Developing and Integrating Life Cycle Management Methods in Project Management Systems

Case: Faveo Prosjektledelse AS

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Developing and Integrating Sustainable Life Cycle Management Methods in Project Management Systems,

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Oppgavetekst/Problembeskrivelse
1. A life cycle management literature review   2. A theoretical evaluation of the use of life cycle management in project management   3. The development of practical tools and/or routines for life cycle management including communication protocol using the project management systems of Faveo as a case   4. An evaluation of the added value for clients in incorporating life cycle management with project management   5. A discussion of the application of the life cycle management methods in other companies

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Partene er gjort kjent med avtalens vilkår, samt kapitlene i studiehåndboken om generelle regler og aktuell studieplan for masterstudiet.

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Abstract (English)

This master thesis was written as a requirement in the completion of the international Master of Science degree in Industrial Ecology with a specialization in environmental management and politics at the Norwegian University of Science and Technology. The thesis was written with the Department of Industrial Economics and Technology Management and under the supervision of Associate Professor John Eilif Hermansen. The case company for this thesis is Faveo Prosjektledelse AS, and the thesis is a continuation of the specialization project completed with Faveo in the fall of 2012.

The goal of this master thesis was to develop life cycle management tools and methods for use in project management. The research questions concerned the practical integration of these tools in a system dynamics perspective and the contribution this can have in creating value. First an introduction of the research area is given, followed by the methods employed, an exploration of the theoretical foundation, a theoretical analysis of how life cycle management in project management can be used, an explanation of the tool that was developed, an explanation of the application of the tool on a project and how it contributes to value creation, and finally a discussion is given followed by a conclusion. The Sustainable Project Life Cycle Management (SPLCM) Guide is the tangible result of this thesis, and it is an easy to use tool that project managers at Faveo (and at other companies) can use in their projects to mitigate the environmental and social impacts of their projects. Using this guide will change the Faveo system (illustrated in the specialization project) and allows the project managers to have a direct relationship with the community and the environment in the life cycle of their projects. The SPLCM Guide not only has the potential to reduce the impact the projects at Faveo have on society and the environment, but it can also create value for the project owners and for Faveo itself. Sustainable value creation meets the needs of stakeholders while creating value for the company, and the SPLCM Guide (in conjunction with other initiatives) can realize this for Faveo.

Abstrakt (Norsk)

Denne masteroppgaven var skrevet som en del av det internasjonale masterprogrammet i industriell økologi med fordypning i miljøledelse og politikk. Masteroppgaven ble skrevet hos Institutt for industriell økonomi og teknologiledelse, og førsteamanuensis John Eilif Hermansen var veilederen. Masteroppgaven var gjennomført i samarbeid med Faveo Prosjektledelse AS, og dette var fortsettelsen til fordypningsprosjektet som ble gjennomført hos Faveo i høsten 2012.

Målet med masteroppgaven var å utvikle livsløpledelsesverktøy og metoder for å bruke i prosjektledelse, og oppgaven har forskningsspørsmål som handler om praktisk integrering av disse verktøyene i en system dynamics tilnærming og bidraget dette har for verdiskaping. Denne masteroppgaven innholder en introduksjon som forklarer forskningsområdet, metoder, teoretisk sammendrag, teoretisk analyse til bruk av livsløpsledelse i prosjektledelse, verktøyforklaring, forklaring av hvordan verktøyet var brukt i et eksempelprosjekt og hvordan det bidrar til økt verdiskaping, og til sist er det en diskusjon og konklusjon. Sustainable Project Life Cycle Management (SPLCM) Guide er det konkrete resultatet av masteroppgaven. Dette er enkelt for prosjektledere å bruke hos Faveo (og i andre bedrifter) for å redusere miljø- og sosialeffekten til prosjektene sine. Bruk av denne guiden skal forandre Faveosystemet (utviklet i fordyningsprosjektet), og gjør det mulig for prosjektledere å ha en direkte innflytelse på samfunnet og miljøet i livsløpet til prosjektene sine. SPLCM Guiden har ikke bare potensialet til å redusere den negative effekten prosjektene hos Faveo har på samfunnet og miljøet, men den kan også skape verdi for prosjekteiere og for Faveo. Bærekraftig verdiskaping oppfyller hva aktørene trenger mens den skaper verdi for bedrifter, og SPLCM-Guiden (sammen med andre initiativer) kan realisere dette for Faveo.

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1.0 Introduction

Project management consultancies have the ability to influence the community and environment both positively and negatively. The range of industries in which project management consultancies operate gives the potential for these companies to influence the development of a sustainable society. However, these companies also have the potential to negatively impact the community and environment in which their projects take place, as well as further up the value chain. In a social and environmental perspective, the goal is to have sustainable projects; and to reach that goal, tools and techniques need to be developed to guide and aid project managers in their decision making. Sustainability cannot be achieved without thinking about the life cycle of both the projects and the products produced from those projects, and this life cycle needs to be managed to inhibit harm to the community and environment and to foster prosperity. The goal of this master thesis is to develop life cycle management tools and methods for use in project management. This thesis has been completed in cooperation with Faveo Prosjektledelse AS.

1.1 Background

This master thesis is the second half of a year-long project. The first half was the specialization project which used system dynamics methodology to evaluate the project management systems of Faveo Prosjektledelse AS. This section describes Faveo as a company, gives a summary of the specialization project and its relationship to the master thesis and provides a description of the master thesis.

1.1.1 Faveo

Faveo Projektledelse AS is the largest project management consultancy company in the Nordic region. They offer independent project management and project competence both in the private and public sector and have the goal of practicing project management at a world class level. Their services include project development and project control, and they work with both small and large projects (Faveo 2012). Faveo's projects are in a range of different areas including: construction, transport, property development, business development, IT and technology development, research and development and industrial projects. They have specialized competence and tools in many areas including economic, risk, time and environmental management. Examples of their projects include the hospital in Trondheim, Norway, a wind power project in Denmark and developing project, program and portfolio management at Nordea (a Nordic bank). In 2011, Faveo was involved in 1421 projects (representing billons of kroner in value), and it is because of the amount and scale of the projects Faveo is involved with that they significantly influence communities in both Norway and Sweden (Faveo 2011).

1.1.2 The Specialization Project

The goal of the specialization project was to analyze Faveo as a system in order to find opportunities for including corporate social responsibility (CSR) and environmental management in their project management systems and to create concrete world class project management criteria that Faveo can strive towards. Organizational learning and systems

thinking were the theoretical foundation for the specialization project. Using system dynamics methodology, Faveo was modeled as a system and further analyzed. This analysis showed that Faveo needs an integration of life cycle management in their project management systems that involve both CSR and environmental management for application in projects regardless of industry or project type. This problem needed to be solved in order to reach the goal of sustainable projects. Backcasting created a pathway to reach that goal, and a systemigram was created to show how life cycle management is necessary for sustainable projects. A gap analysis was also completed to show where Faveo is now in terms of sustainable projects. Opportunities for CSR and environmental management inclusion were identified to begin the process of developing life cycle thinking at Faveo. Concrete criteria for world class project management were also developed in the areas of organizational learning and sustainability. The specialization project laid the foundation for the development of life cycle management tools and methods.

1.1.3 The Master Thesis

The master thesis project will develop methods for the practical application of the results from the specialization project, i.e. integrating life cycle management with project management systems. This integration requires methods and competence building. The development of tools for the practical application of life cycle management will be based on the system dynamics evaluation of the Faveo system. To develop these methods, life cycle management will be explored. This exploration will include such questions as: what does life cycle management include and what is the current state of research on this topic? Life cycle management will also be evaluated in terms of its use in project management. This evaluation will research life cycle management methods which are currently utilized in order to develop their application for project management. From this evaluation and the knowledge of the Faveo system acquired from the specialization project, a tool will be developed for the practical implementation of life cycle management in project management. The added value for clients in incorporating life cycle management with project management systems will also be explored in this thesis by evaluating life cycle management's role in value creation.

1.2 Motivation

Faveo Prosjektledelse AS is an active member in the CSR Network at NTNU and was approached by the analyst in June 2012 to cooperate in the completion of both the specialization project and master thesis. Faveo has the vision and motivation to become an industry leader in terms of their ethical standards and the environmental performance of their projects. Their commitment to these goals has already been demonstrated by their achievement of ISO 9001 and 14001 certifications. Faveo's commitment to organizational learning is demonstrated through their Faveo Academy which works to build broad competence within their professional staff. Faveo's motivation and commitment has created an opportunity to develop tools that can be used industry wide to create sustainable project management.

Beyond Compliance

Faveo fully complies with all the environment, health and safety laws and regulations in Norway. On the national level, environmental regulations are administered by several

government bodies: the Ministry of the Environment, the Ministry of Petroleum and Energy (Olje- og energidepartementet), the Norwegian Climate and Pollution Agency (KLIF - Klima og Forurensnings Direktoratet) and the Climate, Industry and Technology Department: section for Climate Change and Emissions to Air (KLU), The laws in Norway concerning a company's impact on society and the environment are directed towards gross misconduct (e.g. the Pollution Control Act (KLIF 2013)). Faveo wants to go further than this.

The World Business Council for Sustainable Development (WBCSD) is a CEO-led organization that pushes for sustainability efforts within business instead of waiting for lawmakers to require sustainable action. The cornerstone to their organization is *Vision 2050* which details a pathway to a business-led sustainable future (Sandberg et al. 2010). This ambition is shared by Faveo, and this thesis is a part of their efforts in contributing to sustainable development.

However, it is not just for altruistic reasons that Faveo wants to increase its sustainability efforts. They work for their clients, the project owners, and Faveo needs to show how implementing sustainable initiatives will increase the value for the clients' projects.

1.3 Challenges

In undertaking this thesis, several challenges were soon realized. Life cycle management has been studied in various industries, and life cycle management in project management has focused on one industry at a time. The main challenge for this thesis is to develop a tool that is specific enough to be useful in all project types regardless of industry, but one which project managers can easily access the necessary parts for their particular project. If all project types are targeted, then project managers will have a lot of information that is irrelevant for their project. A filtering mechanism must be developed to avoid this so the project manager can use the tool with ease.

Another challenge is time. The tool will not be tested for the life cycle of a project. The application of the tool will be on a project that has already been completed, and the results of the actual application of the tool cannot be documented. This is, however, an unavoidable challenge, but one that can be remedied with future research.

1.4 Research Questions

This thesis will address the following research questions:

1) How can life cycle management be practically integrated into project management systems using the case of Faveo Prosjektledelse AS?

2) What is the added value for clients in the incorporation of life cycle management into project management systems?

1.5 Thesis Chapters

To answer these research questions, a system dynamics scientific approach is used. Chapter 2 explains this approach and the methodology. Chapter 3 gives a literature review of life cycle management. Chapter 4 gives a theoretical evaluation of the use of life cycle management in

project management. Chapter 5 explains the development of the life cycle management tool. This tool is then applied to one of Faveo's projects and the project manager who uses the tool is interviewed; Chapter 6 provides an interpretation of the results of this application. Chapter 7 explains the contribution of life cycle management to the value creation of projects. Finally, Chapter 8 discusses the results of this research, including the transferability of the life cycle management tool developed in this thesis.

2.0 Scientific Approach and Methodology

> *"We can't impose our will on a system. We can listen to what the system tells us, and discover how its properties and our values can work together to bring forth something much better than could ever be produced by our will alone."*
> — **Donella H. Meadows, *Thinking in Systems: A Primer***
> Environmental Scientist

This research uses a system dynamics scientific approach (explained in section 2.1.1). The methodology used in this thesis includes a literature review, qualitative modeling and a semi-structured interview; sections 2.2.1, 2.2.2 and 2.2.3 respectively explain how this thesis employs these methods. Lastly, section 2.3 discusses reliability and validity.

2.1 Scientific Approach

This research uses a system dynamics approach to answer the research questions. System dynamics was the scientific approach taken in the specialization project, and it was through system dynamics methodology that the specialization project was undertaken. While this thesis uses no new system dynamics methodology, this thesis is still operating within a system dynamics scientific approach because this thesis uses the results of the analysis in the specialization project. Section 2.1.1 explains system dynamics as a concept.

2.1.1 System Dynamics

System dynamics is used to address the main research goal of analyzing project management as practiced at Faveo Prosjektledelse AS. System dynamics methodology was originally developed at MIT by a group dedicated to this pursuit founded by Jay Forrester (Meadows 2008). Systems thinking and systems engineering are used interchangeably in some contexts; however systems engineering is more the process of creating and analyzing systems, and systems thinking is the cognitive processes used in the creation of those systems. Systems engineering is an iterative, interdisciplinary process which views problems holistically. Essentially, using systems engineering involves identifying elements, subsystems, and the systems' context, boundaries and properties, and then mapping how they are connected. Figure 1 shows an illustration of the ontology of systems engineering.

From this illustration, it is possible to see that systems engineering is used to analyze the world in a structured way, incorporating all the elements' needs and expectations. Systems engineering embodies life cycle thinking as it takes a holistic view of the world. Figure 2 shows the model of a product system, and from this illustration, it is possible to see how systems engineering focuses on the entire life cycle: from the people who need the product to the disposal of the product while illustrating the feedback loops and interactions.
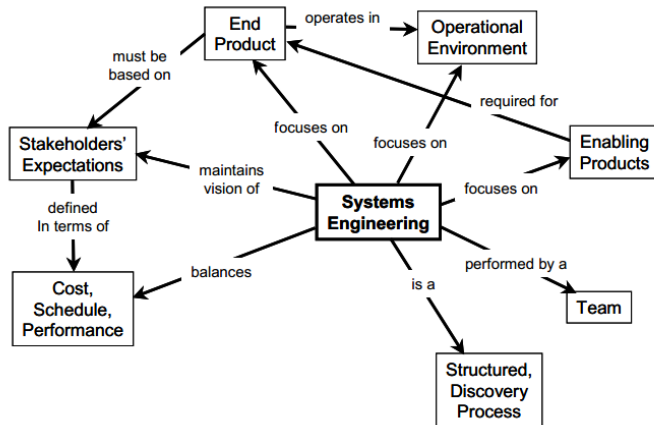
Figure 1: Concept Map of Systems Engineering (Bahill et al. 2002)   **Figure 2: Life Cycle of a Product (Haskins 2006)**
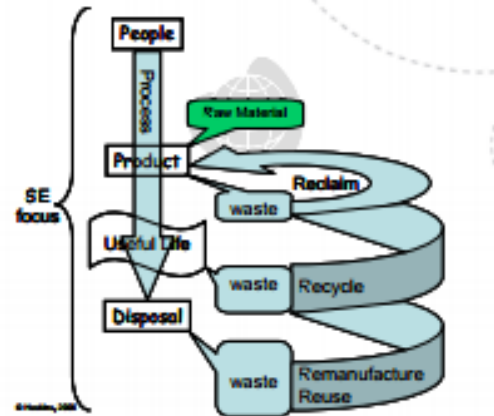
Some basic terms used in system dynamics include: system element, interconnections, function/purpose, system of interest and enabling system (Meadows 2008). A system element is one part of a system; this can be tangible or intangible. Interconnections in a system are the relationships between the elements. These relationships can be difficult to see, and the function/purpose can be even more elusive. Function is the term usually used for a non-human system (mechanical), and purpose is used for a human system (organizational and social systems) (*ibid*). The system of interest is the system that is being studied, and the enabling system is a system that complements the system of interest somewhere in its life cycle but is not directly responsible for its function. Systems engineering is both systematic and systemic in that there are systematic processes that can design complex systems, but it is rooted in systemic thinking in order to recognize and solve complex problems by seeing the whole instead of only the parts (Haskins 2008).

According to ISO/IEC 15288:2002 (2002) on system life cycle processes, a system is "a combination of interacting elements organized to achieve one or more stated purposes." This can be applied to an organization as well because the organization is exactly that: elements interacting purposefully. System dynamics is useful in analyzing companies because the corporation is a complex feedback system and using systems engineering can test social systems; yielding the same benefits it does for engineering. Organizations are systems, and by applying systems engineering methodology to Faveo Prosjektledelse AS, it is possible to gain an understanding of how the company operates and interacts with the environment and the community.

2.2 Methodology

The specialization project and this thesis both use a qualitative research design. The data collection for the development of the life cycle management tool in this thesis was completed in the specialization project in the fall of 2012, but this is supplemented by the methods in the master thesis in order to develop the life cycle management tool and to answer the thesis research questions. This analysis uses literature review, qualitative modeling and a semi-structured interview. However this thesis contains no new qualitative models; the models from the specialization project are the only ones used for further analysis. Section 2.2.1 explains how the literature review is undertaken. Section 2.2.2 describes the qualitative

modeling completed in the specialization project, and Appendix 1 provides all models. Section 2.2.3 explains why and how the semi-structured interview is used in the research design.

2.2.1 Literature Review: Theoretical Resources

An academic literature review is used for several different purposes in this thesis. While the goal of this thesis is to develop life cycle management tools and methods for use in project management, life cycle management must be explored as a concept. This is not a traditional literature review; it is an exploration of the theoretical foundation for this thesis. The current state of research for life cycle management will help shape the concept for further analysis. What is meant by further analysis is how life cycle management is or could be used in project management. In this thesis, literature is reviewed for the theoretical evaluation of the use of life cycle management in project management. This theoretical evaluation helps in the development of the life cycle management tool. Value creation is an important topic related to project management that is advantageous to explore in this thesis because of the added value life cycle management incorporation can contribute to the client's projects, and an exploration of the literature will assist in understanding this.

The process of choosing the literature was tailored to fit each purpose stated in the previous paragraph. The exploration of life cycle management begins with an explanation of sustainability, sustainable development and life cycle thinking. These are established concepts and many authors explain these in the literature. The literature chosen for the explanation of these concepts is from well-known sources in the field of sustainability (e.g. Elkington and UNEP), and they were chosen because of their contributions to the field itself. While there is a wealth of sources for these concepts, there are few for life cycle management as a concept. This is partly because it is called by other names (e.g. life cycle engineering) and because life cycle management is often not seen as different from environmental management. Therefore, the literature for life cycle management was chosen by "snowballing;" by finding applicable sources and then investigating the literature used in the first source. The theoretical evaluation of the use of life cycle management in project management also uses snowballing. There is very little research conducted on this topic, and there was very little choice as to which sources needed to be included in the evaluation. The value creation literature was chosen for two reasons: first, Faveo's own researchers have published on the topic and the analyst was able to discuss the literature with the authors; second, the sustainable value creation literature is rather unique in that there are few sources on the topic, and the explanation by the author chosen (see Laszlo 2003) was the most applicable to the tool developed in Chapter 5.

2.2.2 Qualitative Modeling

The development of the life cycle management tool uses the results of the system dynamics analysis completed as part of the specialization project. The specialization project used qualitative modeling as a way to illustrate and analyze the Faveo system. The SPADE framework developed by Haskins (2008) was used to develop and analyze this system model. SPADE stands for: Stakeholders, Problem Formulation, Analysis, Decision-Making and Evaluation. Within each of SPADE's elements, it is possible to use various methods for analysis.

For the stakeholder part of the framework, a stakeholder analysis was applied to Faveo Prosjektledelse AS. The specialization project uses the model for stakeholder analysis developed by Haigh & Griffiths (2007) which is adapted from Mitchell et al., (1997) and Driscoll and Starik (2004). Each stakeholder is evaluated based on the attributes of power, urgency, legitimacy and proximity; and in doing so, places the stakeholder into one of five categories: non-stakeholder, latent stakeholder, expectant stakeholder, definitive stakeholder and primary stakeholder. This model is used because it incorporates the natural environment into the stakeholder analysis, and the natural environment is an important focus for this project. Appendix 1.1 provides the stakeholder analysis from the specialization project.

In formulating the problem, the specialization project uses concept mapping as explained by McCartor et al. (1999). Concept mapping is a way of making non-linear relationships explicit by placing every element (object or event) in a circle and then arranging these in a hierarchal manner with the most general being the outermost circles and the most specific being the innermost circles. The circles are connected with lines to illustrate the connection between the elements. By using concept mapping, the problems and challenges in the Faveo system became apparent. Appendix 1.2 and 1.3 provide the level 1 and level 2 concept maps respectively.

To analyze the problem and to create a pathway for reaching Faveo's goal of becoming a world class project management company, the specialization project used backcasting according to the framework described by Holmberg & Robert (2000). Backcasting is the opposite of forecasting in that it describes the end goal and explains the steps needed to achieve this. In using backcasting, the system conditions and principles must be clarified. Backcasting was used to analyze the Faveo system because it provided an explanation for how to solve the problem and tackle the challenges uncovered in the problem formulation concept mapping, and this yielded a pathway for reaching the end goal. Appendix 1.4 provides the backcasting from the specialization project.

For the decision-making part of the SPADE framework, the specialization project used systemigrams (developed by Boardman and Sauser (2008)). The systemigram illustrates systems in a way that other system diagrams cannot. Systemigrams use both prose and pictures to describe complex non-linear systems. Boardman and Sauser (2008) provide rules for creating the prose and graphics, and these were applied to the Faveo system. The systemigram designed the system and addressed the problems and challenges identified earlier in the application of the SPADE framework; decisions were then made concerning them. Appendix 1.5 provides the systemigram from the specialization project.

Concerning evaluations, the specialization project used an evaluation matrix developed by Blanchard and Fabrycky (1998). This project used the evaluation matrix for the gap analysis of Faveo Prosjektledelse AS. This matrix lists criteria (created by the analyst) based on the earlier SPADE framework analyses and then measured whether Faveo was fulfilling these criteria. Some of the criteria were weighted by the analyst. Appendices 1.6-7 provide the evaluation matrices.

2.2.3 Semi-Structured Interview

For the initial testing of the tool presented in Chapter 5, the tool is applied to a completed project at Faveo. Because of time challenges, the tool is applied to a completed project. The goal of this application is not to scientifically test the tool (the goal of thesis is to develop the tool), but the test application is meant to give an initial indication of how the tool will work in an actual project. Because of the lack of time (and scientific testing being beyond the scope of this thesis), the project manager who applied the tool to a completed project is interviewed to understand the potential effects of using the tool and to understand how the tool will work in an actual project. The project manager is interviewed to understand their experience in using the tool to test the language and explanations in the tool and to understand their thoughts about how it will affect the environmental and social performance of their project. Appendix 4 provides the interview guide and gives the interviewee's (the project manager) answers in full. The interview guide was developed based on the guidelines and information in Bryman's (2012) *Social Research Methods* (4th edition). The interview guide has two parts: part 1 seeks to understand the potential effects of using the tool; part 2 questions the project manager on their experience in using the tool. The interview is semi-structured to allow for flexibility in the interview because of the interview's exploratory nature.

2.3 Reliability and Validity

Concerning reliability, it is useful to use the term dependability when using qualitative research methods (Bryman 2012). The research in this thesis is carried out by one person, but it is in collaboration with those both at Faveo and NTNU. These collaborators then act as 'auditors', and this interaction increases the dependability of the methods. For example, the analyst created the interview guide but was 'audited' by the thesis advisers, Ole Jonny Klakegg and John Hermansen. The specialization project supervisors, Cecilia Haskins and Ole Jonny Klakegg audited the qualitative models

This thesis uses triangulated methods in pursuit of its research goal. The goal is to develop a sustainable project life cycle management tool and integrate it into the project management system of Faveo. This research uses qualitative modeling, literature review and a semi-structured interview to accomplish this. Triangulation increases the credibility (and hence internal validity) of the results; in that several different methods construct a social concept. In this thesis, it is the concept of life cycle management in project management.

External validity is a concern in this thesis because the development of the life cycle management methods is based on the system dynamics analysis of Faveo Prosjektledelse AS. This company was chosen as a case company because of their motivation to improve their corporate social responsibility and environmental performance and their willingness to cooperate in this project. Because of the variety of project types and volume of projects (both number and worth) that Faveo is involved with, the methods developed based on their project management systems stand a good chance of being applicable in other project management consultancies. Testing is, however, crucial in understanding whether this is possible, and section 9.1 discusses the necessary future research. Section 8.4 discusses the external validity of the results of this thesis.

3.0 Theoretical Resources

Sustainable development is like teenage sex – everybody claims they are doing it but most people aren't, and those that are, are doing it very badly."
— Professor Chris J Spray
Dundee University

This chapter explains life cycle management (LCM) and its theoretical foundation. It begins by introducing sustainability; this section explains important terms such as the triple bottom line (TBL), sustainable development and the green economy, as well as the business case for sustainability and how sustainability is approached systemically. This explanation leads to the discussion of how life cycle thinking is an important part of sustainability; and section 3.2 explains life cycle thinking, its advantages and drivers, and introduces supply chain management. Section 3.3 gives a thorough explanation of LCM, including methods for implementation, its role in green supply chain management and tools used in the application of LCM.

3.1 Sustainability

Sustainability can be defined simply as balance. Balance between growth, resources, welfare and health of a system. Sustainability as a term can be applied to any kind of system, but the system referred to in this research is the earth. In order for the human race to continue inhabiting the planet, the economic activities need to switch focus to long term sustainability goals so as not to degrade the environment to the point that it makes it uninhabitable for life.

3.1.1 The Three Pillars of Sustainability: The triple bottom line

In the sustainability of the earth, there are three areas that must be in balance: the economy, society and the environment. These are called the three pillars of sustainability and are shown in Figure 3.

Figure 3: The Three Pillars of Sustainability
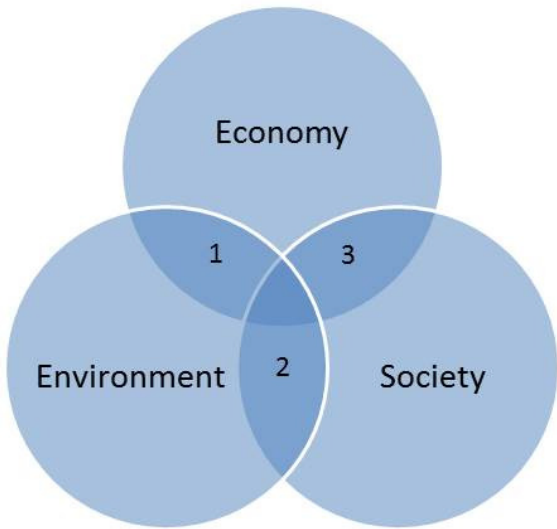
Figure 4: The Triple Bottom Line (TBL) and the shear zones: 1=eco-efficiency, 2= environmental justice, 3= business ethics

At the 2012 United Nation Conference on Sustainable Development (UNCSD), or Rio +20, the UN Major Group, Indigenous Peoples, wanted culture to be added as another pillar (IPMG 2012). They were not successful in their campaigning, but it illustrates that what has been defined as sustainability is not all encompassing and is subject to debate.

The triple bottom line refers to the interaction between the three pillars of sustainability. These interactions form economic, social and environmental accounting that must be in balance in a sustainable world. Elkington (1998) explains that these lines are constantly in flux. He describes them as tectonic plates, and when they interact with each other they form 'shear zones.' The shear zone between the economic and environmental agendas is *eco-efficien*cy; between the environmental and social agendas is *environmental justice* (intra- and inter-generational equity); and between the social and economic agenda is *business ethics*. The shear zones (represented in Figure 4) express how the relationships must be managed in a sustainable world.

3.1.2 Sustainable development and the Green Economy
The difference between sustainability and sustainable development is growth. Economic growth in a manner that does not negatively affect the environment and the welfare of its inhabitants is called sustainable development. The most well-known definition of sustainable development is from the 1987 report from the World Commission on Environment and Development, "Our Common Future," which states: "sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs." (WCED 1987). This is a very vague definition of sustainable development because it does not explain "the how;" it only explains the pillars of sustainability need to be in balance if economic growth is to be sustained. This is where the green economy fits into the concept of sustainability.

There is no agreed upon definition of the green economy. Business and industry, the UN, NGOs and various governments have each developed their own definition of the green economy. The term is sometimes used synonymously with sustainable development, but the green economy is however a way of operationalizing sustainable development. The United Nations Environmental Program's definition of the green economy is: a *system of economic activities related to the production, distribution and consumption of goods and services that result in improved human well-being over the long term, while not exposing future generations to significant environmental risks and ecological scarcities* (UNEP 2011).

What makes the green economy different from sustainable development is its focus on concrete economic measures. Sustainability is the goal, sustainable development is how it is accomplished and the green economy includes the economic actions that drive the process.

3.1.3 The Business Case for Sustainability
If the inherit goal of business is to make profit, why is it in their own interest to contribute to sustainable development? Sustainable development cannot be accomplished without the contribution of business. Business, however, benefits from this contribution. This is a subject that is complex and organizations have formed to support it (e.g. World Business Council for Sustainable Development (WBCSD)). This thesis provides a brief overview of the business

case for sustainability. Below are three of the most common arguments for the business case for sustainability.

Competition
Competition is driving business to take sustainable development seriously (Holliday et al. 2002). It is becoming the norm for business to implement sustainability initiatives. As the competition for talent and new customers increases, business will be forced to become more sustainable.

Value Creation
Sustainability practices are developed and implemented by companies because of the potential contribution these practices could have for value creation (Chapter 7 explores this in detail.) For example, companies often begin new activities before they are known to be profitable (*ibid*); sustainability is in that unknown profitability category for most companies. It has also been argued by SustainAbility (a think tank for sustainable business) that sustainable development practices are at worst neutral for shareholders and have been shown to add value (SustainAbility 2001). Shareholder value is driven by brand value and reputation, risk profile and customer attraction, and sustainability performance affects all of these.

Transparency
Increasing transparency is also driving business to take a more serious look at their social and environmental impact. Unwanted attention of the media and NGOs from highlighting the poor and social and environmental performance of companies pushes management to factor in the needs of their company's stakeholders. Also, financial markets are more cognizant of unsustainable business practices than ever before and will become even more aware in the future (Holliday et al. 2002).

3.1.4 A Systemic Approach to Sustainability
There are different approaches in attempting sustainable development. For example, anthropogenic and eco-centric approaches see the world from the point of view of humans and the earth respectively. To have a strong approach to sustainability, there needs to be an ethical foundation, and one approach that does this holistically is systems thinking. This was described earlier in section 2.1, and in this section systems thinking will be briefly discussed in terms of how it can be used to approach sustainability.

In using a systemic approach to sustainability, the focus is on the interaction of the elements relevant to sustainability (Espinosa Salazar and Walker 2011). Sustainability in this perspective entails the interactions between social systems (human systems) and ecosystems. This is a whole system perspective called the socio-ecological system (Gallopin 2003), and the basic properties of this system are: (1) availability of resources, (2) adaptability and flexibility, (3) general homeostasis: stability, resilience and robustness, (4) capacity of response, (5) self-reliance and (6) empowerment (*ibid*).

Sustainability is not the same as constancy; in sustainable systems, there can be constant change. Sustainable system change can be seen as co-evolutionary because of the adaptability of the system to the change. Change in sustainable systems is not the same as sustainable

development because sustainable development implies one-directional, progressive change (Gallopin 2003).

Sustainable development does not always mean growth either; development implies increasing complexity. An important part of sustainable development is the redefinition of progress. The current socio-ecological system is unsustainable, but the question now is what is to be changed in the system to make it sustainable.

3.2 Life Cycle Thinking

Sustainable development is embedded in life cycle thinking. In traditional environmental management, the focus has been very often on production process, and cleaner production and pollution prevention are common methods for improving the environmental performance of this process (Pesonen 2008). By focusing on production, a very narrow scope of the environmental impacts of a product is taken. If the environmental performance of production is improved, this improvement may be at the expense of another stage of the life cycle. This is called environmental problem shifting. To avoid this, it is important to use life cycle thinking which takes the focus away from production and puts it on the product. The relationship between systems thinking and life cycle thinking is explained in section 2.1.1. The focus of this section is to expand this explanation to include environmental management.

Life cycle thinking is a cradle to grave perspective (creation to disposal) of the product. The life of the product is broken down into stages, as shown below in Figure 5 where each arrow is a different stage in the life cycle. There is also a cradle to cradle perspective which adds an additional life cycle stage which accounts for any environmental impacts from materials taken from recycling after the end of life (EOL).

resource extraction → Production → Deployment → Use → Disposal or End of Life (EOL)

Figure 5: Life Cycle Stages

As mentioned, life cycle thinking avoids problem shifting because if production is made cleaner, the environmental impacts of other life cycle stages can be monitored for change. And while cleaning up production may help improve environmental performance, this improvement may mean very little when compared to impacts in other life cycle stages (UNEP 2004). An interesting example of this is the British government reporting that its carbon footprint had fallen by 19 % between 1990 and 2008 (Beament 2012). This is not actually true. The carbon emissions generated in the UK had decreased, but if the entire life cycle of the products consumed in the UK is considered, then emissions actually rose by 20 %. Production of goods in the UK has largely been outsourced to developing countries (as has happened in most first world countries), and the carbon emissions in production were no longer being accounted for.

In corporate environmental management, life cycle thinking must be developed. To begin this process of development, management needs to consider the supply chain.

3.2.1 The Supply Chain

Even in life cycle thinking there are boundaries to what is incorporated into the life cycle. In Figure 6, the life cycle of a product is on the right side of the figure (same figure shown in Figure 5). On the left side, activities further up the supply chain are shown (further "upstream"). In this figure, the activities for the minerals that need to be extracted for the production of company A's product is shown. The different suppliers that are needed for these activities are shown, as well as the suppliers that supply the suppliers, i.e. the supply chain. There are, of course suppliers in the life cycle to the right of the dotted line that are accounted for, but this figure shows all the suppliers that are not accounted for even when taking a life cycle perspective and illustrates the complexity of supply chains. They essentially never end. When a company adopts life cycle thinking, it is important to not just think of the suppliers and relationships, but also the suppliers of the suppliers and so on. In this way, life cycle thinking can begin to take hold (UNEP 2007).
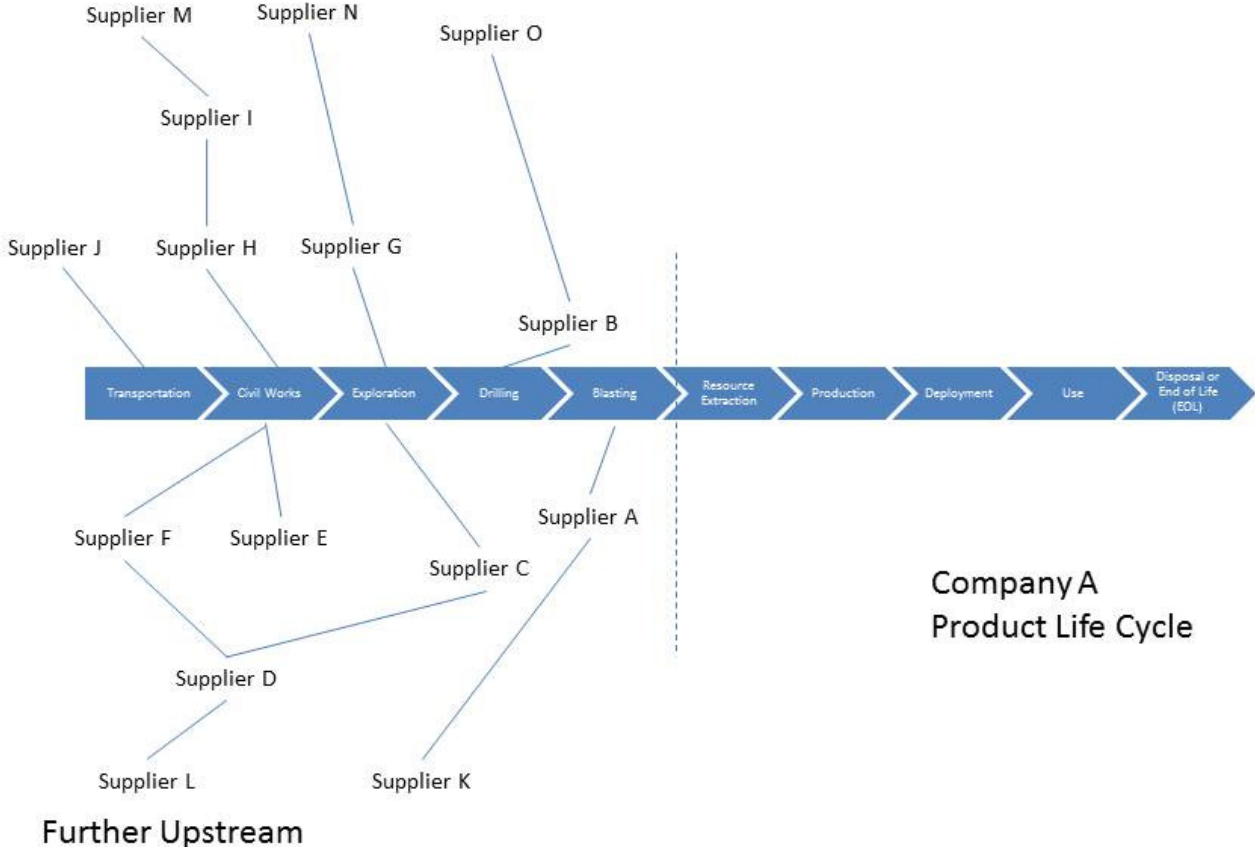
Figure 6: Life Cycle Thinking and the Supply Chain

Green supply chain management (GSCM) is an environmental management concept that takes environmental management and introduces it to the supply chain. This includes for example: design, choice of raw materials, packaging and the environmental performance of the suppliers. GSCM begins by using life cycle thinking and understanding how a product or service indirectly impacts the environment and society through its suppliers. GSCM needs to

be strategically planned through life cycle management starting with green procurement and operations planning (Emmett and Sood 2010). Green procurement fosters collaboration with suppliers that builds sustainable supply networks. Once these networks are developed, GSCM continuously improves the supply chain's impact on the environment and society by identifying the environmental and social problems in the supply chain and working to minimize or eliminate these problems.

3.2.2 Advantages of a Life Cycle Approach

From a business perspective, there are many advantages in using life cycle thinking as an approach to environmental initiatives. These are termed 'internal driving forces' in adopting life cycle thinking and these are listed below (Remmen and Münster 2003).

The Responsibility of Management: An important responsibility of management is to reduce the environmental impact of their business. Using life cycle thinking will allow for a more precise and thorough identification of the impacts.

Improved Product Quality: While the purpose of life cycle thinking is to understand environmental (and social) impacts, using life cycle thinking may improve product quality in the process.

Reputation: If a company has a desire to improve its image, adopting life cycle thinking in its environmental initiatives can be marketed in a way that helps the reputation management of the company.

Reduction in Costs: Improving the life cycle impacts has the potential to help both the environment and the bottom line. Cutting waste is one example of this, as well as increasing efficiency.

Employees: Employees in a company are often interested and willing to be involved in environmental initiatives, and life cycle thinking can improve this culture. Improved environmental performance will also help attract new talent to the company.

Technology Development: The potential for fostering technology development and innovation is also possible when taking a closer look at the life cycle of a product.

There are also 'external driving forces' for adopting life cycle thinking in approaching environmental initiatives which are forces connected to elements outside of the company (Remmen and Münster 2003). The following list gives examples of the main external driving forces.

Goodwill with the Authorities: Life cycle thinking will take the companies environmental initiatives above and beyond what is required from government agencies which will foster goodwill with these entities.

Market Advantage: Cleaner products receive eco-labels, such as the EU Flower and the Nordic Swan. A life cycle thinking approach offers more than what is required by most eco-labels, and this can give a company an advantage in the market.

Public Demand: The public is not only increasingly buying products that have a good environmental performance, but they are questioning the companies that do not. By adopting life cycle thinking in environmental initiatives, this demand will be better satisfied.

Competitive Advantage: Life cycle thinking within a company will put its environmental initiatives in the forefront of the industry. In operating in this way, it may even be possible for a company to create the benchmark for environmental management within the industry.

Network Demand: As knowledge of supply chain environmental impacts are better understood, a life cycle approach may be required in their environmental initiatives to maintain buyer/seller relationships.

Network Collaboration: The network that a company operates in is a community that can share information to foster environmental innovation which can work to everyone's mutual advantage.

3.3 Life Cycle Management

It has been established in the previous section that life cycle thinking is important if sustainability goals are to be reached. This section will explain how the life cycle is incorporated into environmental management, i.e. life cycle management (LCM). LCM will first be explained as a concept, and how it can be implemented. For this implementation, tools are needed; and the most common tools are explained in this section, including life cycle analysis (LCA), strategic life cycle management, (SLCM), environmental life cycle costing and stakeholder analysis. This section ends with examples of how LCM is applied in different industries.

3.3.1 What is Life Cycle Management?

Life cycle management seeks to manage environmental aspects over the entire life cycle of a product or service to make the environmental impact as small as possible so that sustainability goals can be achieved. This life cycle encompasses the entire value chain from the extraction of raw materials to the end of life management (McLaren and McLaren 2010). UNEP (2004) gives a concise definition of life cycle management: "life cycle management (LCM) is the application of life cycle thinking to modern business practice, with the aim to manage the total life cycle of an organization's product and services toward more sustainable consumption and production" (p. 10). LCM is a framework that includes many different tools, methods and procedures that incorporate the environmental, social and economic elements of the company's products and services. LCM is a management framework that must be tailored to meet the particular industry and company it is applied to (UNEP 2004).
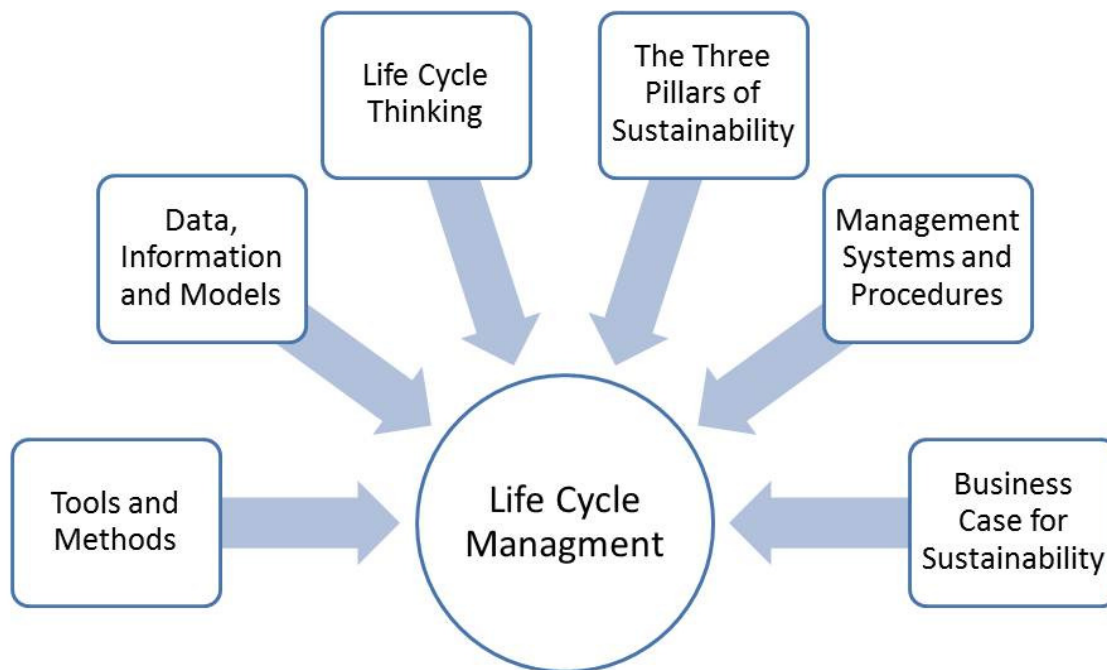
Figure 7 illustrates what is involved in life cycle management. Life cycle thinking, sustainability and the business case for sustainability have already been explained. The tools and methods are explained in section 3.3.2. Examples of management systems and procedures include (UNEP 2007):

- Communication
- Eco-labeling
- Certification
- Sustainable Procurement
- Stakeholder Engagement/ Product Panel
- (Product-Oriented) Environmental Management Systems
- Design for Sustainability
- Dematerialization
- Environmental Impact Assessment

This list is not exhaustive; the aim in listing this here is to show a sampling of the systems already in place in companies that can utilize elements of life cycle management.

This is also true for the data that companies have at their disposal. Companies have a lot of information and raw data that can inform life cycle management. What is important is to utilize this data when using life cycle thinking. Examples of data, information and modeling include (UNEP 2007):

- Databases
- Best Practice, e.g.
- Benchmarks,
- Standards
- Weighting Schemes
- Models, e.g.
- Dose-Response
- Fate and Exposure
- Scenario

McLaren and McLaren (2010) discuss the elements of life cycle management. These elements are organized under three categories: organization aspects, internal LCM project areas and communication. This is illustrated in Figure 8.

Organizational Aspects: The entire organization of a company needs to be considered in life cycle management. This includes the strategy, the structure and responsibilities, management review and decision making processes and internal capability building processes. There needs to be a clear vision for the environment and social responsibility. This vision needs to be turned into strategy, and the structures in place need to embody the responsibility and accountability to turn strategy into practice. There are technical and non-technical aspects of LCM that will be new to the employees, and this will require the company to raise its competence level in order to practice LCM. Using some LCM tools, however, can be outsourced to consultants (e.g. LCA), and the information gained from these tools can be utilized in decision making in the company.

Organisational Aspects	Internal LCM Project Areas	Environmental Communication
Sustainability and environmental strategy	Sustainable product design and development	Communication and marketing strategy
Organisation structure and responsibilities	Operations and environmental management systems	Market facing information: environmental product declarations, product ecolabels, standards, sector level requirements
Management review and decision making processes	Supply chain management	Environmental reports, life cycle studies
Internal capability building processes	End-of-life management	Stakeholder relations and communication to build networks for change

Figure 8: Elements of LCM (McLaren and McLaren 2010)

Internal LCM Projects: Internal LCM project areas break LCM down into targeted areas. These include: sustainable product design and development, operations and environmental management systems, supply chain management and end of life management. If life cycle thinking is embedded in product design and development, innovation will be fostered which can only benefit the environment and society. Operations and environmental management systems include having control over the internal environmental aspects of a company, possibly with environmental management certifications such as ISO 14001 and EMAS. Green supply chain management takes the boundaries of the life cycle further by understanding how suppliers and other companies in the supply network are practicing environmental management and using life cycle thinking. End of life management can create opportunities for a company to strengthen customer relationships and possibly create first mover advantage.

Information gained in this part of the life cycle can inform other stages which will in turn improve the end of life environmental and social performance.

Communication: Communication is about transparency and brand management. Transparency is important in environmental and social responsibility reporting, and it is important to have a stakeholder management system that includes how the stakeholders are engaged and communicated with. Communication and life cycle management work together for marketing purposes as well. This can take the form of eco-labeling and environmental product declarations, but it can also be used as strategy to engage green consumers.

Implementing LCM

Implementing LCM in a company can seem like a daunting task because it requires employees to change the way they think. The Danish Environmental Protection Agency in 2003 explained a nine step process for beginning the implementation of LCM in a company.

1) **Policy:** The first step is to set goals and determine the ambition in terms of sustainability. Once this is established, the policies of the company need to be changed to reflect this. The policies need to be concrete and realistic; this will avoid creating a gap in what the company says it does and what it actually does.

2) **Organize:** This step involves using the organizational aspects of LCM described above to enable the policy of the company.

3) **Survey:** The data, information and models mentioned above are the basis for the survey the company needs to execute in order to evaluate the present state of the environmental and social impact of the company. This step may require the involvement of experts for the evaluation.

4) **Goals:** Based on the survey, the company must decide where it must direct its efforts. Decisions must be made between what is most important to fix now and what resources are available to fix them.

5) **Environmental (and Social) Improvements:** Once these decisions are made, the plans then need to be enacted to make the improvements.

6) **Reporting:** Transparency is important. As plans are put into action, the results of these plans need to be communicated and should be made public. The type of reporting is dependent on the ambition level of the company. Reporting can be quite simple or it could conform to the level of the Global Reporting Initiative (GRI).

7) **Begin Again:** The process should begin again with a review of the company policy and ambition level. This will conform to the continuous improvement that is required in the environmental management system standard: ISO 14001.

8) **Additional Investigations:** Supplementary investigation of the environmental and social impacts of a company's products and services might be beneficial once a basic evaluation of the company has been undertaken to create a richer decision making environment.

Information can also be gained by cooperating with other companies in the company's network.

9) **Revise Initiative Areas and Goals:** A company, at this point, has gained experience in applying LCM and can reevaluate what environmental and social initiative areas are most important for the company, and this may change the environmental and social sustainability goals the company has.

A company has many different departments and the employees have very different roles. It is important to remember that every function in a company can play some part in life cycle management. This is illustrated below in Figure 9.
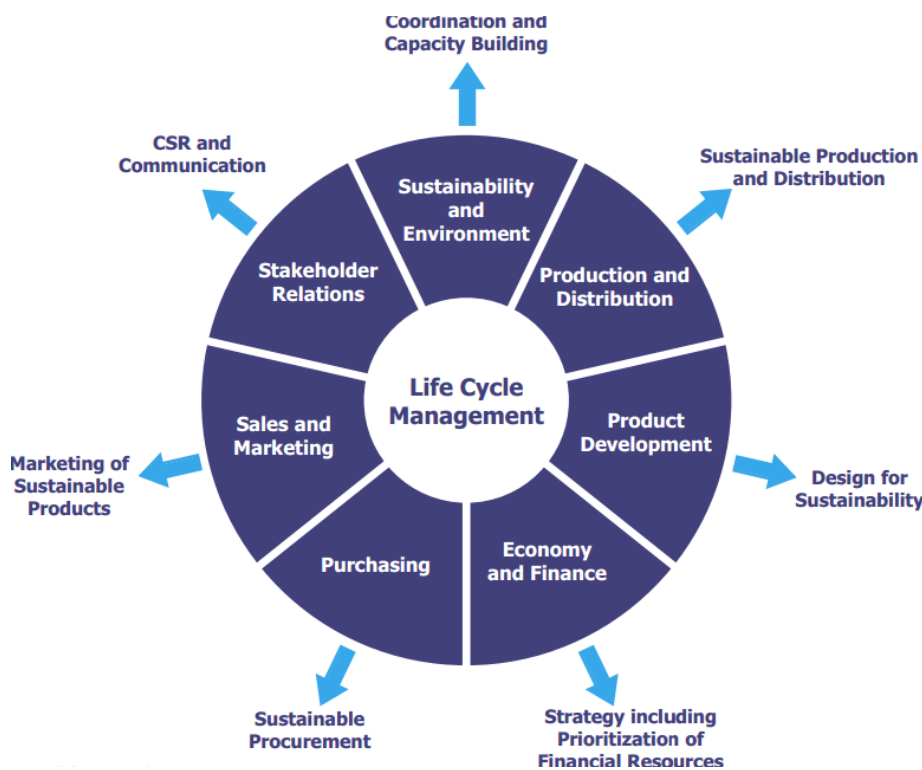
Figure 9: Contributions from different functions of an organization (UNEP 2007)

3.3.2 Life Cycle Management Tools
There are many different tools and methods used in LCM. Examples of these include:

- Life Cycle Assessment (LCA)
- Life Cycle Costing (LCC)
- Cost Benefit Analysis (CBA)
- Material and Substance Flow Analysis (MFA/ SFA)
- Material Input Per Unit of Service (MIPS)
- Investment strategy
- Cumulative Energy Requirements Analysis (CEPA)
- Cleaner Production Assessment (CPA)
- Risk Assessment (RA)
- Stakeholder Analysis
- Audits
- Input-Output Analysis (IOA)

This section will describe some of these tools and methods. Life cycle Analysis is explained because it is the most important tool for identifying environmental aspects in the life cycle of

a product or service. Strategic life cycle management (SLCM) (long term sustainability strategy) and environmental life cycle costing are discussed because they represent the economic pillar of sustainability. Lastly, stakeholder analysis is discussed because it represents the social pillar of sustainability.

Life Cycle Analysis (LCA)

Life cycle analysis (LCA) is the tool most often thought of in LCM. Though LCA has its limitations (as do all the tools in LCM), LCA provides a thorough assessment of the environmental impacts of the entire life cycle of a product, process or service. LCA has four components (Curran 2006), and each is described below and illustrated in Figure 10.

Goal, Definition and Scope: In this initial step in conducting an LCA, what is being evaluated must be established and most importantly the system boundaries need to be set. The functional unit, context and the environmental effects must be defined in this step.

Inventory Analysis: Once the context and boundaries are established, energy, water, material usage and environmental discharge need to be identified and quantified.

Impact Assessment: This component takes the inventory analysis and evaluates the potential human and environmental impacts.

Interpretation: This is the evaluation of the impact assessment and inventory analysis to make decisions. These decisions could include changing material types to improve the environmental impact or to select a preferred product, process or service that has a better environmental performance.
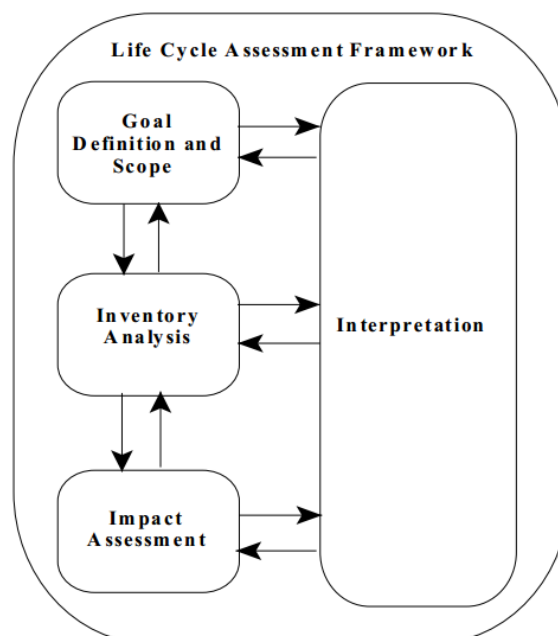
Figure 10: LCA Components (ISO 14041:1998)

LCA can help decision makers make more informed decisions (choosing between alternatives or improving design) and can avoid (or at the very least illustrate) problem shifting; however, LCA has a limited scope and can be resource and time consuming. Also, the data available for

the inventory analysis is not always correct or complete. Because of this, LCA must be used with other LCM tools (Curran 2006).

Environmental Life Cycle Costing

Environmental life cycle costing (LCC) builds upon traditional life cycle costing, i.e. the evaluation of costs in the life cycle of an asset. However in a traditional LCC, the environment is considered an externality and the evaluation is concerned with purely economic costs. The life cycle of the asset in traditional LCC is split into four life cycle stages: investment, operation, maintenance and disposal (or EOL-end of life). In environmental LCC, environmental costs are included in the evaluation over this life cycle (as well as social and economic). Environmental LCC uses environmental management tools, such as LCA, in order to ascertain the environmental impact of the asset in question. However, the environmental impacts uncovered in LCA must be quantified in monetary terms to be included in the environmental LCC. Therefore, environmental LCC cannot be used on its own, but must be used in conjunction with other environmental management tools (Hunkeler et al. 2008).

Stakeholder Analysis

Stakeholder analysis is based on stakeholder theory developed by Edward Freeman in his 1984 book: *Strategic Management: A Stakeholder Approach*. There are many different ways to do a stakeholder analysis, but identifying the stakeholders is the first step. A stakeholder is any person, group of people or entity that can claim a relationship with a company (or the product or service). These can include: customers, competitors, shareholders, the environment, NGOs, the media, local and national government and etc. By identifying who or what has a stake in the operations of a company, this company can greatly expand its contributions to corporate social responsibility. Once the stakeholders are identified, then they must be categorized. Categorization can be done in several different ways; however, the stakeholder matrix is a very common method. Below is an example of the stakeholder matrix developed by Polonsky (1996) (Figure 11). Once the stakeholders are categorized, a communication and engagement strategy must be developed for each stakeholder type. Categorizing stakeholder shows more clearly how the stakeholders should be managed. Mixed blessing, supportive, non-supportive and marginal stakeholders have different ways in which they should be managed and this is explained in Polonsky (1996).

Strategic Life Cycle Management (SLCM)

Strategic life cycle management (SLCM) is using LCM to identify investment pathways that enable sustainable development (Ny et al. 2006). This is a sustainability assessment of the life cycle of a product or service that uses backcasting (determining the end goal and forming a pathway to reach that goal) based on sustainability principles. If the goal of the company is to have a sustainable product, this would be the goal in the backcasting of the product. The company then needs to get an overview of what it would take for the product to be sustainable. This would require a detailed analysis, as is done in traditional LCA but with a broader scope making it more relevant in sustainable development. In this way, environmental, economic and social sustainability issues are covered in the SLCM. SLCM is the combination of the LCM and strategic management.

Mixed Blessing

Supportive

Non-supportive

Marginal

Willingness to cooperate

Ability to threaten
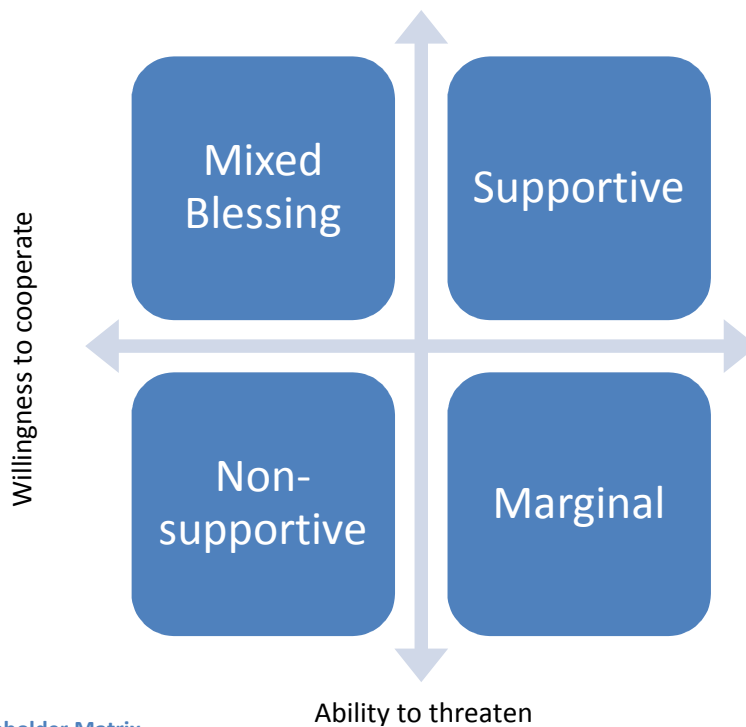
Figure 11: Stakeholder Matrix

3.3.3 Different Industries, Different Applications

Different industries have different environmental and social impacts in the life cycles of their products and services. Project management consultancies often offer services in more than one industry. Below, Figure 12 shows all the different project types at Faveo. This section will give a brief introduction of how LCM is applied in the construction and manufacturing industries.

Project Types

Construction | Transport | Property Development | Business Development | IT/Tech Development | Industrial | R&D
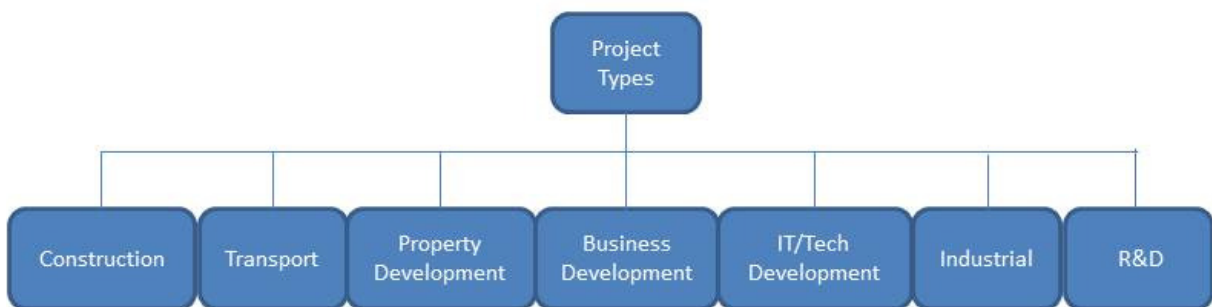
Figure 12: Faveo's Project Types

In the construction industry, there are several different environmental frameworks based on life cycle thinking which are established. The most well-known are BREEAM (UK) and LEED (USA) (Oritz et al. 2009). Environmental impacts in the building sector have been well researched, and these frameworks have been developed to improve environmental performance in construction. Although BREEAM and LEED are based on life cycle thinking, LCA is used to a very limited extent in the building sector due to its complexity and uncertainty; however using LCA in this sector is important because of the support it lends to

decision-making. The current use of LCA and LCC in the building sector is mostly used to make decisions on choice of materials (LCA) and deciding on alternate installations in buildings (LCC) (Malmqvist et al. 2010).

In the manufacturing industry, LCM is broken down into four different approaches: Design for Life Cycle, Life Cycle Evaluation, Life Time Management and Product Cycle Management (Westkämper et al. 2000). Design for the life cycle involves the design for the environment (DfE) framework. Life cycle evaluation applies LCA and LCC to manufacturing. Life time management includes the technical support in manufacturing processes. Product life cycle management involves recycling and waste management. These different areas of life cycle management encompass different spheres of work in the manufacturing industry, and the different tools and frameworks for applying LCM are turned into life cycle programs or intelligent manufacturing systems (IMS).

In a project management company, such as Faveo, the real challenge lies in introducing a life cycle management methodology that is applicable to all the industries in which the company has projects. Each industry has different environmental and social impacts, so the methods need to be general enough to cover all the industries yet specific enough to address all environmental and social aspects in the life cycle of all projects. The following chapter will evaluate the theoretical application of LCM in project management.

4.0 The Use of Life Cycle Management in Project Management

Good management is the art of making problems so interesting and their solutions so constructive that everyone wants to get to work and deal with them.
-Paul Hawken
Environmentalist and Author

The preceding chapter explained the theoretical foundation for life cycle management (LCM), and concluded with how LCM methods must be tailored to the industry in which it is applied. The life cycle in project management is usually considered to end with the finished project; however in this chapter it is explained that the life cycle of a project includes both the life cycle of the project and the asset that the project produces. First, the need for the implementation of LCM in project management is explained through the results of the specialization project and from literature presented in Chapter 3. Project management's theoretical foundation is then explained through the Project Management Institute's (PMI) PMBOK (Project Management Book of Knowledge) and the International Project management Association's (IPMA) Competence Baseline (ICB). Lastly, projects are explained in terms of their life cycle.

4.1 The Need for LCM Implementation

The specialization project (through a system dynamics analysis of the project management systems of Faveo) produced a systemigram which showed the need for implementing LCM to enable sustainable development. The systemigram is given in Appendix 1.5, and the following is a summary of the results from the specialization project.

LCM and the Project Management Systemigram

The systemigram illustrates the story and the relationship between project management, life cycle management and sustainability. This illustration provides insight into how the pathway explained with backcasting will be undertaken (given in Appendix 1.4). The entry point for the systemigram is society which gives corporations the license to operate. The stakeholders are shown to have several relationships, and this gives guidance on how to approach stakeholder engagement (especially concerning communication needs because it shows who the stakeholders are being affected by and who is engaging them.) The next step in backcasting is: understanding environmental aspects/CSR in projects. This is important because, as shown in the systemigram, project managers at Faveo have to understand how to effectively manage the project life cycle in order to find the improvement areas, and the project managers will need to understand EMS tools (the next step in backcasting) to get information on the project life cycle in order to make the right decisions in their projects. The systemigram shows that the project managers need to have a high level of competence in life cycle management in order for this system to work. Once the project manager's competence is raised, and they can then effectively recognize opportunities for integrating environmental management and CSR in their individual projects, then LCM becomes internalized into the project management system of Faveo. The management of all the project types is aligned with the long term investment strategy as shown in the systemigram, and if the project

management has already internalized LCM, then this will create long term strategy that complies with sustainability. The improvement areas monitored by the project managers and found by EMS tools contribute to sustainability and must be combined with long term strategy in order to reach sustainability (as mentioned in backcasting), but what is not explained was how this can be combined.

The systemigram shows that this combination can be achieved through LCM. Understanding the project life cycle and from the use of EMS tools by the project managers are going to give the answer to how to combine short and long term rewards. Project type and industry affect how this can be done. The project manager is an expert in their particular industry, and once their LCM competence is raised, they will know how to tailor and implement LCM to their specific needs.

As mentioned in section 3.2.3, there are many internal and external drivers for the implementation of LCM; and the systemigram illustrates how LCM in project management contributes to sustainable development. Project management is found in every industry; therefore through LCM frameworks in project management, there is the potential to develop life cycle thinking in every industry, furthering the progress towards sustainable development goals.

4.2 Theoretical Foundations for Project Management

The section explains the PMBOK and the ICB as the theoretical foundation for project management. These guides are the theoretical foundation for the project management systems of Faveo, and this is the reason they were chosen for explanation. The way in which projects are managed at Faveo depends on the type of project being managed and by how much experience and knowledge the project manager has. The Faveo Academy, however, has created a filtering mechanism to guide the project management. There are four areas in this filter: business areas, specialist areas, project models and work flow; this is illustrated in Figure 13. How Faveo combines the theoretical foundation with their own theoretical elements is explain at the end of section 4.2.
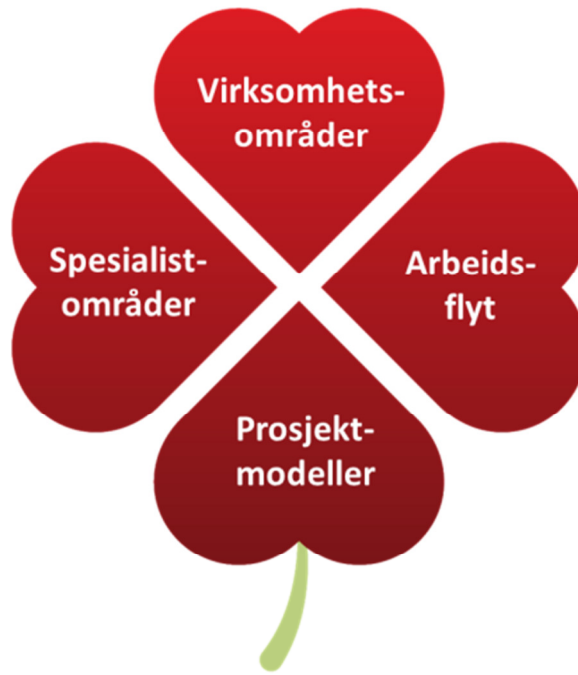
PMBOK Guide

The PMBOK Guide is produced by the world leader in project management: PMI (Project Management Institute) (PMI 2004). PMI certifies project managers, and produces the PMBOK guide which is based on a traditional project management approach (PMI 2012). The PMBOK guide is meant to be tailored to the project manager's specific project and gives project managers a common vocabulary within project management by defining key terms. This guide is organized around the life cycle of the project which is described in the following phases: initiating, planning, execution, monitoring and controlling and closing. The PMBOK covers nine knowledge areas including: project integration management, project scope management, project time management, project cost management, project quality management, project human resource management, project communication management, project risk management and project procurement management. The life cycle and the knowledge areas are mapped in Figure 14. The map in Figure 14 shows what needs to be in place as the project manager develops their project management framework for a given project.

Knowledge Areas	Process Groups				
	Initiating	Planning	Executing	Monitoring and Controlling	Closing
Integration Management	Develop Charter	Develop Management Plan	Direct and Manage Execution	Monitor and Control Work Perform Change Control	Close Project or Phase
Scope Management		Collect Requirements Define Scope Create WBS		Verify Scope Control Scope	
Time Management		Define Activities Sequence Activities Estimate Resources Estimate Durations Develop Schedule		Control Schedule	
Cost Management		Estimate Costs Determine Budget		Control Costs	
Quality Management		Plan Quality	Perform QA	Perform Quality Control	
HR Management		Develop HR Plan	Acquire Project Team Develop Project Team Manage Project Team		
Communication Management	Identify Stakeholders	Plan Communications	Distribute Information Manage Expectations	Report Performance	
Risk Management		Plan Risk Management Identify Risks Perform Risk Analysis Plan Risk Response		Monitor and Control Risk	
Procurement Management		Plan Procurements	Conduct Procurements	Administer Procurements	Close Procurements

Figure 14: Project life cycle phase and knowledge area map (adapted from the PMBOK guide (PMI 2004))

IPMA Competence Baseline (ICB)

The International Project Management Association (IPMA) is another leading project management organization. IMPA is an association of non-profit organizations that serves as an authority on project, program and portfolio performance competence (IPMA 2012). The IPMA Competence Baseline (ICB) is produced by IPMA to certify project managers on four different levels: certified projects director, certified senior project manager, certified project manager, certified project management associate (ICB 2006). The ICB is a framework and has 46 competence elements in three different competence areas: behavioral competences, technical competences and contextual competences. The competence elements are shown in Figure 15. The elements are not specific to company, industry or country which allows for the use of this framework in many different projects where it can be tailored to fit not only specific projects needs but also different cultures (IPMA 2012). The ICB differs from the PMBOK in that it is more a collection of elements and because of its focus on competence.

The Periodic Table of Project Management Competence Elements

IPMA PM Competence Element Groups
- Contextual Competence Elements
- Technical Competence Elements
- Behavioral Competence Elements

Contextual Competence Elements:
- 3.01 P — Project orientation
- 3.02 Pg — Programme orientation
- 3.03 Pf — Portfolio orientation
- 3.04 Pp — Project, program & portfolio implemen.
- 3.05 Po — Permanent organization
- 3.06 Bu — Business
- 3.07 Sa — Systems, products & technology
- 3.08 Pe — Personnel management
- 3.09 Hs — Health, security, safety, & environment
- 3.10 Fi — Finance
- 3.11 Le — Legal

Technical Competence Elements:
- 1.01 Ps — Project management success
- 1.02 Ip — Interested parties
- 1.03 Rq — Project requirements & objectives
- 1.04 Ri — Risk & opportunities
- 1.05 Q — Quality
- 1.06 Po — Project organization
- 1.07 T — Teamwork
- 1.08 Pb — Problem resolution
- 1.09 Ps — Project structures
- 1.10 Sd — Scope & deliverables
- 1.11 Tp — Time & project phases
- 1.12 Re — Resources
- 1.13 C — Cost & finance
- 1.14 Cn — Procurement & contract
- 1.15 Ch — Changes
- 1.16 Cr — Control & reports
- 1.17 In — Information & documentation
- 1.18 Ca — Communication
- 1.19 Su — Project startup
- 1.20 Cs — Project closeout

Behavioral Competence Elements:
- 2.01 L — Leadership
- 2.02 M — Engagement & motivation
- 2.03 Sc — Self-control
- 2.04 As — Assertiveness
- 2.05 R — Relaxation
- 2.06 O — Openness
- 2.07 Cy — Creativity
- 2.08 Ro — Results orientation
- 2.09 E — Efficiency
- 2.10 Co — Consultation
- 2.11 Ne — Negotiation
- 2.12 Cc — Conflict & crisis
- 2.13 Rl — Reliability
- 2.14 Va — Values appreciation
- 2.15 Et — Ethics

Based on IPMA's ICB® www.ipma.ch

Figure 15: Periodic Table of Project Management Competence Elements (IPMA 2012)

Faveo has thirteen elements in the theoretical foundation for their project management: value, scope, leadership, project environment, integration, communication, procurement, uncertainty, economy, quality, environment, health and safety and time. From the PMBOK, Faveo uses all nine knowledge areas (the quality knowledge area is, however, split into quality, environment (nature) and health and safety), From the ICB, Faveo uses leadership and project environment. Faveo also uses an additional element in the theoretical foundation for their project management that is not a part of either the PMBOK or the ICB: value.

4.2.1 Current State of Life Cycle Management in Project Management

In successful project management, it is the norm for companies to develop their own project management frameworks based on the PMBOK and the ICB with well-defined stages for all projects (Buttrick 2000), just as Faveo has done. Each of the stages has actions and deliverables, and the specification of these is done to exercise a level of management control. These project management frameworks insufficiently include the management of social and environmental aspects. In the cases where social and environmental aspects are given attention, the life cycle is only partially considered (Labuschagne and Brent 2005).

These project management frameworks need to be reevaluated and expanded to include social and environmental management in order to reach sustainable development goals, and this requires life cycle thinking. In the next section, the life cycle of the project and the life cycle of the product of the project (the asset/process and product life cycles) along with their relationship are defined.

4.3 The Project and the Life Cycles

The purpose of a project is to create, which is explained by the PMBOK's definition of a project: "a temporary endeavor undertaken to create a unique product or service" (PMI 2008, 14). Depending on what is being created, the project itself may have very few environmental and social consequences; but it is the outcome of the project that has the greatest potential for environmental and social impacts. The life cycle explained in this section is based on a study of life cycle management in the manufacturing sector. The reason this was chosen is because of the variety of industries that are found within manufacturing and the ability to adapt the life cycle stage of manufacturing sustainable project life cycle management to project management that is not in the manufacturing sector in the traditional sense (i.e. all projects manufacture something, however it might not be in the manufacturing sector).

Sustainable project life cycle management includes the life cycle of the project and the life cycle of the product or service that is created by the project. Explaining sustainable project life cycle management in the manufacturing sector, however, introduces another life cycle: the process or asset life cycle. The asset is produced from the project which then in turn produces products. The life cycle stages of a project, process/asset and product can be seen also outside of the manufacturing sector. For example, Faveo has projects in business development, and they have helped other companies implement project, program and portfolio management. This can be seen as a type of manufacturing. This example project is creating a process/asset that will in turn create products/services. These three life cycles and their relationship to each other are explained and illustrated in the following sections.

The Project Life Cycle

There are many different models in academic literature (as well as company specific models) to define the life cycle stages of a project. Each of these models varies depending on the industry they are targeting, project type and the company utilizing them. In their 2005 study on sustainable project life cycle management in the manufacturing sector, Labuschagne and Brent explained that three different life cycles were involved in manufacturing: the project life cycle, the asset/process life cycle and the product life cycle. For the project life cycle, they summarized seven different generic life cycle phases based on Buttrick (2000): Idea Generation, Pre-feasibility, Feasibility, Development and Execution, Commissioning, Launch and Post Implementation Review (PIR). An explanation of these phases are given in Table 1 and illustrated in Figure 16.

Phase	Description
Idea Generation	In this phase the idea for a new project is generated and the initial proposal that describes the business need must be prepared. This phase does not require a formal project plan.
Pre-feasibility	The goal of this phase is to evaluate the existing proposal in terms of financial, operational and technical viability as well as against the company's strategy. Overlapping or synergy with other projects should also be checked out
Feasibility	The optimum solution to address the business need must be identified and defined. All areas of this solution must be analyzed and assessed to determine killer concerns and risks
Development and Execution	This phase involves design, development, creation and building of the chosen solution. The supporting system, manuals, business processes and training for the solution must also be developed during this phase
Commissioning	In this phase the solution is tested in an operational environment. The purpose is to validate the acceptance and capabilities of the solution
Launch	The project is handed over to the business units and thus released to the operational environment during this phase. This phase also marks the beginning of operational support
Post Implementation Review (PIR)	After sufficient time (9–15 months) the project should be assessed to determine if the benefits were delivered and what the impact of the project was on the business. Lessons learned should be captured for future reference

Table 1: Description of Life Cycle Stages (adapted from Labuschagne and Brent (2005))
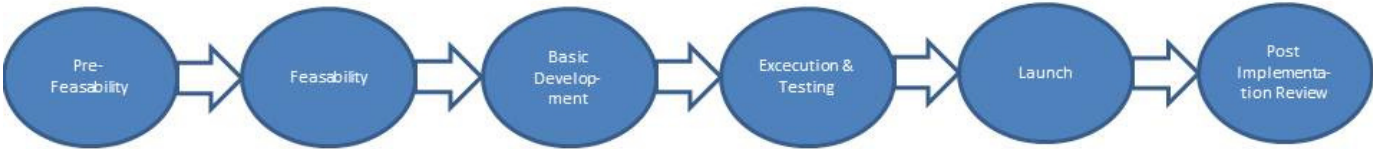
Figure 16: Project Life Cycle Stages (adapted from Labuschagne and Brent (2005))

The Asset Life Cycle

The asset is the process that is created as a result of a project. Using the same life cycle stages described for the project, six life cycle stages are created for the asset. This is shown in Figure 17 with the six stages in the bottom part of the figure and a simplified four stages in the top part of the figure.
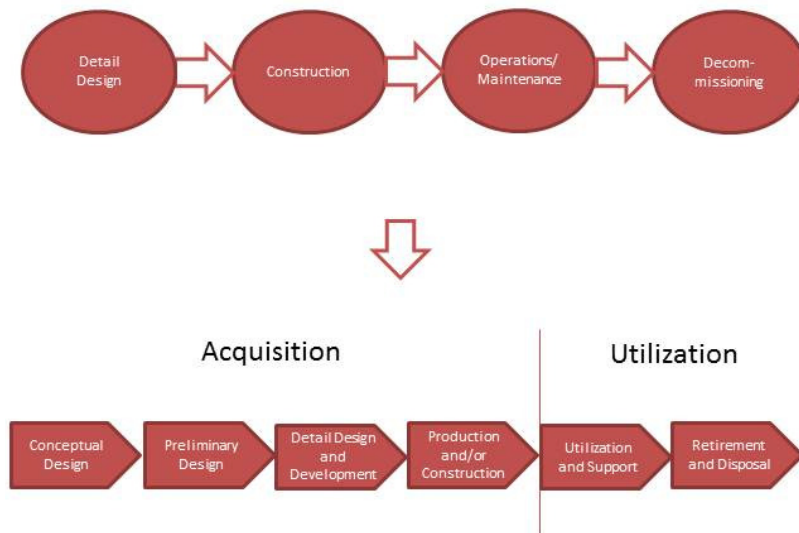
The goal of the project is to design, construct and implement the asset. Therefore these asset life cycle stages interact with the life cycle stages of the project. This is shown in Figure 18. The design stage of the asset is handled in both the pre-feasibility and execution and testing phase of the project. Construction is completed in the execution of the project, but the construction can be changed during testing and launch (this is why this is represented with dotted lines.) The operations and maintenance asset life cycle stage is a part of the launch and PIR project life cycle stages.

The Product Life Cycle

The goal of the asset is to create the product. The product however has its own life cycle stages: pre-manufacturing which includes material extraction; construction which occurs in the operations of the asset; product use; and phase-out and disposal of the product also referred to as end-of-life. Figure 19 shows how the product and asset life cycles are related. The operations and maintenance life cycle stage of the asset is the stage that produces the product. The rest of the product life cycle is independent of the asset life cycle.

It is not the project itself that usually has the environmental and social impacts (this depends on project type). It is the resulting asset/process and product that impacts the environment and society, and it is the life cycle of these that need to be managed in the life cycle of the project in order to minimize the impact. This is why sustainable project life cycle management needs to be practiced. A framework has been developed that evaluates a project's social and environmental consequences as a result of the asset and product life cycles. This framework was developed by Labuschagne and Brent (2005) (shown in Figure 20). Methodologies, however, need to be developed for this to be implemented in business, and that is the goal of this thesis.
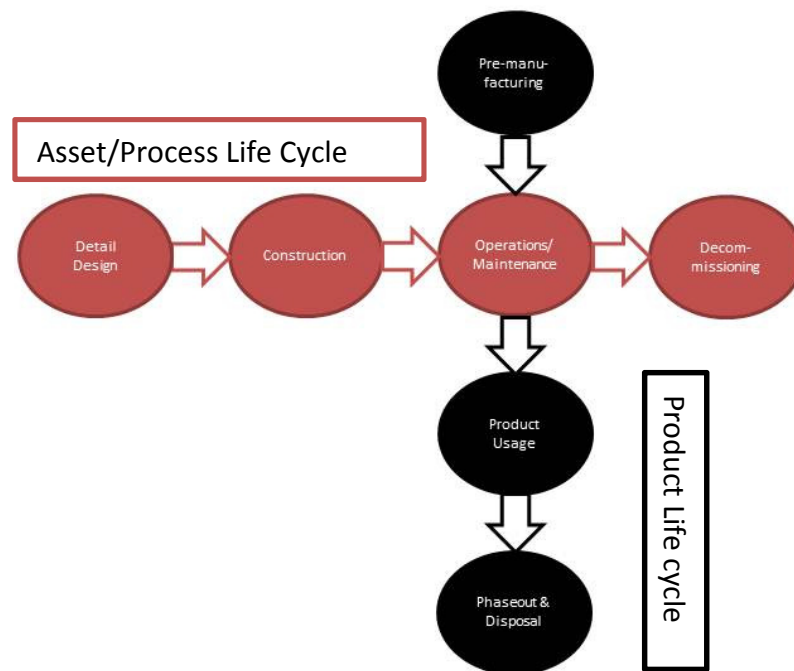
Figure 19: The Product Life Cycle in Relation to the Asset Life Cycle
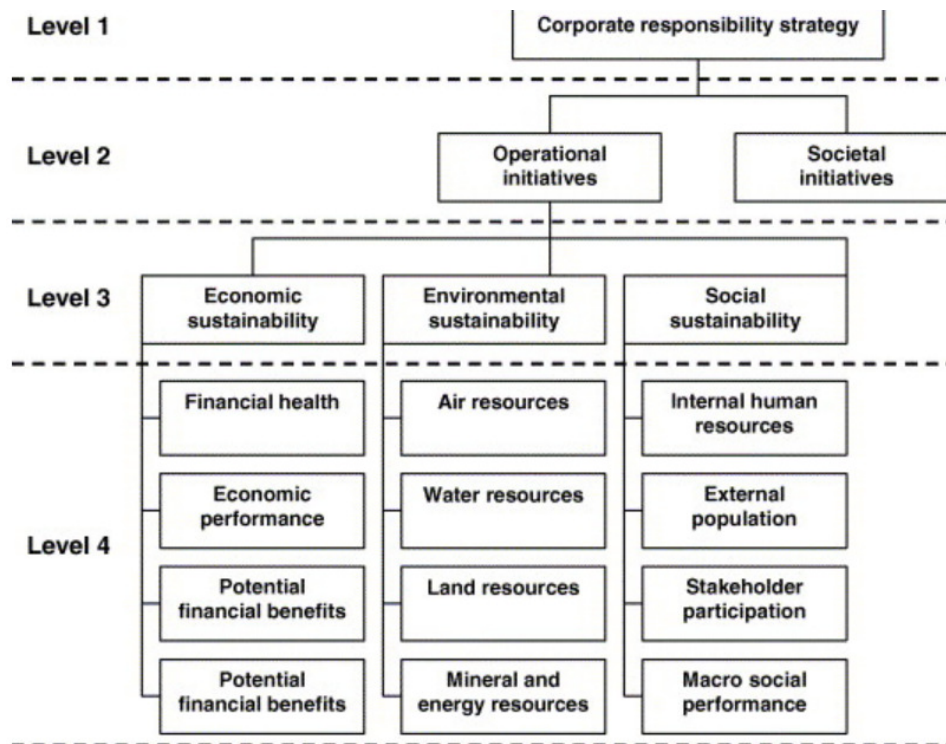
Figure 20: Assessing sustainability in operations (Labuschagne and Brent (2005))

4.4 Theoretical Use of Life Cycle Management in Project Management

As explained in section 4.2.1, environmental and social aspects are not efficiently managed in the entire life cycle of a project, and life cycle thinking in project management is not developed enough that the life cycle of the asset/process and product is thought of as a part of the project's life cycle. If it is possible to use LCM in project management (i.e. sustainable project life cycle management), how can it be practiced by project managers? It is assumed that project managers working in project management consultancies are not trained in environmental management and social responsibility. These project managers do not know how to use the tools introduced in Chapter 3. They do not use life cycle thinking to the level explained in section 4.3. They are experts in producing the product or service of their project. What is needed is to combine the project's life cycle (hereafter the project life cycle includes also the asset and product life cycle) with LCM tools covering all the areas of level 4 in Figure 20.

As mentioned earlier, sustainability has three pillars: economic, environmental and social. Economic sustainability will not be covered in this thesis except in terms of environmental life cycle costing because it is outside the scope of the research questions. Environmental and social sustainability elements in LCM can be managed in project management using several different approaches. Frameworks for the application of environmental sustainability can be applied to project management and integrated with the project management guide, the PMBOK using a life cycle approach. Concerning the social pillar of sustainability, there is a social sustainability LCM framework for project management that has been developed by Labuschagne (2005) in her doctoral thesis, and this can be developed in to an implementable tool for project management.

There are many frameworks for the different elements of sustainability. Some are quite basic and merely explain the pillars of sustainable development. There are others that are more complex such as the one developed by Labuschagne (2005). The project manager can learn and study frameworks that are more or less comprehensive, but they lack the application component. A practical guide that can be used by the project manager in project planning is necessary for the application of frameworks. For example, the PMBOK is a guide for project management, making it a very valuable tool. This type of tool for environmental and social sustainability in project management is lacking. This is what has been developed in this thesis and is presented and explained in Chapter 5.

Practical guide development is best accomplished in a real project management environment, and Faveo has provided this environment for this master thesis.

5.0 Tools and Methods for the Application of Life Cycle Management in Project Management Systems

"What's the use of a fine house if you haven't got a tolerable planet to put it on?"
— **Henry David Thoreau**, *Familiar Letters*
American Author

This chapter will explain the tool that was developed from the literature review (Chapter 3), the theoretical evaluation (Chapter 4) and the results of the specialization project (Appendix 1). This tool, called the Sustainable Project Life Cycle Management (SPLCM) Guide, is provided in Appendix 2. This guide has been built from Faveo's project management system that was analyzed in the specialization project, and the theoretical foundation for the use of life cycle management in project management explained in Chapter 4.

The following sections will explain: how this tool was developed (5.1), the goals of the tool and step by step how the tool works (5.2), and how the tool will lead to the internalization of LCM into the Faveo system (5.3).

5.1 The Development of the Sustainable Project Life Cycle Management Guide

Most project management frameworks that companies use are not taken directly from project management theory. They are adapted by the company to fit their specific needs and working culture. As explained in Chapter 4, Faveo is no different. They use elements of the ICB and the PMBOK guide and elements that are unique to Faveo. What is lacking from these elements is a basis in life cycle thinking. The PMBOK guide gives the theoretical foundation for the life cycle of a project; but, as shown by Labuschagne and Brent (2005), the PMBOK guide's project life cycle is lacking both the asset/process life cycle and the product life cycle. This was the first issue that needed to be tackled in the SPLCM guide: making the project managers understand what the life cycle of their project is actually composed of. The redefinition of the project life cycle forms the basis of the guide, and this is heavily based on Labuschagne and Brent's (2005) work. The reason for this is because their work is the only research that expands the project life cycle to include not only the product, but also the asset/process and product life cycle as well. They also explain the relationships between these different life cycles and their stages.

The SPLCM Guide uses the new project life cycle definition to help identify environmental aspects and directs the project manager to specific environmental management tools used in LCM which were described in Chapter 3. In this way, the SPLCM guide acts as a worksheet in order to direct the project manager to LCM tools.

The SPLCM Guide again uses the new project life cycle definition to identify and categorize stakeholders, also discussed in Chapter 3, to arrive at management techniques based on the categorization. There is also a social aspect checklist that is based on the work of Labuschagne's (2005) dissertation because this is the only work that currently addresses social sustainability aspects. Just as in the environmental section of the guide, the social

section also acts as a worksheet to arrive at LCM tools. In this sense, the guide acts as a router for stakeholder management and social impact mitigation techniques.

The guide was also developed using the GRI G3.1 guidelines because it is the standard for sustainability reporting (GRI 2011). As explained later, this guide only provides a recommended communication strategy and does not try to provide a standard reporting procedure. The SPLCM Guide only provides the recommendation for which environmental and social performance indicators the project manager should gather information. Concerning internal communication, recommendations in the SPLCM guide were based on the research of Morsing and Schultz (2006) because of their focus on stakeholder involvement.

5.2 The Goals and an Explanation of the SPLCM Guide

The Sustainable Project Life Cycle Management Guide is a tool that can be used by project managers in project planning. It will guide the project manager's understanding of the environmental and social life cycle of their project. Based on the tailored life cycle that this guide helps the project manager to create, the Sustainable Project Life Cycle Management Guide will suggest tools and methods for the mitigation of the environmental and social impact of the project.

The purpose of this tool is to raise the project manager's environmental and social management competence and to develop life cycle thinking skills. This guide is a competence building tool, in that using this guide the project manager will learn how to practice environmental management and corporate social responsibility in a comprehensive project life cycle perspective, i.e. sustainable project life cycle management. The goal of the guide is for the project manager to internalize the steps in the guide as they develop their life cycle thinking skills so that life cycle management in incorporated in the project management system at Faveo. Once the competence of the project manager is raised and LCM is internalized, the project manager may in the future not need to use the guide.

The guide seeks to not only develop life cycle thinking in the project manager, but also their ability to recognize environmental and social aspects, stakeholders and impact mitigation tools and techniques. The guide is composed of four sections: The Project Life Cycle, Environmental Life Cycle Management, Social Life Cycle Management and Communication Recommendations.

This guide is set-up so that the project manager will need to answer a series of questions, as well as supply information about the project in each section. In Section 1, the answers to the questions will determine which stages of the life cycle are relevant to the particular project type. In Section 2 and Section 3, there are both questions and worksheets to develop the best strategy for managing the environmental and social aspects of the project.

In developing the tailored project life cycle, Section 1 provides the input for the following sections which are intended to guide the project manager's decision-making and management in the project. In Section 2, environmental management tools are suggested for the project manager to use in the management of the project. In Section 3, a recommended stakeholder

and social responsibility strategy is created for the project. Section 4 is a guide for environmental and social communication.

The example presented in the guide is the result of the test application in a project at Faveo. Because of time constraints, the guide was applied to a completed project and the project manager filled out the guide as if they were in the planning stage of the project. The results of this application are explained in Chapter 6, and the resulting worksheets from the application are presented in Appendix 3.

Section 1: The Project Life Cycle

The guide begins with explaining what the project life cycle includes. This was previously explained in this thesis in section 4.3. The explanation begins with the general project life cycle and explains the stages in a table, and then it leads to what the asset life cycle is and how they are related to each other. To simplify for the project manager, there is only the general project life cycle and the asset life cycle. The project manager decides how many life cycles to include by answering the questions in this section. The asset of a project can produce another asset, for example. After this brief introduction to what a project life cycle includes, the project manager must begin modeling their own life cycle specific to their project by answering questions and referring them to different life cycle scenarios based on their answers.

The purpose of modeling the life cycle and tailoring it to the specific project is to make the project manager understand how the decisions made in the project will affect other stages of the project life cycle (the term project life cycle includes all asset life cycles.) This exercise makes the project manager aware of the boundaries of their project's life cycle. The model of the life cycle developed in section 1 is used in the remaining sections in the guide.

Section 2: Environmental Life Cycle Management

Based on the information given in Section 1, the project manager should be able to identify the basic stages of the life cycle that are specific to the project in question. In Section 2, the environmental aspects and mitigation options will be identified. Once these are identified, tools are suggested for input into the project manager's decision making.

The section begins by explaining the terms environmental aspects and environmental impacts. This leads to the environmental aspect analysis, where the project manager fills in the applicable environmental aspect in the life cycle stage of the project in which they are found. The model that was created in Section 1 is used as a worksheet for identifying environmental aspects. The generic or specific environmental aspect checklist can be used. In the specific checklist there are mitigation options under various environmental aspects that the project manager can implement in their project. The specific checklist also includes positive environmental aspects (such as environmental awareness education) to inspire the project manager to positively influence the environment wherever possible.

This section ends by explaining how LCA and environmental LCC can provide important input into the project manager's decision making.

Section 3: Social Life Cycle Management

This section again uses the life cycle developed in Section 1 in order to identify social responsibility issues in the life cycle of the specific project. Section 3 begins by explaining the term stakeholder and explains to the project manager how to identify all the stakeholders in the life cycle of their particular project. Once the stakeholders are identified in each life cycle stage, the project manager classifies each stakeholder using the power, urgency and legitimacy typology developed by Mitchell et al. (1997). Based on the classification of the stakeholder, stakeholder management advice is given based on Mitchell et al. (1997).

The next step in Section 3 is to identify the social aspects. With the completion of the stakeholder analysis, there may be social aspects of the project life cycle that are not addressed. A way to include all social aspects of a project life cycle, it may be necessary to do a social impact assessment (SIA). This is done in a similar way as identifying the environmental aspects in Section 2. There is a checklist that the project manager uses to fill in the social aspect number in the applicable life cycle stage in the life cycle scenario worksheet. This social aspect checklist also gives the appropriate mitigation techniques for the social impacts that they cause.

Section 4: Communication Recommendations

The section recommends a communication procedure that the project manager can use throughout the life of their involvement in the project life cycle. There is currently no integrated sustainability reporting system at Faveo. While it is recommended that they adopt integrated reporting such as that outlined in the GRI (Global Reporting Initiative,) the communication recommendations outlined in the Sustainable Project Life Cycle Management Guide explains what the project manager can do on the project level in terms of communicating and reporting environmental and corporate social responsibility. It is not the goal of this guide to provide a reporting system for the sustainability of projects. This section of the guide only provides guidelines in which the project manager can follow. This has the potential to develop into a standard sustainability reporting format for projects in the future.

The first part explains what communication procedures the project manager should take to build relationships with the stakeholders. This is based on the stakeholder analysis that was completed in section 3 of the guide.

The second part guides the project manager to the environmental and social information they should be recording. A checklist of the environmental and social performance indicators from the GRI are given with instructions for the project manager to identify what indicators are applicable with respect to the life cycle of their project and to record or keep track of information regarding those applicable indicators. The recommendations for reporting are given to encourage Faveo and other project management consultancies to adopt the GRI on the corporate level by gathering information concerning the environmental and social performance indicators on the project level.

5.3 How the SPLCM Guide will Develop LCM in Faveo's Project System

The problem that was discovered in the specialization project was: *an integration of life cycle management in the project management systems of Faveo that involves both CSR and*

environmental management for application in projects regardless of industry or project type. This problem was uncovered in the concept mapping of the Faveo system as shown by the disconnect between the project management systems and the community and environment. The SPLCM Guide was developed to raise the competence of the project managers at Faveo so they can make LCM a part of their project management system. When the SPLCM Guide is incorporated in the project management system, LCM then becomes a part of the Faveo system. This is illustrated through the concept mapping.

The concept mapping of the Faveo system was completed in the specialization project, and the original is given in Appendix 1.3 (Level II Concept Mapping). Below (Figure 21) is a reproduction of that concept map that shows how the SPLCM Guide, when used by the project managers, will make LCM a part of the Faveo system.

In Figure 21, the concept mapping shows that the SPLCM guide is now a part of the project management system (given in red). By making this guide a part of the project management system at Faveo, the complete project life cycle is overseen by the project management system in order to control the effects to the community and environment. This is shown with the red lines in the concept map (everything that is changed from the original concept map is shown in red.) Thus, LCM will then become a part of the Faveo project system.
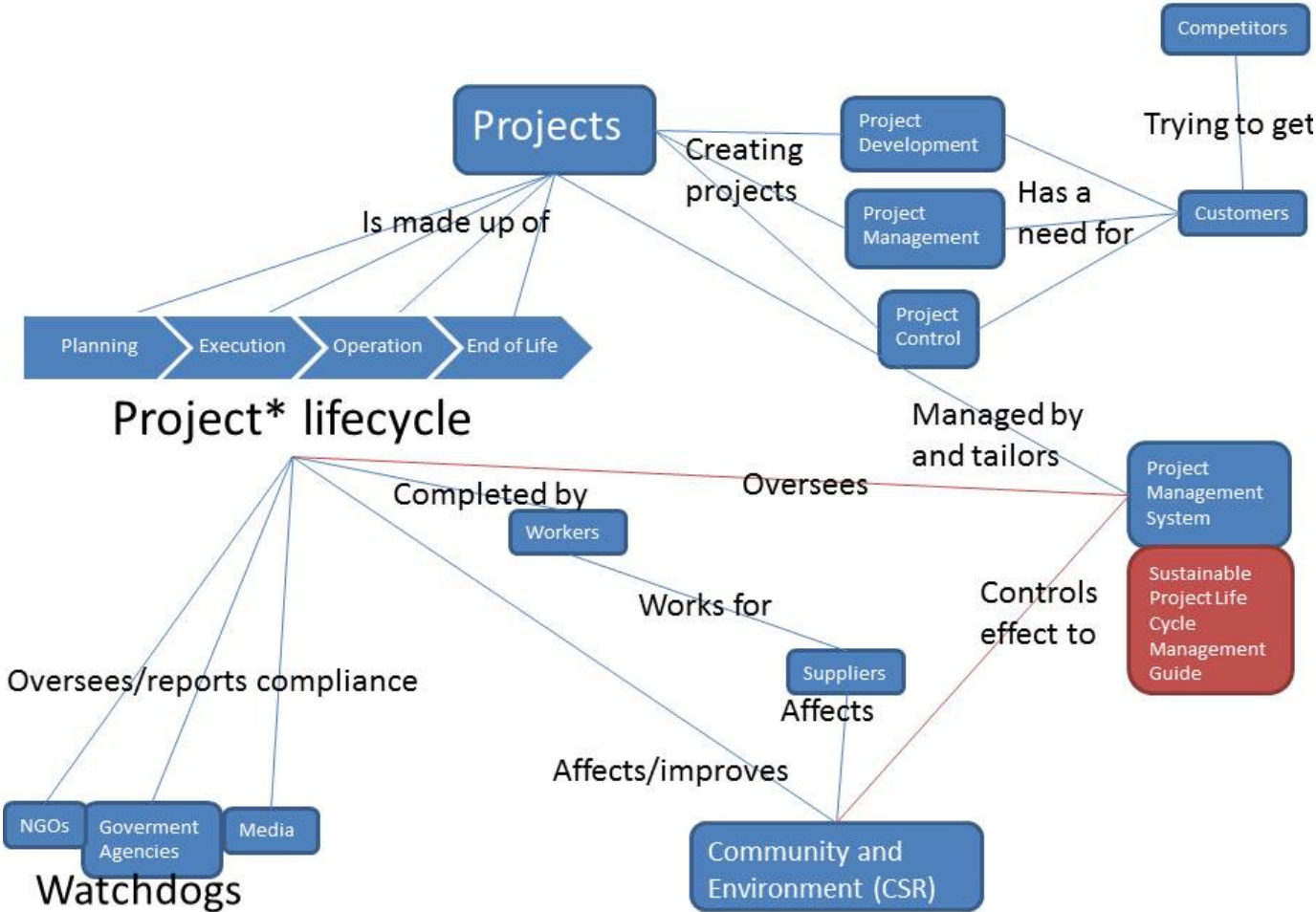
Figure 21: Level Two Concept Mapping with the addition of the SPLCM Guide

The problem stated above also includes the issue of the particular project type. This guide has been written so that it can be adapted by project managers (using their industry specific expertise) to fit their specific project type. This allows the SPLCM Guide to be used in any project type.

The development of the guide has been in cooperation with those supervising this project at Faveo and at NTNU. Their feedback has been valuable in the production of the final version of the guide. The following chapter applies the SPLCM Guide to a project at Faveo.

6.0 SPLCM Guide Application

One of the greatest and simplest tools for learning more and growing is doing more.

-Washington Irving
American Author

This chapter explains the application of the SPLCM Guide to a completed project at Faveo. It is not the goal of this thesis to scientifically test the SPLCM Guide. The purpose of this application is to test how it would work in order to develop it further and to understand the guide's potential in developing life cycle thinking and raising environmental and social competency in the project managers at Faveo.

The reason this particular project was chosen was due to the availability of the project manager to take part in this thesis project, and the nature of the project. The project is the building of the Blakstadelva Bridge, managed by Nils Morten Beitnes, and both the project and the background of the project manager are described in section 6.1. The results of the project manager using the guide are given in section 6.2, and the worksheets are provided in Appendix 3. After the project manager completed the guide, he was interviewed in order to assess the potential environmental and social impact mitigation the guide could have induced if it has been completed at the beginning of the project life cycle. The interview was also completed in order to assess the usability of the guide and to get feedback for the further development of the guide. The results of the interview are given in section 6.3, and the interview guide (semi-structured interview, explained in section 2.2.3) is given in Appendix 4. Section 6.3 is a summary of the results of the interview (the full answers are provided in Appendix 4), and the interpretations and recommendations taken from the interview are explained in section 6.4.

6.1 Description of the Project and Background of the Project Manager

The project that the SPLCM Guide was used on was the Blakstadelva Bridge project. The project manager for this was Nils Morten Beitnes. The need for the Blakstadelva Bridge was realized by Statens vegvesen (the road authority in Norway). The planning for the project began in 2009, and the bridge has only just been completed in the spring of 2013.

The project manager, Nils Morten Beitnes, has been working in the construction industry since 1992 following his education in civil engineering. He has worked for Faveo as a project manager for the past five years. Before this, Nils Morten worked as a quality manager for a construction company. He has no specific education in sustainability except an EHS (environmental, health and safety) short course. As a quality manager in previous positions, he gained experience in auditing that had environmental elements to it.

6.2 Filling out the Guide

Appendix 3 shows the output of the test application of the guide, and this section will explain the process of how the project manager created it. First, the project manager needed to have the guide personally explained. This, however, can be done on a larger scale (a presentation of

the SPLCM Guide to all Faveo project managers) for the guide to be fully deployed in the company. After the guide was explained by the analyst, the project manager took the guide to be completed on his own with a one and a half week deadline.

Only Sections 1, 2 and 3 of the guide were completed by the project manager.

The results of the test application are as follows:

Section 1: The Project Life Cycle

The life cycle of the Blakstadelva Bridge project followed Scenario 1 but was tailored according to the specifics of the project. The life cycle consisted of the project life cycle with the following phases: idea/need, consequence analysis, planning/design, approval, tender phase, building/construction and finishing. These project life cycle phases were followed by the life cycle phases of the bridge itself, which included: evaluation, use, surveillance/maintenance and decommissioning/recycling. The project manager noted that in the first part of the project life cycle, there are often gaps in road construction projects because after the planning and design; there may be several years before the project is selected by Statens vegvesen to be completed.

Section 2: Environmental Life Cycle Management

The environmental aspects from the general and the specific environmental aspect checklist were used. The general list was used more in the early phases of the project life cycle with the specific list used more in the latter stages of the project life cycle. The mitigation options given in the early phases were also not from the checklist but were explained by the project manager. The mitigation options given in the latter stages were those given in the checklist.

Section 3: Social Life Cycle Management

The stakeholder analysis was completed by listing the relevant stakeholders according to the life cycle phase in which they were found. Each of the stakeholders was then assigned a letter, and this letter was put into the Power, Legitimacy, and Urgency Diagram provided in the guide to give the stakeholder their classification for stakeholder management advice. Although the social aspects should have been assigned by the project manager in the same way the environmental aspects were, this was not completed due to time constraints and schedule conflicts. The project manager did, however, look through the social aspect checklist and understood what was relevant for his project.

6.3 Interview Results

The interview (the guide and answers are given in Appendix 4) was a semi-structured interview which took place on 23 May 2013. The project manager was not given the questions in advance, and the analyst took notes during the interview to record the answers. The interview guide has two sections: 1) the first part was designed to get the project manager's opinion on the effects the SPLCM Guide would have had on the community and environment if the guide was used in the planning stages of the project; 2) the second part was designed to get the project managers reactions to using the guide.

The SPLCM Guide version that the project manager used is provided in Appendix 2; the changes based on the feedback in the interview are explained in section 6.4 as possible changes and have not been implemented in the guide. The answers to the interview are provided in full in Appendix 4. The following sections act a summary of the answers.

6.3.1 Part 1

The purpose of the questions in Part 1 of the interview is to understand the project manager's thoughts of how the use of the SPLCM Guide will mitigate the project's societal and environmental impact.

The project manager felt that he could have implemented the environmental and social mitigation measures suggested by the guide; however he felt that the specific environmental aspect checklist could be more elaborate (including every possible measure even if it is not applicable to the particular project). The relationship with the stakeholders would have been improved by using the guide because of the environmental and social approach of the SPLCM Guide, as well as the expanded life cycle. Faveo project managers already do a stakeholder analysis before a project begins, but he explained that it is in the position of defending against threats. He described it as "who is on our team, and who is not." The SPLCM Guide's stakeholder analysis goes beyond this. He also indicated that there is already a stakeholder involvement strategy as part of the project management, but it is only aimed at defending against threats. The communication plan is done in a "selfish way" because it is not about collaborating with stakeholders but defending the project against them.

The project manager felt that the environmental and social impact would have been improved by implementing the guide, but it would be difficult to measure because they do not have any active involvement in the product part of the life cycle and the project manager is not always on site to see what is happening and following-up on mitigation measures. The project manager has seen social mitigation measures enacted in other projects and has seen them reduce the social impact, and he feels confident that the SPLCM Guide would reveal more social mitigation measures that could be successfully implemented.

Overall, the project manager liked the new perspective the SPLCM Guide gives to project management, and it would bring about a mitigation of the social and environmental impacts; but because the project manager is not the project owner, he felt that this reduced level of power could cause some friction in the implementation of mitigation measures.

6.3.1 Part 2

The purpose of the questions in Part 2 of the interview is to understand the project manager's impression of how the SPLCM Guide works and to record any feedback the project manager has about using the guide and the purpose of the guide.

The project manager felt that the guide was easy to use and that it was a very good way to raise the sustainability competency of project managers. He felt that the checklists should be organized differently; perhaps in the table format that he used when filling out the guide (see examples in Appendix 3). He indicated that all parts of the guide were useful and relevant for his project; however the environmental life cycle management section (section 2) was the

most useful. The social life cycle management section (section 3) was not new, but it did create a new comprehensive way of doing this analysis.

In developing the life cycle model, the project manager felt that the information about the life cycle became more concrete. In physically seeing the visual representation of the comprehensive project life cycle, it made the project manager feel a sense of ownership for it. This also allowed him to see aspects that were not only the most dangerous risks to the project, but also all the social and environmental threats.

The project manager felt that from his project specific expertise, he was able to identify the environmental and social aspects, as wells as the stakeholders. He felt that the explanation in all the sections was useful and clear. He did, however, indicate that this needs to be translated into Norwegian to be better understood at Faveo.

Section 4 (Communication Recommendations) was not to be completed by the project manager; there is nothing to implement concerning a finished project. However, he did read the performance indicator checklists, and when asked if he would be able to provide information for any of the relevant indicators, he said that they already have to document some of them. To provide information for the performance indicators, it would only be a matter of organizing the documentation in a different way. The SPLCM Guide showed him how they could be better documenting the social and environmental relationship of the project.

The specific recommendations the project manager gave for the guide include developing the SPLCM Guide into software and organizing the checklist into a table format with aspects on one side and mitigation measures on the other. He used about 2.5 hours in completing the guide, but this would have been shorter if he had done it in one sitting and in an easier format (i.e. software). If he had to complete this as a part of project planning, he said he would have used more time and done it more thoroughly because he would have consulted colleagues for their opinions.

6.4 Interpretations and Recommendations

Throughout the interview and in discussing how he completed the guide, the project manager stressed how important it was to complete this sort of environmental and social analysis for all their projects. To date, the environmental and social analysis completed before a project begins is only in the form of defending against threats, and not being proactive in helping the community and the environment. The goal is compliance to environmental and social regulations, but nothing beyond this.

The overall feedback for the SPCLM Guide was favorable, and the only recommendations for the guide that the project manager gave concerned the format (checklist in a table format and turning the guide into software). The project manager did not feel that completing the guide was too time consuming to complete for every project; it could be used in every conceptual/planning phase of a project. There were no content recommendations that he could give. He felt the guide is necessary to implement at Faveo because of a problem that was not uncovered in the system dynamics analysis of the project management systems of Faveo. He

explained that there are many project managers at Faveo who are not open to new ideas because of their experience level. Faveo does not hire new graduates because they do not have a training system in place and because Faveo's goal is to sell competence. Faveo is selling the experience level of their project managers to the project owners (Faveo's clients). Because of this, Faveo has a tendency to employ project managers who feel they know how to practice project management in the best possible manner. Without the advantage of new graduates, Faveo is losing the innovation, new ideas and openness that these potential employees could give to the company. This has an impact on the sustainability of their projects as well, as experienced projects managers are less likely to be open to the type of change that the SPLCM Guide would bring to their projects. He felt that Faveo needed to find a way to modernize, and requiring the project managers to use the guide could be one route to this without hiring new graduates (especially those with sustainability education).

Faveo feels that their project management competency is strong, and they are correct; however this mindset needs more humility on the project manager level, and they need to be open to improvement.

The project owner was indicated as a hindrance in implementing mitigation measures; cost being the issue. However, as will be explained in the next chapter (Chapter 7 Sustainable Project Life Cycle Management and Value Creation), it is possible to show the project owner that implementing mitigation measures can create monetary value. The goal is to get not only Faveo and project management consultancies to use the SPLCM Guide, but also to have the project owners expand the borders of the project to include sustainable development in their own company. The project manager indicated that the project owner (in this case Statens vegvesen) needs to think about their projects in a different way. As of today, Statens vegvesen does not want to be dictated to in terms of how they complete their projects (e.g. from politicians); they want to complete their projects according to their own plans. In order for the SPLCM Guide to be successfully implemented in projects and generate results, the project itself needs to be such that the project manager has the ability to influence the decisions being made. The strict borders that are often given by the project owners inhibit this. If Faveo project managers show how projects using the SPLCM Guide can generate value, Faveo will also be selling their sustainability competence along with their project management competence.

7.0 Sustainable Project Life Cycle Management and Value Creation

Humans cannot create matter. We can, however, create value. Creating value is in fact, our very humanity. When we praise people for their strength of character we are actually acknowledging their ability to create value.

-Tsunesaburō Makiguchi
Japanese Educator

The goal of this chapter is not to explain the business case for sustainability. This was explained in section 3.1.3. This chapter will explain the concept of sustainable value creation and how it can be created. This leads to the concept of value creation and management in projects and the role of qualitative utility functions (e.g. stakeholder value) in multi-criteria decision analysis (MCDA). Sustainable value creation is then explained on the project level, and how the SPLCM Guide can aid in value management in projects.

7.1 Sustainable Value

In sustainable value, the boundaries of value creation are expanded to include all the stakeholders of a company. The concept of sustainable value is at its core the negative and positive stakeholder value that is created through financial value creation (Laszlo 2003). Negative stakeholder value is the negative influence a company has on the well-being of its stakeholders, and positive stakeholder value is created when a company has added to the well-being of its stakeholders. Positive stakeholder value creation is not made at the expense of financial value creation. For example, when a company operates beyond minimal environmental compliance, this can lead to: reduced costs, faster permit approvals, governmental lobbying benefits, access to socially responsible investor capital, acquisition and retention of talent and many others. In this context, business value needs to be reframed to include the value that stakeholders possess.

The sustainable value creation model is about promoting relationships and collaboration with stakeholders to foster mutual benefits. This model is meant to create opportunities for the company to reach long term social, environmental and economic goals (Laszlo 2003). Different stakeholders are affected or affect a company at different points in the value chain. At each point, there is a potential for negative or positive value creation. These are opportunities for the company to create value or they can be threats that destroy value.

Companies understand how to measure the financial value of a company, but it is much more difficult to assess the value that stakeholders possess. However, it is this hidden value/risk in the value chain that is important for companies to understand and manage. It is not, however, the stakeholder needs that are the focus of sustainable value creation; it is what addressing their needs can bring in terms of value to the company. This is where the mutual benefit lies: in the sustainable value model, stakeholders are collaborative partners whose needs are met while creating value for the company.

7.1.1 Creating Sustainable Value

When value creation is framed in a sustainability perspective, this model for value creation can be used strategically. In this way, stakeholder management becomes strategic for the purpose of value creation. In his 2003 book, *Sustainable Company: How to Create Lasting Value through Social and Environmental Performance,* Laszlo explains eight disciplines of sustainable value. These are listed and described in Table 2.

Table 2: Laszlo's Eight Sustainable Value Disciplines (Laszlo 2003)

Laszlo's Eight Sustainable Value Disciplines	Description
1: Understand Current Position	How is the company positively or negatively affecting stakeholder value
2: Anticipate future expectations	Track the future needs of the stakeholders
3: Set sustainable value goals	Where will the company focus its efforts to increase stakeholder value
4: Design value creation initiatives	Identify the sources of stakeholder value creation
5: Develop the business case	Make an argument for the initiative to obtain the resources needed to complete them
6: Capture the value	Execute the initiatives
7: Validate results and capture learning	Track progress and results
8: Build sustainable value capacity	Improve internal competence to achieve greater sustainable value creation results

These eight principles are grouped into discovering value opportunities, actually creating value and then keeping the process going (feedback loop). This is shown below in Figure 22. The degree or scale to which these principles are applied in a company is not nearly as important as applying all eight principles, and it does not matter how the company enters the cycle as long as eventually the cycle is completed (i.e. all eight disciplines are practiced.)

Assessing stakeholder value and performance can be ascertained from various sources. In Chapter 5, the SPLCM Guide creates a way for the project manager at Faveo to understand the social and environmental impact in the life cycle of their project. This can be used as a starting point for assessing stakeholder value and performance. There are also global standards such as the UN Global Compact and the Global Reporting Initiative which can be used in the evaluation. Government regulations (such as EU directives), best industrial practices and company management policies, capital markets (such as Sustainable Asset Management (SAM)) and direct stakeholder input can all be a part of the assessment for assessing stakeholder value.
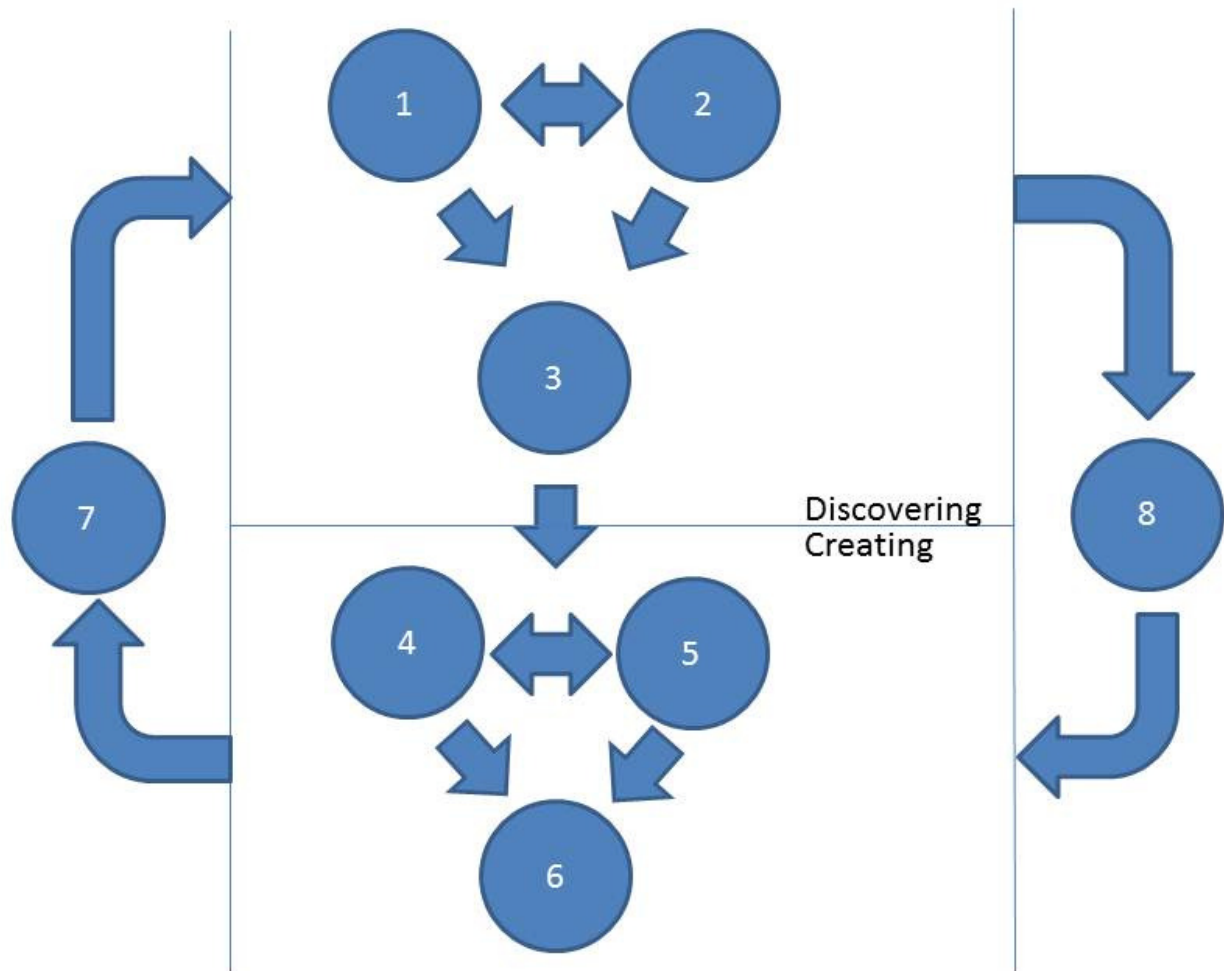
Figure 22: Relationship between the eight disciplines of sustainable value creation (adapted from Laszlo 2003)

7.2 Value Management in Projects

Sustainability is a value expressed on the corporate level, and value management on the corporate level concerns creating a set of values with the goal of having those values internalized by those working for the organization. In this value-based organization, the employees take ownership of the company's values, goals and mission for the purpose of value creation (Jordanger and Klakegg 2013).

In project management, the purpose of value management is to create as much value as possible in projects. According to the Project Management Institute (PMI) (2004), earned value is *"the value of work performed expressed in terms of the approved budget assigned to that work for a schedule activity or work breakdown structure component. Also referred to as the budgeted cost of work performed (BCWP)."* Earned value *management* is then described by PMI as:

A management methodology for integrating scope, schedule, and resources, and for objectively measuring project performance and progress. Performance is measured by determining the budgeted cost of work performed (i.e., earned value) and comparing it to the actual cost of work performed (i.e., actual cost). Progress is measured by comparing the earned value to the planned value. (PMI 2004)

When the parameters of value creation are widened to include stakeholder value, it has the potential to increase the earned value of a project. This is dependent on the cost of increasing stakeholder value; however in many cases, as shown in Table 4 in section 7.3, the cost of meeting stakeholder needs can be minimal compared to the increase in stakeholder value.

In section 7.1, sustainable value creation as expressed by the Laszlo's eight disciplines must be driven on the corporate level, but it is the project managers in projects that are creating the value. Sustainability (i.e. sustainable project life cycle management) must be internalized by project managers to create value on the project level. This can be achieved in the conceptual phase to choose between different alternatives for a project or it can be achieved by optimizing the stakeholder value in a given project.

Stakeholder value can be a part of decision making in the conceptual phase of a project. As expressed as a utility function in multi-criteria decision analysis, Jordanger and Klakegg (2013) showed that qualitative elements (e.g. community development) can be a part of multi-criteria decision analysis (MCDA) in order to choose between different alternatives in the conceptual phase of a project based on value creation. By using the methodology explained in their work, it is possible for the project manager to model value creation for different alternatives involving quantitative utilities such as net present value (NPV), and then calibrating the qualitative utility functions (e.g. community development) to NPV and then balancing them by using willingness to pay (WTP) (in this instance WTP asks: are the qualitative functions worth what they were calibrated to? In not, they are to be adjusted accordingly). The alternatives are then evaluated based on this model, and a comparison is made between the alternatives to aid decision-making.

This methodology illustrates how sustainable value creation and management can be integrated with quantitative elements in MCDA. This helps not only the project manager make decisions, but it also sells the more sustainable alternative to the client (i.e. project owner). This can be the biggest hurdle in practicing sustainability in a project management consultancy. The values set on the corporate level of a company such as Faveo must prove to add value for the client. Sustainability goals provide more than just branding and reputation management opportunities (although this can create considerable value in projects (Laszlo 2003)). Sustainability measures in projects can increase earned value, and should be considered in the conceptual phase of a project in order to sell sustainable options to the project owner.

7.3 The Incorporation of LCM in Project Management Systems and Value Creation

The internalization of sustainable project life cycle management, through tools such as the SPLCM Guide, aids the project manager to recognize sustainable value creating opportunities in the life cycle of a project. This life cycle is important to the project owner (clients) because the majority of the project life cycle occurs after it has left the project manager's hands. The value creation of a project (depending on the project) will also be in a part of the life cycle that the project manager is no longer a part of. Sustainability management in a life cycle perspective in the Faveo system will ensure the maximum sustainability value creation for the client. To make this happen, the SPLCM guide can be a useful aid, however, there must also be other methods and tools available for the project manager. This section will explain how the SPLCM guide can be used as an aid in achieving Laszlo's eight disciplines of sustainable value creation, and where the gaps are in maximizing sustainable value creation in the Faveo system.

To maximize the stakeholder value in a project, it is important that the project managers assess the stakeholders and recognize opportunities for value creation in addressing stakeholder needs. The SPLCM Guide, explained in Chapter 5 and available in its entirely in Appendix 2, allows the project manager to enter the eight disciplines of sustainable value creation at the first discipline. In completing the guide, the project manager will understand the effect their project has on the environment (in sustainable value creation, the environment is a stakeholder) and the needs of the stakeholders. The scale in which this is evaluated is determined by the project manager; but as mentioned in section 7.1.1, the scale is not as important as including all eight disciplines.

The SPLCM Guide is a bottom-up approach to incorporating life cycle management in projects. Value creation is a side effect of using the guide, but in order to fully exploit the value of stakeholders, there needs to be a top-down approach to generating stakeholder value. The SPLCM Guide: can assess the current position of sustainable value (discipline 1), may help the project manager understand the future expectations of stakeholders (discipline 2), has the potential to uncover stakeholder value creation opportunities (discipline 4) and will improve internal sustainability competence (discipline 8). The SPLCM Guide does not: contribute in setting sustainability strategy (discipline 3), develop a business case for the initiatives uncovered by using the guide in order to get resources (discipline 5), help with the execution of sustainable value creation initiatives (discipline 6) or help with tracking progress and results (discipline 7). Disciplines 3 and 5 require a more top-down approach or help from outside the project manager role. Disciplines 6 and 7 require additional tools to help the project manager create value in their projects. A summary of the different disciplines that the SPLCM Guide contributes to is given in Table 3.

Disciplines aided by the SPLCM Guide	Gaps in the Faveo System
Discipline 1	Discipline 3
Discipline 2	Discipline 5
Discipline 4	Discipline 6
Discipline 8	Discipline 7

Although the SPLCM Guide is not comprehensive in its ability to help the project manager maximize value creation in their project, it does aid in the generation of value. The most important way that it does this is through the identification of stakeholders and their needs. Below in Table 4 is a list of example stakeholders. To the right of the list are examples of the ways in which value can be created by meeting their needs.

Because the project manager is the expert in their specific project type, they are in the best position to evaluate how their project's stakeholders can create value in their project. By internalizing LCM, and thereby increasing their sustainability competence, the project manager will be able to recognize the potential for sustainable value creation in the life cycle of the project.

Table 4: Examples of Potential for Value Creation by Addressing Stakeholder Needs

Example Stakeholders	Potential for Value Creation
Investors	Socially responsible investor capital; and potentially lower weighted average cost of capital (WACC)
Employees	Acquisition and retention of talent; improved morale and productivity
Clients	Building brand loyalty and reputation
Business Partners	Access of strategic resources and capabilities
Unions	Improved labor relations and conflict resolution
Others in the Value Chain	Cost-reduction/value-enhancing collaboration in the value chain
Regulatory Bodies	Validation of specific product/service quality levels; lobbying opportunities; and increased flexibility
Different Levels of Government	Favorable fiscal and industry specific environmental and social policies
Local Community	Mutual support and accommodation; license to operate; reasonable treatment concerning local taxes and service fees
Private Organizations	Constructive collaboration with individual organizations and groups; improved public opinion; and license to operate

The SPLCM Guide is only part of the process in maximizing stakeholder value at Faveo. As mentioned earlier, the scale in which the disciplines are executed is not as important as completing all the disciplines. The project manager cannot do this with the guide alone, as shown in Table 3. However, the guide can act as a starting point for Faveo maximizing the stakeholder value of their projects.

8.0 Discussion

In the discussion of this thesis, the research questions will be directly answered based on the information provided in the preceding chapters and the appendix (section 8.2) after a short summary of the results of this thesis (section 8.1). The SPLCM Guide is the main outcome of this thesis; the development of which has been based on the results of the specialization project, the literature review and theoretical analysis, the test application and by physically working at the company. Section 8.3 discusses how the SPLCM Guide fulfills its purpose and argues support for its implementation. This thesis has in large part been developed with Faveo Prosjektledelse AS. Because of this, the generalization of the results of this thesis needs to be discussed (section 8.4), and section 8.5 goes even further with its discussion of the validity of the results.

8.1 Summary of results

This master thesis project was the second half of a yearlong project undertaken in cooperation with Faveo Prosjektledelse AS. The specialization project was completed in the fall 2012, and its goal was to analyze Faveo as a system in order to find opportunities for including CSR and environmental management in their project management systems and to create concrete world class project management criteria that Faveo can strive towards. In accomplishing this goal, it was revealed that Faveo would benefit with the integration of sustainable life cycle management into their project management systems.

The specialization project showed through backcasting (Appendix 1.4) that the ultimate goal in project management (in a social and environmental context) is to have sustainable projects. To reach this goal, tools and techniques need to be developed to guide and aid project managers in their decision making. The goal of this master thesis was to develop life cycle management tools and methods for use in project management. The outcome of this master thesis is the SPLCM Guide that can be used by project managers regardless of project type.

The scientific approach for the development of the guide was system dynamics which is explained in Chapter 2 (section 2.1 Scientific Approach). In order to develop the guide, life cycle management as a concept and its use in a systems perspective needed to be explored, and this is provided in Chapter 3. Life cycle management then needed to be applied to project management theoretically (Chapter 4) so that the guide could begin to formulate. Chapter 5 explains in detail all the sections of the guide and how the guide can serve to close the gap in the project management systems of Faveo so that it addresses the needs of the community and the environment systematically.

The purpose of the SPLCM Guide is to raise the project manager's environmental and social management competence and to develop life cycle thinking skills. This guide is a competence building tool in that using this guide, the project manager will learn how to practice environmental management and corporate social responsibility in a comprehensive project life cycle perspective, i.e. sustainable project life cycle management. The goal of the guide is for the project manager to internalize the steps in the guide as they develop their life cycle thinking skills, so that life cycle management is incorporated into the project management system at Faveo.

The guide has four sections: *The Project Life Cycle* helps the project manager expand the boundaries of the general project life cycle to include the assets that the project produces. *Environmental Life Cycle Management* helps the project manager identify the environmental aspects in each stage of the project's life cycle and gives mitigation options and information about available tools, such as LCA, to aid in their decision making. *Social Life Cycle Management* helps the project manager identify the project's stakeholders and takes them through a stakeholder analysis which results in stakeholder management advice. This section also helps the project manager identify the social aspects in each stage of the project life cycle and provides mitigation options. *Communication Recommendations* provides the project manager with advice for engaging with the project's stakeholders and lists environmental and social performance indicators so that the project manager can keep track of the relevant information should Faveo adopt the GRI or some other sustainability integrated reporting system.

The guide was then applied to a completed project (a completed project was chosen due to time constraints) and showed how the SPLCM Guide would work in an actual project environment and problems with the design of the guide when used by project managers.

To address the second research question, it was necessary to investigate the relationship between sustainability and value creation. Chapter 7 explains that the stakeholder value creation model expands the boundaries of value creation to include the mutual benefit from addressing stakeholder needs in the life cycle. Creating stakeholder value can be accomplished by following Laszlo's (2003) disciplines, and this chapter explains how the SPLCM Guide fulfills some of the disciplines. These disciplines are a top-down (corporate level) approach to sustainable value creation, while the SPLCM Guide is a bottom-up approach (a tool used by the project managers.) This chapter also explains that stakeholder value can be used as a qualitative utility function in multi-criteria decision analysis (MCDA).

8.2 A Discussion of the SPLCM Guide

Chapter 4 explains the theoretical use of LCM in project management, and the SPLCM Guide which resulted from this evaluation is the practical application of LCM in project management. This section will explain how this is justified.

The beginning of Chapter 4 explains the theoretical foundation for project management, consisting of an overview of the Project Management Book of Knowledge (PMBOK) and the IPMA Competence Baseline (ICB). What is lacking from this theoretical foundation is a life cycle perspective and a focus on environmental and social aspects of the life cycle. The work of Labuschagne (2005) and Labuschagne and Brent (2005) tackle these issues by expanding the life cycle of a project to include the life cycles of the assets that the initial project produces. Labuschagne (2005) goes even further by developing a social sustainability framework that can be applied to the project creating social sustainable project life cycle management.

This then laid the foundation for the guide to be developed. The life cycle section was created based on this widened perspective of the project life cycle, and the social life cycle

management section was partly based on the framework that Labuschagne (2005) created. The theoretical foundation for the stakeholder analysis in the guide was the same stakeholder analysis that was completed by the analyst in the specialization project (see Mitchel et al. (1997), Driscoll & Starik (2004) and Haigh & Griffiths (2007)). This is a widely accepted method for analyzing stakeholders, and the stakeholder management advice is also based on Mitchell et al.'s (1997) work.

To build upon the work of Labuschagne (2005) and Labuschagne and Brent (2005), the analyst put the project life cycle information and the social sustainability framework together and added the environmental life cycle management. The environmental LCM was not built upon a theoretical foundation as it is a guide that lists a wide range of environmental aspects and mitigation options that the project manager must fill in in the appropriate life cycle stage. A basic explanation of LCM tools is then explained with information on how they can use these tools or obtain the information from their use.

The communication recommendations that are given in last section of the guide are built upon the work of Morsing and Schultz (2006) because they explain a symmetric two-way communication strategy that is iterative with the goal of building relationships between the project and the stakeholder. This stakeholder involvement strategy needs to be practically applied, and this is the reason for the inclusion of their work in the guide. The second half of the communication recommendations is based on the GRI G3.1 guidelines, which is the most comprehensive reporting system available to business. This section does not act as a reporting standard for projects, but it recommends that the project manager keep track of the relevant performance indicators in the event that Faveo wants to adopt the GRI or another reporting standard.

Through the literature review and the theoretical evaluation of the use of LCM in project management, the SPLCM Guide was created and subsequently applied to a completed project to understand how it would work in an actual project environment and evaluated for its value creation potential. How this directly addresses the research questions is explained in the next section.

8.3 Addressing the Research Questions

The research questions stated in the introduction (section 1.4) are as follows:

1) How can life cycle management be practically integrated into project management systems using the case of Faveo Prosjektledelse AS?
2) What is the added value for clients in the incorporation of life cycle management into project management systems?

The following sections will address each question individually.

8.3.1 Research Question 1

In addressing research question 1, this master thesis had to explore the meaning of and theoretical foundation for life cycle management which was presented in Chapter 3. This was necessary because there was a need to explore what life cycle management entails and the

background for it so that it could be applied specifically to project management. This application was accomplished in Chapter 4, and the term sustainable project life cycle management was introduced. However, in Chapter 4 there was still no practical application of sustainable project life cycle management. The development of the SPLCM Guide directly answers the first research question. This guide can be used by any project manager regardless of project type. This was the most difficult challenge in developing the guide: developing a tool that was not project type specific. Because the guide utilizes the project manager's expertise in an environmental and social perspective, the guide overcomes this challenge. The guide does not need to be project specific; its goal is to raise the environmental and social competence and increase their life cycle thinking skills so the project manager can use their project specific expertise in a new way.

The project management systems of Faveo were analyzed in the specialization project, and the qualitative models which were the result of this are presented in Appendix 1. It was these system models that the SPLCM Guide was designed to enter into. The SPLCM Guide itself answers the "practical part" of the first research question, and how the use of the guide changes the concept mapping answers the "integration part" of the first question. Figure 21 in section 5.3 illustrates how the integration of the SPLCM Guide will allow the project managers at Faveo to directly manage the effects the life cycle of their projects have on the community and the environment.

The Faveo system was shown in the specialization project to be lacking an integration of life cycle management in the project management systems of Faveo that involves both CSR and environmental management for application in projects regardless of industry or project type. This problem is solved by project managers applying the SPLCM Guide to all their projects.

8.3.2 Research Question 2
The second research question was directly answered in Chapter 7. The concept of sustainable value was introduced which explained how stakeholder value in different stages of the life cycle can be created by addressing stakeholder needs. The sustainable value creation model is about promoting relationships and collaboration with stakeholders to foster mutual benefits. There is a mutual benefit in addressing stakeholder needs: the stakeholder benefits and the company creates value. Creating sustainable value can be accomplished by executing Laszlo's (2003) eight disciplines. This is a top-down approach to value creation (coming from top management). The SPLCM Guide is a bottom-up approach to life cycle management which practically implements LCM in projects.

In using the guide, the project manager is implementing value creation initiatives when they implement the mitigation options identified when using the guide provides. The guide can be even further developed (see section 9.1 Future Research) to specifically address value creation and how it is increased when addressing the needs of stakeholders in each stage of the life cycle.

Chapter 7 explains that stakeholder value can become a part of the decision making in the conceptual phase of the project by using stakeholder value as qualitative utility function in MCDA. Although this is outside the scope of the SPLCM Guide, project managers can use

the methodology explained by Jordanger and Klakegg (2013) with the concept of stakeholder value to understand which alternatives in a project will create the most value for the project owner.

Sustainable value creation and stakeholder value as a qualitative utility function in MCDA show that sustainable project life cycle management is not done for purely ethical or altruistic reasons. The monetary value creation for the company can be evaluated so that sustainable project life cycle management can be sold not only to the project owner but would also be attractive to project management consultancies to practice.

The research questions have now been answered. The SPLCM Guide was developed with the cooperation of Faveo; however because it is the role of the project manager that is targeted by the guide, the SPLCM Guide can be used in other companies as well. The next section discusses the generalization of the results of this thesis.

8.4 Generalization of the Results (External Validity)

The SPLCM Guide was developed from the analysis of Faveo's project management systems that was completed in the specialization project (see models in Appendix 1) and from the theoretical evaluation of the use of life cycle management in project management (Chapter 4). Because the guide is partially based on company specific data, it may be difficult to see how the guide can be used outside of Faveo.

The question of generalization must be addressed because of the value that the SPLCM Guide can help create for companies and the potential it has for facilitating the mitigation of social and environmental impacts of projects. The development of the project life cycle section of the guide was based largely on the work of Labuschagne and Brent (2005). Their work was based on the manufacturing industry, but the SPLCM Guide expanded its applicability to include any project type. The environmental LCM section of the guide was developed by compiling a list of the most common environmental aspects and mitigation options. This information can be used by any project manager because it is not company specific. The social LCM section of the guide was also based on literature (see Labuschagne 2005 and Mitchell et al. 1997) and is also not company specific.

The elements of the guide that are closely tied to Faveo as a company are the development of the language and figures in the guide. Faveo affected the language, figures and explanations because what is presented in the guide is what will be best understood by project managers at Faveo. Furthermore, the need for the development of the guide and how it closes the gap between project management and project life cycle management in the Faveo system (see Figure 21) is based on the specialization report results.

The SPLCM Guide is targeted to the position of project manager; such that it is not a company tool, but a tool for the individual project manager. The SPLCM Guide overcomes the generalization issue by targeting the role of project manager. It is the person using the guide, not Faveo as a company. Therefore any project manager can use this guide, regardless of what company they work for, and because the SPLCM Guide is meant for any project type, it can be used in other project consultancies even if they are specialized for a particular

industry. The SPLCM Guide may benefit from tailoring for a specific project management company if they do not have as many different project types as Faveo. For example, if a company specializes in a particular type of project management, then the guide can be tailored to make it more specific for their particular industry.

The SPLCM Guide can be directly used by project managers working for companies other than Faveo. The guide is meant to be adapted to suit the needs of the project manager for their particular project (this is how the challenge of addressing all project types was overcome.) The guide utilizes the expertise of the project manager to improve the environmental and social performance of their project and to improve their relationship with the stakeholders. Because the guide has the goal of raising the competence of the project manager, it can be more generally applied to all project managers regardless of the company they work for or the project in which the guide is used.

The second research question addresses the value creation potential in using the SPLCM Guide and evaluating stakeholder value in the decision making in the conceptual phase of the project. Although the idea of using qualitative utility function in MCDA is from researchers at Faveo, this is not a Faveo-specific concept. Using stakeholder value as a qualitative utility function can be used by any project manager in any company. Because the guide can be used by project managers in other companies, it will contribute to value creation in other companies as well if they adopt other measures that will fulfill Laszlo's (2003) disciplines that are not fulfilled by the SPLCM Guide.

The application of the guide (Chapter 6) was the first step in testing the SPLCM in a real project environment. The next section will address the validity issues that were made apparent by the guide's application.

8.5 The Validity of the Results

The purpose of this thesis is not to scientifically test the guide, but it instead focuses on the development of the SPLCM guide and its ability to create value. The external validity has been addressed in the previous section, but to understand the validity of whether using the SPLCM Guide has the potential to reduce the environmental and social impact, the guide must be tested on a project and the impacts measured. The application of the guide in this thesis was done on a completed project because of time challenges and because scientific testing is outside the scope of this thesis. The test application, however, did shed some light on the validity of the SPLCM Guide and its role in value creation.

The guide was favorably accepted by the project manager who tested it, but this does not mean that it will be accepted by everyone at Faveo or project managers in other companies. The project manager who tested the guide even indicated that this would not be the case at Faveo because the high experience level and attitude of many project managers render them unlikely to accept change in how they practice project management. This, however, needs to be researched further and in companies other than Faveo. The results of the application also showed a favorable indication that the SPLCM Guide could be used on all projects because the time it takes to complete the guide and the benefits in using it are a worthwhile trade-off.

One of the major hurdles uncovered in the test application was the ability to sell the mitigation measures to the project owners. This can be accomplished by integrating the value creation information with the guide (see section 9.1), and Faveo making the decision to take on projects where the project managers have a greater ability to influence decision making. When the project manager has limited power in a project, the effect of the guide will be minimal. In terms of value creation, this has only been theoretically assessed in this thesis. It can be used as a selling point to the project owners which will help give the project manager more influence in terms of implementing mitigation measures. To further test this, value should be evaluated on a project that uses the guide, and this has not been done in this thesis.

The results of the test application only provide a glimpse of the validity of the SPLCM Guide and must be further tested.

9.0 Conclusion

This goal of this master thesis was to develop life cycle management tools and methods for use in project management with research questions that concerned the practical integration of these tools in a system dynamics perspective and the contribution it can have in creating value. The Sustainable Project Life Cycle Management (SPLCM) Guide is an easy to use tool that project managers at Faveo and beyond can use in their projects to mitigate the environmental and social impact of their projects. Using this guide will change the Faveo system and allow the project managers to have a direct relationship with the community and the environment in the life cycle of their projects. The SPLCM Guide will not only reduce the impact the projects at Faveo will have on society and the environment, but it will also create value for the project owners and for Faveo itself. Sustainable value creation meets the needs of stakeholders while creating value for the company, and the SPLCM Guide (in conjunction with other initiatives) can realize this for Faveo.

Because the results of this master thesis are just the first step in the way towards sustainable projects (see Backcasting model and Systemigram in Appendix 1.4-5), Faveo has a lot of work ahead of them. Specifically for the SPLCM Guide, however, there are some concrete steps forward which are explained next in the final section of this thesis.

9.1 Future research

There are several roads forward from the results of this master thesis. The SPLCM Guide needs to be tested on actual projects to see how if there are any unforeseen problems with the guide that were not revealed in the application of the guide on a project that has already been completed. One of the challenges of this thesis was time, and to overcome this challenge the application of the guide was done on a project that was already completed. To understand the weaknesses of the guide, it would have benefited from a real-life application where performance indicators could have been measured to assess the influence the guide has on social and environmental impact mitigation. This, however, can be attempted in future research.

For Faveo, the application of the SPLCM Guide could be the first step in developing a company specific eco-label for sustainable project management. This would put Faveo in a position to be an industry leader for sustainability, creating a new benchmark in which other companies strive.

The SPLCM Guide could also be the first step in developing a standard for sustainability reporting in projects. It was beyond the scope of this master thesis to develop a reporting system to include in the SPLCM Guide, and provided communication recommendations based on literature and the GRI instead. This part of the guide could be developed to move beyond recommendations and provide a protocol for project managers to report the environmental and social performance of their projects. The guide could also make it easier for the project manager to understand how their efforts at improving stakeholder relations will also increase value. There could be another section of the guide that is dedicated to this where sustainable value creation is explained and is set in the project specific life cycle model.

The clear potential for the SPLCM Guide is its development into a web-based tool or locally installed software. This would make the life cycle section of the guide much easier for the project manager to create and manipulate to make it fit their particular project. Filling in the environmental and social aspects would also be easier, and the mitigation options/stakeholder management information/assessment tool information can be listed for them without the project manager having to keep track of the relevant information.

Although further development would benefit the SPLCM Guide, using this tool in the project management at Faveo will result in raised competence in the project managers so that they can help create a more sustainable society.

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Appendix 1: Specialization Project Qualitative Models

The following appendix sections provide the qualitative models from the specialization project completed in the fall 2012. These models (which are referenced often in this thesis) form the basis for the development of the Sustainable Project Life Cycle Management Guide which is provided in Appendix 2.

1.1 Stakeholder Analysis (adapted from Haigh and Griffiths 2007)
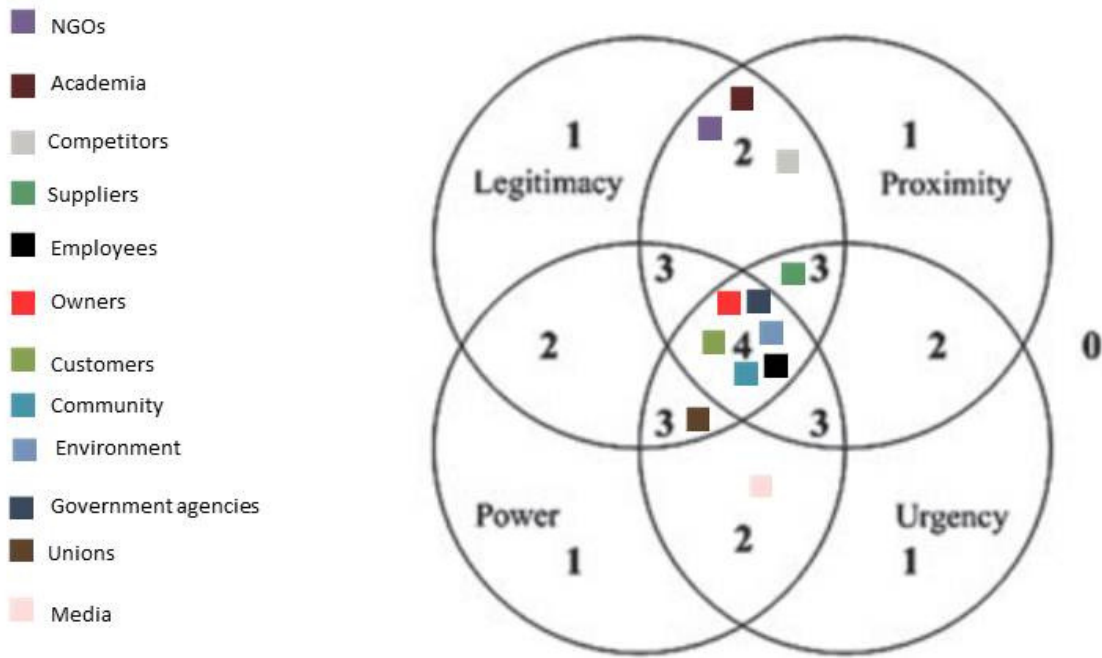
0= Non-Stakeholder 1= Latent Stakeholder 2=Expectant Stakeholder
3=Definitive Stakeholder 4=Primary Stakeholder

1.2 Level I Concept Mapping
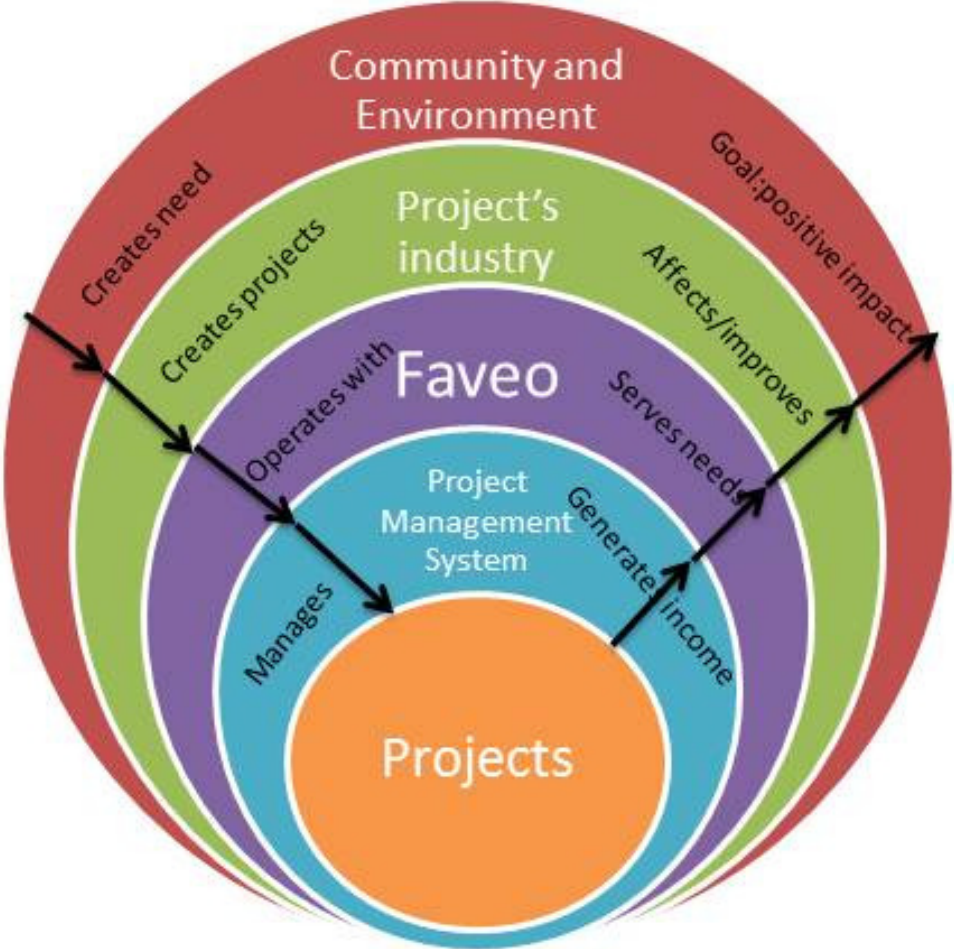
1.3 Level II Concept Mapping of Faveo's Projects
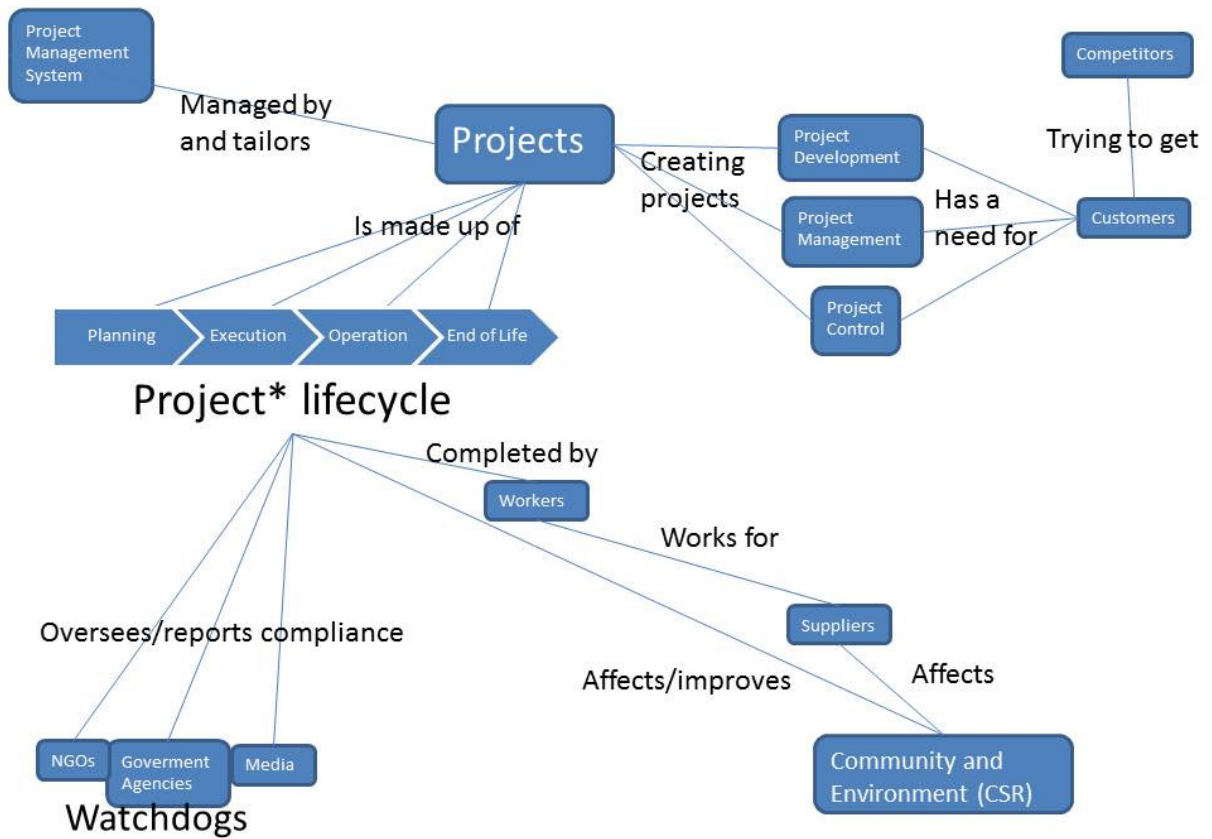
*Project and the product of the project's life cycle

1.4 Backcasting

```
┌─────────────────────┐      ┌─────────────────────┐      ┌─────────────────────┐
│                     │      │   Understanding     │      │                     │
│ Engaging Stakeholders│ ──►  │   environmental     │ ──►  │  Understanding EMS  │
│                     │      │   aspects/CSR in    │      │       tools         │
│                     │      │     projects        │      │                     │
└─────────────────────┘      └─────────────────────┘      └─────────────────────┘
                                                                     │
                                                                     ▼
┌─────────────────────┐      ┌─────────────────────┐      ┌─────────────────────┐
│                     │      │                     │      │    Recognizing      │
│ Creating a long-term │ ◄──  │ Integration of LCM  │ ◄──  │  opportunities of   │
│ sustainability strategy│    │ with project mgmt.  │      │ inegrating CSR and  │
│                     │      │                     │      │ env. mgmt. in projects│
└─────────────────────┘      └─────────────────────┘      └─────────────────────┘
          │
          ▼
┌─────────────────────┐      ┌─────────────────────┐      ┌─────────────────────┐
│                     │      │  Combine the «low   │      │                     │
│ Pick the «low hanging│ ──►  │  hanging fruit» with │ ──►  │ Sustainable projects │
│       fruit»        │      │ long term investment │      │                     │
└─────────────────────┘      └─────────────────────┘      └─────────────────────┘
```

1.5 Systemigram: LCM and Project Management, Faveo Perspective

LCC-Life Cycle Costing
CP-Cleaner Production
LCA-Life Cycle
Assessment   EPD-
Environmental Product
Declaration DfE-
Design for
Environment   EA-
Environmental
Assessment
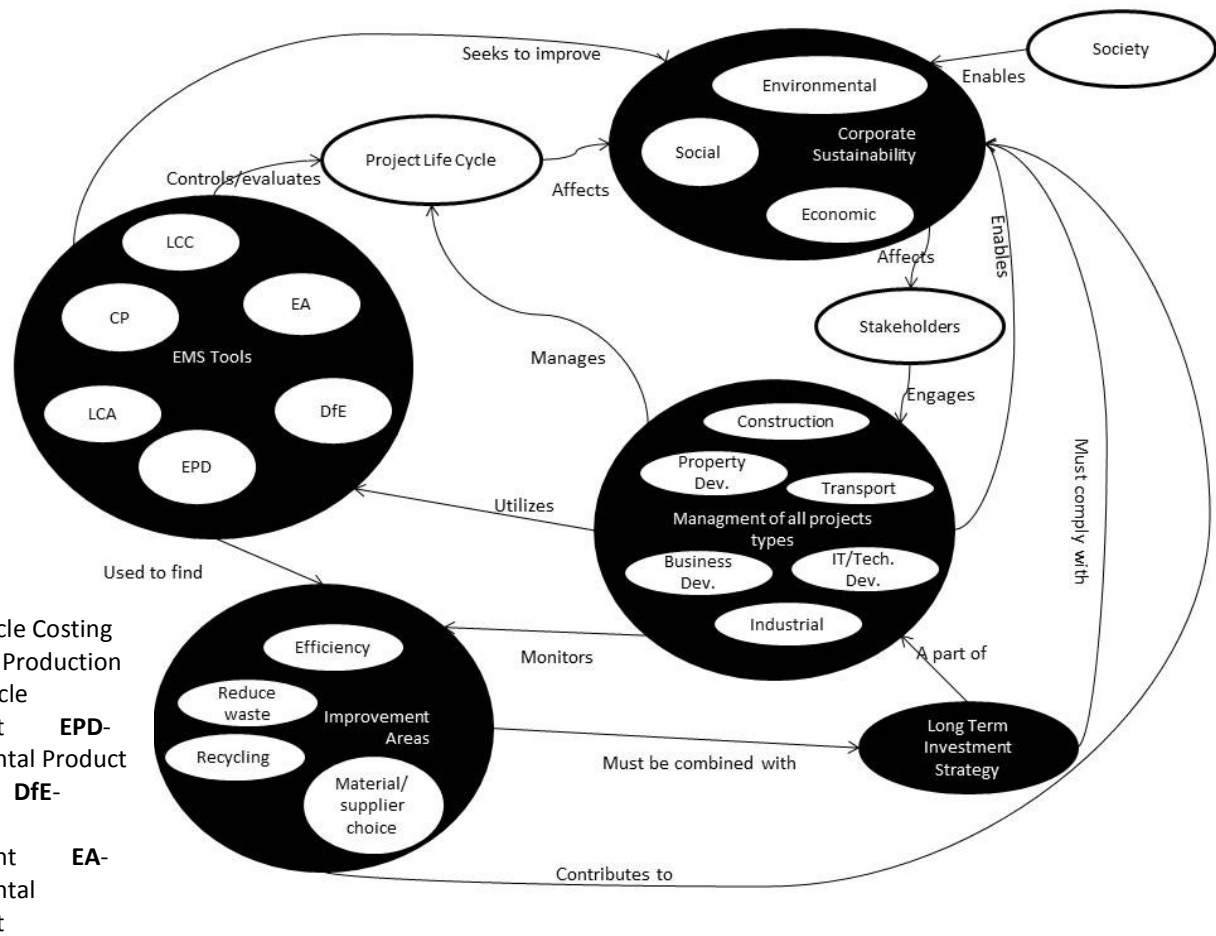
1.6 Evaluation Matrix: First Level Evaluation

Mandatory Criteria	Does Faveo meet this criterion?
Structures in place for organizational learning	Yes
Employee understanding of life cycle management	No
Employee understanding of CSR	Yes
Employees able to identify stakeholders in their projects	Yes
Employees able to identify environmental aspects in their projects	No
Employees are able to understand and make use of environmental management tools, such as life cycle analysis (LCA) and environmental project declarations (EPDs)	No

1.7 Evaluation Matrix: Second Level Evaluation

Desirable Criteria	Weight	Score: Fully meets=2,Partially meets=1,OR does not meet=0	Weighted Score
Utilization of structures for organizational learning	3	1	3
Social and environmental needs are given the same priority as financial needs	1	1	1
Understanding and use of life cycle thinking	1	0	0
Employees effectively communicate their CSR and environmental management performance of their projects	2	0	0
Faveo has developed an integrated CSR and environmental performance reporting system made easily available to the public (e.g. the Global Reporting Initiative (GRI) and easily accessible information on Faveo's website)	3	0	0
Faveo has tools and structures for internal communication of CSR and environmental management issues	2	1	2
Employees engage stakeholders in their projects	3	1	3

Appendix 2: The Sustainable Project Life Cycle Management Guide

This appendix provides the SPLCM Guide in its entirety.

Environmental Management and Corporate Social Responsibility in the Project Life Cycle

The Sustainable Project Life Cycle Management Guide

Sustainable Project Life Cycle Management Guide

The Sustainable Project Life Cycle Management Guide is a tool that can be used by project managers in project planning to improve their project's environmental and social performance (the focus of this tool does not include the financial part of sustainability.) It is a tool designed to set up the project in a way that is environmentally and socially responsible. The guide will improve the project manager's understanding of the environmental and social life cycle of their project. Based on the tailored life cycle that this guide helps the project manager to develop, the Sustainable Project Life Cycle Management Guide will suggest tools and methods for the mitigation of the environmental and social impact of the project.

The purpose of this tool is to raise the project manager's environmental and social management competence and to develop life cycle thinking skills. Once this competence is raised, the guide will help the project manager identify the ways in which their project interacts with the environment and society so that mitigation measures can be employed.

About the Guide

The Sustainable Project Life Cycle Management Guide is composed of four sections.

Section 1 establishes the life cycle stages in the project. Project life cycle stages vary in sustainable project life cycle management because it is dependent on what the project is producing.

Section 2 identifies the environmental aspects found in each life cycle stage. Once these are identified, potential mitigation options are given and tools are suggested for use in decision-making.

Section 3 identifies the stakeholders of each project life cycle stage to manage social improvement areas. The stakeholders are then categorized to establish the best possible way to engage them. Information is provided for the project manager on how to do this.

Section 4 gives communication recommendations for sustainable project life cycle management.

How to Use this Guide

This guide is set-up so that the project manager will need to answer a series of questions, as well as supply information about the project in each section. In *Section 1,* the answers to the questions will determine what stages of the life cycle are relevant to the particular project type. This is necessary so that the borders of the project manager's mental model are expanded to include the life cycle(s) of the resulting asset(s) of their project. In *Section 2* and *Section 3,* there are both questions and worksheets to develop the best strategy for managing the environmental and social aspects of the project.

In developing the tailored project life cycle, *Section 1* provides the input for the following sections which are intended to guide the project manager's decision-making and environmental and social management in the project. The following sections are built upon what is developed in the first section. All sections should be completed; however, if the project manager is only concerned with either the environment or social responsibility, the first section must be completed in order to complete the section concerning the desired focus area.

In each section, any text in bold is an action for the project manager to complete.

Section 1: The Project Life Cycle

The purpose of this section is to expand the horizons of how you conceptualize the project life cycle. This section begins by explaining the general project life cycle stages that all project managers should be familiar with. However, in terms of sustainable project life cycle management the life cycle does not end there. The result of completing this section will be a life cycle model that is specific to your project.

Before the development of your project specific life cycle, it is important to understand project life cycles in an environmental and social context. In sustainable project life cycle management, the general project life cycle is extended to include the life cycle of the project's result (the *asset life cycle*)[1]. The definition of the term *project life cycle* is then extended to include the asset life cycle as well.

The general project life cycle has life cycle stages that all project managers understand. The name and number of the stages varies depending on the source. In this guide, the following six stages are used: *pre-feasibility, feasibility, basic development, execution and testing, launch and post-implementation review (PIR)*. These stages are illustrated in Figure 1, and an explanation of these stages is given in Table 1.

Figure 1: General project life cycle stages

Table 5: Explanation of the general life cycle stages (adapted from Labuschagne and Brent (2005))

Phase	Description
Pre-feasibility	The goal of this phase is to evaluate the existing proposal in terms of financial, operational and technical viability as well as against the company's strategy. Overlapping or synergy with other projects should also be checked out
Feasibility	The optimum solution to address the business need must be identified and defined. All areas of this solution must be analyzed and assessed to determine killer concerns and risks
Basic Development	This phase involves design, development, creation and building of the chosen solution. The supporting system, manuals, business processes and training for the solution must also be developed during this phase
Execution and Testing	In this phase the solution is tested in an operational environment. The purpose is to validate the acceptance and capabilities of the solution
Launch	The project is handed over to the business units and thus released to the operational environment during this phase. This phase also marks the beginning of operational support
Post Implementation Review (PIR)	After sufficient time (9–15 months) the project should be assessed to determine if the benefits were delivered and what the impact of the project was on the business. Lessons learned should be captured for future reference

The asset is the result of a project. This could be a product, a service or a process. The result of the project can be tangible (a product) or intangible (a process or service). The asset life cycle can be summarized in four stages, and this is illustrated in Figure 2.

Asset Life Cycle

Figure 2: The asset life cycle

The project and the asset life cycle interact, and this is illustrated in Figure 3. In a project, the goal of the project is to design, construct and implement the asset. Figure 3 shows that the design stage of the asset is handled in both the pre-feasibility and execution and testing phase of the project. Construction is completed in the execution of the project, but the construction can be changed during testing and launch (this is why this is represented with dotted lines.) The operations and maintenance asset life cycle stage is a part of the launch and PIR project life cycle stages.

General Project Life Cycle

Pre-Feasability → Feasability → Basic Development → Execution & Testing → Launch → Post Implementation Review (PIR)

Design → Construction → Use → End of Life (EOL)
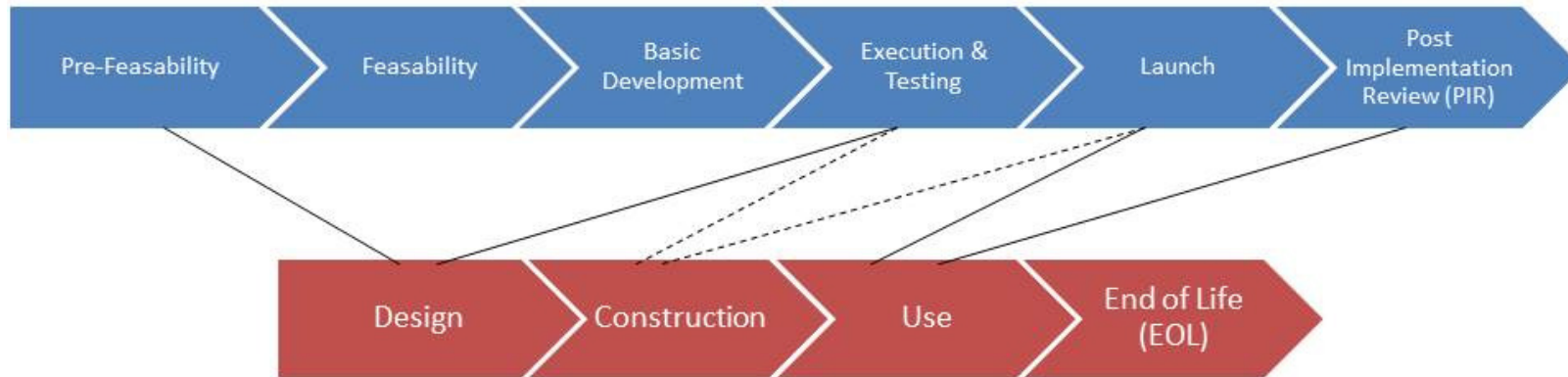
Asset Life Cycle

Figure 3: Interaction between the project and asset life cycles. The solid lines represent potential relationships and the dotted lines represent possible iterative relationships.

The goal of the asset may be to create another asset, and this resulting asset also has its own life cycle stages. Figure 4 shows how the asset life cycle interacts with the asset it produces (the construction of asset 2 occurs in the use of asset 1.) This figure illustrates the value chain, and it is all these stages of the value chain that have environmental and social consequences that are a result of decisions made in the general project life cycle. Many project managers feel that it is "not their problem" to tackle the environmental and social challenges in later stages of the life cycle because it is not demanded by the project owner. However, the decision to manage your project's social and environmental interactions can lead to value creation in the project, and it is the objective of the project owner to create value. As well as for the sake of the environment and society, this is why sustainable project life cycle management needs to be practiced.
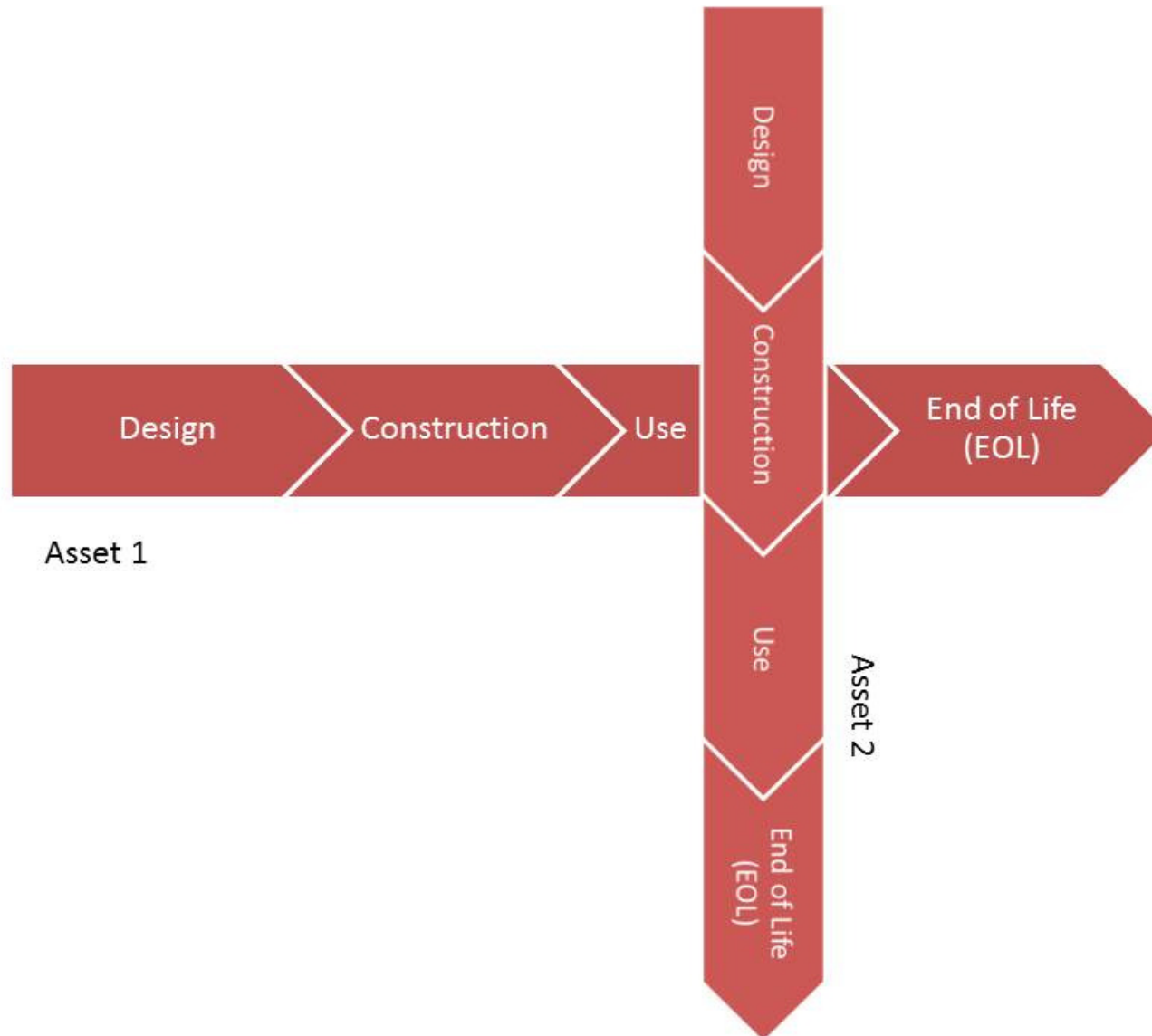
Figure 4: The interaction life cycle stages of asset 1 and 2

The project life cycle will continue from Figure 4 if Asset 2 produces yet another asset. The use phase of every asset may be the construction phase of another asset. In sustainable project life cycle management, the term *project life cycle* includes all life cycles in which the project manager wishes to control in terms of the project's environmental and social impact. In some projects, it may be difficult to understand how the project's life cycle stages are delineated. This next part of this section asks a series of questions to help create a model of your project specific life cycle that will be used in the next two sections of this guide.

Modeling the life cycle

The general project life cycle shown earlier in Figure 2 is the part of the life cycle where the project manager is involved and can therefore influence the resulting asset(s) life cycle impact on the environment and society. The general project life cycle provides the project manager with a starting point in understanding what the project life cycle includes. Figure 2 is given again below to illustrate the starting point.

General Project Life Cycle

Pre-Feasability → Feasability → Basic Development → Execution & Testing → Launch → Post Implementation Review (PIR)

Below is a series of questions that will delineate the project life cycle further which will guide you to either Scenario 1 (page 11) or Scenario 2 (page 12):

1) Does your project produce something that is intangible?

Yes: If your project produces something that is intangible, business development projects for example, then it can seem as if the life cycle of the asset is not applicable. This is not the case. If the project manager is developing program and portfolio management in a company for example, then the project is creating a process that will in turn create other projects, services and/or products (see the model in scenario 2). This puts the project manager in a position to influence the environmental and social impact further down the value chain. Move on to Question 2.

No: Move on to Question 2.

2) Is the result of your project an asset that does not produce another asset (or does not produce an asset that you would like to include in this model)?

Yes: If your project produces a product or service and this is a reasonable end point for managing the environmental and social effects of your project (i.e. you do not feel that it is necessary to add another life cycle to your life cycle model), then please refer to the project life cycle in Scenario 1. An example of a reasonable end point in a building project would be the life cycle of the building. In this example, the project life cycle would include both the general project life cycle and the life cycle of the building.

No: The result of your project is an asset that produces another asset that is within the boundaries of what you wish to include in the life cycle model. Refer to the life cycle shown in Scenario 2. Move on to Question 3.

3) If there another life cycle (i.e. Asset 3-this is the product of Asset 2) that must be included in the project life cycle (will your decisions affect another life cycle which will have an impact on society or the environment)?

Yes: Add another life cycle to Scenario 2 so that the construction phase of Asset 3 is produced in the use phase of Asset 2.

No: Use Scenario 2 without the addition of another asset life cycle.

Choose either Scenario 1 or 2 based on the questions above as a starting point for delineating your project specific life cycle. Tailor the project life cycle scenario so that it best fits your project. Add lines to connect the different life cycle stages if you feel that they interact. Add or take away life cycle stage in the scenario if you feel they represent/do not represent your project.

NB! The lines in the scenarios, representing the common relationship between the different life cycle stages are not fixed and can change with different project types. These lines are put in as an example. If the project manager feels that these relationships do not adequately represent the life cycle of their specific project, they should be changed. These scenarios should be used as a rough sketch of the project life cycle.

General Project Life Cycle
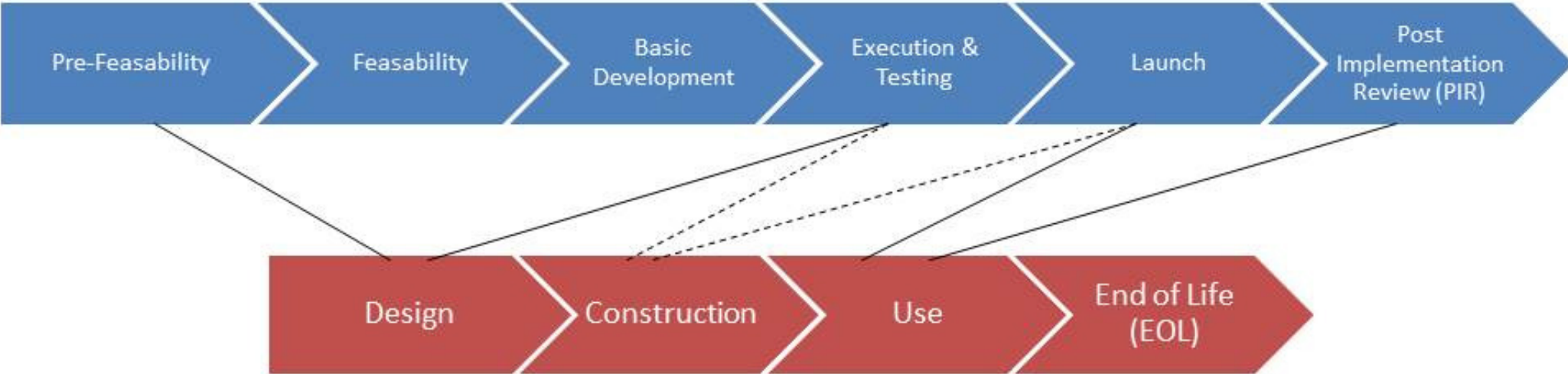
Asset Life Cycle

Scenario 2: Project/Asset/Asset Life Cycle

Section 2: Environmental Life Cycle Management

Based on the information given in *Section 1*, the project manager should be able to identify the basic stages of the life cycle that is specific to the proj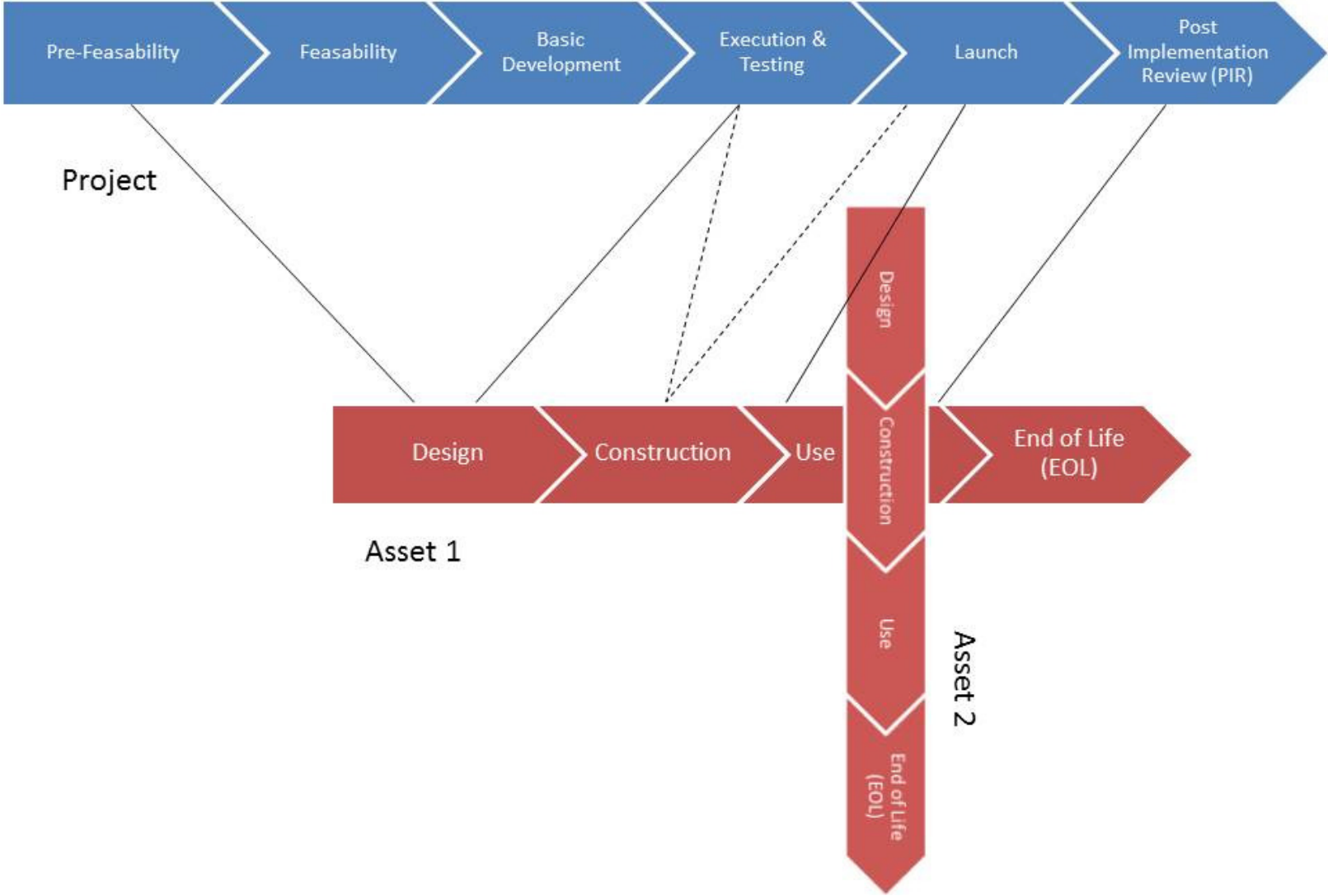ect in question. In *Section 2*, the environmental aspects and mitigation options will be identified. Once these are identified, tools are suggested for input into the project manager's decision-making.

Before the environmental aspects of the project are identified, an explanation of environmental aspects and impacts is required.

Environmental Aspects (in a project life cycle context) are elements in the project life cycle that interact with the environment. This term is often confused with environmental impact. However, **Environmental Impacts** are the environmental effects that these interactions cause. For example, transport (because of the release of CO_2) is an environmental aspect, and global warming is the environmental impact. Environmental aspects can be very general (as listed below) or very specific (as seen in the environmental aspect checklist). Basic environmental aspects include:

- Emissions to Air
- Discharges to Water
- Contamination of Land
- Use of Raw Materials and Natural Resources

- Energy Consumption
- Water Consumption
- Land Use

Environmental aspects are project specific, and the project manager is the expert on their particular project. To determine the environmental aspects of a particular project, the project manager must draw on their own knowledge and expertise.

Environmental Aspects in the Life Cycle Stages

To begin with, you will have one of two life cycles (Scenario 1 or Scenario 2 from Section 1). Use these scenarios as a worksheet. It is acceptable to use the general environmental aspect list given in the introduction to Section 2; however environmental aspects are best managed when the interaction is more specific because it will be easier to understand how to mitigate the impact of the environmental aspect. At the end of this section is a detailed checklist of environmental aspects to guide you. Not all possible environmental aspects are listed, so you may add aspects that are not in the checklist.

Take your life cycle scenario and place the environmental aspect number from the checklist below in the circle of each life cycle stages in which it is found.

The environmental aspects have numbers, and the suggested mitigation options have letters. The last section of the checklist gives positive environmental aspects to give the project manager ideas about how to positively affect the environment in their projects.

Suggested Tools to Assist in the Mitigation Measures

If you have completed the environmental aspect analysis, then you will have a list of appropriate mitigation measures that correspond with the environmental aspects. Some of these mitigation measures require decisions that needed further information; this is where environmental management tools can help.

Life Cycle Assessment (LCA)

Life cycle analysis (LCA) is the tool most often thought of in environmental life cycle management (LCM). Though LCA has its limitations (as do all LCM tools), LCA provides a thorough assessment of the environmental impacts of the entire life cycle of a product, process or service. The goal in this section is not to explain how to do LCA, but how to utilize it results. In LCA, the environmental aspects are quantified and put into an inventory from which the environmental impact is calculated. The environmental impact categories (midpoint indicators) are them summed into end-point indicators which are used to inform decision making. This is shown below in Table 2.

Midpoint Categories	Endpoint Categories
climate change (CC)	Damage to Human Health
ozone depletion (OD)	Damage to Ecosystem Diversity
terrestrial acidification (TA)	Damage to Resource Availability
freshwater eutrophication (FE)	
marine eutrophication (ME)	
human toxicity (HT)	
photochemical oxidant formation (POF)	
particulate matter formation (PMF)	
terrestrial ecotoxicity (TET)	
freshwater ecotoxicity (FET)	
marine ecotoxicity (MET)	
ionizing radiation (IR)	
agricultural land occupation (ALO)	
urban land occupation (ULO)	
natural land transformation (NLT)	
water depletion (WD)	
mineral resource depletion (MRD)	
fossil fuel depletion (FD)	

To use LCA results, the project manager can use either midpoint or endpoint categories, but it should be noted that midpoint indicators are more accurate. The different categories have different units, so they cannot be compared directly. The following example shows how you can use LCA information in a project.

There is a choice between two different materials in a building project; a building built with material A has a higher climate change potential than material B, but material B is slightly higher in its human toxicity potential. This is called an environmental trade off. Material B is also more expensive, and the contractors have very little experience with it. It is now up to the project manager to decide if the environmental tradeoffs are worth the extra costs and complications.

There are several ways to access LCA information. You can research LCA studies that have already been done and are published in academic papers or you can use software, such as SimaPro, to calculate LCA information yourself. LCA information is also given with products in the form of Environmental Product Declarations (EPDs).

Environmental Life Cycle Costing (LCC)[3]

Most project managers are aware of life cycle costing (LCC), i.e. the evaluation of costs in the life cycle of an asset. However in a traditional LCC, the environment is considered an externality and the evaluation is concerned with purely economic costs. The life cycle of the asset in traditional LCC is split into four life cycle stages: investment, operation, maintenance and disposal (or EOL-end of life). In environmental LCC, environmental costs are included in the evaluation over this life cycle. Environmental LCC uses environmental management tools, such as LCA, in order to ascertain the environmental impact of the asset in question. However, the environmental impacts uncovered in LCA must be quantified in monetary terms to be included in the LCC. Therefore, environmental LCC cannot be used on its own, but must be used in conjunction with other environmental management tools[3].

There are several tools that can help the project manager conduct an environmental LCC. The Swedish Environmental Management Council (SEMCO) has developed several Excel tools for environmental LCC in public procurement and for particular product groups. These can be found at this address: http://www.msr.se/en/green_procurement/LCC/

The SMART-SPP project has developed a tool to compare LCC and CO_2 emissions' information in the bidding process. This tool is available in English, French, Dutch Portuguese, Danish and Spanish and can be downloaded at this address: http://www.smart-spp.eu/index.php?id=7633

For LCC in sustainable construction, a methodology has been proposed by a study for the European Commission. The methodology can be found at this address: http://ec.europa.eu/enterprise/sectors/construction/studies/life-cycle-costing_en.htm

Checklist of Environmental Aspects and Mitigation Options

General:
1. *1.* Emissions to Air
2. *2.* Discharges to Water
3. *3.* Contamination of Land
4. *4.* Resource Use
5. *5.* Land Use

Specific:

A. Electricity Consumption
1. Electricity depletion of coal reserves and generation of greenhouse gases
2. Gas depletion of gas reserves and generation of greenhouse gases
3. Liquid fuel depletion of oil reserves and generation of greenhouse and other harmful gases
4. Steam depletion of fuel reserves and generation of greenhouse gases
   a. Heating efficiency and wastage
   b. Lighting efficiency
   c. Use of power-management feature on equipment
   d. Unnecessary usage
   e. Use of inefficient equipment
   f. Reuse of waste heat where viable
   g. Co-generation opportunities

B. Water Consumption
1. Depletion of town water reserves
   a. Examples of ways in which water use can be reduced:
   b. Maintain equipment to minimize leakage
   c. Mulch and other measures to reduce need for watering gardens
   d. Native plants to reduce need for water and fertilizers
   e. Focus on equipment and practices which use the most water in a building or on a site

C. Chemical Use
1. Chemical purchase and/or usage
2. Environmental contamination by chemicals and chemical residues
   a. Purchase of smaller package sizes in line with need
   b. Use existing stock (share chemicals) where possible rather than buying new chemicals
   c. Reuse or recycling of waste
   d. Minimize use of environmentally-toxic chemicals (find safer alternatives)

D. Other Resource Use

1. Paper use
2. Paper manufacture and even recycling has various environmental impacts and leads to pollution
    a. Examining all paper usage and eliminating usage where possible
    b. Double-sided printing (and providing equipment capable of double-sided printing
    c. Collection and reuse of paper printed on one side
3. Use or disposal of packaging
    a. Packaging is often seen as unavoidable, but it can be reduced by bringing pressure on suppliers to:
    b. Minimize the amount of packaging used
    c. Collect and reuse packaging
    d. Use environmentally-friendly materials (paper rather than plastic)
4. Equipment usage (including vehicles)
5. Inefficient resource usage because of poor maintenance of equipment and because equipment is too old
6. Wasted resources due to equipment running when not in use or under-utilized
7. Excessive resource usage because of inefficient operation (e.g. long flush/wash cycles)
8. Opportunities to use more efficient or cleaner fuel source for equipment
9. Storage issues
    a. Minimizing risk of spillage and pollution by using good storage practices:
    b. Good basic housekeeping
    c. Labeling and segregation of chemical classes
    d. Bunding of liquids
    e. Removal from site of excess raw materials and other stock that is unlikely to be used
    f. Ready access to MSDS in the event of a leak or spill
    g. Availability and adequacy of spill kits
    h. Staff competent in mitigating the environmental effect of a leak or spill
    i. Minimizing rework and scrap to minimize resource wastage

E. Waste Generation and Discharge

1. Temperature effects (e.g. creating of vapors potentially harmful to sewer workers)
2. May lead to contamination of town water
3. Segregation to maximize reuse and recycling opportunities
4. Disposal to general garbage
5. Pressure on land-fills due to large volume of general garbage
6. Leakage of oil
7. Leakage of PCBs from old electrical equipment (especially from old capacitors)

8. Leakage of CFCs and HCFCs from closed-cycle cooling equipment
9. Long-term contamination of landfills from NiCad, mercury and lead-acid batteries
    a. Reuse and Recycling (general)
    b. Mulching and composting or organic waste
    c. Recycling (or reusing):
        i. Glass, plastic and metals
        ii. Paper
        iii. Cardboard
        iv. Packaging
        v. Chemicals
        vi. Old equipment and furniture
    d. Reducing use of disposable cups, plates, cutlery etc.
    e. Use of recycled paper and other products to support the recycling industry (create a demand for such items)
    f. Converting paper printed on one side to notepads to facilitate reuse
    g. Recyclability of manufactured products (LCA)
    h. Reuse of waste materials generated on-site
    i. reuse of waste heat

F. Land Use
1. Destruction of natural ecosystems and rare plants
2. Creation of conditions conducive for breeding of mosquitoes, mice, cats and other pests
3. Spread of human, animal or plant disease within the site
4. Disturbance of natural habitats or bio-systems
    a. Preserve natural ecosystems
    b. Control sanitation conditions on project site
    c. Preserve natural habitats for plant- and wildlife

G. Positive Environmental Aspects
1. Environmental awareness education (including knowledge of environmental aspects) to:
    i. Staff whose duties may lead to intended and unintended environmental impacts
    ii. General staff
    iii. Students (for educational institutions)
    iv. Contractors and collaborators
2. Use of "Green" products (to support reuse and recycling industries)
3. Clean-up of past environmental damage
4. "Spread the word" to others (co-workers, local community, sports groups etc.) on environmental sustainability
5. Use of Sustainable Design

Section 3: Social Life Cycle Management

This section will again be using the life cycle developed in *Section 1* in order to identify social responsibility issues in the life cycle of your specific project. The first step in identifying the social aspects of a project life cycle is to look at the life cycle scenario in *Section 1* that applies to your project. Next, it is important to identify all the stakeholders in the life cycle of in your particular project. In identifying the social aspects, a stakeholder analysis is an important tool. The stakeholder analysis will allow you to see more clearly what social aspects are found in the life cycle of your project. After the stakeholder analysis is complete, information is provided on how to engage and manage the stakeholders.

With the completion of the stakeholder analysis, there may be social aspects of the project life cycle that are not addressed. A way to include all social aspects of a project life cycle, it may be necessary to do a social impact assessment (SIA). This is done in the same way as identifying the environmental aspects in *Section 2* except that you will use a social aspect checklist.

Stakeholder Analysis

There are many different ways to do a stakeholder analysis, but identifying the stakeholders is the first step. **A stakeholder** is any person, group of people or entity that can claim a relationship anywhere in the life cycle of the project. These groups affect or are affected by the life cycle of the project. Stakeholders can include:

- Customers
- Shareholders
- NGOs
- Local and national government
- Sub-contractors

- Competitors
- The environment
- The media
- Employees

By identifying who or what has a stake in the life cycle of a project, the project manager can greatly expand its contributions to corporate social responsibility (CSR). Creating a list of stakeholders by using the life cycle scenario from *Section 1* helps to reveal groups that would otherwise be missed and therefore have the potential cause a breach in CSR of the project. One of the most common breaches of CSR is human rights abuse further down the supply chain of a project. However, if you are using a life cycle

perspective in the identification of stakeholders, you will be able to identify what parties are involved in various parts of the supply chain. Once the stakeholders are identified, then they must be categorized. Categorization can be done in several different ways, and one way that combines both the analysis and management techniques is the Power, Legitimacy and Urgency Topology[4]. This typology categorizes stakeholders based on how much power the group has, whether or not their claim is legitimate and how urgent their needs are.

Step 1: Using your life cycle scenario, make a list of stakeholder that affect or are affected in each life cycle stage of your project.

Step 2: Determine whether or not each stakeholder has the attributes: power, legitimacy and/or urgency. Assign each stakeholder a letter, and place them in the stakeholder diagram in the Stakeholder Worksheet on page 20.

Step 3: Read how each stakeholder should be managed based on your analysis on pages 21-23.

Stakeholder Worksheet
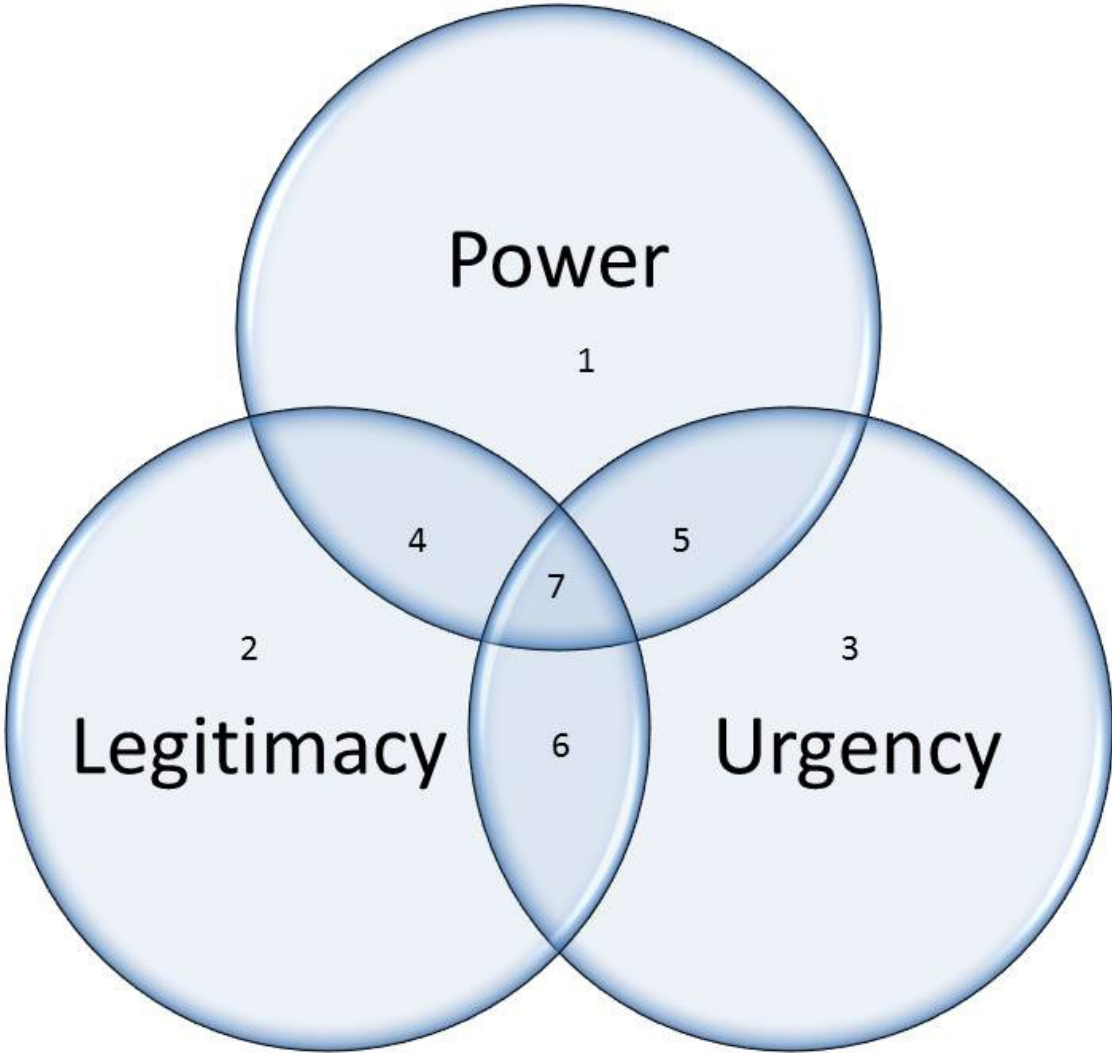
Stakeholder Management

1. **Dormant Stakeholder**

   These stakeholders have power, but neither a legitimate claim nor an urgent need that must be addressed. Dormant stakeholders must be managed so that they do not exercise their will in a way that negatively impacts the project life cycle. Examples of dormant stakeholders include: ex-employees who have been terminated and want to negatively affect a project and terrorists who possess power in their potential for violence. Other examples include those that can spend a lot of money and have a coercive impact and introduce corruption in the project life cycle. A stakeholder that can command the attention of the media is also powerful though may have no legitimacy or urgent need. The interaction of dormant stakeholders with the project manager or the company is usually limited. They must be managed in a way that monitors whether they gain a second attribute. Stakeholder relationships are dynamic, and their changing relationship to the project must be monitored (especially those dormant stakeholder that the project manager feel is likely to acquire a second attribute).

2. **Discretionary Stakeholder**

   These stakeholders have legitimacy but neither power nor an urgent claim. Discretionary stakeholders are usually the recipients of traditional corporate social responsibility measures, i.e. corporate philanthropy. There is no pressure on the project manager to engage with these stakeholders because of the absence of power and urgency. However, it is these groups that the project manager may utilize to have a positive social impact for their project.

3. **Demanding Stakeholder**

   Demanding stakeholders have an urgent claim but neither power nor legitimacy. These stakeholders usually are not engaged with by the project manager. An example of such a stakeholder is a lone picketer on a building site exclaiming that "development is creating an end to the world as we know it." In terms of the social responsibility of the project life cycle, these stakeholders do not require management. They are simply an irritating presence that must be managed in a way that examines whether their claims are actually illegitimate. If a picketer is claiming that a building project is hurting the surrounding ecosystem, and their claim is true, then the picketer is a dependent stakeholder (lacking only power).

4. **Dominant Stakeholder**

   Dominant stakeholders are both powerful and legitimate. These stakeholders can be seen as in a coalition with the project as their influence is assured. Because of their power and legitimacy, they have a high potential to move into the definitive stakeholder category if the situation arises in which they have an urgent claim. Because of their ability to influence, they can act on these urgent claims if they arise. This makes the stakeholder "dominant," ever on the margins until they have a need.

Power and legitimacy are less dynamic than urgency. Because of their influence, they will most likely have some sort of formal agreement about their influence in a project, such as in the form of a contract or permit. An example of a dominant stakeholder can be the local government in a building project. They may not have needs in every life cycle stage; but when they do, if the project manager does adhere to their influence or engage with them, the project can be halted. Adhering to social responsibility and environmental regulation from their respective governing bodies is how these stakeholders (the governing bodies) must be managed. If there is doubt about the laws and regulations or if the project affects society or the environment in a way that is not covered by the law or regulations, then the project manager must engage with the relevant bodies to establish the way forward. Employees are often in this category as well, and they must be engaged in a way that they can communicate and engage with the project manager if an urgent claim arises.

5. **Dangerous Stakeholder**

Dangerous stakeholder lack only legitimacy. Because they have both power and urgency, this can lead them to violence, coercion. This makes them dangerous to the project life cycle. Examples of this can include employee sabotage and unlawful labor practices in the supply chain (sweatshops) and terrorism. Another example of a dangerous stakeholder (one that is not literally dangerous) is unprofessional practices of the media in which they wish to harm the reputation of a company or project for illegitimate reasons. Mitigating the danger to other stakeholders and the project itself is how these stakeholders must be managed. It is very important to identify these stakeholders because of their potential to harm. Identifying these stakeholders increases preparedness of the project manager. However, in the case of illegal sweatshops in the supply chain, the project manager should either boycott the product in question or take actions to address the situation or bring the attention of the situation to the relevant authorities; and if that fails, the media or NGOs.

6. **Dependent Stakeholder**

Those stakeholders with urgent needs and legitimacy but who lack the power to influence are considered dependent stakeholders. They are called dependent because they depend on the project manager to address their needs. These stakeholders may rely on other stakeholder's power to address their claims. This is seen when an NGO (dependent) involves the local government (dominant) to enforce environmental regulation. The dependent stakeholder is then under the guardianship of the other stakeholder or the project managers themselves because of business ethics and the internal values of the company. A good example of a dependent stakeholder is the group of indigenous people who are affected by the oil extraction from the Canadian oil sands in Alberta. They can appeal to other powerful stakeholders on whom they must depend, such as the media in this case (and to a limited extent NGOs), to influence the government and the oil companies.

7. **Definitive Stakeholder**

   Definitive stakeholders possess all three attributes: power, legitimacy and urgency. These stakeholders have the ability to influence the project and their claims are legitimate and urgent. They will be in some sort of partnership with the project, as explained in the dominant stakeholder classification (they will have a formal agreement in perhaps the form of a contract or permit.) Because these are already dominant stakeholders, when they possess an urgent claim, the stakeholder is issuing a mandate to the project manager. Their needs must be addressed because of their ability to halt the progress in the completion of the project. An example of this is when shareholders in a company want a change in top management when their stock value drops very low. In project management, for example, this can be a governing authority enforcing health and safety compliance in a building project. Any dominant, dependent and dangerous stakeholder can become a definitive stakeholder by acquiring the missing attribute. It is important for the project manager to monitor the classification of stakeholders because of its dynamic nature. Though urgency is more dynamic than power or legitimacy, it is possible for a dependent stakeholder to gain power and a dangerous stakeholder to gain legitimacy. In the example of the Canadian oil sands, for example, the indigenous people could fall under the guardianship of an ally in government and influence the ability to enact legislation. This would make the indigenous people a definitive stakeholder. A dangerous stakeholder can become legitimate, as in the example of the media uncovering corruption in the supply chain of a project. Definitive stakeholders have the highest amount of engagement of all the stakeholders.

Social Aspects in the Project Life Cycle

The stakeholder analysis has given you some perspective about who the key players are in the life cycle of the project, and how their needs should be managed. These groups, however, do not reveal all the social responsibility information in a project life cycle. On page 25 there is a checklist of social aspects and mitigation measures. For the purposes of this guide, a **social aspect** is any element that interacts with people and society during the life cycle of the project.

Social Impact assessment

To begin the social impact assessment, you will need to use the life cycle scenario developed in *Section 1*.

Take your life cycle scenario specific to your project and place the social aspect number in the appropriate life cycle stage.

Some social aspects may be relevant to your project life cycle that not listed. You, as the project manager, are the expert on your project. Now that you understand the sustainable project life cycle stages, you have the ability to combine your project specific expertise with the life cycle information given in *Section 1* to generate a list of social aspects.

Once you have evaluated what social aspects are relevant to your particular, you can find the appropriate mitigation measure from the checklist. These measures are lettered, whereas the social aspects are numbered. By doing this assessment, you will be able to appropriately manage the social responsibility of your project.

Social Aspect Checklist and Mitigation Measures[5]

A. Internal Human Resources
1. Employment Stability
    a. Employment Opportunities
    b. Employment Remuneration
2. Employment Practices
    a. Disciplinary and Security Procedures
    b. Employee Contracts
    c. Equity
    d. Labor Sources
3. Health and Safety
    a. Health and Safety Practices
4. Capacity Development
    a. Research and Development
    b. Career Development

B. External Population
1. Human Capital
    a. Health
    b. Education
2. Productive Capital
    a. Housing
    b. Service Infrastructure
    c. Mobility Infrastructure
    d. Regulatory and Pupil Services
3. Community Capital
    a. Sensory Stimuli
    b. Cultural Properties
    c. Social Pathologies
    d. Security
    e. Economic Welfare
    f. Social Cohesion

C. Macro Social Performance
1. Socio-Economic Performance
    a. Economic Welfare
    b. Trading Opportunities

D. Stakeholder Participation
1. Information Provision
    a. Collective Audience
    b. Selected Audience
2. Stakeholder Influence

a. Management of the Decision Influence Potential
b. Stakeholder Empowerment

E. Cultural Heritage

1. Interaction with heritage issues
2. Preservation of heritage structures (e.g. buildings)
3. Preserving culturally significant sites
4. Interaction with local community issues
5. Changes affecting visual appeal of buildings and property
6. Shadows cast by buildings during the day
7. Light pollution at night
8. Changes affecting traffic density and associated hazards, and availability of local parking
9. Changes affecting access to public land
10. Vibration from equipment
11. Activities affecting land conservation

Section 4: Communication Recommendations

This section will explain a recommended communication strategy that can be adapted to the project manager's specific project. *Section 4* is composed of two parts: internal project communication and reporting. The first part will utilize the stakeholder analysis completed in the previous section. The second part is sustainability reporting based on the GRI (Global Reporting Initiative). The GRI is a sustainability reporting framework designed for transparency on the corporate level; however, the guidelines below have been adapted for use on the project level.

Internal Project Communication[6]

The stakeholder analysis completed in *Section 3* will be used in this part. There are various strategies for communicating with stakeholders. A stakeholder information strategy has the goal of relying information to the stakeholders in a project life cycle. This is a one-way communication channel. A stakeholder response strategy allows the stakeholder to give feedback to the project manager, thus establishing a two-way communication channel. This is an improvement over a stakeholder information strategy, but a **stakeholder involvement strategy** goes even further. A stakeholder involvement strategy is a symmetric two-way communication strategy that is iterative with the goal of building relationships between the project and the stakeholder. In this strategy the project manager makes the stakeholder a part of the CSR message of the project. The stakeholders are involved by participating and suggesting actions that affect them/are affected by them.

Based on the stakeholder analysis, decide which stakeholders are necessary to involve in the stakeholder involvement strategy.

Task: Invite these stakeholders to establish a frequent, systematic and pro-active dialogue.

Project Sustainability Reporting

It is not the goal of this guide to create a standard reporting procedure. Instead these project sustainability reporting recommendations are given so that sustainability information on the project level will be available so that on the corporate level the GRI can be adopted. Below is a checklist of the environmental and social performance indicators from the GRI.

1) Decide which environmental and social performance indicators are applicable to your project with regards to the life cycle.

2) Keep track of the information that is relevant to these performance indicators so that it can be reported on the corporate level.

GRI Performance Indicators[7]

Environment

Aspect: Materials

EN1 Materials used by weight or volume

EN2 Percentage of materials used that are recycled input materials

Aspect: Energy

EN3 Direct energy consumption by primary energy source

EN4 Indirect energy consumption by primary source

EN5 Energy saved due to conservation and efficiency improvements

EN6 Initiatives to provide energy-efficient or renewable energy based products and services, and reductions in energy requirements as a result of these initiatives

EN7 Initiatives to reduce indirect energy consumption and reductions achieved

Aspect: Water

EN8 Total water withdrawal by source

EN9 Water sources significantly affected by withdrawal of water

EN10 Percentage and total volume of water recycled and reused

Aspect: Biodiversity

EN11 Location and size of land owned, leased, managed in, or adjacent to, protected areas and areas of high biodiversity value outside protected areas

EN12 Description of significant impacts of activities, products, and services on biodiversity in protected areas and areas of high biodiversity value outside protected areas

EN13 Habitats protected or restored

EN14 Strategies, current actions, and future plans for managing impacts on biodiversity

EN15 Number of IUCN Red List species and national conservation list species with habitats in areas affected by operations, by level of extinction risk

Aspect: Emissions, Effluents, and Waste

EN16 Total direct and indirect greenhouse gas emissions by weight

EN17 Other relevant indirect greenhouse gas emissions by weight

EN18 Initiatives to reduce greenhouse gas emissions and reductions achieved

EN19 Emissions of ozone-depleting substances by weight

EN20 NO, SO, and other significant air emissions by type and weight

EN21 Total water discharge by quality and destination

EN22 Total weight of waste by type and disposal method

EN23 Total number and volume of significant spills

EN24 Weight of transported, imported, exported, or treated waste deemed hazardous under the terms of the Basel Convention Annex I, II, III, and VIII, and percentage of transported waste shipped internationally

EN25 Identity, size, protected status, and biodiversity value of water bodies and related habitats significantly affected by the reporting organization's discharges of water and runoff

Aspect: Products and Services

EN26 Initiatives to mitigate environmental impacts of products and services, and extent of impact mitigation

EN27 Percentage of products sold and their packaging materials that are reclaimed by category

Aspect: Compliance

EN28 Monetary value of significant fines and total number of non-monetary sanctions for noncompliance with environmental laws and regulations

Aspect: Transport

EN29 Significant environmental impacts of transporting products and other goods and materials used for the organization's operations, and transporting members of the workforce

Aspect: Overall

EN30 Total environmental protection expenditures and investments by type

Aspect: Employment

LA1 Total workforce by employment type, employment contract, and region, broken down by gender

LA2 Total number and rate of new employee hires and employee turnover by age group, gender, and region

LA3 Benefits provided to full-time employees that are not provided to temporary or part time employees, by significant locations of operation

LA3.5 Return to work and retention rates after parental leave, by gender

Aspect: Labor/Management Issues

LA4 Percentage of employees covered by collective bargaining agreements

LA5 Minimum notice period(s) regarding operational changes, including whether it is specified in collective agreements

Aspect: **Occupational Health and Safety**

LA6 Percentage of total workforce represented in formal joint management–worker health and safety committees that help monitor and advise on occupational health and safety programs

LA7 Rates of injury, occupational diseases, lost days, and absenteeism, and total number of work-related fatalities, by region and by gender

LA8 Education, training, counseling, prevention, and risk-control programs in place to assist workforce members, their families, or community members regarding serious diseases

LA9 Health and safety topics covered in formal agreements with trade unions

Aspect: Training and Education

LA10 Average hours of training per year per employee by gender, and by employee category

LA11 Programs for skills management and lifelong learning that support the continued employability of employees and assist them in managing career endings

LA12 Percentage of employees receiving regular performance and career development reviews, by gender

Aspect: Diversity and Equal Opportunity

LA13 Composition of governance bodies and breakdown of employees per employee category according to gender, age group, minority group membership, and other indicators of diversity

Aspect: Equal Remuneration for Women and Men

LA14 Ratio of basic salary and remuneration of women to men by employee category, by significant locations of operation

Human Rights
Aspect: Investment and Procurement Practices

HR1 Percentage and total number of significant investment agreements and contracts that include clauses incorporating human rights concerns, or that have undergone human rights screening

HR2 Percentage of significant suppliers, contractors, and other business partners that have undergone human rights screening, and actions taken

HR3 Total hours of employee training on policies and procedures concerning aspects of human rights that are relevant to operations, including the percentage of employees trained

Aspect: Non-Discrimination

HR4 Total number of incidents of discrimination and corrective actions taken

Aspect: Freedom of Association and Collective Bargaining

HR5 Operations and significant suppliers identified in which the right to exercise freedom of association and collective bargaining may be violated or at significant risk, and actions taken to support these rights

Aspect: Child Labor

HR6 Operations and significant suppliers identified as having significant risk for incidents of child labor, and measures taken to contribute to the effective abolition of child labor

Aspect: Forced and Compulsory Labor

HR7 Operations and significant suppliers identified as having significant risk for incidents of forced or compulsory labor, and measures to contribute to the elimination of all forms of forced or compulsory labor

Aspect: Security Practices

HR8 Percentage of security personnel trained in the organization's policies or procedures concerning aspects of human rights that are relevant to operations

Aspect: Indigenous Rights

HR9 Total number of incidents of violations involving rights of indigenous people and actions taken

Aspect: Assessment

HR10 Percentage and total number of operations that have been subject to human rights reviews and/or impact assessments

Aspect: Remediation

HR11 Number of grievances related to human rights filed, addressed and resolved through formal grievance mechanisms

Society
Aspect: Local Communities

SO1 Percentage of operations with implemented local community engagement, impact assessments, and development programs

SO9 Operations with significant potential or actual negative impacts on local communities

SO10 Prevention and mitigation measures implemented in operations with significant potential or actual negative impacts on local communities

Aspect: Corruption

SO2 Percentage and total number of business units analyzed for risks related to corruption

SO3 Percentage of employees trained in organization's anti-corruption policies and procedures

SO4 Actions taken in response to incidents of corruption

Aspect: Public Policy

SO5 Public policy positions and participation in public policy development and lobbying

SO6 Total value of financial and in-kind contributions to political parties, politicians, and related institutions by country

Aspect: Anti-Competitive Behavior

SO7 Total number of legal actions for anticompetitive behavior, anti-trust, and monopoly practices and their outcomes

Aspect: Compliance

SO8 Monetary value of significant fines and total number of non-monetary sanctions for noncompliance with laws and regulations

Product Responsibility
Aspect: Customer Health and Safety

PR1 Life cycle stages in which health and safety impacts of products and services are assessed for improvement, and percentage of significant products and services categories subject to such procedures

PR2 Total number of incidents of non-compliance with regulations and voluntary codes concerning health and safety impacts of products and services during their life cycle, by type of outcomes

Aspect: Product and Service Labeling

PR3 Type of product and service information required by procedures and percentage of significant products and services subject to such information requirements

PR4 Total number of incidents of non-compliance with regulations and voluntary codes concerning product and service information and labeling, by type of outcomes

PR5 Practices related to customer satisfaction, including results of surveys measuring customer satisfaction

Aspect: Marketing Communications

PR6 Programs for adherence to laws, standards, and voluntary codes related to marketing communications, including advertising, promotion, and sponsorship

PR7 Total number of incidents of non-compliance with regulations and voluntary codes concerning marketing communications, including advertising, promotion, and sponsorship by type of outcomes

Aspect: Customer Privacy

PR8 Total number of substantiated complaints regarding breaches of customer privacy and losses of customer data

Aspect: Compliance

PR9 Monetary value of significant fines for noncompliance with laws and regulations concerning the provision and use of products and services

SPLCM Guide References

[1]The Project Life Cycle section of this guide is based on the work of: Labuschagne, C., Brent, A.C. 2005. Sustainable Project Life Cycle Management: the need to integrate life cycles in the manufacturing sector. International Journal of Project Management 23, 159–168.

[2] Heijungs, R., Goedkoop, M., Struijs, J., Effting, J., Sevenster, M., Huppes, G. 2003.Towards a life cycle impact assessment method which comprises category indicators at the midpoint and the endpoint level. Report of the first project phase: design of the new method. Accessed on 06/06/2013 at http://www.leidenuniv.nl/cml/ssp/publications/recipe_phase1.pdf

[3] European Commission 2013. Life Cycle Costing, Environment. Accessed on 06/03/2013 at
http://ec.europa.eu/environment/gpp/lcc.htm.

[4] The Power, legitimacy and Urgency Topology was developed by: Mitchell, R. K., Agle, B. R., & Wood, D. J. 1997. Toward a theory of stakeholder identification and salience:
Defining the principle of who and what really counts. Academy of Management Review, 22: 853–886. The Stakeholder Management part of Section 3 is also based on this research.

[5] Sections A-D of the checklist are based on the framework by: Labuschagne, C. 2005. Sustainable project life cycle management: Development of social criteria for decision-making, Doctoral thesis, Department of Engineering & Technology Management, University of Pretoria, May 2005.

[6] The Internal Project Communication section is based on: Morsing M, Schultz M. 2006. Corporate social responsibility communication: Stakeholder information, response and involvement strategies. *Business Ethics: A European Review* 154: 323–338.

[7] Global Reporting Initiative. 2011. *G3.1, Sustainability reporting guidelines*. Global Reporting Initiative: Amsterdam. Available at:
http://www.globalreporting.org.

Appendix 3: The Application of the Sustainable Project Life Cycle Management Guide

This appendix provides the worksheets that resulted from the application of the SPLCM Guide. These were completed by Nils Morten Beitnes, and this was the basis for the interview (Appendices 4, analysis in Chapter 6).
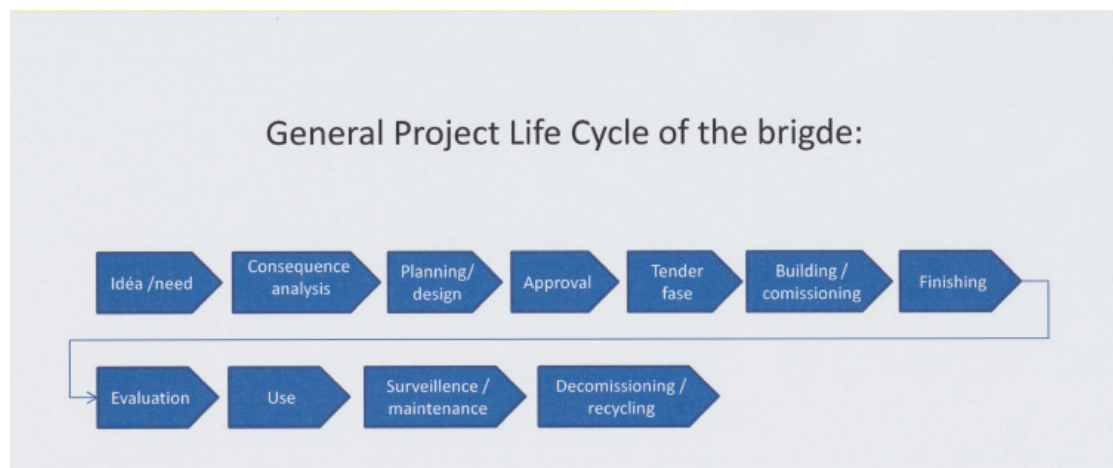
General Project Life Cycle of the brigde:

Environmental Aspects and Mitigation Options:
ref. Checklist of Environmental Aspects and Mitigation Options

	Aspects	Mitigation Options
Idéa /need	None	None
Consequence analysis	1, 2, 3, 4, 5	Assess possible aspects and possible consequences. Define acceptance criterias, make necessary adjustments
Planning/ design	5 G1, G5	Plan to minimize negative impacts
Approval	1, 2, 3, 4, 5	Set conditions for approval
Tender fase	1, 2, 3, 4, 5	Implement contractual regulations regarding identified environmental aspects (and mitigation options)

Environmental Aspects and Mitigation Options:
ref. Checklist of Environmental Aspects and Mitigation Options

	Aspects	Mitigation Options
Building / comissioning	1, 2, 3, 4, 5 A1, A3 C1, C2 D1, D3, D4, D5, D6, D7, D9 E2, E3, E6 F1, F3, F4 G2, G3, G4, G5	A4a, A4b, A4c, A4d, A4e C2a, C2b, C2c, C2d D2a, D2b, D3b, D3d, D9b, D9c, D9e, D9f, D9g, D9h, D9i E9a, E9c, E9d, E9e, E9h F4a, F4b, F4c
Finishing	None	None
Evaluation	G1, G4, G5	
Use	1, 2, 3 A3 D4, D5, E2, E6 F1, F4	None in the project. Mitigations must be adressed to users (typically by authorities)

Environmental Aspects and Mitigation Options:
ref. Checklist of Environmental Aspects and Mitigation Options

|	Aspects	Mitigation Options
Surveillence / maintenance	1, 2, 3 A1, A3 C1 D4, D5, D7 E6 G2, G3	A4c, A4d, A4e C2a, C2d D9f, D9g, D9h E9c (v and vi)
Decomissioning / recycling	E2, E3, E6 G1, G2, G3	E9a, E9c, E9h

Stakeholders:

	Stakeholders	Attributes	Letter
Idéa /need	Authorities	Power, Legitimacy, Urgency	A
	Neighbours	Power, Legitimacy	B
Consequence analysis	Authorities	Power, Legitimacy	A
	Neighbours	Power, Legitimacy	B
	Environmentalists	Legitimacy, Urgency	C
Planning/ design	SVV	Power, Legitimacy	D
	Consultants	Legitimacy	I
Approval	SVV	Power, legitimacy	D
Tender fase	SVV	Power, Legitimacy, Urgency	D
	Contractors	Power, Legitimacy, Urgency	E

Stakeholders

	Stakeholders	Attributes	Letter
Surveillence / maintenance	SVV	Power, Legitimacy	D
	Contractors	Power, Urgency	E
	Suppliers	Urgency	G
	Neighbours	Legitimacy	F
Decomissioning / recycling	SVV	Power, Legitimacy	D
	Contractors	Power, Urgency	E
	Neighbours	Legitimacy, Urgency	F
	Suppliers	Legitimacy	G

Stakeholders
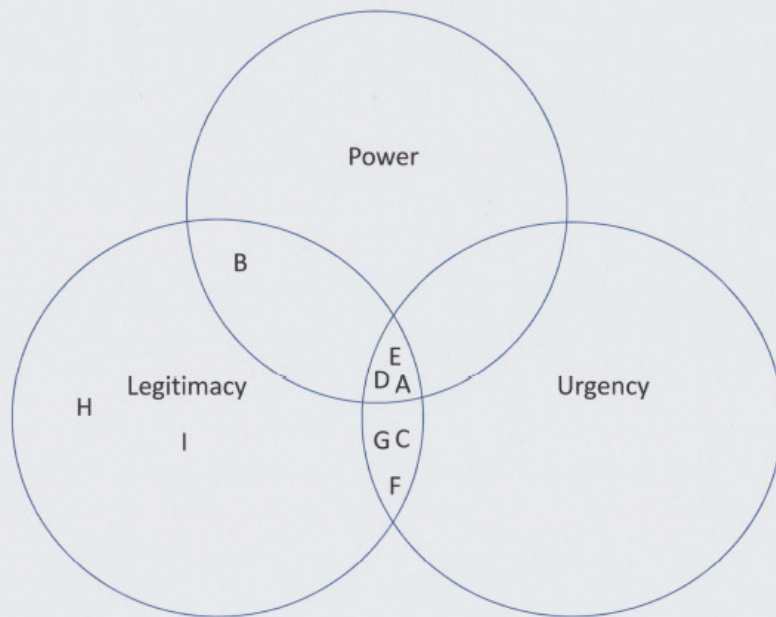
Appendix 4: Interview Guide and Answers

This appendix provides the interview guide that was used in the application of the Sustainable Project Life Cycle Management Guide (Chapter 6) and the answers from the project manager who completed the application of the guide on his completed project.

The Sustainable Project Life Cycle Management Guide
The Interview with the Project Manager in the Test Application

Part 1: Potential Effects of Using the Guide

1. In the identification of environmental aspects (Section2), do you feel that you would have been able to implement the suggested mitigations measures? If not, why?

   Yes, definitely. The list could be longer and more elaborate, but the point is that you change your mindset, and then use it as an inspiration. The situation may require you to do even more or less.

2. In the identification of social aspects (Section 3), do you feel that you would have been able to implement the suggested mitigation measures? If not, why?

   Yes, we already have schools visiting, open days for community; we must always coexist with the community, and it is best with as little friction as possible.

3. Do you feel that the relationship the project had with its stakeholders would have been improved by the completion of the stakeholder analysis (Section 3) together the communication recommendations (Section 4)? If yes, how? If not, why?

   Yes, because it is not always with the legitimacy, only with threats normally. We focus only on the team and opponents. It is helpful because it goes beyond what we normally cover.

4. Do you think that the environmental impacts would have been reduced by the use of this guide in your project? If yes, which impacts/aspects? If not, why?

   Yes, but it would be difficult to measure; also because it would be difficult to oversee all the time. While the mitigation could be implemented, it is difficult to measure. We have actually used bikes on site, no cars, but for a safety issue for traffic and collisions not for the environment.

5. Do you feel that you would have been able to enact a stakeholder involvement strategy? If yes, explain, if not, why?

Yes, they often do but not with the environment and society as a theme. Normally we have a communication plan but not with this focus, but we do it always in a selfish way. Always want to minimize the negative not bring up the positive.

6. Do you think that the social impact would have been reduced by the use of this guide in your project? If yes, in what way (a better relationship with stakeholders, a reduction in the impact on the community?) If not, why?

Yes, for example in another building project by a kindergarten, we must communicate with them about noise and any impacts needs to be communicated. Dust as well.

7. Overall, in your opinion, do you think that using this guide would have reduced the impact your project would have had in its entire life cycle? If yes, how? If not, why?

It has a new perspective on project management and environmental management. There needs to be more impact mitigation measure. The project manager is not always the one in power because we are not the project owner. The expectation is that the project manager should tell the owner everything that they don't know, so the guide will help give more information. We need a way to sell the concept to the project owners. It depends on the person you are speaking with at the project owner company and whether they are open to new ideas.

Part 2: Feedback for the SPLCM Guide

1. What are your general Impressions of the SPLCM Guide (did you find the guide difficult/easy to use?)?

Overall good, good start, checklists need to be organized better, needs to be translated. I used one hour on the environmental part and 2,5 hours total. It would have been faster if I did it all in one sitting. I would have used more time if it was required for a project because I would have collaborated with others. It is also best communicate this so that everyone in the project has the same knowledge of the social and environmental impacts. It would not be too time consuming to do on every project. There may be some resistance from some experienced project managers, "world champions," who think they do everything right and there is no room for improvement. These are experienced people, but they practice an old fashioned style of project management. Faveo prides itself on selling competence and doesn't hire new graduates, but we are missing out on what they could offer: innovation, idealism and new perspectives. Faveo needs to find a way to modernize.

2. Did you find any parts of the guide which were not applicable to your project? If yes, which ones?

No, all useful

3. What parts of the guide did you find most useful/least useful (besides the irrelevant parts)?

Environmental aspect analysis was the most useful. The other parts are not new, but we can use the environmental approach in other societal processes. Turning the whole project into a sustainability pro.

4. Did you feel that the SPLCM Guide increased your ability to conceptualize the life cycle of your project (e.g. did you have problems setting the boundaries for the life cycle? Did you have problems understanding how to complete section 1?)

The life cycle information is always in the back of your head, but helps to be concrete, by illustrating and making it a model. There are no bells going off unless there is something really bad, and high risk. Sometimes there are large gaps in the times between phases because a project may not be taken up for execution for several years, so the aspects can change in the gap periods.

5. Did you feel able that you were able to identify from your own expertise (and the use of the guide):
   a. The environmental aspects? (if no, why not?)
   b. The stakeholders? (if no, why not?)
   c. The social aspects? (if no, why not?)

Yes to all, but it would have been better to collaborate with others if this was required in the planning of a project. It would be good to discuss with others.

6. Was the guide useful in its explanation of:
   a. The life cycle of a project? (If yes, explain; if no, why not?)
   b. The environmental management tools (LCA and Env. LCC)? (If yes, explain; if no, why not?)
   c. Different stakeholder management techniques? (If yes, explain; if no, why not?)

Yes to all, but it needs to be translated into Norwegian when it is implemented.

7. Did you feel that the life cycle section was easy enough to tailor to your specific project? (if no, why not?)

Yes, it was easy to manipulate to my needs.

8. Do you think that you would have been able to provide information from the project concerning the environmental and social performance indicators in section 4? (If yes, explain; if no, why not?)

Yes, we have some documentation now, but it needs to be organized in a different way. Contractors have to report so of this information, so it is just to use this information for a different purpose. We do some things already, but it is good to know that we could do more.

9. Do you have any recommendations to make the SPLCM Guide more user-friendly or any other feedback about the guide?

The aspect checklists should be in a table format with aspects on one side and mitigation measure on the other. The guide would be more user-friendly as software.