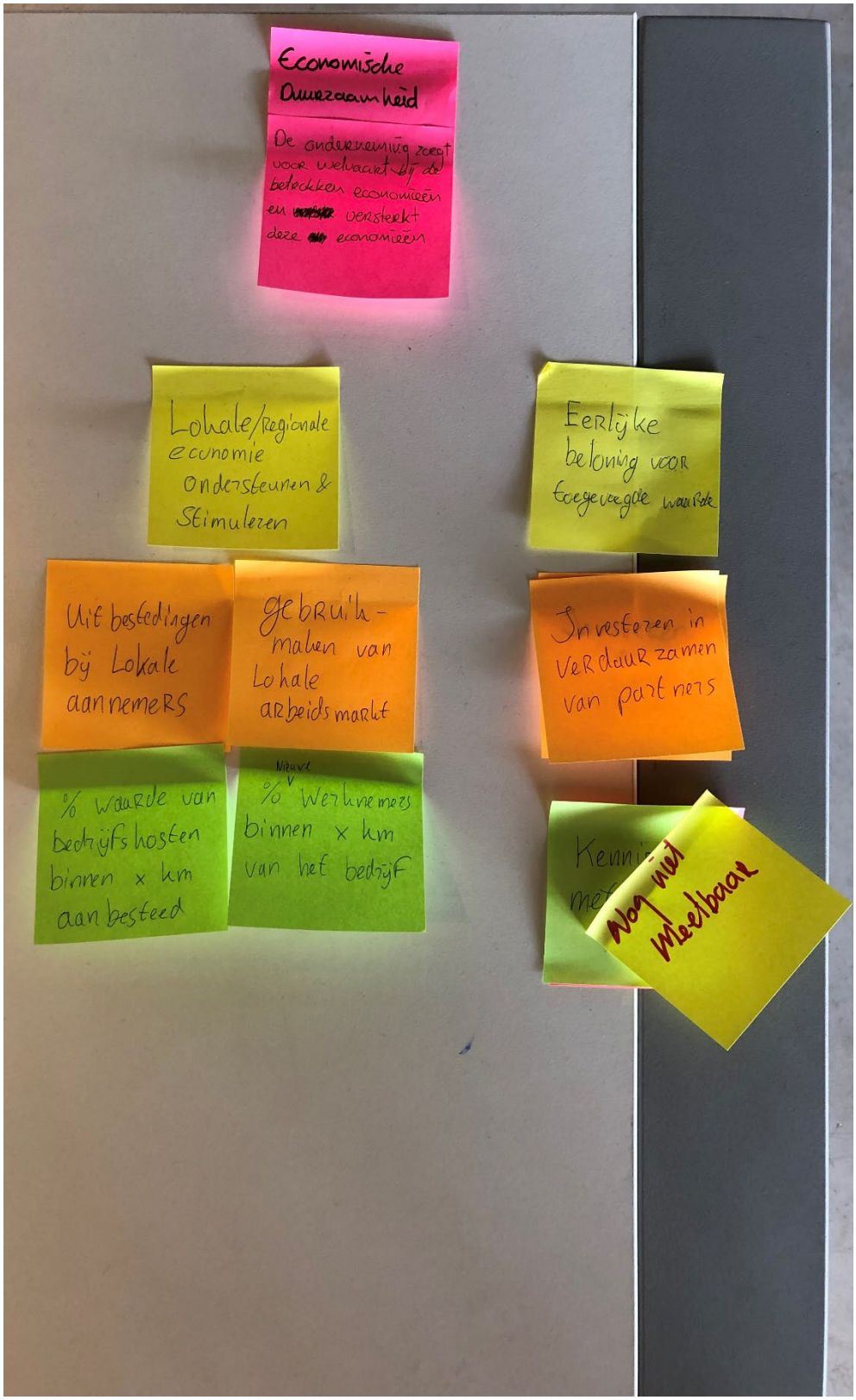


Figure 76 Overview of translation of mission and vision statement to sub goals and indicators

Figure 77 snapshot of group brainstorm process translating mission and vision to sub-goals and indicators workshop

Appendix 18) Brainstorming session: Action generation session

This appendix provides an overview of the first action generation brainstorming session. The overall list of generated actions is provided in the prioritisation model (M.G. Hoevenagel, 2022b). The second action generation brainstorming session is excluded, since this session was based on a "snowball e-mail". Due to time limitations of the employees this individual brainstorming technique was used to facilitate more actions in their own time. The results are in Dutch.

Results brainstorming session

Figure 78 Overview Action generation brainstorming session one

Figure 79 Overview Action generation brainstorming session one

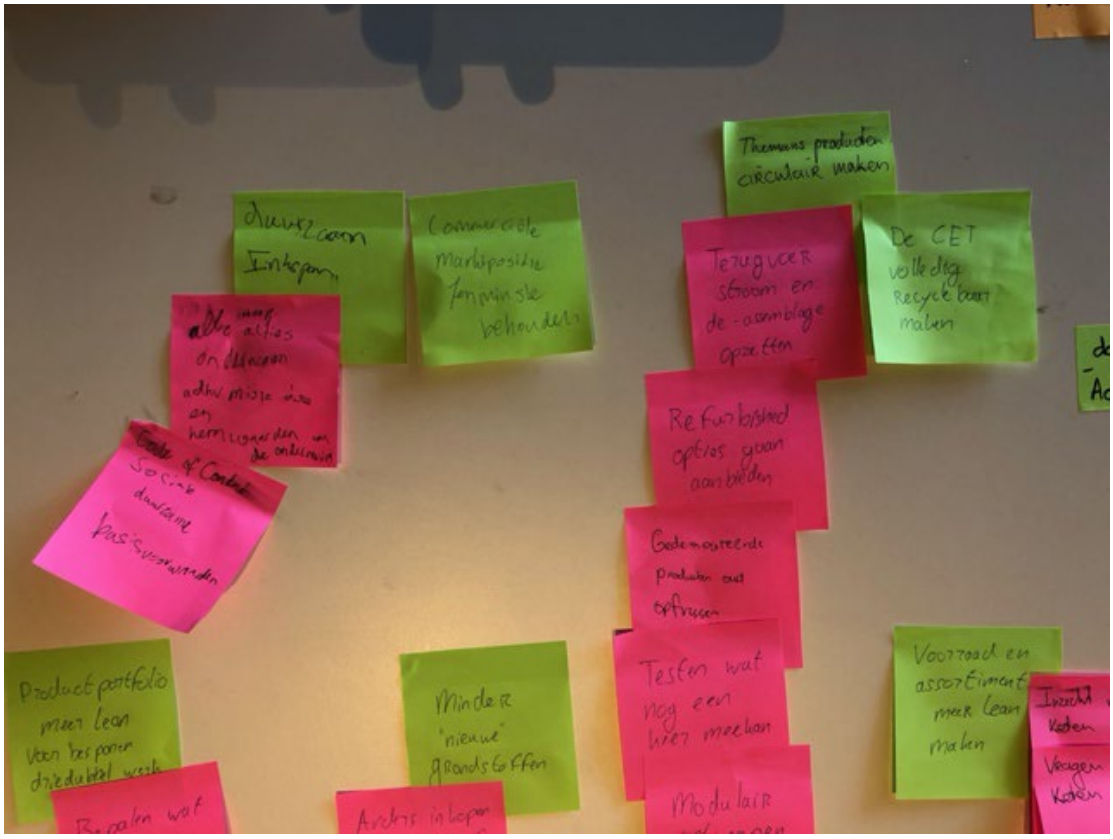


Figure 80 Overview Action generation brainstorming session one

Figure 81 Overview Action generation brainstorming session one

Overview of the actions in English:

making Themans products circular, - making the CET fully recyclable,- sustainable procurement, - making product portfolio more lean for saving triple work, - using less new raw materials, - recycled materials fittings line, - energy-neutral office/premises, - more efficient packaging, - more efficient transport, - more insight into people in the production chain, - draw up code of conduct - modular design - design for maintenance and repair - test whether refurbishing offers profitable options - develop return flow and de-assembly line - simplify product portfolio - investigate how to buy recycled materials - generate more contact with supply chain partners - insulate building better - add solar panels - install neutral air conditioning - reduce transport between production steps - arrange bulk transport from China - design more efficient packaging - set up additional assembly capacity - analyse current packaging

Not all actions could be used, due to incorrect formulation of the actions.

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