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Towards Sustainable Project Governance

A Multisystem and Multilevel Analysis

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ACADEMIC DISSERTATION

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Julkaisun nimike
Kohti kestävää projektinhallintaa: monisysteeminen ja monitasoinen analyysi

Tiivistelmä
Tämä tutkimus esittää monitasoista arviointia keskeiseksi välineeksi kestävän kehityksen haasteiden ratkaisemiseen. Sen johdolla on analysoitu mikrotason lisäksi kahta muuta tärkeää tasoa: meso- ja makrotasoa. Spatiaalisen mallinnuksen avulla tämän tutkimuksen tarkoituksena on edistää projektisalkunhallintaa sekä muodostaa systeemien kokonaisuus.
Tutkimus on aloitettu kestävän kehityksen makrotason analyysilla eurooppalaisessa kontekstissa. Mallin neljä keskeistä elementtiä ovat innovaatio, tehokkuus, yhteiskehittäminen ja ympäristö. Tämä lähestymistapa tarjoaa myös ratkaisun paradigman muutoksen aiheuttamalle haasteelle, joka on lisännyt projektisalkunhallinnan monimutkaisuutta.
Tämän seurauksena projektisalkun alkuvaihe on muodostettu kestävää menetelmää hyödyntäen. Samalla on arvioitu ekotehokkuuden kehitystä EU-15 maissa sekä pitkittäisanalyysin avulla määritetty ne tapaukset, jotka ovat edistyneet kestävästi.
Kestävän kehityksen haasteet vaativat myös liiketoimintamallin, jolla voidaan hallita koko järjestelmää. Siten mesotasoa on tarkasteltu sekä systemaattisen kirjallisuuskatsauksen että merkittävien eurooppalaisten yritysten avulla. Sen seurauksena viitekehityksenä on käsitelty avointa innovaatiomallia ketterän mallin muuntavana tekijänä.
Tutkimus kapenee asteittain kohti mikrotasoa Suomessa. Vaikka monien eri tapauksien tehokkuutta onkin jo analysoitu, tehdään toinen analyysi tehokkuuden syiden selvittämiseksi Suomessa. Projektien suorituskykyä Suomessa on arvioitu dekompositioanalyysillä.

Asiasanat:
avoin innovaatio, spatiaalinen analyysi, tehokkuusanalyysi, vihreä energiatalous, kontingenssiteoria, muutoksenhallinta, kestävä kehitys, uusiutuva portfolio

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Towards Sustainable Project Governance: A Multisystem and Multilevel Analysis

Abstract

Multilevel assessment has been put forward in this study as a key tool for tackling the challenges of sustainable development. Therefore, in addition to the micro scale, two other important levels are analysed: the meso and macro levels. Through spatial modelling, this research contributes to the context of project portfolio management and presents a gestalt of systems.

The study starts from the analysis of macro scale sustainable development within the European context. Four key elements of the model are introduced: innovation, efficiency, co-creation and environment. This approach also presents a solution to the challenge of the paradigm shift that has increased the complexity of project portfolio management.

Subsequently, the front-end of the portfolio has been formulated with a sustainable method. Meanwhile, the trend of eco-efficiency in the EU-15 countries is evaluated, and a longitudinal analysis determines the cases that are promoting sustainability.

Furthermore, the challenge of sustainability requires a business model that governs the whole system. Thus, the meso scale has been studied through a systematic review of the literature and exploratory case studies of prominent companies in Europe. Consequently, an open innovation model as a mediator of the Agile method is discussed as a framework.

The study gradually narrows down towards the micro scale in Finland. Although the efficiency of various cases has been analysed, another layer of analysis is performed in order to explore the reasons behind the efficiency in Finland. The performances of projects in Finland are assessed through decomposition analysis.

Keywords:

open innovation, spatial analysis, efficiency analysis, green energy economy, contingency theory, change management, sustainable development, renewable portfolio

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I also thank members of the VTT MittaMerkki research project for involving me in this project and for the interesting research collaborations that extended my research vision and enhanced my learning process.

By undertaking this PhD, I have learned more about myself. I have learned that the degree of Doctor of Philosophy is not just about making a research contribution at the highest level and creating new scientific ideas but is also about having a better understanding of life. As a result of my PhD journey I am now better able to experience the power of curiosity and to overcome uncertainties.

Hosein Daneshpour

Vaasa May 2018

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Abbreviations

PMO	Project management organization
OI	Open innovation
SCA	Sustainable competitive advantage
PMI	Project management institute
OECD	The Organisation for Economic Co-operation and Development
AHP	Analytic hierarchy process
IDA	Indexed decomposition analysis
LMDI	Logarithmic mean Divisia index
DEA	Data envelopment analysis
SFA	Stochastic frontier analysis
PCA	Principal component analysis
HACCP	Hazard analysis and critical control points
RBV	Resource-based view

Publications

1. Daneshpour, H. and Takala, J., 2016, December. The key drivers of sustainability. In *Industrial Engineering and Engineering Management (IEEM), 2016 IEEE International Conference on* (pp. 1205-1209). IEEE.

2. Daneshpour, H. and Takala, J., 2017. Decision Making Towards Integration of Sustainability Into Project Management; A Multilevel Theory Building Approach. *Management and Production Engineering Review*, *8*(3), pp.13-21.

3. Daneshpour, H., 2017. Integrating Sustainable Development into Project Portfolio Management through Application of Open Innovation. In *Optimal Management Strategies in Small and Medium Enterprises* (pp. 370-387). IGI Global.

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1 INTRODUCTION

1.1 Background

We are surrounded by infrastructure developments such as buildings, factories and power plants. Meanwhile, the outcomes of the process of development of these artefacts or projects directly impact on the quality of our lives. Considering a wider perspective, projects make up the majority of the infrastructure changes in the world and also influence the environment. The challenge of sustainability in (mega) projects is a critical element in improving project governance (Ahola et al., 2014).

Recently, sustainable development has become a vital criterion for decision-making procedures at organizational, national and international scales. Hence, this study evaluates and challenges the logic of the management of project portfolios in order to present a more successful, mature and practical understanding of project portfolio knowledge.

The multilevel and multisystem approach of this study focuses on the linkages, leverage points and main criteria that can increase the impact of change in the project management. Therefore, the study examines the main variables of sustainability and then evaluates how these important variables can be integrated and can interact with each other in order to build the decision-making process in project management. The core concepts presented in this study will contribute to the co-creation and innovation approach in project management, to support real and long-term value.

1.2 A brief history of Project management

The history of project management goes back to the Egyptian era. However, until 1980, the concept of project management was ambiguous. Although project management started to become a management model in the 1950s, unlike fields such as marketing or accounting, a coherent history of project management cannot be produced. Nevertheless, in the 1990s research in this field became more structured and theoretically based by considering systematic and organizational concepts. One of the main obstacles to this was the difficulty of integrating project management with traditional management disciplines. In addition, the reconciliation of the theoretical and professional aspects has been a significant

challenge. Nonetheless, the main research contributions to the history of project management can be classified as case studies, sector analyses and "typologico-historic" studies. (Garel, 2013) explains the difference between "managerial practices" and "management models" and gives more value to the study of the history of models compared to the history of individual practices.

Meanwhile, the project management institute (PMI) was established in 1969 in the United States of America, quickly establishing links with prominent organizations such as NASA. The International Organization for Standardization (ISO, 2004, p. 1) defines a standard as "a document, established by consensus and approved by a recognized body, which provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context".

Overall, four main periods of project management can be identified. The period prior to 1958 is considered to be the origin of modern project management, with such developments as Gantt charts or the WBS. For example, the very basic administrative efforts of project management offices described by T. D. Juhah such as the plan for building the Pacific railroad, could be mentioned. Similarly, in the Hoover Dam project, the project was completed under budget and on time. Between 1958 and 1979 a significant improvement in the application of project management can be observed, for instance in the advent of project management software companies such as Oracle. Between 1980 and 1994, the revolution in the IT sector, the presence of the Internet and the trend towards widespread application of PCs was observed, and project management developed accordingly. Finally, from 1995 onward is regarded as the period of the creation of advanced project management, and since this time, companies have started to implement various project management practices actively (Kwak, 2005).

The following are the key events in the history of project management (Morris, 2011):

- 1917: The Gantt chart was created by Henry Gantt to monitor the progress of projects
- 1958: The program evaluation and review technique (PERT) was invented for a US army project (Polaris rocket programme)
- 1957-9: The critical path method (CPM) was invented by M. R. Walker of E. I. du Pont de Nemours and J. E. Kelly of Remington Rand
- 1962: United States Department of Defense/NASA develop the work breakdown structure (WBS) approach

- 1980s: Earned value management was initiated by the DoD (Department of Defense), the DOE (Department of Energy) and NASA.
- 1983: *A Guide to the Project Management Body of Knowledge* (PMBOK) was published by PMI
- 1996: PRINCE2 was published
- 2017: The sixth edition of the PMBOK Guide was released (and also the *Agile Practice Guide*)

1.3 Motivation for the study

This research concerns the state of the art of project portfolio management, which represents a paradigm shift in this field of research. The academic motivation for this research is provided by the gaps identified through the calls for papers in the *International Journal of Project Management*:

1. Call for papers: International Journal of Project Management: Theme: "Managing projects and sustainability", 2015.

> *"The aim of the special theme is to explore how the changes that relate to the concerns for sustainability are changing the profession of project management. Given the challenges that face society, sound academic knowledge is about integrating" (Huemann & Silvius, 2015, p. 1)*

Gaps are suggested that need to be closed, for example, the linkage of projects, programmes and portfolios to sustainability, the relevant changes in the methods and knowledge areas of project management, the development of indicators and models, the role of project managers (such as leadership behaviours and ethics) and project marketing.

2. Special edition: Social responsibilities for the management of megaprojects; International Journal of Project Management,2016.

> *"The urbanization process particularly in those developing countries have led to the implementation of large number of megaprojects such as highways, bridges, tunnels, and airports, among others. Therefore, it is important to apply proper mechanisms to ensure that social responsibilities are committed in the process of managing megaprojects.*

> *However, existing research literatures on the subject of social responsibilities for megaprojects are very limited and fragmented" (Shen et al., 2016)*

Here, various proposed gaps need to be closed, for example, the impact of social responsibility on the provision for sustainability in projects, the role of stakeholders in the management of megaprojects, the interaction of business performance and public accountability and the main criteria for social responsibility, risk management, policy mechanisms and performance assessment.

1.4 Main gaps studied in this PhD

This study aims to address the lack of multilevel/multisystem studies in the sustainable management area, from a project portfolio management perspective.

Regarding this, the current efficiency measurement for organizations is based on the traditional productivity approach, which is based on the performances of industry peers and does not consider the real needs of society, such as environmental issues (Kuosmanen, 2005). Moreover, studies show that the sustainability measures taken by many companies have not been successful so far. For instance, lack of a correct corporate social responsibility strategy has been reported as a frequent cause of project failure. An innovative oriented approach is required to cope with this issue (Silvius, 2012).

Previous studies have presented some criteria for the success of projects. For instance, the Organisation for Economic Co-operation and Development (OECD) has defined five criteria for the assessment of the success of a project: sustainability, efficiency, effectiveness, impact and relevance (OECD, 2010). However, the development of a strategy for implementation and a comprehensive framework to formulate the portfolio from beginning to end, is lacking. Thus, improvement of strategy (of an industrial sector or a country) is a critical factor, and this will be a key objective in this study. In addition, the realization of co-creation in the project business is a challenging issue, and in the current complicated project business environment, the development of a suitable business model is required (Wikström et al., 2010).

1.5 Main objectives

The purpose of this PhD study is to develop a practical solution for implementation of real value creation in a project portfolio by incorporating a more applicable and practical definition of sustainability indicators (innovation, co-creation, environment and efficiency) into project business, while providing sustainable competitive advantages.

Firstly, this study formulates the front end of the portfolio funnel. Hence, the main objective is to optimize the portfolio while considering environmental issues. For this purpose, a project mix is evaluated (European countries) based on a multilevel framework which is in accordance with eco-efficiency and innovation concepts. A general challenge will be the fact that in real-world scenarios, in addition to the routine inputs and outputs (such as return on investment, emissions, etc.), other influential factors will also affect the efficiency of the portfolio and should be included as additional explanatory variables in the assessments (The Z-variable in this research will be the impact of innovation on sustainability). Innovation is also a key driver of sustainability and competitive advantage, and this study strives to justify the role of innovation within this research context.

However, sustainability, (e.g., renewable energy) often requires new and innovative types of business models. According to the extant literature, the linkage between open innovation (OI) and various disciplines in a strategic management context has not been discussed adequately so far. Consequently, the OI literature has not dealt with sustainability in project management. Therefore, one of the articles in this PhD study deals with this gap and reveals the project management potential of OI.

Subsequently, the study narrows down towards the micro level (Finnish cases), to provide a comprehensive and integrated approach to sustainability. Therefore, having assessed the position of Finland in comparison with other countries, the study also makes a more detailed analysis of the environmental impacts.

Sustainability realization (long-term value creation) relies on system life cycles; therefore, life-cycle thinking is increasingly gaining the attention of a wide variety of decision makers from industry to government. Hence, one the main concerns in this study is to provide an integrated mechanism by considering a network of organizations, governance mechanisms and stakeholders (Artto et al., 2016).

1.5.1 Sustainable decision-making and value creation

The research project MittaMerkki was conducted between 2015 and 2016. The main aim of this project was to facilitate sustainable decision-making processes by considering the complex nature of decision models with regard to aspects such as cultural and social values, risk and uncertainty, and by including all the relevant stakeholders (Räikkönen et al., 2017).

The model implemented in this research project aims to meet the needs of companies that contribute to social, environmental and economic sustainability. The effectiveness of the project can be evaluated using the logic model approach, including the following steps (Foundation, 2004):

- Inputs: the resources required for the project
- Activities: products, services or infrastructures for the implementation of the project
- Outputs: results of the activities (in the form of the size or scope)
- Outcomes: the changes generated by the outcomes at the individual level
- Impact: the changes occurring at the organization level or on a policymaking scale

In addition, according to (Social Impact Investment Taskforce, 2014), the necessary steps for successful portfolio impact measurement are:

- Setting goals: formulating the impact through the value creation logic
- Developing an integrated framework and selecting metrics
- Collecting and storing data
- Validating data
- Analysing data
- Reporting data
- Making data-driven investment management decisions. mainly through assessment of stakeholders

The decision-making model in this project, and in multidimensional sustainability problems in general, require a combination of methods. This integration can occur in various contexts, such as methods to address sustainability issues and cross-disciplinary perspectives to generate a more holistic vision (Bond et al., 2001). Figure 1 presents the logic framework implemented in the research project.

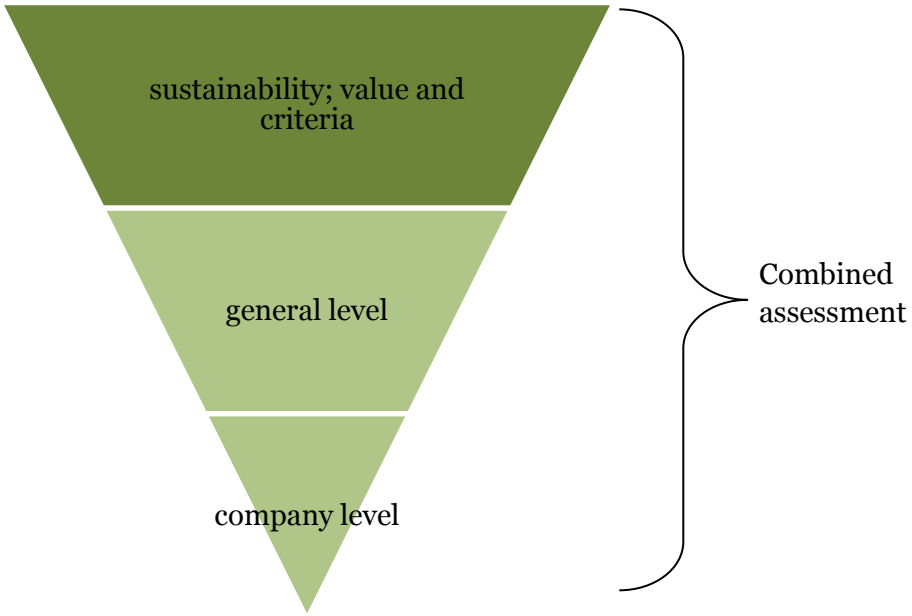

Figure 1. Assessment framework in the MittaMerkki research project

1.6 Research design

Technically, the traditional concept of project management is revised in this study by the introduction of new measurements, and models for the success of project portfolio management. Generally, this study is an integration of four main research themes and steps as presented below:

- **System boundary/dimensions study**: Primarily, there have been different ideas on the concept of sustainability among scholars. These include emissions reduction, return on investment, economic growth, waste management, etc. Meanwhile, the Eurostat database has introduced more than two hundred indicators for sustainability. The challenge of the paradigm shift has been an important issue for this research. Therefore, from a policymaking point of view, the study first defines a clearer and more practical view of sustainability through the determination of four key elements.
- **Co-creation / innovation theme:** One of the forces hindering the realization of the process of the greening of project management is the lack of an appropriate business model, although the

innovative approach of the model should be emphasized. Hence, this study has striven to clarify the business model and to introduce an approach that project management can implement to facilitate sustainability in project portfolio management. Therefore, the impact of co-creation and the degree of openness in sustainability has been studied.

- **Efficiency theme:** The link between the output/input, the strategies and other criteria in the framework has been presented.
- **Environmental theme:** Finally, the evaluation of this theme completes the integrated approach in the study by assessing the environmental aspect of the framework (or technically the denominator of the eco-efficiency). Figure 2 presents the criteria that will be evaluated in this study.

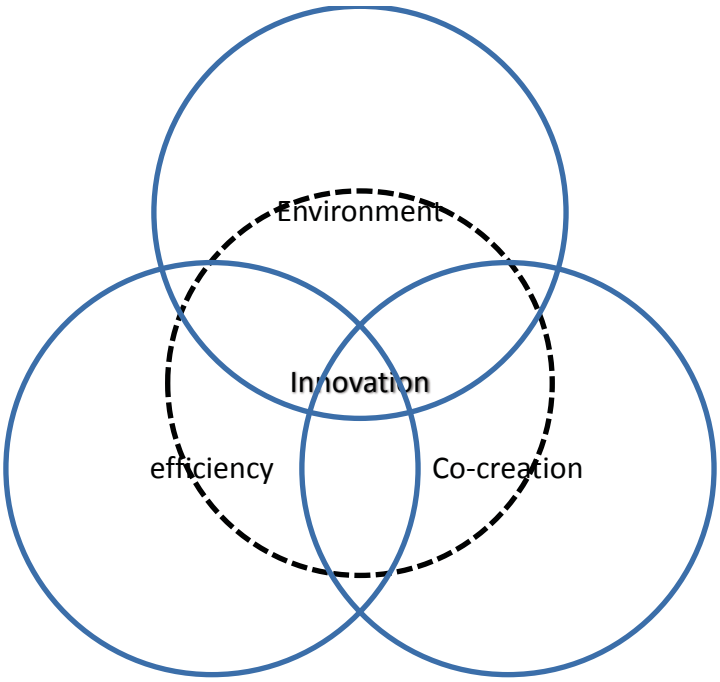

Figure 2. Research framework – studied themes

As well as the research scope, the research assumptions are also important elements of the study (Leedy & Ormrod, 2010). Thus, a general assumption in this study is that sustainability is a good thing (Banerjee, 2008); however, it is a journey (process) rather than a destination (state) (Wu, 2013). Subsequently, the limitation of the research is its context (and data) which mainly relates to Europe (Finland). In addition, from a framework point of view, it is assumed that the complex interactions of systems at different levels can generate the desired

outcomes (House et al., 1995). Meanwhile, the theoretical assumption is based on the concepts of contingency theory (Venkatraman, 1989; Drazin & Van de Ven, 1985; Shenhar, 2001).

Main research questions:

- What is the appropriate integrated environmental and socio-economic sustainability model that supports co-creation for the portfolio organization?
- How can sustainable development objectives be advanced in project governance while providing sustainable competitive advantages? (From a strategic management point of view, where are the leverage points?)

Sub-questions:

1. How should the challenge of paradigm shift be dealt with in this study?
2. What are the key drivers of sustainability?
3. How can the project mix (portfolio) be optimized, while considering environmental measures? (Benchmarking of the sustainability performance of Finland, e.g., in the energy production industry in Finland.)
4. Which project management approach (guide or methodology) is best?
5. How important are the roles of innovation and R & D in this complex era?
6. What is the most appropriate business model for green portfolio management?
7. How can an integrated approach towards eco-efficiency be made?
8. How can efficiency be improved by government policy or better managerial practices?

1.6.1 Research Methodology

Generally, research consists of the following steps: formulating the research topic and research questions, critical review of the literature, defining the philosophy and approach (qualitative, quantitative or mixed), research design, (e.g., experiments, ethnography), data collection, analyses and answering the research questions (Creswell, 2013). Research methodology offers the systematic solutions

towards problems (Kumar & Phrommathed, 2005). Meanwhile, scientific research always takes a philosophical position (attitude, commitment and approach) (Boucher, 2014). (Guba, 1990) categorized research paradigms based on ontology (the nature of reality that can have the two aspects of objectivism and subjectivism), epistemology (what is regarded as acceptable knowledge) and methodology (the process of research) (Bryman & Bell, 2015).

Although several philosophical approaches can be implemented in research, only an appropriate philosophical stance can properly link the problem and the methodology, and consequently extend the research vision to questions of why as well as how and what (Holden & Lynch, 2004). Therefore, it is crucial to give proper attention to the "the importance of coherence in ontology, epistemology and methodology in building a valid philosophical basis for the interpretation of study results" (Biedenbach & Müller, 2011, p. 83).

This research, and strategic decision-making studies in general, strive to underpin the success of the measures taken by organizations with logic, and also to enhance the efficacy and efficiency of these measures. The realization of research in real-world scenarios demands both qualitative and quantitative approaches. Therefore, a mixed method has been used in this study.

However, each of the two methods (qualitative and quantitative) have strengths and weaknesses. Basically, qualitative research is more inclined towards inductive reasoning, and can help to generate theory. It can explain complex social realities, from the points of view of people and participants (the "emic" perspective). The data set sizes are usually smaller than for quantitative research and can be acquired via interviews or literature reviews, and interpretations can lead to the explanation of the phenomena. Qualitative research is recommended for the evaluation of complex cases that cannot be evaluated quantitatively and also for helping to obtain a comprehensive picture of the problem. However, qualitative research does not have the capability to test theories and hypotheses or to make quantitative predictions, and there is some likelihood of biased and idiosyncratic results. In addition, it is tedious and time-consuming. On the other hand, quantitative methods can test and verify theories, define the variables of the study, provide a precise and unbiased approach and make quantitative predictions, and the study can cover a wide range of participants. These methods can also help to test the results of qualitative studies through the mathematical calculations that form the foundation of quantitative research. Nonetheless, it has some weaknesses. For instance, the research theory or the studied category may not

comply with local understanding (confirmation bias) or there may be a lack of potential for theory generation (Johnson & Onwuegbuzie, 2004).

Mixed methods can include the strengths of both qualitative and quantitative methods, by leading to theory building and to validating, testing and assessing the research questions from different angles. Nonetheless, (Johnson & Onwuegbuzie, 2004) have remarked that it can be difficult for a single researcher to cover both qualitative and quantitative methods simultaneously. In addition, it can also be more time-consuming and expensive.

The main purposes and advantages of mixed-method implementation can be defined as: complementary vision, completeness, development, expansion, confirmation, compensation for weaknesses of a single approach and diversity of outlooks with respect to the studied case (Venkatesh et al., 2013). Thus, the key advantage of mixed methods is the potential to generate rigorous research questions and to answer them (Johnson et al., 2007). An outline for successful implementation and reporting in the mixed method can be described as follows (O'Cathain et al., 2008):

1. Justification for applying a mixed-methods approach to answer the research questions
2. Description of research design (purpose, priority and sequence of methods)
3. Depiction of the method from the point of view of data collection and analysis
4. Explanation of where and how integration has been achieved
5. Descriptions of the limitations of each method and the contribution of the alternative method
6. Statement of insights gained from the mixed method

Moreover, the mixed methodology is appropriately linked with the constructive research approach in project management (Oyegoke, 2011). (Kasanen et al., 1993) have defined the iterative process of the constructive research approach as an attempt to remove the gap between theory and practice in business and management research. Thus, this study advocates the main phases of the constructive research approach as follows.

1. Justifying the research problem (section 1)
2. In-depth literature analysis (section 2)
3. Proposing an innovative construct (sections 1 and 3)
4. Validation of solutions, through multilevel/multisystem approaches and triangulation of a variety of methods (sections 4 and 5)

5. Demonstration of theoretical and practical connections (sections 3, 5 and 6)
6. Evaluation of the scope of application, and suggestions for future research (sections 4, 5 and 7)

1.7 The outline of the dissertation

After becoming familiar, in the current section, with a general view of the thesis, including its motivations, gaps and objectives, the next section illustrates the main scientific background and domains of the study, such as strategic management, innovation, change and governance in project management. Then, the research methodology is explained. After justifying the research methodology, an abstract of each paper is presented. Finally, the contributions are discussed together with the linkage of each paper to the framework.

This PhD study is an article-based thesis. In Finland, an article-based dissertation is considered as a set of publications covering the same scientific domain, together with a compilation summary (UVA.fi, 2017). The number of publications may vary depending on the nature of the studied cases; however, typically three to five peer-reviewed articles are expected (Aalto.fi, 2016; helsinki.fi, 2017).

2 THEORETICAL FOUNDATION

In this section, the main scientific background is discussed, together with the theories that underpin the logic of this PhD study.

2.1 A multi-level approach towards sustainability

(Starik et al., 2016) argue that the majority of the extant research on sustainability management relates mainly to one level (the organizational level). Furthermore, studies have been performed on either the environmental aspects of sustainability or the socio-economic aspects, without linking them to each other. Therefore, from both a managerial and a research point of view it may be a crucial requirement to have a comprehensive approach to addressing sustainable development objectives at different levels of human activity. (Starik & Kanashiro, 2013), while mentioning the superficial attention of research to multilevel issues, discuss the fact that a multilevel study of sustainable development could not only open new windows for further generation of new ideas but could also facilitate the evolution of sustainability theories and management theories.

Generally, a multilevel study as a "proto-theory", constructs an ecosystem that can embrace the objectives of sustainable development by considering a systematic approach between individuals, organizations and societies. This interconnected system consists of three main components: input, output and strategy, while the efficacy of the connections can have a positive impact on sustainability management. (Starik & Rands, 1995) initially explained the main characteristics of these multi-levels network as follows.

- Ecological Level: considering the (natural resource) inputs, outputs and efficiency. In addition, this includes the development of ecological mechanisms and principles.
- Individual Level: promotion of sustainable innovation, and cultural artefacts among individuals (citizens) incorporated into organizations.
- Organizational Level: development of environmental partnerships in inter-organizational collaborations.
- Political-Economic Level: promotion of legislative, market-based, and life-cycle approaches.
- Social-Cultural Level: disseminating environmental information in society, for various stakeholders.

2.2 Systems thinking perspective

System orientation is a requirement in sustainable management (Espinosa & Porter, 2011). Ludwig von Berttalanffy introduced the basic definition of systems theory in 1940 (Cummings, 1980). Later, (Forrester, 1969) linked systems thinking to organizational change and the competitive advantages that firms can obtain in order to sustain their business. However, a significant work by (Senge, 1990) developed five disciplines and the idea of a "learning organization". This idea mediates the "sustainable competitive advantage" for organizations while focusing on long-term benefits rather than short-term objectives.

The five disciplines of systems thinking are:

- Systems thinking: focusing on the whole system, and not on individual items. Therefore, the interactions of different elements in the system, their interrelationships and their outcomes must be analysed, instead of individual things.
- Personal mastery: the approach of continually enhancing personal aspirations and personal commitment to truth and reality, using the unconscious mind.
- Mental models: deep thoughts and structures in the mind that affect our understanding of the world and how we operate in it. Usually, we do not have enough knowledge about our mental models and the effect they have on our performance.
- Shared vision: the successes of organizations are rooted in the goals and values that are deeply accepted by the organization. Therefore, the aim is to create a common vision and goal for the future.
- Team learning: conversation and discussion form the main pillars of this discipline.

There are various ways of defining systems thinking. The common understanding of systems thinking focuses on forecasting relationships, boundaries and change trends (Smith, 2011). (Cabrera et al., 2008) explain it as a bridge between different scientific disciplines, such as sociology and natural science, and as a potential that can be applied to solve the multidimensional problems of sustainability.

The application of this method in different disciplines of management has been presented. However (Smith, 2011, p. 6) defines the main feature of systems thinking as its capacity to "enable integration across the dimensions of sustainability", through development of an integrated approach. Systems thinking can be a solution to the problems of complexity in sustainability, while facilitating changes in the system. This approach can help in foreseeing the long-term outcomes of decisions and polices (Maani & Cavana, 2007).

A paradigm represents the origins of a system and defines the features of the system. (Kuhn, 1962), explaining "the structure of scientific revolutions", focused on the failures and anomalies in the old paradigms in order to change the paradigm. Although, (Williams et al. 2017) have highlighted the importance of systems thinking for sustainable development, a lack of comprehensive research in this area is mentioned.

2.2.1 Leverage Points for sustainable development

Leverage points identify the places where changes in the system can happen, in order to lead to the long-term goals of the system. The importance of recognizing the leverage point is to enable the critical action points (or opportunities for improvement) to be identified where they are not obvious (Eid, 2013). (Meadows, 1999) explains that it is crucial that these power points are oriented in the correct direction; this issue can be demonstrated, for example, by defining economic "growth" as a general goal for global problems, while simultaneously disregarding the associated negative environmental impacts.

Therefore, the places to intervene in the system to implement changes can be determined from the mindset and the paradigm of the system (with maximum effectiveness), leading to the constants and parameters of the system (with a minimum level of effectiveness in transforming the system). On a 12-point scale they are (Abson et al., 2017):

- Parameters:
    - 12. Constants, parameters, numbers
    - 11. The sizes of buffers and stabilizing stocks
    - 10. The structure of material stocks and flows
- Feedbacks:
    - 9. The lengths of delays
    - 8. The strength of negative feedback loops

- 7. The gain around driving positive feedback loops

- Design:
  - 6. The structure of information flows
  - 5. The rules of the system
  - 4. The power to add, change, evolve or self-organize the system structure

- Intent:
  - 3. The goals of the system
  - 2. The mindset or paradigm out of which the goals arise
  - 1. The power to transcend paradigms

(Senge, 2006, p. 64) points out that leverage points are the "right places in a system where small, well-focused actions can sometimes produce significant, enduring improvements". (Nguyen & Bosch, 2013) explain that the interest rate is an example of a leverage point in every economy, as it is a system which is not easy to identify. However, the development of an archetype of the system can be a solution to this problem. (Holling, 2001, p. 392) illustrates the positive impact of leverage points in sustainability management by characterizing them as "the points at which a system is capable of accepting positive change and the points where it is vulnerable".

2.3 Business model for sustainable change

As (Kelly & White, 2009) have discussed, the roots of current business models go back to the nineteenth century and are mainly outdated. Although there have been some successful examples of the implementation of new business models among companies, there is also a great resistance to changing current models. Moreover, these models are not capable of addressing the needs of sustainable development and demand some radical changes (Birkin, 2009). According to (Stubbs & Cocklin, 2008) in addition to structural attributes such as redesigning the systems and triple bottom line reporting, cultures and mindsets also need to be included, to ensure a long-term perspective in a sustainability business model. In the sustainable business model context "sustainability-phase modelling" is a traditional example illustrating the progress of change in an organization towards achieving global sustainability. For instance, (Benn & Griffiths, 2014) have defined

six steps to achieving sustainability in an organization: rejection or short term planning, non-responsiveness, compliance, efficiency, proactive strategy and a sustainable corporation.

(Osterwalder & Pigneur, 2010) have depicted the main features of a business model through which values can be created, delivered and captured by organizations. The CANVAS business model has gained considerable attention among researchers and practitioners because it provides a process-oriented guideline and format for implementation that helps to evaluate the current business model and sustain the business. It consists of four areas of a business (customers, offer, infrastructure and financial viability), divided into nine building blocks as follows.

- Customer segments: these describe the areas targeted by a firm in order to gain profit. The customers can be divided into five main markets (mass market, niche market, segmented, diversified and multi-sided platform), and each one requires different management strategy.
- Value proposition: this describes the product or service that the company delivers to the customers. Performance, newness, design and price are some of the attributes.
- Channels: the channels of communications between customer and company for value propositions.
- Customer relationships: the relationship between the firm and its customers can be promoted by boosting sales and by customer acquisition and retention. They can include (dedicated) personal assistance, self-service, automated service, communities and co-creation.
- Revenue streams: this block represents the willingness of the customer to pay for the product or service. Revenue streams can be designed through mechanisms such as asset sales, usage fees, subscription fees, licensing and advertising.
- Key resources: these are the main inputs of the company for generating the services and products. Resources such as physical, intellectual, human and financial resources can either be owned or acquired from other partners.
- Key activities: the key activities are the most important measures for companies to create value, guaranteeing the profitability of the firm. Key activities (such as software development or supply chain management) can be categorized based on production, problem solving and networking.
- Key partnerships: the network of critical customers and suppliers required in order to optimize the product and economies of scale, reduce risk and uncertainty and acquire resources. The main partnership types can be defined as strategic alliances between non-competitors, cooperation, joint ventures and buyer-supplier partnerships.
- Cost structure: the costs and expenditures required for the business to operate. According to the cost structure, businesses can be cost driven or

value driven with the following characteristics: fixed costs, variable costs and economies of scale or scope.

The notion of sustainability has transformed the old concept of value creation (Zabolotnyy et al., 2016). (Barney, 1991) presented the pillars of sustainable competitive advantage (SCA) through the resource-based view (RBV) model: value, rarity, limitability and substitutability (organization or VRIO). Likewise, (O'Riordan, 2006) argues that the resources that comply with these four indicators can generate sustainable competitive advantages. For instance, according to the VRIO, the project management decision-making organizations (PMOs) can provide SCA, but not financial resources or bodies of knowledge, as these are imitable and simple (Jugdev & Mathur, 2012).

2.4 Sustainable innovation, system niche management, and transition management

Successful combination of a theoretical concept with technical invention and commercial implementation of a new idea can define an innovation (Trott, 2012). According to (Vilanova & Dettoni, 2011) there are five types of innovations: introduction of new products, introduction of new methods of production, opening of new markets, development of new sources for raw materials and invention of a new market structure. If an innovation leads to major disruptive change it can be considered "radical", while an "incremental" innovation provides small and gradual improvements. Furthermore, if an innovation facilitates sustainable development it can be defined as a sustainable innovation.

Modern societies that consist of a network of complicated subsystems such as industry, energy and transport require continuous changes and improvements; however, end-of-pipe solutions cannot meet the challenge of structural changes. Strategic niche management strives to respond to this need by aligning the technical and the social elements. From this perspective, technology, the relevant context and real-life experiments should be handled simultaneously. For instance, an invention may be lacking in the technical aspects required to perform properly and survive; moreover, it may not fit with existing governmental regulations. Other cultural and societal factors are also a matter of concern. Strategic niche management can help to overcome these barriers (Schot & Geels, 2008).

A transition is a result of fundamental change in a society during a long-term process, in other words, "changes from one sociotechnical regime to another"

(Geels & Schot, 2007). The principle of transition management can be justified through the systematic thinking concept, considering multidomain, multi-actor and multilevel aspects by linking the impact of each level to another level. The transition management cycle consists of four main processes: problem assessment, development of a long-term sustainability agenda, application of transition experiments and monitoring (Loorbach & Rotmans, 2006).

System innovations demand interaction at different levels: the micro level, the meso level and the macro level. From the point of view of a nested hierarchy, radical novelties and niches merge to form the micro level. The meso level consists of the sociotechnical regime (energy, transport, etc.), and above this the macro level is formed by elements such as such as macro-economics. From this multilevel perspective, the levels of structuration go from niches to regimes and sociotechnical landscapes. On the level of technological niches, a limited structuration for local actors is provided, originating from unclear visions and expectations, while sociotechnical landscapes have a stronger structuration for local practices (Geels, 2002).

Accordingly, (Hart & Milstein, 2003) have developed a framework for sustainable value creation. The concept expresses the requirement for sustainable development through shared value creation. The framework consists of four main strategic areas: pollution prevention, product stewardship, clean technology and sustainability vision. For instance, through environmental efficiency and reduction in waste, the ratio of input and output for saleable units of production increases, reducing the operational risk of the firms.

An importance principle in the portfolio is the development of a life-cycle approach to product stewardship, since "by constructively engaging stakeholders, firms increase external confidence in their intentions and activities" (Hart & Milstein, 2003, p. 61). Meanwhile, a clean technology strategy can also contribute greatly to the economic growth of companies; a good example of this is the marketing of hybrid cars by car manufacturers such Toyota or General Motors in 2002. In addition, development of a sustainability vision provides a shared roadmap that can help to solve social and environmental problems and help companies to exploit future markets. The initial framework matrix is defined as:

- Innovation and repositioning (tomorrow/internal)
- Cost and risk reduction (internal/today)
- Growth path and trajectory (tomorrow and external)

- Reputation and legitimacy (external /today)

Figure 3 shows the above-mentioned framework for the research objectives and the variables of this thesis.

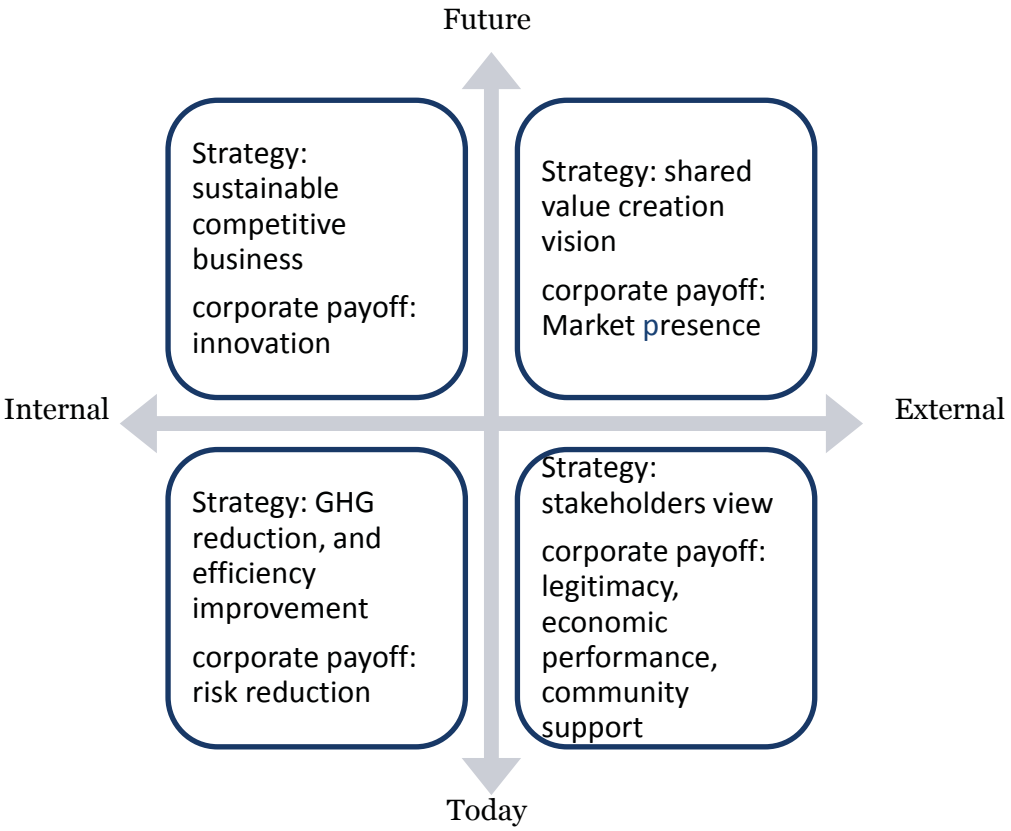

Figure 3. Sustainable development value portfolio (adapted from Hart & Milstein, 2003)

2.4.1 Impact of innovation on sustainable decision making

According to (PMI, 2013, p. 309) , qualitative risk management is defined as "the process of prioritizing risks for further analysis or action by assessing and combining their probability of occurrence and impact" by implementation of various tools such as an impact matrix. However, in "quantitative risk analysis" intensive numerical analyses of the risks are performed.

Generally, three main steps have been carried out for risk assessment in the studied case (company JE in the MittaMerkki research project) (ISO 31000, 2009; ISO 31010, 2009):

- Risk identification: this step attempts to find the answer to the fundamental questions of what can happen because of the risk, and why. It consists of finding, recognizing and describing risks. It can be achieved through assessment of historical data, expert ideas and stakeholders' requirements. Some of the methods that can be used are: evidence-based methods, HAZOP and the Delphi method.
- Risk analysis: the process of evolution of the nature and level of the risk, providing an input to the risk evaluation step. This analysis can be performed through qualitative analysis, quantitative analysis or combinations of both. Examples of important methods for this step are: failure mode effect analysis, consequence/probability matrix, the structured what if technique and environmental risk assessment.
- Risk evaluation: based on the risk analysis output, this step can determine the risks that require a response and the priorities for responding. ISO recommends three levels for this purpose: upper band (risk treatment is crucial), middle band and lower band. Hazard analysis and critical control points (HACCP) and Monte Carlo simulation are some the well-known methods applied in this process.

However, quantitative risk management is still a matter of concern among researchers and is an emerging field of research. Furthermore, traditional risk assessment methods for the mitigation of risk cannot serve the purposes of a case study in this research; therefore, the sand cone model was developed.

The sand cone model has three levels based on the AHP values. The items at the bottom of the pyramid are crucial factors for value creation for stakeholders. The rest of the items rest upon this base, with the middle (second) factors facilitating the third layer of resulting factors. The original version of the sand cone model was developed by (Ferdows & De Meyer, 1990), in order to analyse four key capabilities: quality (at the bottom), dependability, speed and cost-efficiency (at the top). Consequently, in order to improve performance, developments should start from the bottom of the model. In this study, the new parameter of knowledge and technology has been added to the sand cone model to measure the level of uncertainty.

2.5 Open innovation from the micro to the macro scale

According to (Jennings & Zandbergen, 1995) organizations can achieve sustainability only if the whole system they are involved in is sustainable. In spite of the booming trend of open innovation research at the micro scale (such as SMEs), governmental policy or macro scale studies of open innovation are still lacking. Therefore, transformation of the organization of governmental entities to generate high-quality co-creation services is a major area of concern (Christos et al., 2013). Likewise, (Feller et al., 2011) have evaluated the impact of open innovation on the transformation of public administration. The study positively presents the relationship of open innovation practices on the development of co-creation and service delivery at the governmental scale and concludes that this transformation requires three important things: a fruitful relationship between the public and the external organization, stakeholder (citizen) engagement and knowledge exchange.

Nonetheless, the implementation of OI within governmental organizations requires further attention from researchers and practitioners (Dobni, 2006). One of the main trends in the transformation of open innovation is the movement from product delivery to high-quality service delivery. Subsequently, this evolution will impact on governmental policies. In this context, the degree of performance and maturity is a critical measure. (Becker et al., 2009) point out that in order to develop a mature model, five different strategies can be implemented. Therefore, the generation of a new model, the enhancement of the current model and the combination of new and existing models are the strategies suggested. In addition, the new model can be developed by transforming the structures or applications of the current model for another domain.

The main characteristic of an open system is active interaction with the surrounding environment in the form of, e.g., information or energy exchange (Davis & Scott, 2007). Five main elements represent the necessary criteria for complying with the requirements of an open system for governments: environment, inputs, outputs, transformation and feedback. Therefore, the external environment (institutional, legal and operational organizations) will interact with the inputs and outputs. Here, the inputs are mainly the needs that are defined through the external environment and that generate feedback to the environment (Ham et al., 2015). Figure 4 presents a model for open innovation on the macro scale. The outcome of this framework presents a macro perspective and a general vision of how governments can interact with the external environment.

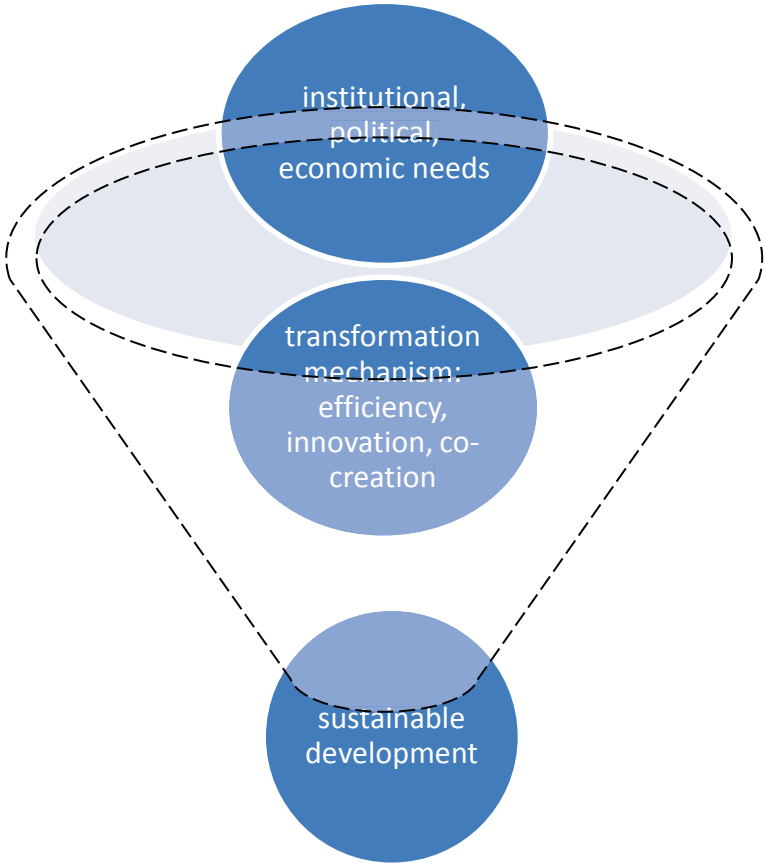

Figure 4. Open innovation prototype on a national scale

2.6 Project business, project marketing, and project management

The project business concept is rooted in the project marketing approach. (Artto et al., 2005, p. 351) while emphasizing the significance of R & D and innovation in this context, have stated that "project business is the part of business that relates directly or indirectly to projects, with the purpose of achieving the objectives of a firm or several firms". According to the marketing perspective, project marketing can be defined as the management of multiple projects between a supplier and a client, focusing on the long-term consequences for the customer's business (Patel & Salouhou, 2010). In spite of the close relationship between project marketing and project management, these two fields have largely remained isolated from each other in the research environment. This may be because projects are mainly generated inside organizations that may not have a need for marketing. However,

the current evolution in project management which has widened the outlook and vision towards external aspects, has changed the requirements.

The link between project marketing and project management can be described by six indicators: the project definition, characteristics of projects, the project cycle, the approach, the stakeholders and the project origin. Basically, in a project management context, a project is considered to be temporary, while in project marketing it is defined as a transaction: "a complex transaction covering a package of products, services and work, specifically designed to create capital assets that produce benefits for a buyer over an extended period of time" (Cova & Salle, 2005, p. 355). This implies a long-term perspective in the project marketing approach.

In addition, the project management definition is bound by triple constraints (time, cost and scope), but in a marketing context a DCU model (discontinuity, uniqueness and complexity) is implemented. The challenge in traditional project management is from a short-term perspective, whereas in project marketing the main issue is discontinuity.

Another divergence between the two is represented by the project cycle. Project marketing is "independent of any project", so a project may not yet exist for the supplier (before the tender preparation phase). On the other hand, this encourages the extension of the definition of project management to consider post-project and pre-project phases also. Furthermore, a project management approach strives to maintain the relationships within a single project, while project marketing enhances the relationship between two projects. Accordingly, three important networks are supported in project marketing: temporary networks, pre-tender networks and permanent networks. Nonetheless, both concepts can play a complementary role in the case of networks existing between and during projects.

In the project networks "governance" can manage "the relationships between the various parties that are engaged in the project as a temporary multi-organization grouping" (Artto & Kujala, 2008, p. 480). (Joslin and Müller, 2015) have pointed out the link between governance and project management success. Meanwhile, (Jonny Klakegg, 2009) has emphasized that sustainability and relevance (usefulness or meeting the user's needs) are key elements for the effectiveness of project governance.

Though stakeholders (either internal or external) have an impact on the project, the relationships between stakeholders are not considered in the project management context. In contrast, project marketing considers them as a network or milieu consisting of both business and non-business actors ("group of territorial

agents and economic, sociocultural, political and institutional elements having specific organization and regulation patterns, shared rules and norms") (Cova et al., 1996, p. 654). The project origin is another issue to be considered. In the current project marketing approach, a project can be given or jointly co-created, while in the traditional approach a project is mostly given rather than constructed collaboratively.

From the discussion presented above it can be seen that project marketing and project management present both similarities and differences. A project marketing approach can potentially facilitate the integration of sustainable development objectives in project management. Accordingly, as argued by (Lecoeuvre & Patel, 2009) project marketing can be linked better with portfolio management logic to define the strategies of the organizations.

The next section justifies the particular tools, techniques and approaches used in the study.

3 RESEARCH APPROACH, AND METHODS IMPLEMENTED IN THIS STUDY

According to (Joslin & Müller, 2015) the comprehensiveness of the project management methodology has a significant impact on project success. This study, by implementing a multilevel and multisystem approach, contributes to sustainability management from the point of view of project business. Therefore, critical factors and linkages between individual, organizational and society levels are evaluated by examining different theories. This approach has the potential to contribute to the challenge of sustainability both theoretically and practically.

Recently, the importance of sustainable management at both the macro and micro levels has gained considerable attention among practitioners. This complex system demands alignment through different levels of the decision-making processes, while embracing a systematic thinking type of logic. Therefore, places that facilitate interventions in the system can be recognized, and possibilities for improving the performance of the system can be identified. Hence, the major hypothesis of the research can be studied, i.e., the key points for intervening in the project system.

(Cameron et al., 2015) have highlighted the lack of mixed methods in the project management research area. Their study identified the prevalent criticisms against mixed methods with respect to project management. Therefore, the lack of good reporting about the implementation of mixed methods has been recognized. In addition, the insufficient attention of researchers to the growing popularity of mixed-method concepts and foundations has been mentioned (though some studies may have mixed qualitative and quantitative methods). Furthermore, the difficulty of publishing papers in highly regarded journals may be among the reasons for the scarcity of mixed-method studies.

In spite of the fact that the mixed methodology has not been explicitly mentioned (and developed) in project management research papers so far, (Cameron et al., 2015) have shown that a few papers have appropriately reported the implementation of mixed methods (mainly through qualitative data analysed quantitatively, or the other way around). In order to overcome this barrier in the field of project management, the following is suggested as a minimum requirement: mentioning the theoretical motivation, explaining the main reasons for mixing qualitative and quantitative methods in the study, presenting the steps of the process, explaining the priorities and illustrating the reason for integration using a diagram.

However, decision-making in project management sciences requires a practical approach. Thus, the outcome of the research should have the possibility of being implemented and should solve managerial problems (Joslin & Müller, 2015). The extant scholarly works have pointed out that triangulation can help to tackle the challenges of complex project management problems. Five levels of triangulation can be identified, relating to the data, investigator, methodology, theory and philosophy. At the highest level, philosophical triangulation can disclose the connections between different dimensions of the studied case and reduce the risk of a single-view analysis (Joslin & Müller, 2016).

According to (Biedenbach & Müller, 2011), in project management research there are five dominant research philosophies (paradigms):

- Positivism: this covers the majority of the research in project management so far. It leans more towards quantitative methods, but qualitative methods can also be applied. The ontology is external and objective and assumes that only one reality exists.
- Post-positivism: this aims to verify theories "which hold in certain situations but cannot be generalized"(Biedenbach & Müller, 2011, p. 87). This philosophical lens can be used for theory verification.
- Realism (critical realism/direct realism): here, the method should fit the subject of the research (qualitative/quantitative). The ontology is objective and independent of human thoughts. It is argued that realism is a branch of positivism.
- Interpretivism (or constructivism): this method relies on qualitative, in-depth investigation and small samples. The ontology is subjective and socially constructed (such as case studies or conceptual papers).
- Pragmatism: this is external, research-question oriented and focuses on outcomes. In addition, the research questions, and accordingly the relevant responses to them, are highly valued. The main application of the pragmatism perspective is in finding practical solutions that are useful for invention-based studies. Furthermore, this facilitates an abductive approach by moving back and forth between induction and deduction (Morgan, 2007, p. 71). Thus, a mixed method is the recommended method.

Table 1 presents a summary of publications, with details of the methodology for each article in this PhD study.

Table 1. Summary of research publication methodologies

	Publication (Publisher / Author and role)		Methodology	Philosophical perspective
1	The key drivers of sustainability (Daneshpour & Takala. , 2016)	IEEE Xplore – IEEM Proceedings (peer reviewed) Hosein Daneshpour, as corresponding author, collected the data, analysed the data and wrote the paper	The paper is quantitative, using an inductive approach and data collected from the Eurostat database. R software was utilized for the calculations on the data	critical realism
2	Decision Making Towards Integration of Sustainability into Project Management; A Multilevel Theory-Building Approach (Daneshpour & Takala, 2017)	Management and Production Engineering Review (peer reviewed) Hosein Daneshpour, as corresponding author, collected the data, analysed the data and wrote the paper	The paper is quantitative, using the abductive approach. Data were collected from the Eurostat database. R software was used for the calculations on the data	Post-positivism
3	Integrating Sustainable Development into Project Portfolio Management through Application of Open Innovation (Daneshpour, 2017)	IGI Global (peer reviewed) Hosein Daneshpour, as corresponding author, collected the data, analysed the data and wrote the paper	The paper is qualitative, taking the inductive approach. The paper is mainly based on a structured review of the literature (and exploratory interviews)	Interpretivism and critical realism

4	Analysis of Sectoral Energy Infrastructure Projects in Finland (Daneshpour, & Takala, 2017)	IEOM Proceedings - IEEE Xplore (peer reviewed) Hosein Daneshpour, as corresponding author, collected the data, analysed the data and wrote the paper	The paper is quantitative, using a deductive approach. Data were collected through the WIOD database (World Input-Output Database).	Positivism
	Dissertation	-	Mixed methodology	Pragmatism

As stated by (Shannon-Baker, 2016, p. 321) the purpose of mixed methods is "to provide a more complex understanding of a phenomenon that would otherwise not have been accessible by using one approach alone". It is not possible to determine the best paradigm for the mixed method; rather it is a matter of justification and elaboration by the researcher. Furthermore, the mixed-method approach is suitably aligned with the pragmatic approach of constructive research. The discussion and the different points of view explained in this section justify the use of mixed methods for this research.

3.1 Reliability and validity of the research

The reliability and validity of the research is always an important issue (Gibbert et al., 2008). This study has been conducted through an article-based (peer-review process) approach. This strategy ensures that critical requirements are met, such as clarity of exposition, technical adequacy, empirical and theoretical contribution, significance of contribution, novelty, innovation, interest and practical application (Colquitt & Ireland, 2009). Furthermore, the logical validity of the study was constructed using different theories and extracting the framework from the extant literature. In addition, construct validity or operationalization was performed via triangulation and case studies. Likewise, the nested approach of the study strives to achieve generalizability.

Moreover, the methodological and philosophical triangulation in this study improves its validity and reliability and supports its practice orientation, keeping in mind that "real scientific breakthroughs are only possible through changes in underlying paradigms" (Joslin & Müller, 2016, p. 1053).

Similarly, the quality of mixed-method inference can be assessed based on the quality of design and explanations, and through the following criteria: design appropriateness (proper answers to the research questions), design adequacy (internal validity, reliability, dependability and credibility), analytic adequacy (theoretical and statistical validity), quantitative inferences (validity of statistical results, internal and external), qualitative inferences (transferability) and integrative inference (efficacy, transferability and correspondence) (Venkatesh et al., 2013).

According to (Hambrick, 2007) the significance of the contribution to theory can be recognized through the potential to promote future research while also affecting managerial practices and theories. Similarly, (Miller, 2007, p. 182) defines valuable research as "the discovery of new arguments, facts, patterns or relationships that, in a convincing way, help us to better understand some phenomenon that is of consequence to a social or scientific constituency. Such research may bear little or no connection to pre-existing or future theory, span many theories, or give rise to understanding that only eventually will form the basis of new theories". The taxonomy of levels of theoretical contribution is presented below (Colquitt & Zapata-Phelan, 2007):

- Reporter (minimum theory-building and testing contribution): attempts to replicate a previously demonstrated effect, and to make predictions with reference to the past finding.
  - Qualifier (moderate theory-building and testing contribution): provides predictions from existing models and examines previously unexpected relationships.
    - ♦ Builder (maximum theory-building, and minimum testing contribution): institutes new constructions and predictions via logical speculation.
    - ♦ Tester (minimum theory-building, and maximum testing contribution): provides predictions from existing theories and replicates previously demonstrated effects
      - ➢ Expander (maximum theory-building and testing contribution): provides predictions from existing theories and introduces new constructs.

This PhD study aimed to take a position somewhere between expander, tester and builder.

The next section presents a summary of the papers, and their contributions to the research framework.

4 SUMMARY OF THE PUBLICATIONS

This section presents a summary of the five papers of this PhD study.

4.1 Summary of publication 1

The traditional definition of sustainability has been reformed in this paper. Generally, since the introduction of sustainable development the common definition of sustainability has not changed. In this PhD study a more practical understanding of sustainability is required. This paper also provides the main variables to be studied in this research.

Hence, principal component analysis (PCA), as an orthogonal transformation, was applied, in order to transform the set of correlated variables into linearly uncorrelated components. PCA was invented in 1901 by Karl Pearson for developing predictive models such as regressions, time series, etc. This method is especially useful for reducing the number of variables when it is not clear which should be retained. In addition, it can ensure that the variables are independent of each other. From a mathematical point of view, the principal components are sorted based on the maximum variability coverage in the data, and the chosen variables account for the remaining variability (Abdi & Williams, 2010). This approach advocates the fit as a gestalt that considers the system as a whole (Buttermann, 2008). The gestalt is defined as "an organized entity or whole in which the parts, though distinguishable, are interdependent; they have certain characteristics produced by their inclusion in the whole, and the whole has some characteristics belonging to none of the parts" (Veliyath & Srinivasan, 1995, p. 212).

The Eurostat database was developed by the statistical office of the European Union in Luxemburg. As well as providing high-quality data their aim has also been to promote innovation and excellence in their services. Data are categorized based on themes, European policies and cross-cutting topics (data relating to some selected topics are grouped together, e.g., data on quality of life, employment, agri-environmental matters, etc.). The main themes are categorized into nine main groups, for example, transport, economy and science, and six main European policy groups, for example European social rights, and 2020 indicators. The database defines 10 main categories for sustainable development, each with several sub-categories. Therefore, from a practical and managerial point of view,

the paper reduces the dimensions of sustainability in order to determine the more practical elements of sustainable development.

In this paper, the traditional environmental, social and economic elements have been replaced by efficiency, environment (energy-related), stakeholders and innovation, as key drivers. For instance, the first principle states that stockholder satisfaction is more valuable than general economic growth (GDP).

4.2 Summary of publication 2

The sustainability revolution can be highlighted as one the most significant phenomena of the industrial and scientific era (Burns, 2012). Although there are various management theories, none of them have been able to foster an appropriate ecosystem for sustainability. But why are new theories of sustainability management needed?

(Starik & Kanashiro, 2013) argue that all organizations are merged within a natural environment. Thus, neglecting the natural and social aspects of an organization can lead to naive and short-sighted decision-making among both practitioners and researchers. Consequently, a more advanced and comprehensive logic of sustainable management theory with a focus on the social environment of the organization is required. Furthermore, theories of sustainable management should encompass the potential to present both practical and scientific approaches to the complex and multidimensional problem of adverse environmental outcomes from the activities of societies and organizations.

In addition, it can be observed that current management theory neither addresses sustainability nor has a systematic approach to integrating individuals, organizations and societies. Hence, the scholars of management (such as the Academy of Management) have identified and justified a need for new sustainability management theories. Finally, it is necessary to highlight the fact that current management theories focus on a limited number of disciplines; in order to deal with the multifaceted problems in sustainability management more disciplines should be considered (engineering, philosophy, anthropology, etc.).

(Hitt et al., 2007) argue that although the majority of management researchers require tools for a multilevel assessment, the current frameworks are presented mainly in terms of a single-level approach. Assessments of strategies with a micro-level lens ignore the environment at the higher levels, and vice versa.

(Klein et al., 1999) argue that multilevel analysis can bridge the gap between the macro and micro analyses and develop the organization's performance. In addition, the synergy of research related to the organization will also increase. Although multilevel analysis can pave the way for organizational success, the challenge will be to deal with the complexity of the framework and to link the processes among the levels precisely. Initially, the many existing theories will tend to hinder the creation of multilevel theories. In addition, the fact that traditionally, researchers (especially doctoral researchers) mainly focus on a single level, forms a potential barrier. A mistake that may occur in multilevel analysis is that the theorists simply translate a proposition into another level, e.g., "we know that when individuals do x, y occurs. Therefore, when groups do x, y must also occur." Thus, it can be difficult to adopt a middle ground regarding the level of complexity within the framework. Furthermore, the issue of too much macro analysis or too much micro analysis could be another barrier in the framework.

The multilevel theory proposed and analysed in this paper suggests the required elements for a better theory of sustainability management. The framework considers the socio-economic environment of the portfolio funnel and integrates the input, the output and the process. Therefore, the paper helps to address the need for action on environmental and fossil fuel problems, while including as many realistic elements as possible.

A requirement for a mature theory of sustainability management is the consideration of multiple levels (at least three levels) and different contexts. The paper meets this requirement. Subsequently, evolution is considered at individual, organization and society levels, and suggested solutions at each level are obtained. This notion aims at a wider aspect of environmental quality that is not limited to human life (the micro scale).

The nested logic of multiple levels has been implemented in this paper. Starting with individuals nested within the organizational scale, the framework finally encompasses national and international levels. However, the number of levels that can be investigated may vary from one research point of view to another. (Rousseau, 1985) explained that the levels can be properly chosen according to three elements: theory, measurement and analysis.

Furthermore, by considering the impact of the Z-variable through the rule of innovation in the framework, the paper conceptually promotes competency and the provision of competitive advantage. The systematic approach of the paper leads to a holistic perspective with the possibility of implementation in different contexts.

According to (Gond et al., 2012), project management as part of a formal management control system can act as a strategic lever for a sustainability control system, for instance through socio-eco-efficiency analysis. In addition, efficiency and ranking analyses represent an extensive field of study, with two main approaches: stochastic frontier analysis (SFA) and data envelopment analysis (DEA). The ranking methodology in this paper is based on SFA. Basically, using this method, it is possible to find the best-performing cases and the sources of efficiency. This method can be implemented in different fields, such as energy, manufacturing and banking, and at both the macro level (individual, company or industry) and micro level (industrial infrastructure at the country level) (Kuosmanen, 2015), As follows (Kuosmanen et al., 2013):

$$\ln y = \ln f(x) - u + v + \alpha z \quad \text{with} \quad u \geq 0, \text{ Equation 1}$$

y: output
x: inputs
f: production function
α: coefficient of Z-variable
z: other variables except for original inputs
u: random variable representing inefficiency
v: random variable representing stochastic noise

Longitudinal evaluations are rooted in sustainability studies (Battaglia, 2016). Figure 5 presents the ranking of 15 European countries. It can be observed that Finland's performance did not improve during the study.

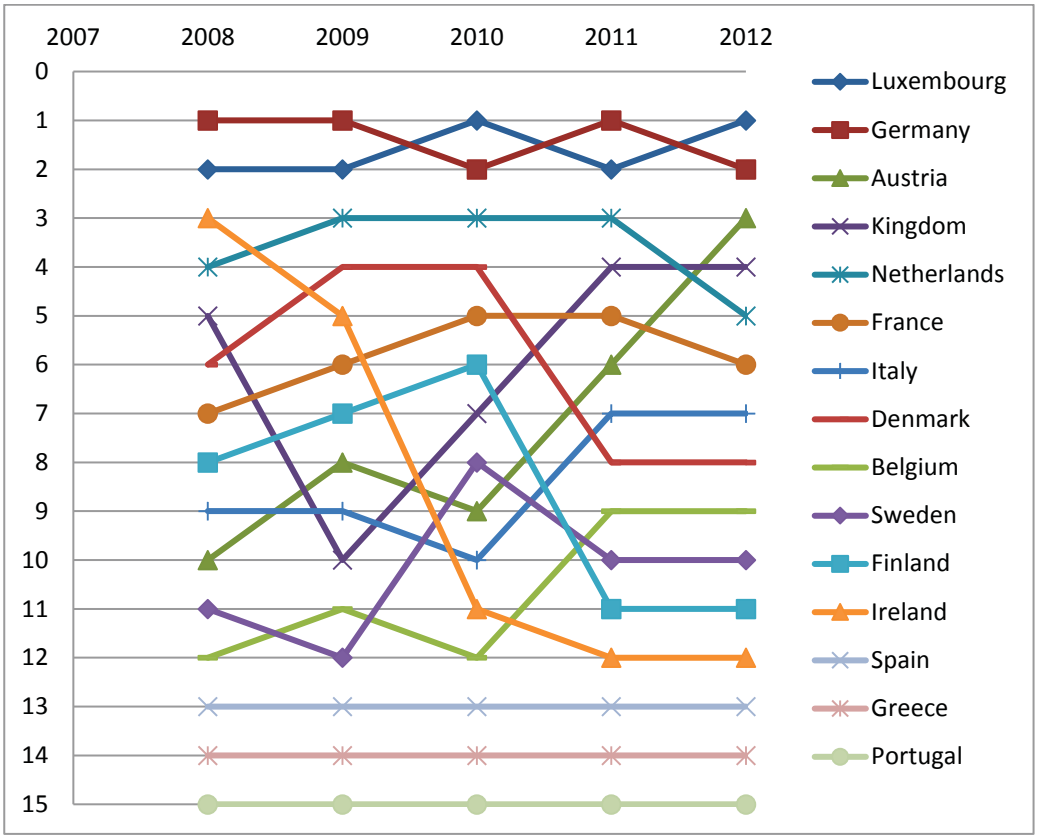

Figure 5. Eco-efficiency ranking trend, EU-15

A general challenge in the context of project management is delivery of the outputs (on time and on budget). However, this approach may not necessarily guarantee the effectiveness of project and strategic objectives. Consequently, research on "project benefits management" is recommended for the future (OferZwikael, 2014). Hence, the study of the links between project efficiency and effectiveness and research in different cultural environments and industries, is suggested. In addition, this paper has attempted to link the best practices of project management to the classic understanding of project management. Research into the "classics of megaproject management" is suggested as a future research avenue (Flyvbjerg, 2015).

4.3 Summary of publication 3

Renewable and green management requires systematic macro-level planning. A business model that facilities change in the foundations of the organization is

explored in this chapter. Business model development is still an ongoing process; however, the main idea is based on the logic of creating change. The aim is not only to change the business but also to transform the whole ecosystem. (Boons & Lüdeke-Freund, 2013) argue that current industrial infrastructures have not implemented a sustainable business model. Therefore, energy infrastructures, as the main emitters of $CO_{2,}$ merit considerable attention.

The extant scholarly works indicate the growing interest in the impacts of sustainable innovation and business models; however, the impact of stakeholders and the link to business models needs to be explored further. (Hellström et al., 2015, p. 227) argue that "sustainable business models aim to create, deliver and capture value in a truly sustainable way by providing products and services that improve quality of life while remaining within environmental limits".

The foundation of any business model is value creation and capturing or co-creation mechanisms. (Chesbrough & Rosenbloom, 2002) have remarked on the role of innovation as an input and output process (financial performance) in the business model. It is worth mentioning that well-known theories such RBV and strategic networks cannot provide such advantages (Amit & Zott, 2001).

Porter and Kramer introduced the shared value creation concept. They argue that in spite of the recent development of corporate social responsibility, companies remain the main reason for environmental, social and economic problems. This is mainly due to the superficial perspective of firms regarding value creation and the fact that they consider short-term objectives rather than long-term successes. In order to cope with this problem they introduced shared value logic: "policies and operating practices that enhance the competitiveness of a company while simultaneously advancing the economic and social conditions in the communities in which it operates" (Porter & Kramer, 2011, p. 66). For this purpose, they consider three processes: reconceiving products and markets, reformulating productivity in the value chain and fostering development of a local industry cluster.

The main logic of this paper is based on a structured literature review, forming the conceptual framework. In addition, the research is supported by an exploratory case study performed in famous European (global) firms to assess the practicality and managerial applications of the research. Interviews were undertaken with the senior managers and vice presidents of extremely prominent companies: W, A, V, and S.

The exploratory study helped to develop a more realistic vision of the problem and to choose the best strategy and methodology for reaching a solution. Therefore,

interviews with experts and literature searches were the principal steps of the exploratory study (Sauders et al., 2009).

Overall, a lack of attention to the purposive use of an open model was observed. Moreover, it was noticed that project management offices have their own localized interpretation of sustainability (such as safety in the work environment or just environmental issues in projects) that are different from the triple bottom line concept, and these have provided a motivation for further study. Table 2 shows a summary of the exploratory studies.

Table 2. Summary of exploratory interviews

Case	Sector	Main approach to project management	Explicit application of OI
1	Manufacturing and service/Power	Stage-gate and PMI	-
2	Power and automation technologies/Electrical equipment	Theory of constraint and internal (quality based) system	-
3	Technology for renewable and industrial applications	(No explicit project management office) Agile method	Awareness of company about OI was recognized
4	Industrial goods and services	Lean	-

4.4 Summary of publication 4

In 2011, the United Nations presented a vision of "sustainable energy for all" to be achieved by 2030 (United Nations, 2011). This emphasizes the fact that sustainable development and energy production are closely related objectives. Consequently, in 2015, 17 sustainable development goals were defined, to be adopted by countries. Goal 7 in this agenda specifically targets the energy area, aiming to

"ensure access to affordable, reliable, sustainable and modern energy for all". A main reason for this objective is that 20% of the world's population do not have access to electricity, and for instance three billion people still utilize old-fashioned methods for cooking, (e.g., charcoal or animal waste). Above all, energy contributes to more than half of the total global greenhouse gas emissions (United Nations, n.d.).

The geographical location of Finland in the Nordic area, results in a cold climate, and in addition, the industrial features of the Finnish economy have an important impact on the energy consumption of the country, leading to high energy consumption per capita. Therefore, approximately half of the primary energy supply is consumed in industry. Energy consumption increased by 90% between 1981 and 2011, while the population growth was 12% during this time. Imported fossil fuels and nuclear power are the main sources of energy in Finland. More than 50% of the energy consumed in 2010 had been imported. However, in accordance with the Finnish policy for energy security the use of fossil fuel and peat diminished by approximately 12% between 1981 and 2011 (Aslani et al., 2014).

Finnish production consists mainly of paper and forestry, or metals and chemicals that are highly electricity dependent. On the other hand, the main sources of energy production are nuclear power, hydropower, coal and peat. The main policy for the reduction of CO_2 in Finland has been the use of renewable energy sources. According to the 2020 plan, 38% of the energy consumption in Finland should come from renewable energy resources. Supply, cost, quality and the Finnish environment are the main barriers to the development of renewable energy in Finland (Aslani et al., 2013).

Since the previous paper demonstrated the general ranking of Finland regarding eco-efficiency, this paper specifically analyses the underlying reasons with respect to Finnish industries. While economic or financial sustainability issues have been discussed in detail in the previous studies, the main interest of this study has mainly been oriented towards other sustainability factors (environmental factors).

Thus, this paper has studied the shift in total energy demand for industrial production in Finland. Therefore, the energy demand and energy-related emissions are analysed. The findings of the study link economic growth, energy efficiency and CO_2 emissions reduction. Figure 6 presents the method implemented.

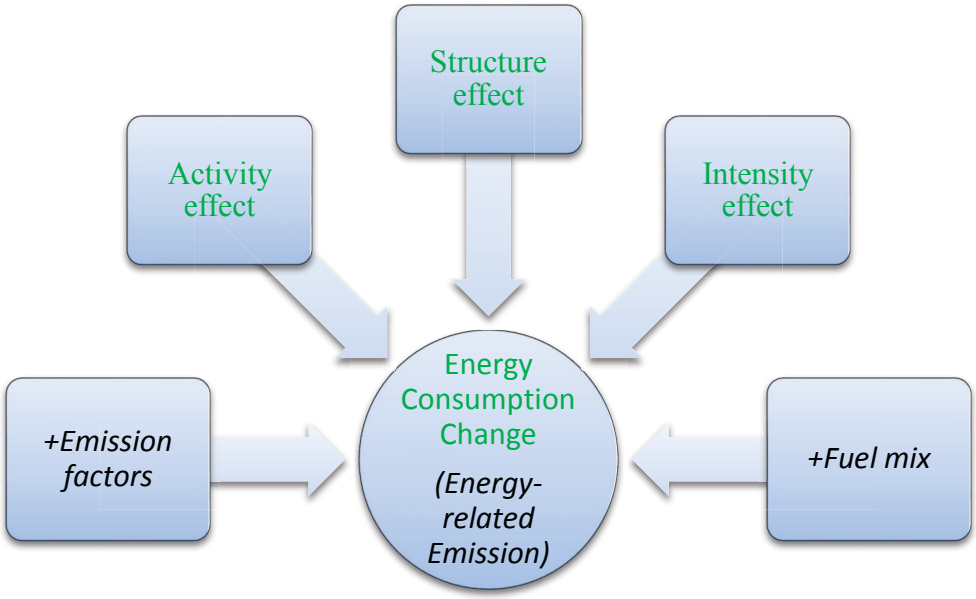

Figure 6. Energy consumption change (three factors) and energy-related emissions (five factors)

The paper used LMDI for this purpose. The application of indexed decomposition analysis (IDA) in the energy sector started in 1991, though IDA is not limited to energy and emission studies (Torvanger, 1991). For instance, in a study in China, this method was used in the area of future policy. The type of fuel was identified as a key driver: coal is mainly used (due to the price) and it will be difficult to change the practices of power generation sectors towards more environmentally friendly fuels (Donglan et al., 2010).

Basically, LMDI is a weighted sum of relative changes, introduced by (Ang et al., 1998). It is composed of two methods LMDI-I and LMDI-II, and can be formulated additively or multiplicatively, as shown in Figure 7.

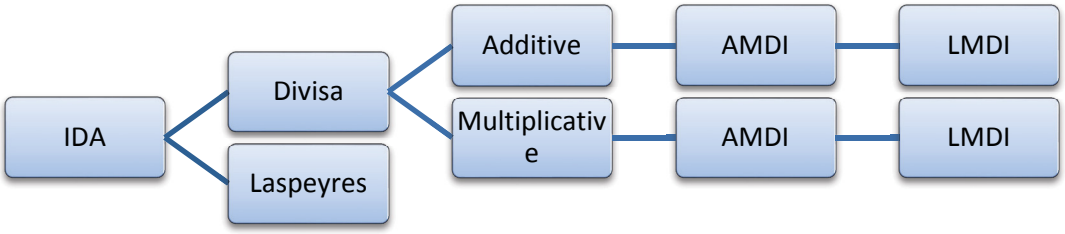

Figure 7. IDA methods

Data were collected from the World Input-Output Database. The database covers 27 European countries and is organized industry by industry (WIOD, n.d.). Tables 3 and 4 present the results of the analysis.

Table 3. Total energy consumption 2000-2009

Sector	Change in consumption	ΔE_{act} Production effect	ΔE_{str} Structure	ΔE_{int} Effeminacy effect	Rank
Electricity, Gas and Water Supply	92,563	431,227	202,803	-541,466	1
Coke, Refined Petroleum and Nuclear Fuel	44,960	400,464	102,115	-457,618	2
Air Transport	36,747	32,190	5,540	-983	3
Chemicals and Chemical Products	30,988	51,972	3,541	-24,524	4
Real Estate Activities	19,140	27,146	6,630	-14,636	5
Food, Beverages and Tobacco	7,625	12,561	-431	-4,505	6
Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies	7,407	6,402	914	91	7
Inland Transport	2,762	22,319	1,734	-21,290	8
Wood and Products of Wood and Cork	2,754	15,856	-9,932	-3,169	9
Retail Trade, Except Motor Vehicles and	2,308	5,659	2,070	-5,421	10

Motorcycles; Repair of Household Goods					
Machinery	2,242	4,619	514	-2,891	11
Electrical and Optical Equipment	1,914	5,268	-3,195	-159	12
Education	1,578	6,386	1,082	-5,889	13
Public Admin and Defence; Compulsory Social Security	1,497	7,027	1,850	-7,379	14
Manufacturing; Recycling	1,262	2,789	-897	-630	15
Textiles and Textile Products	591	1,750	-1,484	325	16
Agriculture, Hunting, Forestry and Fishing	482	27,037	-8,379	-18,176	17
Other Community, Social and Personal Services	455	10,970	3,061	-13,576	18
Transport Equipment	438	2,214	-1,113	-663	19
Water Transport	130	24,019	-2,915	-20,974	20
Rubber and Plastics	82	7,521	-2,803	-4,637	21
Leather and Footwear	-121	223	-206	-137	22
Health and Social Work	-132	10,410	4,424	-14,966	23
Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel	-143	2,155	615	-2,913	24

Financial Intermediation	-304	3,350	-730	-2,924	25
Renting of M&Eq and Other Business Activities	-416	6,087	3,247	-9,750	26
Hotels and Restaurants	-624	3,343	181	-4,148	27
Post and Telecommunications	-660	2,463	-1,147	-1,976	28
Other Non-Metallic Minerals	-1,956	9,658	-2,849	-8,766	29
Mining and Quarrying	-3,234	4,722	1,810	-9,766	30
Construction	-3,573	22,494	2,711	-28,778	31
Wholesale Trade and Commission Trade, Except Motor Vehicles and Motorcycles	-7,962	6,393	480	-14,835	32
Basic Metals and Fabricated Metal	-13,267	60,453	-12,873	-60,848	33
Pulp, Paper, Printing and Publishing	-74,595	206,756	-162,761	-118,590	34
Total	150,939	1,443,904	133,603	-1,426,568	
D_{total}	1.07	1.99	1.07	0.51	

Table 4. Emission decomposition 2000-2009

Sector	ΔC_{act}	ΔC_{str}	ΔC_{int}	ΔC_{mix}	ΔC_{emf}
Electricity, Gas and Water Supply	14,488	6,813	-18,191	1,167	6
Air Transport	2,302	396	-70	0	0
Pulp, Paper, Printing and Publishing	2,249	-1,771	-1,290	121	22
Coke, Refined Petroleum and Nuclear Fuel	1,840	469	-2,103	655	-990
Water Transport	1,822	-221	-1,591	0	0
Agriculture, Hunting, Forestry and Fishing	1,525	-473	-1,025	-142	-2
Inland Transport	1,520	118	-1,450	-83	0
Basic Metals and Fabricated Metal	1,162	-247	-1,170	-389	39
Construction	804	97	-1,028	-114	2
Chemicals and Chemical Products	603	41	-285	-278	129
Other Non-Metallic Minerals	523	-154	-475	-122	10
Other Community, Social and Personal Services	416	116	-515	-187	0
Health and Social Work	346	147	-497	37	0
Mining and Quarrying	300	115	-620	-70	0
Renting of M&Eq and Other Business Activities	247	132	-396	73	0
Other Supporting and Auxiliary Transport	224	32	3	-137	0

Activities; Activities of Travel Agencies					
Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles	222	17	-516	74	0
Public Admin and Defence; Compulsory Social Security	202	53	-212	-18	0
Real Estate Activities	187	46	-101	-49	0
Retail Trade, Except Motor Vehicles and Motorcycles; Repair of Household Goods	183	67	-175	-135	0
Education	168	28	-155	-48	0
Machinery	145	16	-91	-38	-1
Food	125	-4	-45	-668	481
Post and Telecommunications	99	-46	-79	42	0
Wood and Products of Wood and Cork	86	-54	-17	-28	-69
Manufacturing; Recycling	85	-27	-19	98	0
Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel	82	23	-110	-15	0
Hotels and Restaurants	75	4	-93	15	0
Transport Equipment	66	-33	-20	-8	0
Electrical and Optical Equipment	59	-36	-2	-45	51
Financial Intermediation	59	-13	-51	-7	0

Textiles and Textile Products	24	-21	5	-20	31
Rubber and Plastics	18	-7	-11	10	97
Leather	3	-3	-2	0	2
Total	32,258	5,621	-32,397	-309	-194
D_{total}	1.95	1.12	0.51	0.99	1

4.5 Towards risk-conscious investment decision-making and value creation

Company JE, studied in this research, is an electricity, water and district-heat provider with a vision regarding environmental energy generation. The main challenge in this case was the distribution of investment among three departments. Therefore, the investment decision-making consisted of a portfolio of three proposals: electricity, district heating and water/sewage. The main risk impacts in this case are: environmental safety, customers, economics and asset functionality (Takala et al., 2016).

The growth of technology provides great opportunities for business development to be exploited by firms. In addition, the decision-making process, in order to comply with the shared value idea, must provide sustainable competitive advantages. Knowledge management is fundamental to this notion.

The focus of the study is on the interaction of uncertainty, knowledge and technology. Therefore, uncertainty modelling has been implemented to tackle this issue. Like risk, uncertainty can provide both an opportunity and a threat. In this model, a combination of the analytic hierarchy process (AHP), knowledge and technology (K/T) ranking and the sand cone model, has been utilized. The main aim of the K/T calculation is to determine the level of sustainability (in other words, the stability of the sand cone) for each department, according to their competitive range. The K/T ranking was determined via a questionnaire. Figure 8 shows the SR questionnaire implemented in the JE case.

	Scale1=low 100=high		Compared with competitors			Direction of development		
Performance attributes	Expectations (1-10)	Experience (1-10)	worse	Same	better	worse	Same	better
Performance 1								
Performance 2								

Figure 8. SR questionnaire in the JE case study (Räikkönen et al., 2017)

Firstly, the study implemented the SR method to evaluate critical resources. This method can help to solve sustainability and stakeholder satisfaction issues (Sishi et al., 2017). The critical attributes were evaluated through a questionnaire with the following attributes: basic (routinely used technologies that the firm is inclined to outsource, such as cables or transformers), core (current competitive technologies that ensure the further growth of the firm, such as automation systems) and spearhead technologies (future competitive technological needs of the company, such as smart grids). Meanwhile, four decision criteria were chosen, based on the joint decisions of researchers and managers of JE. Consequently, in the case study company (consisting of three departments) four board members, two experts from department A, one from department B and two from department C, answered the questionnaires.

Basically, the sand cone model presents the hierarchy and the relative importance of the items under study through AHP analysis. Hence, the relative weights of the four decision-making criteria (safety-quality of the property/functionality-customers/society-finances) were evaluated through AHP. In the model, two items that cover more than 66% of the weights make up the first layer of the model. The dotted triangle shows the level of uncertainty.

Having calculated the variability of coefficients, they were utilized in the sand cone model to determine the uncertainty levels (Takala et al., 2006). Therefore, the variabilities of coefficients were calculated, and a high level of variability was

observed in all departments, leading to uncertainty in investment decision-making. The results show the department with the highest variability for all criteria (Department C). In addition, the study also indicated the share of each of the three technologies in the uncertainty. The result of the sand cone model with K/T risk is presented in Figure 9.

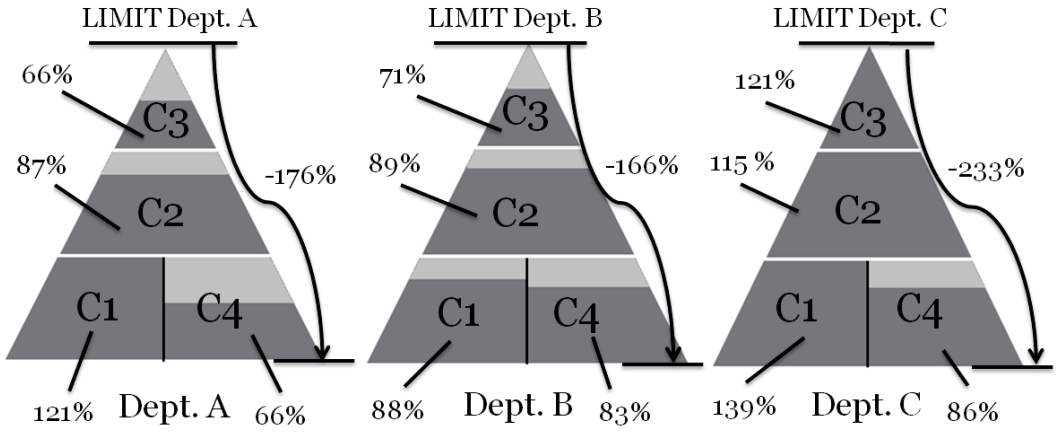

Figure 9. The sand cone model for the case study (Takala et al. 2016)

5 PAPER COMPILATIONS AND CONTRIBUTION TO THE FRAMEWORK

This article-based PhD study has presented papers that are related to each other on three main levels: macro (national/international), meso (organization of project portfolio management) and micro levels. Therefore, from the point of view of the project portfolio concept, this study presents a holistic sustainability approach by integrating several analytical and strategic management models in a variety of disciplines. In this multilevel study the levels of theory and analysis are the micro, meso and macro levels, and the level of the measurement is sustainability.

Therefore, the relevant responses to the research questions in each paper are as follows:

1. How should the challenge of paradigm shift be dealt with in this study?
2. What are the key drivers of sustainability?
    - ✓ Publication 1: main criteria for the research environment (dimension reduction and paradigm management)

3. How can the project mix (portfolio) be optimized, while considering environmental measures? (Benchmarking of the sustainability performance of Finland)
4. Which management approach (guide or methodology) is best?
    - ✓ Publication 2: mathematical formulation of the research environment and innovation justification (Z-variable) for the case of Europe

5. How important is the role of innovation and R & D in this complex era?
6. What is the most appropriate business model for green portfolio management?
    - ✓ Publication 3: business level perspective

7. How can an integrated approach to eco-efficiency be achieved?
8. How can efficiency be improved by government policy or better managerial practices?
    - ✓ Publication 4: integrated approach for eco-efficiency (denominator of eco-efficiency) and environmental issues for the case of Finnish industries

Overall, these integrated papers address the main PhD research question. Figure 10 presents the share and contribution of each paper to the research framework.

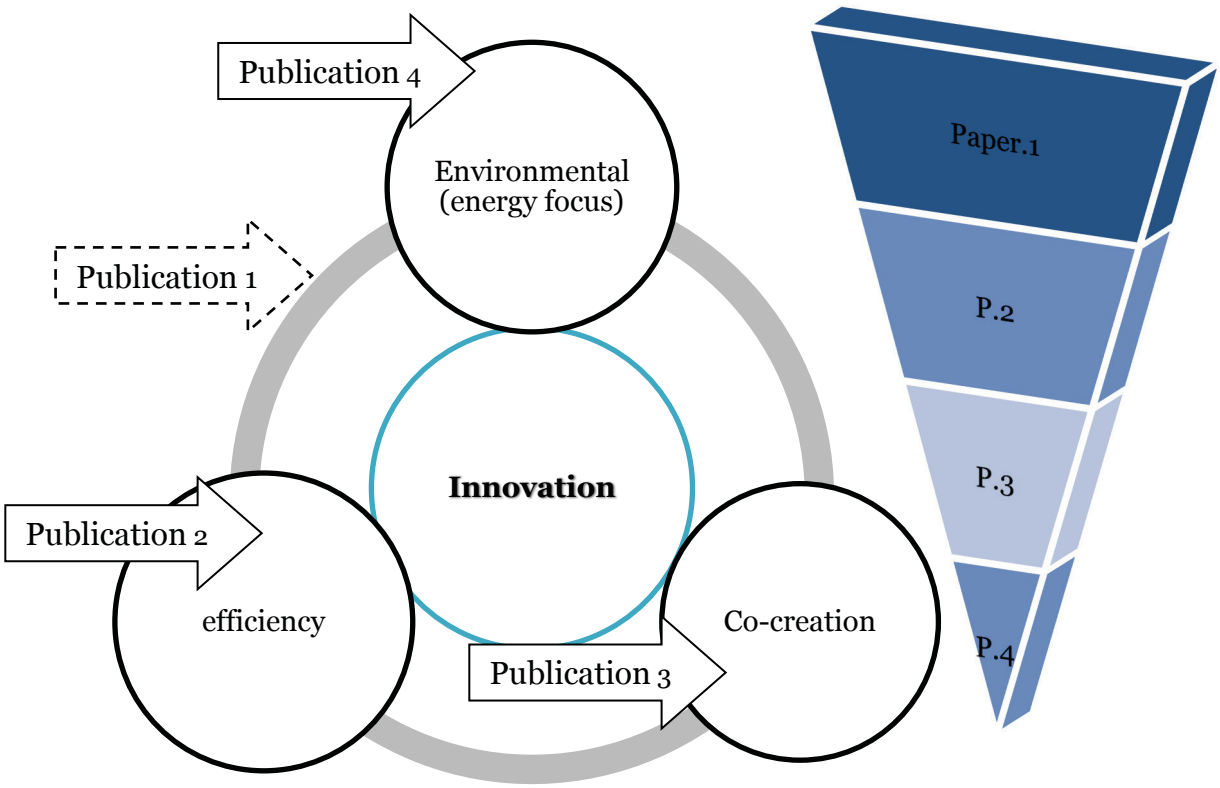

Figure 10. Paper contributions to the framework (and levelized positions)

6 DISCUSSION

This study contributes to seven main research areas and implements the systems thinking approach to sustainability management (according to Table 5). The research areas are:

- Behavioural Change: by answering key questions about the key drivers of sustainable decision makers and then clarifying social values.
- Leadership: the role of leadership in complexity management and adaptive capacity through a quantitative approach.
- Innovation: defining a business model approach to sustainability.
- Industrial Ecology: presenting tools that can help to increase the sustainability performance.
- Social-Ecological: focusing on collaborative mechanisms and organization of change management.
- Transitions Management: the cycle that must be considered in order to support sustainable production and the complex dynamics at the macro and micro scales.
- Paradigm Shifts: linking the best practices of project management to academic studies and presenting an integrated approach to sustainable development.

Table 5. Linking the research to the systematic thinking theme and the relevant leverage points

	Paper 1	Paper 2	Paper 3	Paper 4
Behavioural change	✓		✓	
Leadership			✓	
Innovation		✓	✓	
Industrial ecology		✓		✓
Transitions management			✓	
Paradigm shifts	✓			
Social-ecological systems		✓		✓
Leverage point contributions (examples)	1 and 2	5 and 12	3 and 6	10
Level	Macro	Macro - meso	Macro - meso	Micro

7 RECOMMENDATIONS FOR FUTURE RESEARCH AND MANAGERIAL IMPLICATIONS

Negotiation is part of our daily life (Kahneman, 2011). Likewise, the practical approach of project management has a close relationship with the negotiation process. Generally, project management procedures consist of several key processes which deliver a product or service: initiation, planning, executing monitoring, controlling and closing. Each process requires interactions between different interested bodies and stakeholders. Clients and contractors, as well as internal organization parties, are involved in agreements or disagreements.

In spite of its significance, negotiation has not been studied systematically in a project management context. Negotiation is the process of joint decision-making by two or more parties where they are able to creatively impact on the payoff to the other parties by exchanging information. In the current negotiation approach, a project is considered as "a complex business transaction covering a package of products, services and work, specifically designed to create capital assets that produce benefits for a buyer over an extended period of time" (Murtoaro & Kujala, 2007, p. 722). Current studies have implemented some well-known theories in a project negotiation context, such as game theory, decision analysis and behavioural decision theory.

An analysis of the publications in the area of negotiation and project management indexed in the Scopus database can help to clarify the issue. An inquiry using "project management" as a keyword between 2000 and 2017 resulted in more than 72,500 documents. However, a search on "negotiation" and "project management" keywords resulted in 156 documents for the same period of time. Based on subject area, it was found that engineering (100 documents), computer science (49) and Business, management and accounting (40) accounted for the majority of documents. In these categories, construction industry, contracts and risk assessments were among the frequently used keywords.

However, categorizing according to the source of publication between 2000 and 2017 led to the following as major sources: International Journal of Project Management (8), Construction Management and Economics (6), Journal of Construction Engineering and Management (6), Lecture Notes in Computer Science, including the subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics (6), Jane's Defence Weekly (3), Journal of Computing in Civil Engineering (3) and Journal of Management in Engineering (3).

As explained in this study, the impact of sustainability in the traditional management environment has altered the project management knowledge area. Accordingly, the impact of sustainability in a "negotiation analytic approach" can be a critical field of assessment. Therefore, an important avenue for further research is the implementation of different strategies and schemes in a negotiation analytic approach framework (Kujala et al., 2007). Likewise, the structure of negotiation consisting of the different interests of parties could be revised. Traditionally, the "best alternative to a negotiated agreement" has mostly been under the influence of financial outcomes (traditional customer and supplier relationships), but within the provision of sustainable development objectives, other elements such as environmental and social criteria could be incorporated actively into the negotiation protocols.

Last but not least, it is worth mentioning that recommendations for future research and managerial implications have also been discussed in each paper.

8 CONCLUSION

Project management approaches are moving from delivery approaches towards value creation. This value generation can contribute to the environmental, social and economic criteria that form the pillars of sustainable development. In addition to the traditional (redesigned) sustainability dimensions, a multilevel aspect should also be considered in this context. This multilevel aspect may involve individual, project, programme and portfolio elements. Furthermore, this complex value creation process requires a rigorous business model to facilitate proactive interaction with the external environment.

In addition, the success of project business can be measured based on the level of satisfaction of stakeholders. This not only highlights the importance of the formulation of the project's front end in project management but also raises the need for further research in the context of project negotiation management.

This study attempts to shed light on a new understanding of project governance, by implementing various well-known management theories. The solutions suggest that end-of-pipe solutions cannot address the problems of sustainability. Therefore, by applying multilevel logic to project management and by linking it to systems thinking, the study has contributed to meeting the challenge of sustainable management. An overall view of the steps may be described in terms of: variables detection for paradigm management while targeting the maximum leverage effect, front-end formulation for national-level analysis, businesses model development (meso level), and a micro-level case study. The work supports practitioners and researchers in project and portfolio management and furthers the development of the next generation of project management guidelines, sustainable management tools, decision-making processes and policymaking mechanisms.

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The Key Drivers of Sustainability

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Abstract - **Nowadays, sustainability is gaining considerable attention in decision making processes. Since 1987 that the concept of sustainable development was introduced this field of research has faced with some debates and continuous improvements in the logic. However, sustainability is a multi-faceted notion, which has raised the complexity of sustainable management. Therefore, this paper strives to manage this issue by the reduction of dimensions through the application of principal component analysis. For this purpose, a set of data from Eurostat database that includes the indicators of sustainability is evaluated. The results remark the crucial elements of sustainability such as: innovation, efficiency and renewable energy.**

Keywords - **eco-innovation, sustainability complexity management, efficiency, environmetal management, renewable energy**

I. INTRODUCTION

Decision making towards sustainable development is a challenge for every country and organization as well. However, integration of sustainability has made the strategies more complicated. Generally, sustainable development is defined based on three elements: environmental, economic and social. Nonetheless, the scholarly researches have also determined some other dimensions for sustainability. Hence, sustainability is a multi-criteria process that has made the policy making environment more intricate both at macro and micro level. For instance, recently project management has reached into a new paradigm shift through the integration of sustainability into the project management knowledge area, and integration of all dimensions of sustainability specially environmental and social elements is a critical and challengeable task [1]. Therefore, this paper tries to answer a main question that what are the most important elements in orders to achieve sustainability.

Primarily, this research argues that a way to manage this multi-dimensional case can be the reduction of dimensionality of sustainability. Therefore, the paper applies the principal component analysis (PCA) method for evaluation of sustainability indicators. PCA is a method aimed at reducing the dimensionality of multivariable data set, while considering the variations as much as possible to choose the most effective factors. The data on indicators consist of sixty nine variables was collected from the Eurostat database. Eurostat organization provides the statistical information related to the European countries. The Eurostat database has determined more than one hundred indicators for sustainability, such as climate change and energy, sustainable transport, and good governance [2].

II. SUSTAINABILITY COMPLEXITY

Traditionally, sustainability is defined based on three pillars: environmental, social and economic (or people, planet, and profit). Primarily, in 1968 "the tragedy of the Commons" warned about the exploitation of natural resources on earth. Next, the Bruntland report in 1987 defined the term "sustainable development" that raised the need for considering the future generations [3]. However, the main question is that: what are the key drivers for successful realization of sustainability. Although the economic accept of sustainability has been properly discussed in the lecture, the lack of attention to successful implementation of the other dimensions (such as social and environmental) can be recognized [4]. Consequently, in the current sustainability approaches, there is a lack of attention to the stakeholder satisfaction [5].

Nonetheless, sustainability can be measured based on a variety of tools and techniques such as: product related assessment tools (e.g. Ecological rucksack or life cycle assessment), quantitative Indicators (e.g. ecological footprint or input-output energy analysis) and integrated assessment tools and approaches (multi-criteria analysis methods). Meanwhile, sustainability can be simply interpreted by "doing more with less" or in the other word efficiency [6]. Efficiency improvement has been determined as one the most important measures to mitigate the greenhouse gas emission impact [7].

Furthermore, in the corporate context the concept of sustainability has been linked to the corporate social responsibility (CSR) principle. Based on the CSR, the company has a responsibility not only to the shareholders, but also towards all stakeholders [8]. However, the problem arises from the fact that the organizations usually tend to focus on short-term objectives instead of real and long term needs of societies. Therefore, Porter and Kramer criticize the CSR concept and break a new ground by presenting the shared value creation (SVC) concept. Porter and Kramer claim that in order to solve these issues the principle of shared values should be utilized, and It is defined as "policies and operating practices that enhance the competitiveness of a company while simultaneously advancing the economic and social conditions in the communities in which it operates" [9, p. 6]. Hence, creating shared value includes creating economic value in a way that also makes value for society, and it has the power to unleash global growth.

From the business point of view five dimensions has been defined for sustainability: business, organizational, innovation, triple bottom line (TBL), compliance stance. Therefore, corporate sustainability cannot be successful unless it makes the core of the "business model" of the

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company and collaborate with external stakeholders to co-create the values. Also, while the company considers the TBL, the innovation activities also should meet the sustainability needs. Furthermore, in addition to the compliance with the regulations, the supply chain activities also should be sustainable [10]. Similarly, other scholarly research also criticizes the traditional definition of sustainability and determines five dimensions for sustainability: place (with three dimensions), permanence and persons [11].

Nevertheless, the connection of innovation and sustainability is an undeniable fact [12]. Innovation is the main driver of sustainability, and sustainability can make a perfect platform for more innovation, as well [13]. Exploring the ranking of the top innovative companies in the world reveals that the majority of them have implemented broad sustainability policies and most of them are acting as the main leaders in sustainability, such as: IBM and GE. Likewise, the ranking of companies based on the sustainability indicators presents the names of the similar companies [14].

III. METHODOLOGY AND DATA COLLECTION

Principal component analysis was introduced in 1901 by Karl Pearson [15], and it is one the most well-known method for the evaluation of sustainability indicators [16]. Basically, PCA is a statistical method that based on an orthogonal transformation converts the correlated variables into a set of linearly uncorrelated variables. Therefore the number of obtained principal components will be less than or equal to the number of original variables and the first component presents the largest possible variance.

This paper applies the PCA method for the reduction of variables (dimension). PCA is useful for decreasing the number of variables in a dataset that includes a large number of variables [17]. For this research R software has been utilized [18]. PCA in this paper has been done through the following steps: at first, a correlation matrix has been made. Then, based on the correlation matrix eigenvectors and eigenvalues has been calculated. Next, the eigenvectors are sorted according to the descending order of the eigenvalues. Finally, top eigenvalues (based on the cumulative variances) are chosen for the discussion of the results. Eigenvalues illustrate the variances of PCs. As presented in the Figure 1, 5 principal components can cover the more that 73% of total variances.

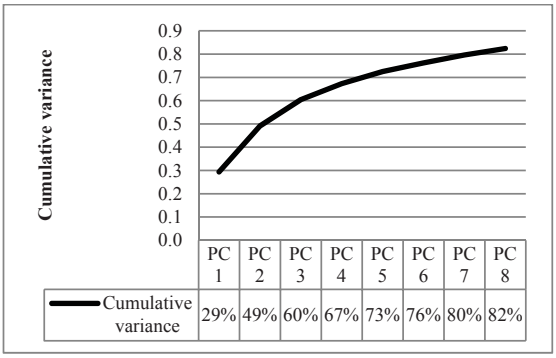

Fig 1. Cumulative variances of Eigenvalues

In addition, the Kaiser-Meyer-Olkin (KMO) test was conducted that is a measure of sampling adequacy, and the value of 0.5 was recorded. The literature approves that the value above 0.5 indicate that sample size is enough. Basically, the KMO value can be between 0 and 1, while the value 0 show that PCA can lead to inappropriate results, and 1 shows that the PCA can be reliable [19].

Data collection has been from Eurostat database and from "sustainable development indicators" category, and sixty-nine variables are chosen for the analysis (in 2013 and with 25 observations for each variable). Sustainable Development indicators have been divided into nine main categories and several subcategories:

- Socioeconomic development (subcategories e.g.: GDP, eco-efficiency, employment)
- Sustainable consumption and production(subcategories e.g.: consumption and production patterns, waste)
- Social inclusion (subcategories e.g.: poverty, education)
- Demographic changes (subcategories e.g.: old age income, public finance sustainability)
- Public health (subcategories e.g.: life expectancy, determents of health)
- Climate change and energy (subcategories e.g.: greenhouse gas emissions, Primary energy consumption)
- Sustainable transport (subcategories e.g.: transport impacts, mobility)
- Natural resources (subcategories e.g.: land use, biodiversity)
- Global partnership (subcategories e.g.: globalization of trades)
- Good governance (subcategories e.g.: policy coherence, openness)

IV. Results

In this research because of the large number of variables, 5 principal components have been selected for the interpretation. Meanwhile, the cut off point for further discussion is five top factors for each PC. Table I presents a ranking of the loadings (top 5).

Principal component 1:

The first PC underpins the findings that highlighted in the literature review section. Therefore, eco-innovation and resource and labored productivity (efficiency) by 19% and 18%, respectively are among the top loadings. Furthermore, the stakeholder satisfaction (disposable income of households) and economic sustainability (GDP) elements are also involved by 20% and 19%, respectively.

Principal component 2:

The second PC is more an indicator of stakeholder concern, and the factor loadings are 18-19% for: young people, neither in employment nor in education and training, total employment rate, inequality of income distribution, in work at-risk-of-poverty rate and early leavers from education and training.

Principal component 3:

The third PC remarks the role of renewables; greenhouse gas emissions (24%) and average carbon dioxide emissions per km from new passenger cars (23%) are among the top loadings. In addition, the economic and stakeholder loadings are also involved: general government gross debt (24%), investment by institutional sectors (24%), and people living in households with very low work intensity (21%).

Principal component 4:

This PC reveals an interesting aspect of sustainability that is the importance of the role of renewable energy. Therefore, the shares of renewable energy in gross final energy consumption by 37%, and electricity generated from renewable sources by 36% are the most important loadings. Then, stakeholder perspective makes the other loadings (old-age-dependency ratio, employment rate by educational attainment level, relative median at-risk-of-poverty gap).

Principal component 5:

This PC highlights the environmental factors including: energy consumption of transport relative to GDP by 36%, greenhouse gas emissions intensity of energy consumption 30% and then the social impacts (employment rate of older workers 27%, aggregate replacement ratio 34%, and tertiary educational 30%).

V. Conclusion

This research underpins the concepts and understandings behind the sustainability logic, through a quantitative assessment (PCA). This paper argues that instead of the traditional concept of sustainable development pillars (environmental, social and economic), some critical factors can be implemented that facilitate practical implication of sustainability, and with a more strategic approach. Therefore, the main focus should be on crucial elements such as renewable energy, stakeholder (social) satisfaction, efficiency improvement and innovation. This paper does not evaluate the economic reason behind the factors, and more is focused on other dimensions such as the social and environmental factors. In addition, the availability of data (observations) has been a limitation in this research. For future research it is recommended to fulfill the research in the organizational or company level.

TABLE I. COMPONENT LOADINGS VALUES (TOP 5)

PC1	%	PC2	%	PC3	%	PC4	%	PC5	%
Real adjusted gross disposable income of households per capita	20	In work at-risk-of-poverty rate	19	Greenhouse gas emissions	24	Share of renewable energy in gross final energy consumption	37	Energy consumption of transport relative to GDP	36
Labor productivity per hour **worked** η	19	Total employment rate	18	General government gross debt	24	Electricity generated from renewable sources	36	Aggregate replacement ratio	34
Eco-innovation index	19	Young people neither in employment nor in education and training (15-24 years) - % of the total population in the same age group	18	Investment by institutional sectors	24	Old-age-dependency ratio	31	Tertiary educational attainment by sex, age group 30-34	30
Real GDP per capita, growth rate and totals	19	Inequality of income distribution	18	Average carbon dioxide emissions per km from new passenger cars	23	Relative median at-risk-of-poverty gap	24	Greenhouse gas emissions intensity of energy consumption	30
Resource productivity η	18	Early leavers from education and training	18	People living in households with very low work intensity	21	Employment rate by educational attainment level	20	Employment rate of older workers	27

: Stakeholder; : Green energy ; η : efficiency ; : innovation

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DECISION MAKING TOWARDS INTEGRATION OF SUSTAINABILITY INTO PROJECT MANAGEMENT; A MULTILEVEL THEORY BUILDING APPROACH

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ABSTRACT
In recent years project management has reached into a new paradigm because of integration of sustainability into the projects. The paper argues that multilevel approach is the key driver of successful sustainable project portfolio management. Hereby, this paper strives to underpin the theory and the logic behind the sustainable project management, while providing sustainable competitive advantages. Therefore, it develops an innovative multilevel framework, and analyses the current project management products and processes, and consequently presents a more holistic insight for the implementation of sustainability in project portfolio management.

KEYWORDS
multilevel theory building, front-end eco-efficiency, stochastic frontier analysis, sustainable development, sustainable decision making.

Introduction

Nowadays sustainability is one of the most significant challenges that societies are faced with and sustainable development plays an important role in every business strategy. Hence, project management must be carried out in the context of sustainable development, in order for projects to meet or exceed the needs and expectations of the current and the future generation. Recently, sustainable management has been mentioned as a core activity for creating project success and it has gained significant attention in project management research and practices [1].

In spite of the numerous researches available on how to cope with general sustainable management, the project portfolio management area has not been benefited adequately [1]. Despite of all promising improvements in project management science till now, because of the complex environment of projects there is a possibility that past project management research might have failed to recognize the crucial elements that correctly control the project success [2]. Unsatisfied stakeholders, in addition to the lack of a correct corporate social responsibility strategy that should be supported by economic sustainability factors have been reported as frequent causes for project failure [3]. In this regard, this is of high importance to evaluate whether the current concept of sustainability implemented in the project management community (displayed in project management standards) can help to meet sustainability expectations and also whether developments within the other supporting fields and resources (such as project management software) can be beneficial to the sustainable project management(SPM).

A sustainability perspective

The idea of sustainable development was introduced in 1968 by the term 'tragedy of the Com-

mons', and claimed that the solution to the over-use of the environmental problems on earth requires societal considerations as well [4]. Traditionally, sustainability has been determined as 'triple bottom line' (TBL) while trying to balance people (social), planet (environmental) and profit (economic) elements [5]. Porter and Kramer challenge the traditional concept of profit making in companies and argue that problem of productivity and growth of global economy requires decision making based on innovative methods that focus on shared values and social responsibilities, as well [6].

Sustainability can be measured with the help of several tools and techniques that generally can be divided into three main categories:

- Indicators: consist of a variety of quantitative indicators that can represent the main elements of sustainability (environmental, economic and social), such as, material flow analysis (MFA) and ecological footprint. The ecological footprint is an indicator to calculate the sustainability of a population based on the resource consumption corresponding land area [7].
- Product related assessment tools: to evaluate the material or energy flows of products and services; such as life cycle assessment tools that focus on the flow of production and consumption of goods and services in the whole life cycle (cradle to the grave). Material-Input-Per-Service (MIPS) and ecological rucksack are well-known index that fall in this category, as well. The ecological rucksack represents the actual material intensity of a product is the amount of material (kg) required to complete the production of a product minus the actual weight of the product. In other words, it is the weight of material that is extracted from natural resources to deliver one kg of resources [8].
- Integrated assessment tools: consist of a group of methods to pave the decision making process and multi-criteria analysis that can assess the complex project, policies and model and trends with multiple inputs to provide a comprehensive approach such as systems dynamics tools let [9].

In practice the strategy behind the sustainability can interchangeably be replaced with eco-efficiency [9]. The International Standard for Organization (ISO) is a well-known organization for standards setting explains that 'Eco-efficiency as assessment is a quantitative management tool which enables the consideration of the life cycle environmental impacts of a product system alongside its product system value' [10].

There are different ways to measure and define the eco-efficiency [11]. The general definition of eco-efficiency is based on the ratio of GDP/CO_2 [12]. Basically, production processes take inputs such as energy, natural resources and produce GHG such as Co_2. Based on the Intergovernmental Panel on Climate Change (IPCC) report, the main reason for the generation of GHG is energy production based on the fossil fuels and efficiency improvement can decrease the GHG generation and consequently has a positive impact on sustainability [13]. In eco-efficiency logic the environment and economic efficiency, both are essential elements that should be considered simultaneously to provide sustainability and competitive strategy for a company or country [14]. GDP at the macro level (or return on investment on company level) solely cannot be an indicator to present the sustainability of an economy, and eco-efficiency as an indicator that combines both environmental and economic elements can better be applied [15]. Eco-efficiency defines this goal based on the maximum of production or services while minimizes environmental pressure occurs and it can be formulated by using multi criteria decision making methods; e.g. [16, 17].

Nevertheless, the sustainability objectives and project oriented business are in contrast to some extent. A sustainable development perspective should be applied in project management if the following principles are considered [18]:

- Companies or projects should be benchmarked against the needs of society.
- Main values for decision making in projects are people, planet and profit, and not only scope, time, budget management.
- Sustainability is about the long term as well as short term objective. In addition a global scale for project management rather than a local is required.

The next section evaluates that: how general sustainable development management theory and mainly the three pillars of sustainable development have been reflected in project management best practices and if they can provide fruitful contributions?

Methodology

This research proposes a multilevel theory for the current shifts in the project management knowledge area [19]. Therefore, this paper answers some main questions, and reveals the potential linkages between the different methodological levels, as follows: what are the real values for project management, and how successful sustainable project management process can be fulfilled? What are the key derivers? and then, how in practice it can be achieved?

Accordingly, this study is developed into two main sections: At first, the organization of project management is evaluated. Next, the outer part of the framework (including inputs, outputs and strategies) is discussed; as presented in the Fig. 1 (adopted from [20]).

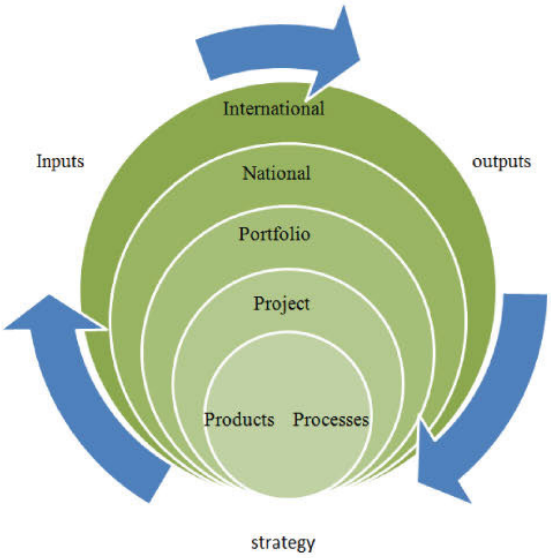

Fig. 1. Multiple levels evaluated in this study.

An analysis of current project management practices from point of view of sustainable development

Generally, internationally and globally used standards, e.g. the Project Management Body of Knowledge (PMBOK) or PRINCE2 are considered as the best practices that influence fundamentally project management. These standards are developed by the experts who accept these as the best or most common measures that have been made based on their experience in a variety of industrial organizations and projects. In addition, they have been implemented for project management certifications worldwide and they reflect a shared understanding of what a project manager should do in order to manage a project in a successful way [21]. Thus, it is important to investigate the idea and the guidelines in these standards because of the worldwide influence of project management standards.

Therefore, in this section the literature on the best practices of project management that has been defined in three project management standards is analysed, in order to identify how sustainable development perspective have been discussed in current project management practices. Hence, the three sustainability principles (people, planet, profit) in each standard are explored and also the comprehensiveness status of these elements in the selected standards in order to find out for instance; how sustainable management elements are mentioned in each "process group" of PMBOK. Consequently, the activities and tools and techniques for each sustainable management element that proposed by each standard is identified (presented in Table 2). The evaluated standards in this paper that are also used for certification of project managers are: (1) The Guide to the Project Management Body of Knowledge 5th edition (PMBOK) (PMI, 2013); (2) The International Competence Baseline, ICB (IPMA, 2006); (3) PRINCE2 (OGC, 2009). In addition, the same analytical method is applied to compare the findings across the well-known project management software (case study of two software) that commonly utilized in the project management office (PMO) and it has been illustrated in Table 3.

PRINCE2 as a project management methodology determines the main interest area of the project as the overlapping area of business, user and supplier which does not conform to TBL [22]. PRINCE2 does not explicitly refer to sustainable development principles, and it narrowly considers the project stakeholders and environmental elements. The standard refers to the stakeholder in communication, risk management (to involve stakeholders) and also in the organization theme, raises the issue and remarks the environmental pressure groups as an example of possible stakeholders. Regarding environmental criteria PRINCE2 proposes to involve the environmental factors in the tailoring section. The 'project cost management' is the section that is discussed well, but not from the point of view of sustainability. It can be concluded that the PRINCE2 provides a limited approach about sustainability in project management.

The PMBOK is a guide rather than a methodology and the standards acknowledge that project managers should take the advantages of methodology based standards such as the PRINCE2 methodology to implement the project management framework. In the introduction section of PMBOK the importance of a sustainable competitive advantage in project management (and portfolio) is noted and briefly mentions the relationship of sustainability and project management organization success [23]. The method that is implemented in whole standards is based on the project management "Process Group" and "Knowledge Area" mapping and by defining the input/output and tools & techniques. Utilizing this method, the standard has determined

the "Enterprise Environmental Factors" as an input to all processes while there are no tools and techniques. The stakeholder and cost management as two separate knowledge area have been discussed, although each topic is isolated from others [24]. PMBOK offers some techniques for cost management and planning such as return on investment (ROI), but the lake of attention to the main economic sustainability indicators such as business agility exists [1].

The ICB as an internationally used project management competence baseline, has defined the competence elements of 'Health, security and safety & environment' in the 'contextual competences' and also notes interested parties (stakeholders) in 'technical elements' and recommends to include their expectations 'in the requirements, objectives, scope, deliverables, time schedule and costs of the project plan' as possible process steps. Nonetheless, in the environmental context superficially mentions about the need for integration of social, technical and environmental aspects. Similarly, ICB cannot address a clear pathway for project management sustainability [25, p. 105].

Overall, in all the above mentioned standards stakeholder, environmental and economic components can be recognized implicitly though with different approaches; however no explicit consideration about sustainable development principles exist and consequently the lack of methods that helps to integrate these pillars of sustainability into project management is considered. The main findings are shown in Table 1 the economic pillar is not illustrated in this table because within these standards the economic considerations have been well-discussed (by far more than the people and environment section), though from point of view of project cost management, and did not mention about the main indicators of economical sustainability Such as: direct economic performance, market presence and indirect economic impact [1].

Likewise, the project management software are among the commonly utilized project management tools and resources. Project management office (PMO) uses project management software to manage the projects in order to control the time, cost and scope, and these software are linked to the performance of project management. As these software are the key tools for management of projects, and they are considered as an important foundation for the management of projects, so it is important to evaluate their potential from the sustainable project management perspective. There is a wide variety of software that companies can utilize, and some of them are more international and widely used such as: Primavera (P6, P3 and etc.) and MS project [26]. This section primarily explains the capability and possible potential that these software can offer to manage a project sustainably, and also to provide sustainable advantages for the organizations. This can be considered as a simulation or a critical review of the current measures of PMO while they strive to manage a project.

Oracle group offers a variety of applications that can cope with different aspects of project management, such as risk and plan. Primavera P6 Professional Project Management software is widely used in PMOs that are coping with mega projects around the world. The program is based on the concept and the methodology of PMBOK in the project life cycle [27]. The software is meant to keep the project under control regarding time, cost (resource) and scope, but has almost no option to involve environmental, and very few in case of social (stakeholders) components; for instance the "threshold and issue" option can help to observe the KPI of projects. Overall, there is no option to carry out sustainability assessment directly with this program individually [28].

Similarly, MS project offers possibilities to meet the deadlines, budget control and the right selection of resources [29]. MS project is recognized as a main competitor of Oracle, and presents almost similar function, but with a more user friendly approach [30]. It is worth mentioning that SAP as a well-known ERP system offers a variety of software with more integrated approach towards sustainability and project management [31], but there are some main disadvantages that usually PMO is not willing to implement SAP as a project management tool that are mainly complexity and implementation costs [32]. However, there is a possibility to aggregate primavera and MSP with SAP [33]. Table 2 shows an overview of main findings.

Although these software do not show an explicit option for sustainable management, but there are some areas that overlap with the sustainability idea. For example: 'resource allocation and levelling' can exhibit a relationship of the mentioned software and the sustainability concept; where it is possible to choose a strategy that would be more efficient in case of resource usage by resource allocation and levelling techniques [35]. Likewise, PMBOK explains resource levelling as a process of improvement in fluctuation of resource load to provide a balanced level of the work force which can help to decrease the excess resources and facilitate resource usage that lead to reduction in demand and costs [23]. Therefore, from sustainable prospective it means: to do the same job with less resource.

Table 1
Analysis of Prince2, PMBOK and ICB.

Standards	Pillars PPP (except economic)	Definition and comprehensiveness	Activities	Tools & techniques
PRINCE2	People	As a part of organization, risk and communication	Recognizing Reporting	Engagement in project Reporting
	Planet (environmental)	Tailor Prince2 to the project environment	customization	Adapt the themes Revise terms and languages, product description and roles Adjust the process documentation
PMBOK 5th	People	Stakeholder as a knowledge area included in all process groups except closing, and social needs in Business Case (project integration management knowledge area)	Identify, plan, Manage and control	Stakeholder analysis – Expert judgment-Meetings-Analytical techniques-Communication methods – Interpersonal skills – Management skills-Information management systems Facilitation Techniques
	Planet (environmental)	EEF is considered as an input to all process (but Fail to mention the Environmental explicitly)	No explicit consideration	No explicit consideration identified
ICB	People	As a part of technical competence element, and project manager should identify all the interested parties	Possible process steps: Identify, analyze and communicate to interest parties, develop a strategy, include their interests into project, risk management; ensure satisfaction, Carry out management plan, manage changes, documentation	Possible process tools: Stakeholder identification; develop internal and external networks formal and informal
	Planet (environmental)	Health, security, safety & environment (Contextual competences), efficiency (Behavioural competence elements element) mentions Social and environmental costs	Possible process steps: Identify applicable law, environmental risks, requirements and existing responsibilities, – Evaluate the actual situation, Develop plans and processes, Monitor and control, Report, Document lessons learned	Environmental factors need to be taken into account in all the project phases: Design, usage of product, its decommissioning and disposal. Material-energy – Co2 – waste – recycling should be considered by Internal and independent external auditing

Table 2
Analysis of P6, MSP from SD perspective.

Software	Pillars	Potential Tools &Techniques	Sustainable Development
Primavera P6	People (Stakeholders)	(Communicating project status to stakeholders example: Status reports that describe where the project is in terms of cost, scope, and schedule progress reports forecasts that predict future) [34]	No explicit consideration (possibility to aggregate with SAP)
	Planet (environmental)	Risk Management calculation (type, impact, exposure value)	
	Profit (economic)	Assigning resource and resource levelling (s-curves), cost plan and control	
MS project	People (Stakeholders)	implicit relationship (such as communication with stakeholders)	No explicit consideration (possibility to aggregate with SAP) [33]
	Planet (environmental)	(common planning tools such as: Creating Dependencies Between Projects [29]	
	Profit (economic)	Almost similar to Oracle P6 (such as Project cost planning and control and etc., with some minor differences)	

Nevertheless, there is a close relationship between software and standards of project management while these standards, themselves, have failed to respond the need of sustainability management properly. Despite the promising improvements in project planning software in the current decade, it can be observed that still these software focus to meet the need of project management according to the iron triangle of project management and regardless of pillars of sustainability: people, planet and profit [27, 36]. In addition, a general limitation in this evaluation is that project management practices may vary across project types, and also each company may show different tendencies and preferences to utilize a variety of standards and software that already exists in the market, which may not be among those that have been assessed in this study.

Overall, this section has reviewed three internationally used project management standards to evaluate and reflect the current understanding of sustainable project management by identifying and applying the concepts from sustainable development theory within general management. This research has highlighted the lack of sustainability considerations in project management organizations and PMO, which raise the demand for further attention both from the side of researchers and practitioners. Also, this structured analysis extends the conceptual frameworks for SPM, such as: products, processes and organizational pillars of SPM e.g. [37].

Meanwhile, project policy requires a comprehensive approach to analyse the project strategy in accordance with the sustainability concepts and provide the optimal economic profit, while considers the environmental and social values; and this strategy should be formulated from the holistic portfolio level. Generally, the main impact of the front-end will be a well-defined project selection output [38]. On the other hand, ideation efficiency is a critical factor for successful portfolio management [39]. Therefore, in the next section a case study as a model is presented in a higher level (national/international) that can realize the concept of integration of sustainability into project management.

Discussion

This section shifts the discussion toward the higher level of the framework, and illustrates how to cope with the front-end considering a sustainable approach. Therefore, stochastic frontier analysis (SFA) method is implemented for the evaluation of technical efficiency of observations, or in other words, the efficiency of portfolio (here countries) [40].

SFA is a parametric statistic method to calculate the relative efficiency (& inefficiency) of a group of observations, for instance projects or companies, while it can take multiple inputs to deliver an output (as a ranking) [41]. This method is an alternative method for the DEA (non- parametric); while noise consideration in SFA is the main difference between these two methods. However, the link between SFA and project management knowledge area has not been explored properly in the literature.

The eco-efficiency of 15 European countries, between 2008–2012 is calculated, while the output is GDP, and inputs are determined as CO_2 and domestic material consumption. Data collected has been from Eurostat database and from 2008–2012 [42]. The year 2008 is the starting point of the first commitment of the Kyoto protocol, and also the Europe economic crisis.

In this case study Cobb-Douglas production functions is utilized [43]. The production function determines the maximum of output that any combination of inputs can produce or "Largest possible output that can be produced by given inputs" [44]. Therefore, considering f as a production function we have:

$$\text{Maximal output} = f(\text{Input, Z variable}) \quad (1)$$

and the stochastic frontier model and efficiency levels can be illustrated as [45]

$$E[e^{-u}|\,\epsilon] = \left[1-\varphi\left(\sigma_* - \frac{\mu_*}{\sigma_*}\right)\right] \cdot \left[1-\varphi\left(\sigma_* - \frac{\mu_*}{\sigma_*}\right)\right]^{-1} e^{-\mu_* + 0.5\sigma_*^2}, \quad (2)$$

where

$$\mu_* = \epsilon\gamma = \epsilon\lambda/(1-\lambda^2),$$
$$\sigma_*^2 = \sigma^2\gamma(1-\gamma) = \sigma^2\lambda^2/(1+\lambda^2)^2.$$

Table 3 presents the results of the evaluation and the rankings between the years 2008–2012. The results shows that Germany and Luxemburg are ranked as the most efficient and Portugal and Greece as least. In addition, since 2008, the eco-efficiency has decreased in the studied countries. Also the case study shows that well-developed countries has relatively better eco-efficiency ranking. Though, the focus is to provide an overview and it does not discuss the reason behind the good or bad performance of these economies. Besides, likelihood ratio test is conducted to evaluate the impact of inefficiency (H0: no inefficiency, only noise). The P-values reject the hypothesis, and approve significant technical inefficiency in the model.

Consideration of noise analysis in the (sustainable) portfolio optimization is a matter of great im-

portance. Furthermore, in real decision making conditions, it is prevalent that the output quantity, in addition to the input values, depends on other variables such as influence of experience of the project manager, or weather condition, and etc.; therefore, these variables should be considered in decision analysis [46]. Accordingly, the role of innovation as a key driver for sustainability as a requirement for the success of portfolio management demands extensive attention [47].

Table 3
Yearly rankings of eco-efficiency for the E15 countries.

Countries	Years				
	2008	2009	2010	2011	2012
Luxembourg	2	2	1	2	1
Germany	1	1	2	1	2
Austria	10	8	9	6	3
United Kingdom	5	10	7	4	4
Netherlands	4	3	3	3	5
France	7	6	5	5	6
Italy	9	9	10	7	7
Denmark	6	4	4	8	8
Belgium	12	11	12	9	9
Sweden	11	12	8	10	10
Finland	8	7	6	11	11
Ireland	3	5	11	12	12
Spain	13	13	13	13	13
Greece	14	14	14	14	14
Portugal	15	15	15	15	15
Mean Efficiency	76.2%	75.6%	74.6%	69.3%	70.3%
$\widehat{\sigma_U^2}$ (estimation of inefficacy)	0.18	0.16	0.19	0.29	0.28
$\widehat{\sigma_V^2}$ (estimation of noise)	0.01	0.01	0.01	0.00	0.00
P-value	0.01*	0.03*	0.03*	0.01**	0.00**

In this context some studies have illustrated the application of previous methods such as AHP and DEA to present a pathway to integrate sustainability in project management [48]. Likewise, integration of SFA with other performance assessment methods is another area that requires further attention.

Conclusion

The successful management of projects has considerable importance in every society; based on the estimations one-third of the worldwide gross domestic product (GDP) is spent on projects so it is expected that in the future projects will be considered as an important area for integrating sustainable development principles. Therefore, in order to be able to cope with the needs and challenges in society the real needs of the project must be recognized and managed [49].

This research expands the current understanding of SPM and in some parts proposes new fields of research. Therefore, it answers several crucial questions both from theoretical and practical point view and argues that real value creation for project management can only be realized when a comprehensive understating of sustainability issue is considered, and a holistic front-end management can be the key driver of successful SPM.

Integration of sustainability into management of the project expands the system boundary of project management and reveals the complex aspect of project management. Furthermore, the request for sustainable development from the society side or legislations will make the future of project management tasks more challenging. Hence, organizations are seeking a more sustainable and environmentally friendly approach in their projects and it is basically expected that the decision making process be started from the portfolio level. The concept of integration of sustainability in project management is an emerging field of research and this paper links the topic into a broader context. This study provides a framework for portfolio management practitioners, and SFA has been implemented as a method for measurement of sustainability as it can favourably provide a single index based on the various inputs of production.

This research benefits both practitioners and researchers in the area of project and portfolio management, and also furthers developments of next generations of project management standards and software, and consequently improves the sustainable project management decision making process and the knowledge of project management in the context of sustainable management by bridging the gaps in this field. In spite of all deficiencies in the current standards and methods, as our research has highlighted, even the current tools and techniques present some potential to cope with this issue. Further development of the project management profession requires project managers that take the responsibility of sustainability in a full life cycle of the projects. This study remarks that the importance of the sustainable management issue should be highlighted in the portfolio organizations.

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Chapter 17
Integrating Sustainable Development into Project Portfolio Management through Application of Open Innovation

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ABSTRACT

In recent years, the idea of integration of sustainability into project management has been put forth, which requires a more comprehensive and holistic approach to project management. Integration of sustainability increases the complexity of project management. Therefore, project management organizations require a framework capable of opening up the traditional organization of the project business and providing competitive advantages. This study argues that the open innovation model presents the requisite capability to approach this issue. This research, through a structured review of the literature and an overview of the open innovation and project management knowledge areas, explains how open innovation can provide a fruitful contribution to the integration of sustainable development into project portfolio management and why it should be favoured. The findings show that open innovation can facilitate the environmental, social and economic sustainability of projects, while rendering the project organization more agile.

INTRODUCTION

Over recent years sustainability has become one of the most significant challenges facing organizations, and companies are thus striving to implement sustainability into their planning processes and strategies. Development of societies is associated with projects that are instruments for change, and that act as stepping stones for the infrastructural changes; therefore project management (PM) skills must be developed in order to lead these projects in a successful and sustainable way. The transition from traditional PM to sustainable PM is a necessity and should be fulfilled by project-oriented organizations in distinct stages.

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The concepts of sustainability and PM have recently been linked together to form an emerging field of research (Marcelino-Sadab, González-Jaen, & Pérez-Ezcurdia, 2015).

Consideration of sustainability in projects moves PM towards the title of a true profession, and expands the system boundary of PM. Integration of sustainability into PM shifts the traditional PM paradigm, and calls for a new approach to handle this complex issue. This new paradigm incorporates a variety of values of partner's (stakeholder's) to create shared values (Silvius, Schipper, Planko, Brink, & Köhler, 2012).

The open innovation (OI) model presents a new paradigm which shifts firms from a closed to an open model, thereby advancing the business. Primarily, the logic of OI was introduced to the world by Chesbrough (2003) as a new way to cope with the innovation process, having observed that some newcomers in the field of high-tech industries were, surprisingly, managing to compete with large established companies such as IBM and AT&T. Subsequently, in 2006 the OI strategy was furthered by the introduction of open service innovation as a business model, and not just a way of doing R&D.

However, the link between OI, different management disciplines and the economic context has not yet been discussed (West, Salter, Vanhaverbeke, & Chesbroughd, 2014). Consequently, the OI literature has not adequately addressed a number of themes, such as sustainability and PM. Therefore, this research explores the PM potentials of OI, tries to link OI to the project portfolio management context and provides a perspective for future research. In addition, until now, the attention of PM researchers has mainly been focused on integrating one dimension of sustainability (triple bottom line) into PM. This study presents a more comprehensive understanding of this case and incorporates other dimensions by means of OI.

This research is based on a sound review of the (Scopus indexed) literature and is presented as follows: first, the link between OI and the concept of sustainability is evaluated. Next, the gap between sustainability and PM is discussed. Finally, the connection between portfolio management and OI is explored.

OPEN INNOVATION BACKGROUND

The OI model shifts firms from a closed model to an open strategy (Chesbrough, Vanhaverbeke, & West, 2006). Chesbrough (2003) coined the term "open innovation", while highlighting that, in a world of widely-distributed knowledge, firms cannot rely entirely upon internal ideas and should utilize valuable ideas generated outside the company made by customers, suppliers and other stakeholders. Therefore, OI emphasizes that "firms can and should use both external and internal (equal importance) ideas and paths to advance their business" (Chesbrough, 2006a, p. xxiv). OI can be defined as "both a set of practices for profiting from innovation and also a cognitive mode, for creating, interpreting and researching those practices" (Chesbrough et al., 2006, p. 286). Subsequently, Chesbrough (2011) developed the concept of the OI model, broke new ground with the "open service innovation" model that considered the business model from an open service perspective, both for product and service delivery businesses, and concluded that OI is not just a method for approaching R&D.

OI is depicted as a porous funnel that benefits the environment of relevant companies via the use of ideas generated outside an individual company (the outside-in process; acquiring externally-sourced knowledge) and the simultaneous transfer of unused ideas to other companies (the inside-out process; transferring internal ideas to the market), as well as coupled processes that combine outside-in and inside-out processes (Lichtenthaler, 2011). A vital feature of this model is that projects can be initiated based on external resources and progress to market at various stages and in a variety of ways, thereby generating additional value, such as licensing revenue. This process should occur through the explicit

and "purposive" incorporation of an open "business model" to "create value" and obtain a portion of that generated value. It is this point that differentiates the OI concept from the previous ordinary utilization of customers' ideas within the company (Chesbrough & Appleyard, 2007). In contrast, the closed model advocates limited interaction with the outside environment, which is similar to a funnel that is surrounded by the limits and borders of the company, while the ideas (projects) generated inside the company progress through internal channels. In the closed model, the science and technology bases of the firm are the main originators of projects, which then progress through internal channels – some are scrapped and others go to market through a sole exit route (Lichtenthaler, 2011).

OI business models can be categorized according to their level of co-creation: market-based innovation strategy (with minimal levels of co-creation and complexity), crowd-based innovation strategy, collaborative innovation strategy and network-based innovation strategy (with maximal levels of co-creation) (Saebi & Foss, 2015). The OI business model acts as a mediator between the technical and economic domains, which takes technological characteristics as inputs and transforms them into economic outputs (Chesbrough & Rosenbloom, 2002). In addition, one of the main features of this model is the creation of value with stakeholders, which helps firms to escape the "commodity trap (Chesbrough, 2006b). Furthermore, OI notes the role of the "Front End" (or "Fuzzy Front End") in the business model, and considers Front End management as a key factor in the success of a portfolio, as a high degree of uncertainty exists in such organizations. The success of the Front End directly depends on stakeholder management, standardized tools and systems and the organization's ideation culture (Heising, 2012).

Nevertheless, what OI means in practice is still up for debate (Giannopoulou, Yström, & Ollila, 2011). Previous studies have also revealed that there are barriers to the adoption of OI approaches (Savitskaya, Salmi, & Torkkeli, 2010) (such as cultural issues, not invented here syndrome, not sold here syndrome, measurement errors, etc.), and the majority of firms are still operating on the basis of the closed model (Lichtenthaler, 2008).

Sustainable Innovation: Incorporating Sustainability into Innovation

The challenge of sustainable development (SD) demands long-term structural changes and innovation in different sectors of society (Geels, 2004). In the year 1972 the "Club of Rome" challenged the concept of development and growth (Turner, 2008). Generally, the concept of sustainability is shaped based on the balance between people, planet and profit or "triple bottom line" (TBL) (Borowy, 2013). Nonetheless, four main dimensions of sustainability can be considered:

1. TBL emphasis
2. Business level;
3. Sustainability oriented innovation;
4. Organizational focus (Amini & Bienstock, 2014).

The concept of "sustainable innovation" (or eco-innovation) merges aspects of SD into innovation (Geels, Hekkert, & Jacobsson, 2008). The interplay between sustainability and innovation is an undeniable fact, as both concepts are critical parts of the corporate agenda (Geels, 2004). Traditionally, the motivation for innovation has been based on cutting the price of production or creating a better product than competitors, while sustainable innovation offers an alternative strategy based on the creation of

products or processes with desirable characteristics and shared value. Porter and Kramer implicitly define the concept of sustainable innovation on the basis of "shared value creation" (Porter & Kramer, 2011).

(Hautamäki, 2010) describes the concept of "sustainable innovation" as innovation activities that are in accordance with ethical, social, economic and environmental sustainability. Therefore, while innovation supports "sustainable development" it should be "participative" to involve a variety of stakeholders and also have the ability to keep the renewal process going "continually". Additionally, the "global innovation" approach challenges companies to open their internal innovation processes to the world, while "innovative management" requires company management to motivate innovation. Nevertheless, the concept of "sustainable innovation" is an emerging research field and, as yet, lacks conceptual consensus (Boons & Lüdeke-Freund, 2013).

OPEN INNOVATION ADDS VALUE TO SUSTAINABLE DEVELOPMENT

The relationship of OI to different disciplines of SD has not yet been adequately presented in the literature as it is an emerging field of research (West et al., 2014). Table 1 presents the current contributions of OI to the dimension of SD. Overall, it can be observed that the link between OI and dimensions of sustainability, except at the business level, have not yet been adequately discussed.

As noted in Table 1, the link between OI and the TBL concept requires further research; for instance (Holmes & Smart, 2009) present the link between open innovation and corporate social responsibility. Based on existing scholarly research, the core idea of TBL can be said to be based on the concept of co-creation (or cooperation), which can be related to the OI philosophy (Hamdouch & Zuindeau, 2010). However, further research is required to present the clear contribution of OI to environmental, social and economic pillars. Similarly, the link between OI and the organizational level (supply chain) requires further attention.

Regarding the relationship of OI to sustainable innovation, as discussed in the previous section, and similar to the sustainable innovation notion, the literature has described OI by using some of the same terms, such as "co-creation", that can be regarded as connecting OI and sustainable innovation (Arnold, 2015). Nevertheless, concerning OI and the business level, the proper potential of OI as a business model has been presented and mainly relies on value optimization using a co-creation model. It is still

Table 1. Main contributions of OI to SD

Sustainability Dimensions	**OI**	
	Paper Indexed	**Key Contributions**
triple bottom line ("corporate social responsibility")	6	(Holmes & Smart, 2009)
organizational focus ("supply chain management")	15	(Erzurumlu, 2010)
"sustainability innovation"	5	(Arnold, 2015)
business level ("business model")	203	(Chesbrough & Appleyard, 2007)

Source: Own presentation of author

an emerging field of science and other business models can offer supporting elements and advantages (Mutka & Aaltonen, 2013).

This section has mainly illustrated the relationship between sustainability and OI; the next section focuses on the interaction of sustainability and PM.

SUSTAINABILITY IN PROJECT MANAGEMENT

The concepts of sustainable project management (SPM) and traditional project management (TPM) contrast with one another: for instance, SPM focuses on people, planet and profit, utilizing a life cycle approach, while TPM is based on the iron triangle of PM (time, scope and cost) and is less complex (Silvius et al., 2012). The value of incorporating sustainability into PM can be better highlighted by taking into account the fact that sustainability is about both long-term and short-term objectives, and SPM respects both current and future generations with a global PM scale, including all necessary stakeholders (not only shareholders) (Eskerod & Huemann, 2013).

The concept of sustainability in PM is closely related to CSR. From the business point of view, CSR can provide competitive advantages if it provides (direct and indirect) financial benefits based on a win-win relationship with stakeholders (Carroll & Shabana, 2010). CSR strategies can be categorized according to three types: philanthropy, corporate responsibility integration and corporate responsibility innovation. Philanthropy is external to a firm's core business and can only provide benefits such as improvement of the firm reputation (e.g., donation to charity groups). Corporate responsibility integration is closer to the existing core business and can improve the firm's social and environmental aspect (e.g., ISO 14001 certification). Corporate responsibility innovation, with its emphasis on a new business model, can offer the greatest potential benefits while alleviating social and environmental problems. Innovative corporate responsibility presents the highest financial performance potential among the three CSR strategies, and may provide business benefits such as entrance to new market segments (Halme & Laurila, 2009). Therefore, an appropriate business model is a key driver of the realization of sustainability within a business.

On the other hand, the link between CSR and business operations can be illustrated on the basis of four main CSR maturity levels. Project management (project-oriented CSR) is the most immature form of these four as the temporary scale of the project is in contrast with the permanent social system. Quality management (quality-oriented CSR) cannot offer competitive advantages and differentiate companies from competitors, as argued by Chesbrough (2011) regarding techniques such as Six Sigma and TQM. Strategic management (strategic-oriented CSR) can, by contrast, facilitate the innovation process in the strategy of the company, as it is based on the creation of "shared value". Finally, organizational learning (transformational-oriented CSR) is the best strategy, as it is based on the integration of "external stakeholders" and business model transformation, which has rarely been implemented in practice (Martinuzzi & Krumay, 2013).

Implementation of business models (such as business excellence models, or BEMs) in the context of PM is a contentious field of research, and BEMs' capacity to address the need for integration of sustainability into PM is a controversial issue (Westerveld, 2003). Basically, BEMs are frameworks for the management of performance excellence in any organization. Mann, Adebanjo, & Tickle (2010, p. 606) define business excellence as "excellence in strategies, business practices, and stakeholder-related performance results that have been validated by assessments using proven business excellence models".

Nowadays there are many BEMs, such as that of the European Foundation for Quality Management (EFQM), and Silvius et al. (2012) have presented some linkages between EFQM and PM. Nonetheless, there is, thus far, limited discussion concerning the application of BEMs in PM (Qureshi, Warraich, & Hijazi, 2009).

The value of PM can be evaluated on the basis of the level of satisfaction of stakeholders, while the creation (or transformation) of a business model can be the main step for value creation (Mir & Pinnington, 2014). Accordingly, innovation is recognized as a critical element of a business model for creating sustainable advantages (Boons & Lüdeke-Freund, 2013). Table 2 presents some indicators for the main pillars of sustainability.

Navigating Complexity in Sustainable Project Management

Integrating sustainability into management of a project increases the complexity of PM. Furthermore, globalization, competitive markets and the demand for innovation have made organizations' strategies more complex (Whitty & Maylor, 2009). The main feature of complexity in the project is "multiple stakeholders" (Kerzner & Belack, 2010).

According to the Project Management Institute (PMI), there are important reasons why companies should be careful regarding this complexity: the level of complexity increases gradually and the budget for complex project is higher, on average. Therefore, there is more money at risk, but if the challenge can be navigated it can provide sustainable competitive advantages (Project Management Institute, 2013). Based on research conducted by PMI, "multiple stakeholders" and "ambiguity" have been recognized as the main characteristics of complexity in projects, while the main facilitators for the success of project portfolio complexity management are: effective communication, standardized project portfolio practices and talent for leadership, accompanied by agility and effective change management (Project Management Institute, 2013). In addition, the main elements for standardized project management are PM tools and processes and leadership (Milosevic & Patanakul, 2005).

Meanwhile, organizational agility is a crucial requirement of the turbulent project business environment (Serrador & Pinto, 2015). The agility of an organization not only helps the organization to meet its business objectives, but to exceed financial objectives and also to provide competitive advantage (Stettina & Hörz, 2015). To improve agility in project organization the implementation of three competencies is necessary: change management, risk management and standardize portfolio management (Project Management Institute, 2013). Successful change management is the main indicator of the agility of an organization, and can be measured according to the level of interaction with the external environment, formal and standard change management and PM office performance (Harraf, Wanasika, Tate, & Talbott, 2015). Table 3 is a summary of the main contributions and gaps.

Table 2. Examples of sustainability indicators in projects

Economic	Environmental	Social
Direct/Indirect Economic Performance Strategic value Market Presence Business Agility	Energy, water, emissions, waste and etc.	Product Responsibility Human Rights Community support Market communication

Source: (Silvius & Tharp, 2013)

Table 3. Incorporation of sustainability dimensions into project management

Dimensions of Sustainability	Key Contributions and Gaps
Economical/social/environmental (TBL) & organizational level	So far the attention of researchers has primarily been applied to this dimension, though yet more research is required (Marcelino-Sadab et al., 2015)
Business level	PM business models and value creation require further analysis (Wikström, Artto, Kujala, & Söderlund, 2010)
Sustainable innovation	More case studies are required (Brook & Pagnanelli, 2014)

Source: Own presentation of author

Organization of Project Management: The Change

The successful management of change is a critical factor for the success of project organization in the present competitive business environment. Approximately 30 percent of worldwide gross domestic product (GDP) is spent on projects (Turner, Huemann, Anbari, & Bredillet, 2010). However, organizational change management suffers from a lack of a proper framework to manage change (Todnem, 2005). PMI describes change management as "a comprehensive cycle and structured approach for transitioning individual groups and organizations from a current state to a future state with intended business benefits" (Project Management Institute, 2013, p.7). Moreover, the issue of organizational change management in the context of PM has not been adequately discussed in the literature; Hornstein (2015) has highlighted the failures of PM guidelines in coping with organizational change management. To cover this traditional gap, PMI, in 2013, introduced a practical guide for managing change in organizations, formulated as: "define the pacing of change in collaboration with the recipient's representative, in order to be able to mobilize the stakeholders and sustain the change" (Project Management Institute, 2013, p. 69). This is still an emerging field. The required elements for sustainable change mainly comprise: leadership, strategic management, paradigm shift, communication, interaction with drivers of change, better planning processes and portfolio approach (Harrington, Voehl, & Voehl, 2014).

Despite the lack of effective guidelines for change management in the literature, there are some practical guidelines for change management within organizations, such as Kotter's eight-step change process (Kotter, 1996)[1], Luecke's seven-steps model (Luecke, 2003) or Kanter's six-steps approach (Kanter, Stein, & Jick, 1992). Chesbrough & Rosenbloom (2002) explain the transition path from a closed to an open model in four steps: first, think of your organization as a service; second, experiment with a new sources of revenue and change the role of stakeholders from passive to active in order to "co-create" with them; third, based on these successful experiments, draw up a new business model – projects can go through internal channels if they fit this business model, otherwise they can be handled through external channels; forth, scale up (transform your model) and assign the model higher volume across the company and stakeholders.

Using maturity models for change management involves practical tools to translate this complex concept into practice (Crawford, 2006). In other words, the level of maturity of organizations impacts its ability to change (Project Management Institute, 2013). Leading PM organizations have developed both standards of PM and maturity models for the assessment of organizations (e.g., OPM3 and P3M3). These maturity models provide a hierarchical structure that includes a number of capabilities and the relevant indicators for the assessment of three organizational levels; projects, programmes and portfolios and can translate complex project concepts into organizational capabilities (Project Management

Table 4. Contribution of OI to PM

Keywords	Paper Indexed	Remarks	Potentially Relevant
Portfolio management & OI	6	No paper in the well-known journals of project management	(Katzya, Turgut, Holzmann, & Sailer, 2013)
Project management & OI	46	No paper in the well-known journals of project management	(Chiaroni, Chiesa, Frattini, & Terruzzi, 2015)
Project management & Co-creation	13	Three papers in the well-known journals of project management	(Chang, Chih, Chew, & Pisarskia, 2013)

Source: Own presentation of author

Institute, 2013). For instance, the PfM3 (Portfolio Maturity Model) defines seven process perspectives through five maturity levels (AXELOS, 2013). Table 4 presents the contribution of the OI literature to PM. Overall, a lack of sufficient research in this area is apparent.

Perspective of Portfolio Management Standards Regarding SD and OI: A Critical Review

Portfolio management is a crucial element of standardized PM performance. The main objective of portfolio management is to achieve a business's strategic objectives by maximizing the value of the portfolio and striking the right balance between projects (Cooper, Edgetta, & Kleinschmidta, 1999). Internationally and globally employed standards (e.g., the MoP or PMI) are considered to be best practices that fundamentally influence project and portfolio management. These standards reflect the best, common understanding of experts based on their experience in a variety of industrial organizations and projects, and reflect what a project manager should do in order to manage a project in a successful way. Due to their worldwide influence, it is of great importance for this chapter that I also assess these standards from the perspective of SD and open model potential (change aspect).

The management of portfolios (MoP) defines portfolio management as a "coordinated collection of strategic processes and decisions that together enable a more effective balance of organizational change and business as usual" (AXELOS, 2014, p. ix)[2]. MoP refers to the stakeholder in the portfolio delivery cycle in terms of "stakeholder engagement" to meet the needs of both external and internal stakeholders. There is no explicit consideration of environmental sustainability, although the "portfolio definition cycle" (understands) raises the point of environmental analysis and mentions some tools, such as PESTLE analysis (AXELOS, 2014). Additionally, financial management is considered to be a principle of the portfolio delivery cycle without mentioning economic sustainability indicators. It can be concluded that the MoP provides a limited approach to sustainability (TBL) in portfolio management.

The standard for portfolio management (3rd ed. PMI) defines portfolio management as "the centralized management of one or more portfolios to achieve strategic objectives" (Project Management Institute, 2013, p. 29). A portfolio, in turn, is defined as "a component collection of programs, projects, or operations managed as a group to achieve strategic objectives", while it is highlighted that this standard is more a guide than a methodology, and it is therefore advised that project managers may prefer a methodology-based standard, such as MoP (Project Management Institute, 2013, p. 3). Similar to the PMBOK, the method and logic that has been implemented in this standard is based on "Process Group"

and "Knowledge Area" mapping, and defining input/output tools and techniques. Although no explicit consideration is given to environmental concerns, Enterprise Environmental Factors (EEFs) are applied to all of these process groups, though no specific tools or techniques are available. In addition, "cost-benefit analysis" is offered as a general economic analysis tool to define the "portfolio road map", which is a key deliverable for "portfolio management processes". Nevertheless, a lack of sufficient techniques for economic sustainability is observed. It can be noted that the standards of PM (Prince2, PMBOK 5th and ICB) also fail to meet the needs of stakeholders (Eskerod & Huemann, 2013).

The key aim of the OI model is to change organizations' business models (opening up). Management of organizational changes is an important part of portfolio management and the standards require portfolio managers to monitor changes continuously (in both internal and external environments). Hence Table 5 also illustrates the change management boundary and potential of the mentioned standards. In PMI, "manage strategic change" is a portfolio management process that allows the portfolio manager to manage changes, encompassing three tools. However, "portfolio communication management" tools as channels of communication can be noted as implicit contributors. MoP has clear, defined roles and responsibilities for the management of change – "change delivery committee" (CDC) and "business change director" – but it does not involve any specific tools (AXELOS, 2014). MoP takes the strategic objective of portfolio management to be to "change the business" and, through the "strategy alignment principle", to align the change initiative with the organization's overall strategy, and argues that "energized change culture" can pave the way. It can be concluded that MoP presents a relatively better and more comprehensive pathway to management of organizational change and change management tasks.

As highlighted in the Table 5, this section has highlighted that the best practices of portfolio management, which act as decision-making business models for project portfolio offices, have not explicitly considered sustainability dimensions in the PM processes and, further, are not capable of fostering the open model perspective. As already discussed, based on OI strategy, the organization should utilize both internal and external resources for the commercialization of products and services, through both external and internal routes (of equal importance), and projects that fit the current strategy of the firm should go through internal channels while those that do not fit should go to the market through external channels. For instance, in the mentioned standards, there is no clear sign that shows how to cope with the projects that at first seem to lack promise, but turn out to be amazingly valuable.

Generally, the study of PM standards (that reflects a shared understanding of PM) has highlighted that the traditional portfolio project management approach is similarly based on the closed model system, and does not provide a fruitful contribution for the PM office and organization towards openness unless some potentials can be exploited.

INCORPORATION OF OPEN INNOVATION INTO SUSTAINABLE PROJECT PORTFOLIO MANAGEMENT

OI can favourably meet the needs of sustainable PM criteria. OI contributes to economic sustainability in PM primarily through its ability to approve market presence. OI attacks the cost side of the organization, both by reducing internal and external development costs and decreasing innovation costs, exploiting economies of scale and scope and providing a new stream of revenue as it addresses a wider range of markets, while also saving time. Therefore, OI supports economic sustainability through market pres-

Table 5. Perspective of portfolio management best practices regarding SD and OI

	The Standard for Portfolio Management-3th Ed. (PMI)			Management of Portfolios (MoP)		
Sustainable Development Pillars	People (stakeholders)	Planet (environmental)	Economic sustainability	People (stakeholders)	Planet (environmental)	Economic sustainability
Relevance	- Manage strategic change - Develop portfolio communication management plan	EEFs	portfolio roadmap	Portfolio delivery cycle: stakeholder engagement	No explicit consideration (Portfolio definition cycle: understand)	Portfolio delivery cycle: Financial management
Tools & Techniques	stakeholder analysis, gap analysis, readiness assessment, elicitation techniques, communication requirements analysis	No explicit consideration	No explicit consideration	Main elements (no explicit tools): managerial support, consistent communication with stakeholders, collaboration with portfolio office, stakeholder engagement plan, key stakeholder identification, active participation of key stakeholders in portfolio cycle	PESTLE, SWOT	No explicit tools and techniques (general portfolio financial management elements)
Potential for OI	Manage strategic change			Energized change culture		

Source: Own presentation of author

ence and return on investment. In addition, the environmental and social pillars of SPM can be very well addressed by OI. OI can benefit SPM through the channel of innovative corporate responsibility or transformational-oriented CSR. Table 6 and Figure 1 summarize the main findings.

Managerial Implications of Open Innovation Model For Project Management

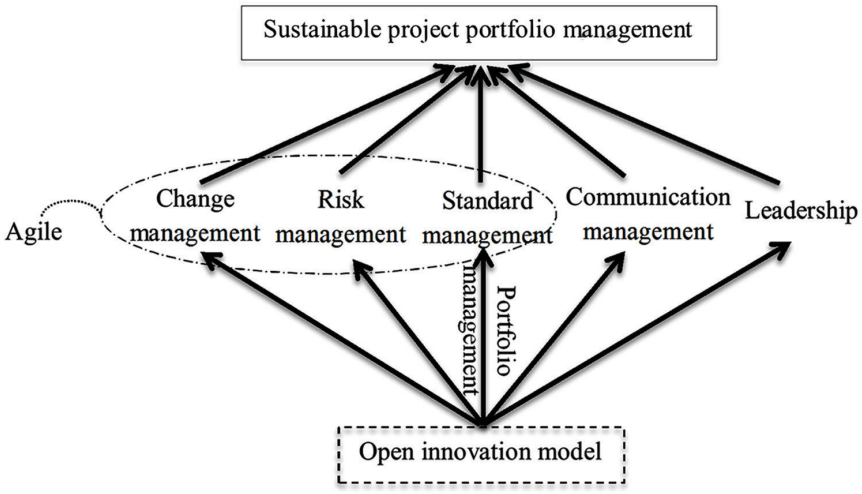
This research primarily underlines the logic behind the proposed scope of the research; however, this section illustrates a perspective with a more practical approach. As discussed above, TPM is similar to the closed approach in organizations and the main PM guidelines have, in relative terms, failed to meet the needs of organizations in regard to both sustainability and change management. Therefore, a transition to an open model can be seen as a necessary solution, and it is thus of great importance that a method for moving towards an open model is made available. This research has highlighted that the main area of cooperation between the OI model and (sustainable) PM is in stakeholder management

Table 6. Summary of the contribution of OI to sustainable project management

	Sustainable Project Management	Contribution of Open Innovation
Indicators	**economic sustainability**	Market presence Direct and indirect economic performance(e.g. economy of scale and scope) Strategic value Flexibility
	social and environmental sustainability	e.g. Corporate responsibility innovation (CR innovation type), transformational oriented CSR
Framework	**portfolio Fuzzy decision making project delivery paradigm shift**	Fuzzy front end funnel Channels of communication (porous funnel) New paradigm

Source: Own presentation of author

Figure 1. Main channels of contribution of OI to sustainable project management
Source: *Own presentation of author*



and engagement, and hence the overlapping area of maturity models of OI and PM can help to assess and improve PM practices (Jia, Chen, Xue, Chen, Cao, & Tang, 2011). Table 7 presents a framework based on the portfolio management maturity and OI maturity models. It should be noted that, in this table, the first groups of "undifferentiated" organizations that have been caught in the "commodity trap" have been excluded.

FUTURE RESEARCH DIRECTIONS

This chapter primarily outlines the theory and logic of the application of OI to the project portfolio management of an organization as it favourably impacts SD. Future research should carry out (quantitative) case studies to illustrate how a specific project organization copes with the OI model. Consequently, the influence of OI on the economic side of the project portfolio (quantitative research from the perspective of financial pay-offs) demands further discussion as, from the managerial perspective, it may appear especially salient. Accordingly, further development of the standards of PM and descriptions of OI modelled on the language of PM best practices and methodologies is required.

A general limitation of this research has been the focus of analysis on certain portfolio management guidelines, where different organizations may prefer to implement other guidelines. An emerging field within sustainability and SPM is the improvement of key performance indicators and, in cases of implementation of OI in project organizations, the development of relevant indicators is also required. Furthermore, development of business models for SPM is an important area for future research.

Table 7. Translation of OI based on the portfolio management maturity model

OI Maturity Model	**Platform Player**	Business models of company and stakeholders are interconnected and, furthermore, innovation in the organization's business model is an important criterion at this level. Additionally, management of innovation is the responsibility of every unit of the organization. Intellectual property (IP) is a "strategic asset".	Communication is a central facet of the organization's culture, facilitating full engagement of stakeholders and continuous improvement.	**Level 5 Optimized**	**Portfolio Management - Stakeholder Engagement Maturity Model**
	Integrated	External and internal innovations are integrated. The company shares its innovation road map, and aligns its business model with those of stakeholders, while focusing on new business as well as current business. IP is managed as a "financial asset".	Advanced and quantitative techniques used for evaluation of portfolio stakeholders.	**Level 4 Managed**	
	Externally Aware	Awareness of external innovations, definition of stakeholders' roles and consideration of IP management as an "enabling asset".	"A centrally managed and consistent approach to stakeholder engagement" exists in the portfolio organization.	**Level 3 Defined**	
	Segmented	There is a plan for innovation which is taken into consideration for future investment. The company can choose projects based on its segmented market. Someone is responsible for innovation management and this process is planned.	Stakeholder engagement is based on the "personal initiative of portfolio managers" to a greater extent.	**Level 2 Repeatable**	
	Differentiated	Some innovative work is done that provides some differentiations in products or services. The innovation environment is based on ad hoc activities and IP management is unplanned.	"Stakeholder engagement and communication is rarely used".	**Level 1 Awareness**	

Source: Own presentation of author

In this context, discussion regarding small and medium sized enterprises (SMEs) is a matter of great importance. If experiments are performed with SMEs by integrating SD into portfolio management through the application of OI, the capability of OI to overcome organizational and cultural barriers in SMEs, by modifying their organization and enhancing their agility, will be demonstrated (Vrandea, Jong, Vanhaverbeke, & Rochemont, 2009). Furthermore, if costs and benefits are computed on the basis of the OI approach for SMEs, the implementation of OI for the firms' decision makers will be facilitated (Gassmann, Enkel, & Chesbrough, 2010).

CONCLUSION

This research, based on a structured review of the existing literature, has revealed both the potential and weaknesses of the existing research and methodologies surrounding OI and SPM. This study has highlighted the need for a more comprehensive understanding of SPM, and claims that an appropriate portfolio management strategy is the key to the realization of SPM. Accordingly, this research evaluates the link between OI and sustainability disciplines, and shows that OI can facilitate integration of sustainability into PM. The current PM methodologies are not explicitly capable of fostering openness in the organization of PM and lack sufficient attention to SD. The close relationship between PM and change management issues has been highlighted as a main obstacle, while OI can favourably change the business organization. If change is made through the application of OI, the consequence will be an agile organization.

This study argues that, as long as the business and organization of PM is based on the closed model, successful integration of SD into projects is not possible or, at least, cannot provide competitive advantages. The overlapping areas of OI and PM can be addressed by reference to stakeholder management in order to better interact with stakeholders to create shared value. In addition, this research highlights the requirement for further evaluation and quantitative analysis of large, small and medium-sized firms. Although OI offers opportunities to cope with this issue, it is still an emerging field of science and requires more in-depth analysis.

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KEY TERMS AND DEFINITIONS

Corporate Social Responsibility (CSR): CSR is a policy that remarks that firms have a responsibility toward society, and companies can take some strategies in order to voluntarily participate in making a cleaner environment and society.

Open Innovation (OI): A term introduced by Professor Henry Chesbrough in 2003, which proposes that firms should exploit both external and internal ideas and innovations. OI has also been put forth as a business model.

Portfolio Management: Management of one or more portfolios in order to achieve strategic objectives of the organization.

Research and Development (R&D): A set of structured activities to provide innovative products and services with higher quality, lower cost, and new users and customers.

Sustainable Development (SD): Development that is based on three pillars: environmental, social and economic sustainability.

Sustainable Project Management (SPM): Project management that is in accordance with sustainable development.

Traditional Project Management (TPM): Project management methodology that mainly focuses on time, cost, scope and quality management.

ENDNOTES

1 Editors' note: For a detailed presentation of Kotter's eight-step change process, see chapter 16, on structural change management in SMEs.

2 Editors' note: In chapter 14 a concept was already introduced that, at SME level, particularly among medium size enterprises, a more effective process management can take place, while the causal relationships are empirically analyzed and described in terms of barriers, enablers and benefits.

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Analysis of sectoral energy infrastructure projects in Finland

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Abstract

In the Nordic area, Finland is one the main emitters of Co_2, and energy consumption is relatively high, as well. Here, through log-mean divisia index analysis between 2000 - 2009, the main reason behind this issue has been analyzed. As a result, electricity and gas supply, coke, refined petroleum and nuclear fuel have been the main reason for the energy increase. On the other hand, pulp, paper, printing and publishing have significantly decreased. In addition, the energy related emission has been evaluated, and electricity, gas and water supply are highlighted as main items.

Keywords
sustainable decision making; green portfolio management; efficiency analysis; sustainability

1. Introduction

Energy project management has been remarked as one the main derivers of sustainable development policy [1]. The previous studies have shown that the energy consumption is related to the three main factors: production changes, structural changes and efficiency that affect the energy intensity. This research implements indexed decomposition analysis (IDA) to evaluate these factors [2]. First, this research analysis the sectorial energy use for the period 2000-2009. Next, the Co2 energy related emission is evaluated. Finland has made a plan for the reduction of Co2 by 80-95% by 2050 compared to 1990 levels, and this analysis can help the policy makers to better achieve the goals [3].

2. Background

Finnish economy is industrialized, and accompanied with the cold clime the Finnish energy consumption is one of the highest in the IEA. Final energy consumption per capita, is ranked as second highest among Nordic countries and OECD average (after Iceland) [4]. Denmark and Finland are the main emitters of CO2 in the Nordic electricity. Furthermore, the eco-efficiency ranking of Finland is not as high as other Scandinavian countries [5], and it is mainly because of a lower ratio of GDP and CO2 emission relatively, as presented in the figure 1.
Finland is dependent on nuclear and coal-fired power plants in electricity generation. Hydro power is also considered as the second important item in the electricity generation mix. The electricity price is among the lowest in the IEA countries. However, diversity in power generation in high in Finland, and renewable energy plays an important role in Finish energy portfolio. Meanwhile, the largest user of bioenergy in Finland is the pulp and paper industry [6].
Despite the decarburization policies in Finland, coal, oil and natural gas have been important resource for the electricity generation. In compliance with European Union climate and energy targets 20.20.20, Finland aims to reduce domestic GHG emissions by 80% by 2050 from the 1990 level. This target includes 38% (20%Renewables in road transport) renewable energy shares of total energy use [7].

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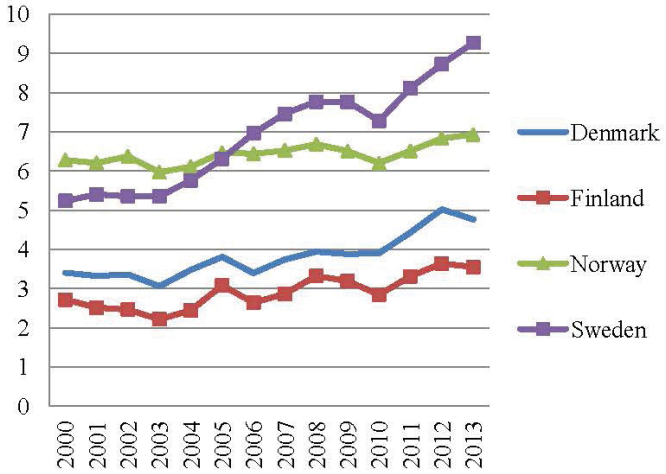

Figure 1. GDP (ppp) (current international $) / CO2 (kt) Co2 emission from fuel combustion - ratio

3. METHOD AND DATA

IDA has gained considerable attention in energy research. This assessment can be done in energy intensity, and CO2 emission, as well. This method can evaluate the changes in energy consumption based on three criteria: changes in the structure of the economy (''change in sectoral share''), changes in efficiency (intensity or technology effects), and production effect (changes in the production) [8].
IDA method is dived into two main groups and this paper implements LMDI1.

$$E_t = \sum_i^n Y_t \frac{Y_{it}}{Y_t}\frac{E_{it}}{Y_{it}} = \sum Y_t \; S_{it}I_{it}$$

Where

E_t: total energy consumption for all sectors in year t
$E_{i,t}$: energy consumption in sector i in year t
Y_t: total output in year t
$Y_{i,t}$: output of sector i in year t
$S_{i,t}$: output share of sector i in year t (=Yi,t/Yt)
$I_{i,t}$: energy intensity of sector i in year t (=Ei,t/Yi,t)

Change in total energy consumption between year 0 and year t (out indicated the change in real output, *str* is structural change and *int* intensity change, or changes in efficiency):

$\Delta Etot = Et - E0 = \Delta Eout + \Delta Estr + \Delta Eint$

According to Ang [6]:

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$$\Delta E_{out} = \sum W_{it}\, Ln\left(\frac{Y_t}{Y_0}\right)$$

$$\Delta E_{str} = \sum W_{it}\, Ln\left(\frac{S_t}{S_0}\right)$$

$$\Delta E_{out} = \sum W_{it}\, Ln\left(\frac{I_t}{I_0}\right)$$

$$\Delta E_{tot} = E_t - E_0 = \sum W_{it}\, Ln\left(\frac{Y_t S_t I_t}{Y_0 S_{i0} I_{i0}}\right)$$

Where:

$$W_{it} = L(E_{it}, E_{i0}) = \frac{E_{it} - E_{i0}}{Ln\left(\frac{E_{it}}{E_{i0}}\right)}$$

In case of emission evaluation the relevant IDA equation is

$$C = \sum_{ij} C_{ij} = \sum_{ij} Q \frac{Q_i}{Q} \frac{E_i}{Q_i} \frac{E_{ij}}{E_i} \frac{C_{ij}}{Y_{ij}} = \sum_{ij} Q S_i I_i M_{ij} U_{ij}$$

Where

C is the total CO2 emissions
Cij is the CO2 emissions from fuel j in industrial sector i;
Eij is the consumption of fuel j in industrial sector i,
Mij is the fuel-mix
Uij is the CO2 emission factor by

And

$\Delta C_{tot} = C_t - C_0 = \Delta Eact + \Delta Estr + \Delta Eint + \Delta Emix + \Delta Eemf$

Data collection has been thorough WOID data base [9].

4. Results

The results are presented in the table 1. The majority of sectors have growth in the energy consumption. It shows that between 2000-2009 the main increase in energy consumption has been in electricity, gas and water supply (92563 TJ) and Coke, Refined Petroleum and Nuclear Fuel (44960 TJ). However, the max reduction occurred in pulp, paper, printing and publishing industry (-74594 TJ). The overall output effect accounts for 1,443,904 (or 99%) of total increase in energy consumption. In addition, the structural changes (change in contribution if each sector to the total output) involves in the increase in the energy consumption 133,603 (or 7%).
On the other hand, the efficiency effect has acted positively in the reduction of energy consumption 1,426,568 TJ (51%) in means that if there were no energy intensity measure in Finland the consumption would have been 1426568 T more. The overall effect are presented in the figure 2; Finnish industrial energy increased by 7%, or 150,939 TJ from 2000-2009.

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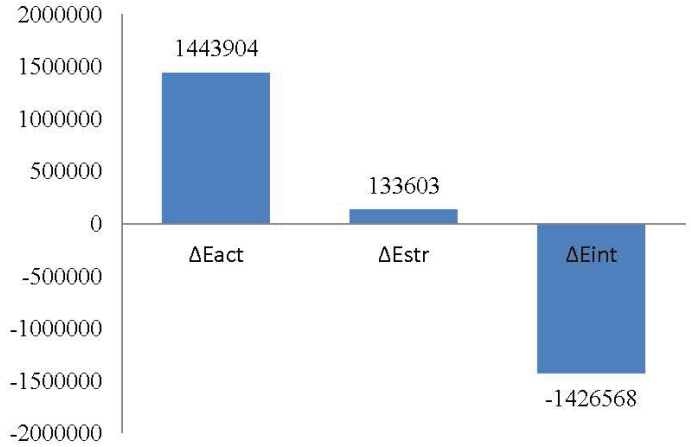

Figure 2. Overall effects contributions

Table1. Total energy consumption 2000-2009 (top5- top less)

Sector	Change in consumption	ΔEact Production effect	ΔEstr Structure	ΔEint Effeminacy effect	Rank
Electricity, Gas and Water Supply	92563	431227	202803	-541466	1
Coke, Refined Petroleum and Nuclear Fuel	44960	400464	102115	-457618	2
Air Transport	36747	32190	5540	-983	3
Chemicals and Chemical Products	30988	51972	3541	-24524	4
Real Estate Activities	19140	27146	6630	-14636	5
⋮					
Mining and Quarrying	-3234	4722	1810	-9766	30
Construction	-3573	22494	2711	-28778	31
Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles	-7962	6393	480	-14835	32
Basic Metals and Fabricated Metal	-13267	60453	-12873	-60848	33
Pulp, Paper, Printing and Publishing	-74595	206756	-162761	-118590	34

Next, this study also has evaluated the CO2 impact of Finnish energy. Table 2 present the sectoral decomposition analysis of each sector. Therefore, for the most influential sectors are: agriculture, hunting, forestry and fishing; pulp, paper, paper, printing and publishing; coke, refined petroleum and nuclear fuel; electricity, gas and water supply; and air and water transports.
Figure 3 present the contribution of five factors in CO2 emission. Emission increased by 4978 kiloton (or 10%). change in the energy mix and emission factor led to reduction in emissions. Therefor activity effect with 32258 kiloton has the maximum of effect to increase the CO2, while intensity has elevated the CO2 by -32397.04 kiloton.

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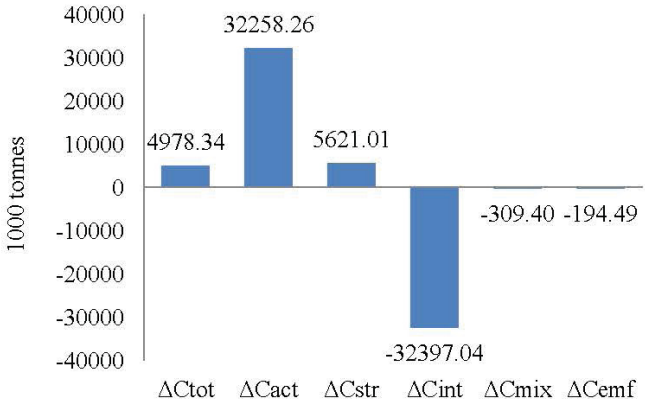

Figure3. Overall effects contributions

Table2. Emission decomposition 2000-2009

Sector	ΔCact	ΔCstr	ΔCint	ΔCmix	ΔCemf
Electricity, Gas and Water Supply	14488	6813	-18191	1167	6
Air Transport	2302	396	-70	0	0
Pulp, Paper, Paper , Printing and Publishing	2249	-1771	-1290	121	22
Coke, Refined Petroleum and Nuclear Fuel	1840	469	-2103	655	-990
Water Transport	1822	-221	-1591	0	0
Agriculture, Hunting, Forestry and Fishing	1525	-473	-1025	-142	-2
		⋮			
Transport Equipment	66	-33	-20	-8	0
Electrical and Optical Equipment	59	-36	-2	-45	51
Financial Intermediation	59	-13	-51	-7	0
Textiles and Textile Products	24	-21	5	-20	31
Rubber and Plastics	18	-7	-11	10	97
Leather	3	-3	-2	0	2

5. Conclusion

This study evaluates the energy consumption and Co2 emission in Finland from 2000-2009. The purpose of the study is to assess the reason for the high energy consumption and Co2 emission, as well. Therefore, IDA (LMDI1) is implemented, and energy consumption is divided into three main criteria: changes in the structure of the economy, changes in efficiency, and production effect.

The finding remarks that consumption is mostly affect by production changes and efficiency has a significant mitigating effect. From table 1 it can be perceived that the change in the structure of economy of sector has impact in reduction of energy consumption.

Through this analysis the main users and polluter is identified. The top contributors to energy use are electricity (92563 TJ) and Coke, Refined Petroleum and Nuclear Fuel (44960 tJ) and in contrary Plup (-74595 TJ). Likewise, the decomposition of emissions reveals important elements in energy use trend in Finland. Production effect has been the main reason for the Co2 emission. Electricity, Gas and Water Supply with 14488 kT and transports items (inland;1520, water;1822, air:2302) with 5644 kT has been the highest. However, energy intensity plays an important role in the reduction of Co2 with 32397 kT.

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Biography

Hosein Daneshpour is a project researcher and PhD candidate at university of Vaasa, Finland. He has done his BSc in industrial engineering, and also fulfilled MSc in the field of environmental energy technology at Lappeenranta University of technology in Finland. His research interests are project portfolio optimization, risk management, open innovation, green management, and co-creation in project business.
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