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Abstract

Contemporary business world is now facing a challenge, a shift from traditional innovation to eco-innovation. Organizations need to recognize the importance of environment in any aspect of innovation. This paper aims to deduce the drivers of eco-innovation from the overview of existing literature and empirical study to provide an understanding of the organization aiming towards eco-innovation.

The aim of this thesis is to identify the drivers of eco-innovation and objectives being able to understand and review the contribution of innovation and eco-innovation as separate entities. This research is limited to the investigation of drivers of eco-innovation in one single organization i.e. Tekniska Verken, Linköping. Conceptual model of drivers of eco-innovation is created from previous research and verified through empirical study. The model of this research is to outline the three categories of drivers within the limit and scope of this analysis. However modification of the model on the basis of additional drivers has been duly appreciated and elucidated to reflect reality of the research.

Keywords

Eco-innovation, supply side drivers, demand side drivers, regulatory and policy drivers, Tekniska Verken

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01 June 2010 Linkoping

Shohana Ahmed & M Kamruzzaman

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1. Introduction

This chapter starts with an introduction of the background about the topic of this thesis. This is then followed by an elucidation of the problem that is to be investigated. Succeeding this are sections that highlight the objectives and the questions to be answered in this thesis and the limitation of the thesis is also discussed. The chapter concludes with reference to the target group for the thesis and the importance of the results obtained.

1.1. Background

In recent years, businesses around the world have recognized the need to respond appropriately to sustainable development challenges, consequently many have changed their business activities (Pujari, 2006). To mitigate sustainable challenges J. Elkington suggests, companies need to balance financial, social and environmental performance (Elkington, 1998). But the scale of environmental problems coupled with financial and social challenges have raised the need to change the business practices and patterns. This change develops several environmental frameworks with 'eco' term in the field of environmental management for instance eco-efficiency i.e (WBCSD, 2000; Kevin & Patrice, 1999), eco-design i.e (Pinar & Jorg, 2005), eco-labelling i.e. (Frieder, Dirk, & Fabio, 2008), eco-architecture i.e. (Min Jung, Yoo Suk, & Nam Wook, 2009) and eco-effectiveness i.e (Giancarlo, 2007). Unlike various environmental or 'eco' approach, innovation in environmental management literature widely termed as environmental innovation or 'eco-innovation' i.e. (Belin, Horbach, & Oltra, 2009; CML-IE, 2008; Fussler & James, 1996; Carrillo, Río, & Könnölä, 2010) 'an innovation that improves environmental performance' (Carrillo, Río, & Könnölä, 2010).

While eco-innovation promise to lowering environmental impact but 'it is not clear under what conditions innovations for environmental sustainability are stimulated' (Fukasaku, 2005, s. 18). Recently many companies in different industry are playing eco-innovative role. For instance, automaker Toyota designed Prius hybrid car (Toyota, 2009),General Electric (GE) introduces energy saving light-bulbs as 'ecomagination' (General Electronics,

Press Releases, 2005), McDonald redesigning or reducing packaging (U.S. Environmental Protection Agency , 2000), consumer product giant Unilever introduced system innovation through sustainable fisheries in the mid 1990s (Esty & Winston, 2006, s. 30), IBM reinvents the data center, Apple removes toxic chemicals from electronic product, Intel reduces energy costs and greenhouse gas emissions (ecoinnovation.wordpress.com , 2008). Besides different eco-innovation practice in various industrial sectors, the question still generally inconclusive what are the drivers of eco-innovation in companies. From this inconclusive dilemma, our research is aimed at focusing on a company in order to find the drivers of eco-innovation.

1.1.1. Innovation and eco-innovation

This section focuses on general innovation approach and environmental issues. Recently it has been observed that environmental challenges created the need to influence the substitution of general innovation towards eco-innovation. The term 'eco-innovation' is evolved at academic level but companies are still not well aware of this term. Companies do not see environmental initiatives as distinct from their normal innovation process (OECD, 2008).

At academic level, innovation is perceived mostly in two ways: one is product innovation e.g. (Abernathy & Clark, 1985; Schumpeter, 1934) and another is process innovation e.g. (Tidd, Bessant, & Keith, 1997; Trott, 2008). Lack of environmental performance concern and concentration i.e. (life cycle thinking, closed loop system, avoid or reduce environmental harm etc.) on product and process specific innovation approach was the major weakness of previous innovation objective. Innovation and eco-innovation is not parallel to each other, eco-innovation is a subset of innovation with environmental promise; for instance, product innovations (e.g. cleaner technologies), process innovations (e.g. end of pipe innovation). As extensive comparative discussion of this part is not our research aim, only some major comparisons on innovation and eco-innovation are mentioned to give a broader picture of the research topic.

1.1.2. Present scenario of eco-innovation

Traditionally eco-innovation was mostly on discharge level. Industries look at pollution control mostly to control their discharge level. For example pharmaceuticals build end of pipe technology to refine or minimize the toxicity of their discharge. But this end-of-pipe approach was costly and most of the time inefficient to reduce the pollution. Such costly and inefficient experience shifted the industrial interest to modern eco-innovation approach. Today's industry rapidly adopted eco-innovative cleaner production by reducing the amount of energy and materials used in the production process. They have started to check entire product life cycle and integrate more environmental management and strategies, such as a closed-loop production system that eliminates final disposal by recovering wastes and turning them into new resources for production i .e. Tekniska Verken Linkoping AB.

Major highlighting points of eco-innovative shift could be summarized as follows:

Cleaner technology: Shifting end-of-pipe solution to cleaner technology approach because achieving environmental benefits from cleaner technology approach is more effective and important see (Frondel, Horbach, & Rennings, 2004; Rennings & Zwick, 2002)

Eco-efficiency: Eco-efficiency means less environmental impact per unit of product or service value (World Business Council for Sustainable Development , 2000) which reduce material intensity, reduce energy intensity, reduce dispersion of toxic substances, enhance recyclability and use of renewability i.e redesign packaging, creating zero-waste or 100% production target, utilize roof and wall for solar panel and so on.

Realize economic benefit of eco-innovation: Eco-innovation gives direct and indirect benefit to company. Companies benefit as it opens up new frontiers of business opportunity. For example operational advantages by cost savings, better image, regulations alignment, health and safety benefits and greater satisfaction (OECD , 2009).

1.1.3. Barriers of eco-innovation

Of all economic action, innovation is perhaps most fraught with risk and uncertainities (Waarden, 2001). Compared to general innovation, firms often see the eco-innovation to be more uncertain and risky. Although several institutions, regulations and policies are

currently designed and implemented to stimulate the innovator for eco-innovation. But studies show poor effect of those regulations, policies and institutions to shape the demand and supply to reduce the uncertainity and risk of eco-innovation. Elimination of such uncertainity and risk to breed success from eco innovation requires identification of the specific barriers. In this regard, Ashford (1993) identified major non regulatory barriers as follows: technological barrier, financial barrier, labor force-related barriers, consumer-related barriers, supplier-related barriers, managerial barrier.

Recent empirical study to identify eco-innovation barrier on eco-innovative companies by Technopolis (2008) found costs, demands, and lack of appropriate sources of finance are major barriers. Regarding high costs, it can be argued that the companies may be not aware of the longer-term opportunities. Another empirical study of Rehfeld et al. (2007) evidenced, that environmental products are more expensive than conventional substitutes. In the same context, study of European Commission Environmental Technologies Action Plan (2004) identifies most relevant barriers to eco-innovations are economic barriers ranging from higher price to higher investment, inappropriate regulations and standards, technological barriers and diffusion barriers. But these barriers are likely to be particular to industry, company and countries. Such barriers of eco-innovation challange the success of it. So finding drivers of eco-innovation could bring the solution to this challenge what is aimed in this research.

1.2. Problem Discussion

It is widely accepted that eco-innovation plays a crucial role for sustainable development and competitive advantage. As we said earlier in 1.1, despite its crucial role, it is not clear under what conditions eco-innovations are stimulated. In this regard, Porterian hypothesis argues that more stringent of environmental regulations could correct the traditional innovation practice and hence increase the innovation. They claim that firms are unaware about cost savings part of innovation to achieve competitive advantage e.g. (Porter & Linde, 1995). Since then, environmental innovations appear not only as an induced outcome of regulation, but also firms started to find a way to compensate the costs of compliance through innovation offset to improve their competitiveness. Hence

enviromental regulation and cost saving factors are noticed as driving factor of environmental innovation.

But it was argued by several scholars e.g. (Hilliard, 2004; Mohr & Saha, 2008; Jaffe, Peterson, Portney, & Stavins, 1995; Palmer, Oates, & Portney, 1995). Among several considered criticism of Porter's work of environmental regulation, Palmer et al (1995) argues that 'increasing the stringency of incentive-based environmental regulations must result in reduced profits for the firm'. This incentive based regulations, directly or indirectly try to motivate firm's to innovation through reward and penalties. These type of regulatory instruments generally include monetary and near-monetary rewards for polluting less, and impose costs for polluting more. Since then, increasing awareness of sustainable development from environmental context creates a condition to focus on both regulatory and nonregulatory factors of innovation.

In addition, theoretical and empirical works around this driving factors are not yet well researched. Several literatures tried to the analyze drivers of innovation which has environmental promise in country, industry and firms level (see (Green, McMeekin, & Irwin, 1994; Porter & Linde, 1995; Jaffe & Palmer, 1997; Florida, 1996; Bansal & Roth, 2000; VINNOVA , 2001; Cohen & Brunnermeier, 2003; Rehfeld, Rennings, & Ziegler, 2007; Frondel, Horbach, & Rennings, 2008). Amongst various studies Horbach (2008), Oltra (2008) and VINNOVA (2001) study on drivers of environmental innovation was found.

Horbach (2008) panel study on German firms shows that improvement of the technological capabilities ("knowledge capital") by research and development (R&D) triggers environmental innovations. In addition, environmental regulation, environmental management tools and general organizational changes also encourage environmental innovation. Oltra (2008) focus on dynamics of environmental study without any empirical study and VINNOVA (2001) emphasize on existing literature on how external demands drive environmental innovations within firms. In this phenomenon, we have found a research gap to find drivers of eco-innovation. So our research aim is to find the drivers of eco-innovation. Thus our contribution is trying to extend earlier body of knowledge on this issue.

1.3. Purpose and research question

The purpose of this research is to find the drivers of eco-innovation. As we found drivers of eco-innovation is not well researched so we analyze existing literature, current research and carried out empirical study for our research to excel innovation for environmental sustainability. With that we aim to find the drivers of eco-innovation.

Present study will address a single company as the case study and aim to contribute to a body of knowledge that will help companies to develop eco-innovation in practice. So that during our research our research question is:

RQ: What are the drivers of eco-innovation in organization?

We did not think any sub question is necessary to clear our research question. Because research question reflects our aim itself.

1.4. Target group

Due to increasing demand of eco-innovation for environmental sustainable future this research will improve the understanding of the different stakeholders to reshape the business world. Our research will provide the drivers of eco-innovation which are very important to different stakeholders, regulatory institutions and organizations who want to start eco-innovation. It will help further research on eco-innovation for researchers. This type of research study will help to reduce the pollution abatement expenditure thus it will be necessary for the pollution abatement organizations. Since the findings will identify the drivers of eco-innovation which may stop unnecessary investment. This research result will give the necessary boundary that needs to be given attention to the environmentally concerned stakeholders and other relevant interested people.

In addition all types of people are also our target group who want to enrich themselves with the knowledge on the drivers of organization for eco-innovation. This type of study would clarify the understanding of the stakeholders on the motivation of organization and their

role. Moreover, those people who have the direct and indirect influence on environmental sustainability are also the target group of this study.

1.5. Limitations

Due to time limit of this study, the research concentrates on a single energy company. More specifically, a company which is environment focused. Because our research is to find the drivers of eco-innovation so for empirical study a company has been chosen which has environmental awareness activities and objectives. The study has been conducted on a Swedish energy company. This thesis will concentrate on one country and one industrial sector. The fact that the result of this thesis, may limit the ability to generalize to other companies on an international level or any other industrial sector, should be taken into due consideration.

1.6. Disposition

In first chapter – Introduction - Current situation of eco-innovation has been outlined. Then the problems to find drivers of eco-innovation, research purpose, research questions, target groups and limitations have been pointed out.

In chapter two – Frame of reference - In this chapter the theories that have been chosen to work with in this thesis have been mentioned. At first we investigated the existing literatures to reveal the bases of this research which are the definition of eco-innovation and drivers of eco-innovation. Then, the conceptual model by combining the three areas drivers was constructed.

In chapter three – Methodology – In this chapter the perspective on methodology and interpretation were laid out. Description of the chosen methodological approach and research techniques were also included.

In chapter four – Data Collection - The empirical data from our case company following the structure of conceptual model in chapter 2 was presented.

In chapter five – Analysis – In this chapter analysis of the data based on empirical findings and secondary data by using the conceptual model was performed and elucidated accordingly.

In chapter six – Results - The aim of this chapter is to answer/address the research questions in order to fulfill the purpose of this study.

In chapter seven – Conclusion- This chapter summarizes the findings on drivers of eco-innovation with some explanation and give implications.

In chapter eight – Discussion- This chapter presents the discussion upon methods and results alternatives.

In chapter nine - Future Research - Suggestions for further research has been mentioned in chapter nine.

In chapter ten – References- All the primary and secondary reference lists are given in this chapter.

2. Frame of reference

This chapter provides concepts of eco-innovations and earlier research in this area. At the onset eco-innovation in organization shall be discussed. Introducing eco-innovation definition for this research from the literature review. Followed by discussion on types of eco-innovation. The drivers of eco-innovation from different research is outlined. And the chapter concludes with the summary, description of the conceptual model as the foundation of our data collection and analysis.

2.1. Eco innovation in organization

The firm, at the centre of analysis, should first of all be seen as a potential eco-innovator, rather than as a polluter (Andersen, 2008). Because eco-innovation in firm reduce environmental harm while generate value for the market. In support to be 'green and competitive' (Porter & Linde, 1995), Foxon et al. (2009) suggests firms may seek to enhance its green competitiveness in two ways: either by acquiring a premium price for its green reputation or product, or to reduce production costs by achieving greater resource efficiency or reducing the costs of costly emissions. According Kemp et al (2004) eco-innovations may be technical, organisational or marketing innovations which improve the "green competitiveness" of a company. As eco-innovation in organization is important, a competitive factor is required to predict the recent concept of eco-innovation and it's dimensions in organization, which will give us the insight to the drivers of eco-innovation.

2.1.1. Definition of eco-innovation

In literature a long range of eco-innovation definition is proposed see (Fussler & James, 1996; Rennings K. , 2000; Rennings & Zwick, 2002; OECD, 2005; European Commission, 2009; Andersen, 2008; Carrillo, Río, & Könnölä, 2010), but there is no generally accepted definition of eco-innovation. In general, these definitions emphasize that eco-innovations that reduce the environmental impact caused by consumption and production activities,

whether the main motivation for their development or deployment is environmental or not (Carrillo, Río, & Könnölä, 2010). But it is difficult to mesure the intension or motivation of the innovation than the result of the innovation (VINNOVA , 2001; Carrillo, Río, & Könnölä, 2010). Despite intentional problem, some definition of eco-innovation consider newness and 'novelty' i.e. (Fussler & James, 1996), some focuses on 'all forms of innovation' i.e. (ETAP, 2009; European Commission, 2009) and some focus on product, process, models and systems innovation i.e. (Rennings & Zwick, 2002) which lower the environmental impact. Whereas engineering related studies consider eco-innovation is a technological change in production processes and products change, management and policy related studies consider a change in behavior of individual users or organizations, strategic view consider change in the business but all these are intertwined (Hermosilla, Gonzalez, & Konnola, 2009).

Although many countries have defined eco-innovation (see appendix 11.2) but according to different source searching OECD (Eco-Innovation in Industry: Enabling Green Growth, 2009) and our study on this area within the mentioned scope and limit no such adequate definition of eco-innovation in Sweden was found.

Addressing various dimensions of the definition, we define 'eco-innovation' for this research as 'innovations that consist of new or modified products, processes, techniques, practices, organizations, markets and systems to avoid or reduce environmental harms'. Three significant features of this definition is firstly, avoiding intentional point of view, because reducing environmental impact is important than innovator's intention. Secondly, avoiding emphasis on novelty because certain level of novelty may do one or two things: it may lower the costs of achieving an environmental improvement or it may offer a greater environmental gain than an old model (Kemp & Foxon, 2007). Thirdly, to 'avoid or reduce' environmental harms because it is not possible implement any innovation without using natural resources so we are only left with the option to avoid or reduce.

With above definitive features we aim to follow this definition for our research. It is beyond our capability to give all the definitional insight on previous eco-innovation. So we set this definition of eco-innovation for the research. Often eco-innovation is used as shorthand for environmental innovation (Rennings K. , 2000). Eco-innovations are mostly found in

various interchangeable terms such as environmental innovation, innovation for sustainable development and sustainable innovation (Charter & Clark, 2007). In addition traditionally it also known as environmental technologies, clean tech in business see (Andersen, 2008).

2.1.2. Types of eco-innovation

Wide focus of eco-innovation invites us to examine it's degree of technological and nontechnological nature, functional and operational dimensions. Andersen (2008) demonstrate functional and operational dimensions of eco-innovation are of five types:

Add-on eco-innovations (pollution- and resource handling technologies and services): The technologies and services typically have limited systemic effect as they generally are added-on to existing production and consumption practices (which is cost effective) without influencing these significantly. The product in itself need not be environmentally friendly. This type of eco-innovations are the products or services that performed at sink side (the many technologies and services which clean up, dilute, recycle, measure, control and transport emissions) and the source side (extraction and supply of natural resources and energy).

Integrated eco-innovations (cleaner technological processes and cleaner products): This type of eco-innovation may be technical or organizational which make either the production process or the product more eco-efficient than similar processes or products.. They contribute to the solutions of environmental problems of the organization *within* the company or other organizations (public institutions, families..), in this sense they are integrated. So that integrated eco-innovations may provide environmental solutions within the organization or for other organizations and enhance eco-efficiency.

Alternative product eco-innovations (new technological paths): This type of eco-innovations are radical technological discontinuity which are not cleaner than similar products but rather offer very different (a new technological trajectory) more environmentally benign solutions to existing products. Examples are renewable energy

technologies (as opposed to fossil fuel based technologies) and organic farming (as opposed to conventional farming).

Macro-organizational eco-innovations (new organizational structures): This means new ways of organizing production and consumption at the more systemic level, entailing new functional interplays between organizations, e.g. between companies ("industrial symbiosis"), between families and workplaces, and new ways of organising cities and their technical infrastructure ("urban ecology"). The innovations are organizational but may include technical innovations. Emphasizing the importance of the spatial dimension for eco-innovation and the need for organisational and institutional change. These innovations are often to a large degree are within the domain of public authorities, who need to cooperate with companies to develop such novel solutions.

General purpose eco-innovations Certain general purpose technologies affect the economy profoundly and the innovation process more specifically as they lie behind and feed into a range of other technological innovations. Changes in the general purpose technologies are so fundamental that they will have major effect on eco-innovations and special attention should therefore be given to developments within these. The enabling (derived rather than direct) of negative and positive effects technologies such as ICT, biotechnology, and lately nanotechnology may have on eco-innovations is in need of special scrutiny.

We will try to find the position of our case company within the above types of eco-innovation. Identification of the position of the case company in which area they are active and also the drivers of eco-innovation would enable us to know what types of drivers are necessary for different types of eco-innovation. We assume that different types of position may hold different types of drivers for their eco-innovation.

2.2. Drivers of Eco-innovation

Previous research on determinants of innovation was long dominated by so-called technology push and market pull theory (Rehfeld, Rennings, & Ziegler, 2007) or separated

in supply and demand side components (Triebswetter & Wackerbauer, 2008). Here determinant factors are considered as driving factor for eco-innovation. In this issue, Pavitt (1984) suggested technology push is particularly relevant for the initial stage of the innovation and market factors is for further diffusion. Although both are necessary for successful innovation but for eco-innovation another factor appear as an important issue in the academic literature and empirical level. In this context, recently several studies on environmental innovation stress on regulation, policy, institutional and political effects see (Horbach J. , 2008; Green, McMeekin, & Irwin, 1994; Rehfeld, Rennings, & Ziegler, 2007; Hemmelskamp, 1997; Oltra, 2008; Porter & Linde, 1995; Jaffe, Peterson, Portney, & Stavins, 1995; Ashfords, 2008).

In addition, according Horbach and Rennings (2007), Horbach (2008) and Oltra (2008) the general innovation theory has enlarged with respect to the analysis of the influence of environmental policy and institutional factors and categorize determinants of eco-innovation in three broad catagories supply side ,demand side and regulation and policy . Following their determinants categorization, drivers of eco-innovation could broadly be categorized as demand side, supply side, regulations and policy related drivers. Now, this research follows this categorization for further steps.

Moreover, it is important to know that as eco-innovation include new or modified products, processes, techniques, practices, organizations and systems innovation to avoid or reduce environmental harms. So previous studies on clean technology, end-of-pipe technology, environmental technology, environmental innovation, sustainable innovation, new product development or any other forms of innovation which reduce or avoid environmental negative impact are considered as eco-innovation. Hence the research and empirical studies on these relevant areas are reviewed to find the drivers of eco-innovation.

2.2.1. Supply side drivers

Supply side drivers of innovation are very much technology pushed and entrepreneurial i.e. (Schumpeter, 1934). According Horbach (2008) a firm is encouraged to innovate only if it makes sense for it. He suggests that it depends on the appropriation capacity of the firm.

And an innovation only makes sense for the firm if the innovator is able to capture the returns of his innovation activities. However, compare to usual concept of profitable regular innovation practice why innovator is encouraged to be eco-innovative in recent days. Attention to this issue makes us interested what are the supply side drivers of eco-innovation. Oltra (2008) addressed that supply side determinants of eco-innovation are very similar to the determinants of innovation in general. In literature, empirical studies on drivers of eco-innovation give us several results. These findings are in various direction, therefore we will try to summarize the supply side drivers of eco-innovation for this thesis.

In literature review of supply side drivers, Green et al (1994) identify cost savings, collaboration or networking, change in supplied components for productivity improvements and personal commitment as the driving factor for eco-innovation. On the other hand, driving factors for product eco-innovation are collaboration with customers, suppliers and competitors was more positively influential than process eco-innovation. About cost savings, Porter & Linde (1995) suggested that innovation offset (cost savings) by reducing resource inefficiency triggers eco-innovation. They assumed that productivity is increased by monitoring, better resource utilization, waste minimization also influence eco-innovation.

Another study shows that productivity increases, research and development, supply chain management, technological improvements, corporate citizenship, relationship with end user and supplier were found as important driver for eco-innovation (Florida, 1996). His study results shows that key factors for eco-innovation are top management, engineers, line workers, R&D staffs, suppliers, customers, consultants, environmental organizations and distributors.

Survey on Italian manufacturing firms by Mazzanti & Zoboli (2006) find that main drivers of eco- innovation are firms involvement in group and networking activities, innovative oriented industrial relations, environmental policy related costs, R&D and voluntary environmental schemes. On the other hand, empirical study by the World business council for sustainable development (WBCSD) about drivers of sustainable innovation in firms found that ‘direct demands from regulators, customers and special interest groups were considered to be least important. Firm image and brand value were considered much more

important than customer or regulator demands (Rohracher, 2006, p. 58). Recently firms are highly interested about company image through eco-innovation. When a company makes visible eco-innovative activities that sends a positive signal to customer, stakeholder and investor which could provide a positive return. Moreover, business leaders try to fill their wave riding position as eco-innovator which may influence the follower to follow. A study shows that corporate image is comparatively more important than environmental features and innovative products or services for eco-innovation (Technopolis, 2008). A surprising example was BP's green brand image. BP was recognized the importance of the environmentalist pound. Hence the company changes their logo, spent $7m in researching the new brand to unveil a new "green" brand image, in an attempt to win over environmentally aware consumers. Now 40% of the company's business is in natural gas and its solar business is one of the world's largest (BBC News Business: BP goes green, 2000).This eco image and brand fever is now spread and increase in most of the business area.

Study of Rehfield et al (2007) shows certification of environmental management systems, R&D as technology push and firms age seems positive drivers for eco-innovation. In support Wagner (2008) shows that environmental management system (EMS) is one important factor to induce eco-innovation. EMS also increase the corporate image (OECD , 2009). His ten EMS elements are:written environmental policy, procedure for identification and evaluation of legal requirements, initial environmental review, definition of measurable environmental goals, programme to attain measurable environmental goals, clearly defined responsibilities, environmental training programme, environmental goals are part of a continuous improvement process, separate environmental/health/safety report or environmental statement and audit system to check environmental programme. Adopting EMS hence induce eco-innovation by allowing cost savings and improve firm's positive environmental image. EMS can lead to an increasing awareness of environmental aspects within a firm (Rehfeld, Rennings, & Ziegler, 2007). It could orchestrate eco-ambidexterity in the firm.

Wagnar (2008) study also finds that environmental management systems are associated with process innovations. The study does not find that environmental management systems

are associated with product innovations.He also shows that firms age show a significant influence on eco-innovation (Rehfeld, Rennings, & Ziegler, 2007). In support Wagnar (2008) also found that firm size is positively affect eco-innovation. It assumed that small size firms usually face problems with resources, skill and technological capabilities than larger firms thus they are less likey to go for eco-innovation which supports the fact that larger firms are correlated with eco-innovation (Hermosilla, Gonzalez, & Konnola, 2009). It also found that smaller firms consider themselves to be environmentally harmless compare to larger counterparts. On this issue, a study shows that larger firms go for to eco-innovation both by internal and external pressure and smaller firms mostly by external pressure (Connell & Flynn, 1999)

Another empirical study by Horbach (2008) shows that technological capabilities developed by research and development (R&D) investment or further education of the employees are the driving factors for eco-innovation. In addition, highly developed innovation capacity (accumulation of human capital, available knowledge) induce further innovations. Moreover, according to Hermosilla et al (2009) eco-innovations require significant skills at the firm level, either to develop or adopt them. Therefore, this significant skill is a function of research and development (R & D). Besides R&D, networking and relationship develop technological capabilities and compitencies to develop and adopt eco-innovation (Hermosilla, Gonzalez, & Konnola, 2009). Also, technological lead is important factor for eco-innovation (Triebswetter & Wackerbauer, 2008).

From above discussion and several point of views on supply side drivers of eco-innovation could be conceptualized according to figure2.1:

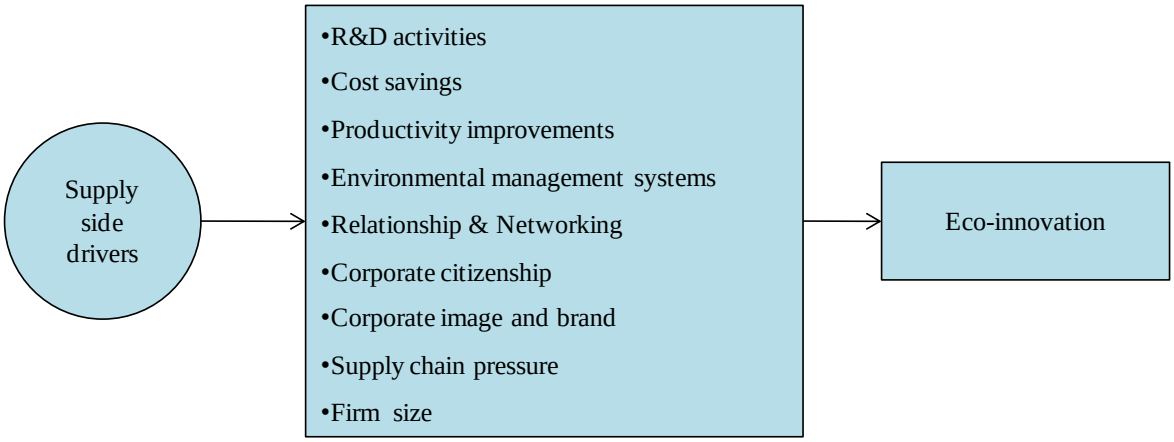

Figure -2.1: Conceptual model of supply side drivers of eco-innovation

2.2.2. Demand side drivers

World demand is moving rapidly to the direction of valuing low-pollution and energy-efficient products (Porter & Linde, 1995). This mid 90s Porterian environmental demand view is now rising issue to trigger eco-innovation in several ways. In this phenomenon, Ugaglia et al (2008) assumes demand side is important in the diffusion phase of innovation, particularly for eco- innovations. Many demand side factors influence firms behavior to eco-innovation. In this regard, Green et. al. (1994) examining that market related drivers such as competition, market share increases, customers pressures are important drivers for environmental activities. Environmental performance of competitors may motivate managers to adopt eco-innovations to improve their own environmental reputation and keep up with their competitors (Hermosilla, Gonzalez, & Konnola, 2009). Competition and uncertainty influence the companies to follow the others. Eco-innovation practice is also encouraged by competition. To achieve capability of eco-innovation company's network, knowledge and cooperation may help to be successful (Technopolis, 2008).

Another study shows customer demand is the essential driver of environmental innovation (Florida 1996). A recent McKinsey study on consumer group shows the positive survey report of consumer's environmental concern. McKinsey survey shows 87 percent respondents of 7,751 consumers in Brazil, Canada, China, France, Germany, India, the UK,

and the USA are concerned about the environmental and social impact of the products they buy (Bonini, Hintz, & Mendonca, 2008). In support Malaman (1996) said that product innovations are driven by market demand than process innovation.

Horbach suggested, customer demands and public pressure are essential drivers of eco-innovations (Horbach, 2008). On the other hand, compared to general innovation, for eco-innovation, customer motivations are affected by environmental policies such as regulations, taxes (Oltra 2008). With the same line of argument, according Belin et al. (2009) in certain extent, "demand pull effects are tend to be lower for eco-innovations than for innovation in general and, when they are effective, they are provoked by policies" (Belin, Horbach, & Oltra, 2009). But it may also be the case of customer demand not having similar effect to every industry. One Swedish study shows that construction and real estate industry is mostly customer demand driven than petroleum products and metal manufacturing, so their environmental motive and work also differ with customer demand. For petroleum products and metal manufacturing, regulation and policy pressure may be the other driver for environmental work (IVA, 1995)

Empirical study result of Green et al (1994) shows market pressure and external pressure is the driver of product and process eco-innovation. These pressures may come from retailer, wholeseller, rivals, expanding market. But the response of consumers to new products is a crucial factor for success. Success of new products are very important for innovation (Beise & renings, 2005, s. 77). Florida (1996) shows that customer demand pressure is more important driver than pressure from green product market and environmental organizations for eco-innovation. Similar result also found in Hemel et al's (2002) empirical study.

Although market demand, customer demand and other demand influence on eco-innovation is important, but reaction of industry or companies to that demand and external pressure are not always similar. Kemp (2000) explained innovative behavior of high volume, mature sectors are positively correlated with environmental monitoring and process controls to improve efficiency and show rigidity to pressure and demand. Because, this resistancy arise with their maturity attempts are made to stand to fight for flexible regulation and policy. Compared to larger firms, smaller firms are more reactive to demand and pressure from this maturity resistancy view point. So it has been found that firm's response to market demand

and pressure are not same for all the sectors. But strategically larger firms are very much ambitious to adopt and develop their present strategy according current and future demand. Empirical study of Triebswetter et.al. (2008) found that eco innovation is driven by a mixture of factors internal and external to the firm, not only regulatory pressure, but also cost pressure, competitive advantages, technological lead and customer pressure are important drivers.

Unlike innovation, eco-innovation diffustion success also depend on customer preferences. In this respect meeting the requirements of customer and market demand may be one primary objective of eco-innovation. Empirical evidence shows that pressure to eco-innovate increase in product market segments that are close to final consumers.Thus consumer and purchaser less awareness of environmental problems may act as a significant barrier to eco innovation. It might be the lack of information on the impact of the consumption of specific products or simply lack of interest to environmental product (Hermosilla, Gonzalez, & Konnola, 2009). According Fukasaku (2005, p. 257) social awareness is also an important driver which interact with other drivers and firms that want to demonstrate social awareness by being innovative in environmental performances. Social awareness for eco-innovation is more important than regular innovation for various reasons. Firstly it helps to increase the adoption of eco-innovative product choices to customer and create a demand for eco-product. Secondly it develops an environmental pressure group to motivate eco-innovation to the different industrial sectors.Thirdly social awareness may influence to consider the long term cost benefit analysis during eco products and service prices which relay firms' motivation. For social awareness information, knowledge, training, dialogue and education are important factors. Hemmelskamp (1997) study shows that customer has little influence on information but public infrastructure such as universities, technical colleges has influence as information providers and exercise a strong influencing factor on the development of environmental innovation. So that to create social awareness this type of infrastructure is positively correlated. On the other hand environmental management system (EMS) and R&D open information of company also can improve social awareness.

With above discussion we attempt to list our findings as drivers of eco-innovation and create a conceptual model of eco-innovation as follows (figure 2.2):

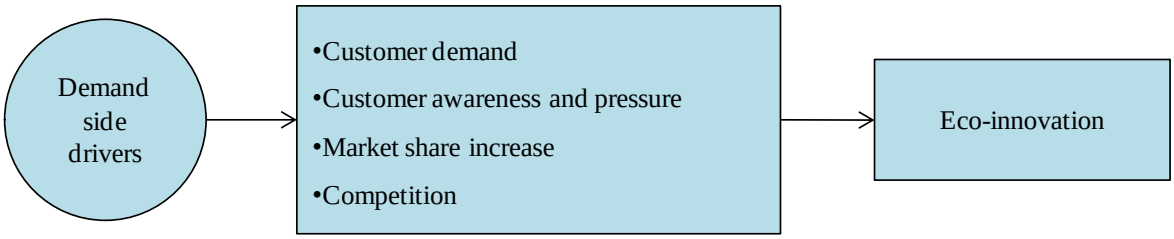

Figure-2.2: Conceptual model of demand side drivers of eco-innovation

2.2.3. Regulation and policy drivers

The scale and direction of a company's innovative behaviour is generally determined by a large number of supply and demand factors (Hemmelskamp, 1997). But Porter and van der linde (1995) added another dimension that environmental regulation would trigger the innovation. In this regulation and innovation debate, traditional, neoclassical cost-based view fears that the private costs initiated through stringent environmental policy which impair competitiveness and productivity (Palmer, Oates, & Portney, 1995). In their view regulation could motivate firms to develop eco-innovations, but that bear additional costs. Conversely Porter et al (1995) argued that ‘‘properly designed environmental regulation can trigger innovation that may partially or more than fully offset the costs of complying with them’’(Porterian hypotheses). As Regulation can trigger innovation offsets through substitution of less costly materials or better utilization of materials in the process (Porter & Linde, 1995) but regulation and policy need to change with demand. It is argued that non prescriptive market based innovation policy (e.g. taxes,tradable permits) are strong than prescriptive regulation (technology based controls,performance standard) to induce innovation (Johnstone, Hascic, & Kalamova, 2010).

Empirical study of Green et al. (1994) and Florida (1996) found environmental regulation remain key elements of triggering eco-innovation. According Green et.al. both product and process innovation, existence of environmental regulatisons and anticipation of

environmentally related regulation are the top most driving factor. Hemmelskamp (1997) empirical study found both positive and negative result of regulations and policy influence on eco-innovation. Because if regulation and policy do not change with newer development it could hinder eco-innovation see (Kivimaa & Mickwitz, 2006). In support, Johnstone (2005) argued that environmental policy prescription and choice of economic instruments (emission taxes,tradable permits), direct form of regulation (performance standards, emission limits, technology based standards) or non mandatory measures (voluntary agreements, information schemes) are focused on the rate of innovation than direction. And suggests the need of policy flexibility and improvement with demand change to induce innovation. It also supported by Driesen (2003) and Ashford (2008).

Johnstone et al. (2010) found empirical evidence that market based policy instrument like environmental related taxes and tradable permits induced innovation more than direct regulations such as technology based standards. It also evidenced that policy stringency significantly induced air and water pollution abatement and solid waste management innovation. Because more stringent policy will provide greater incentives for polluters to search for ways to avoid the costs imposed by the policy (Johnstone, Hascic, & Kalamova, 2010). As all policies such as taxes, subsidies, regulations, information-set a price for polluting. Evidence shows that increase of that price positively induce innovation. It could be said polluter will pay. On this stringency study, Frondel et al. (2004), Rehfield et al. (2007) and Horbach (2008) find significant positive correlation between policy stringency and regulatory measures with eco-innovation.

It is difficult to cover all the debate of environmental regulation and policy issues around eco-innovation for finding drivers of eco-innovation. So drawing conclusion of these empirical study could facilitate further understanding (Figure-2.3):

Figure-2-3: Conceptual model of regulation and policy side drivers of eco-innovation

2.3. Summary and conceptual model for drivers of eco-innovation

In this chapter definition of eco-innovation was deduced and it exemplified the types of eco-innovation. It helped to find mechanism, targets and impacts of case company eco-innovation. Later drivers of eco-innovation from various areas were introduced. Several previous studies and empirical evidences were drawn to find the drivers of eco-innovation within our scope and limits. Three major catagories of drivers were establised depending upon academic literature and shows their arguments. We found general innovation mainly induced by demand and supply factors but eco-innovation is associated with another major driver, regulation and policy. Among many other drivers focus has been set on these three areas to make a clear cut representation of the drivers. The developed conceptual model on the basis of our findings would greatly help us during our empirical research and analysis (figure 2.4).

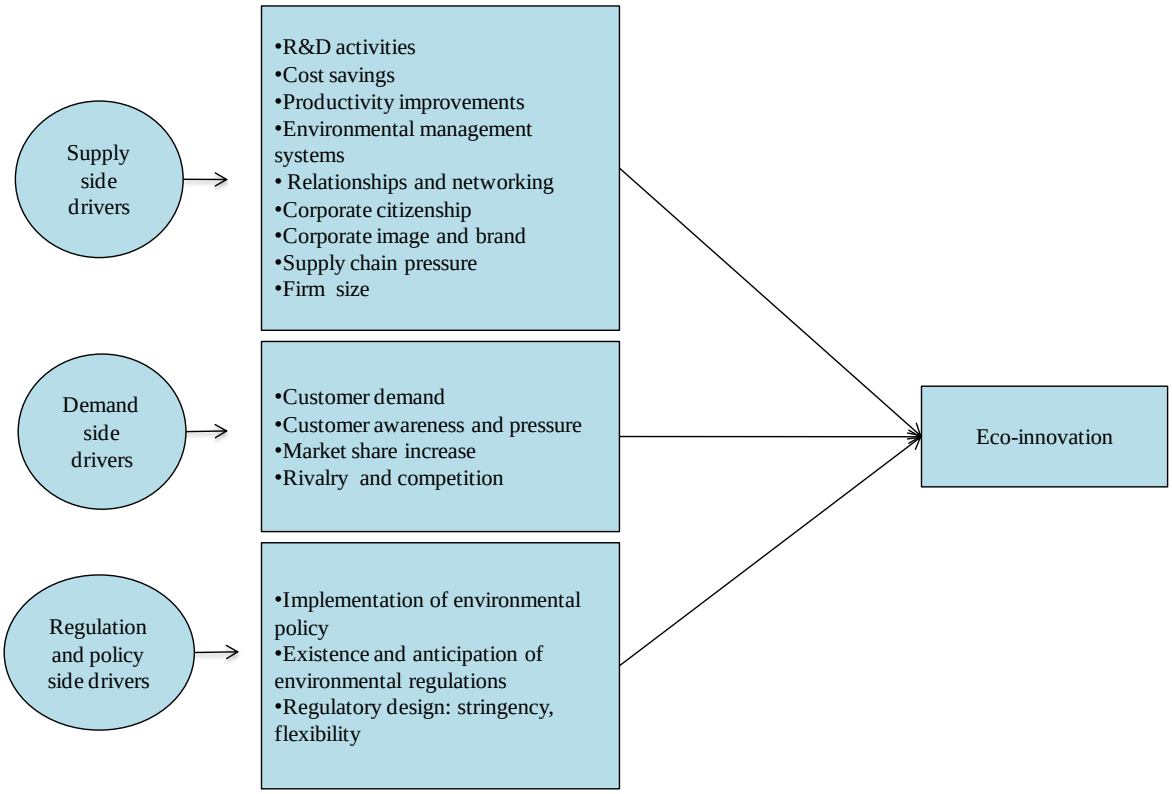

Figure-2.4: Conceptual model of drivers of eco-innovation

3. Methodology

This chapter describes the basic view of the researchers and the research approach which have a significant impact on the result of a study. The problem is that there is no single consistent way of performing research, however, there are certain procedures and criteria, if met adequately, can improve the reliability and validity of the analyses. Otherwise, credibility of the study cannot be evaluated. This chapter aims to present a sensible approach and methodology.

3.1. Research Philosophy

The aim of this thesis is the development of knowledge by finding drivers of eco-innovation. In knowledge creating process 'knowledge' depicts as 'justified true belief' (Nonaka & Konno, 1998). They focus on two attributes of knowledge 'justification' and 'truthfulness'. Nonaka et al (2000) consider knowledge to be "a dynamic human process of justifying personal belief toward the 'truth'". But there are many philosophical ways of knowledge development. Among them, basically two opposite philosophies are well known: positivistic and hermeneutics. The positivistic tradition tries to establish the consistent scientific facts and hermeneutic tradition tries to interpret the subjective drawing to the research topic (Denzin & Lincoln, 1994). According research aim and problem one can follow any of the way between these two philosophies.

In our research, the purpose of finding drivers of eco-innovation use existing theory to investigate case company to find drivers with aim of contribution. As we mentioned earlier, one can follow any of major research philosophies, either positivism or hermeneutics. According to Bryman & Bell (2007) positivism emphasize on objective construction of reality and reliable scientific facts and hermeneutics emphasize on subjective meaning of social action by understanding and interpretation. The major conflict between positivism and hermeneutics is explanation of human behavior and understanding. According to our

research's aims and objectives, a thorough understanding of organizational context, environment and innovation phenomenon does not coincide with the objective of positivism philosophy. The hermeneutic tradition for our research shall be followed.

In addition, as our research requires interpretation of innovation influencing factors, organizational views on innovation, their processes calls the need of pre-understanding. Thus the interpretative understanding (Bryman & Bell, 2007) of our own background, understanding and interpretative way for this research is need to be sorted. According to Gummesson (2000) concept of pre-understanding is people's insight into a specific problem and social environment before they start a research program as an input. In hermeneutic spiral (an iterative process whereby each stage provides knowledge), no understanding without pre-understanding (Gummesson, 2000). Hence our pre understanding from available knowledge sources is to use them during our research and to avoid biased view and perceptions, in order to create pre-understanding from different sources of knowledge.

3.2. Research approach

According relation between theory and research, Bryman & Bell (2007) introduce two opposite directed typical approaches, induction and deduction. When 'deductive is an approach to the relationship between theory and research in which the latter is conducted with reference to hypotheses and ideas inferred from the former'. And 'inductive is an approach to the relationship between theory and research in which the former is generated out of the latter' (Bryman & Bell, 2007). Between these two approaches, it is important to make it explicit which approaches we follow when we present our results as because two are in opposite direction.

Our approach is following deductive approach because we depart from existing innovation theories which are connected with case study findings from case company Tekniska Verken Linkoping. We utilize driving factors of general innovation theory to find the drivers of eco-innovation and look upon our case company with that theoretical segment. Depending on the empirical findings we aim to refine the previous innovation theory in regards to eco-

innovation. This approach makes it inductive too, where empirical data is first collected through interviews and then theories are developed.

3.3. Research method

Research methods typically distinguish between quantitative and qualitative research (Bryman & Bell, 2007). Quantitative research methods usually emphasize quantification in the collection and analysis of data and qualitative research usually emphasize on words rather than quantification in the collection and analysis of data. These qualitative and quantitative research methods provide a different approach to each research, they may differ in validity and reliability, obtained results, type of analysis required and sources. For instance the reliability of qualitative methods mainly depend on researcher's knowledge, integrity, perception, pre-understanding level and right questions to interpret. But in quantitative research reliability mainly depends on what types of instrumentation is used to measure the information to get the right result. So, in one sense researcher becomes an instrument to generate the reliability in qualitative research. In addition, qualitative researcher attempts to make sense and interpret the phenomenon of people's meaning based upon what they bring to them, see (Denzin & Lincoln, 1994).

We aim to conduct a single in depth case study on Tekniska Verken Linkoping to find drivers of eco-innovation, so qualitative method is considered to suit and appropriate for our research. Interpretation from part to whole, accessable resources is important. For our research, we use interviews, other available resources and visual perception to appreciate the whole picture.

3.4. Data collection

To find the eco-innovation drivers in Tekniska Verken our research use both primary and secondary data sources. Both data will be used to test the assumptions we made in conceptual model.

3.4.1. Primary data collection

There are two basic types of data collection techniques found in research process: one is primary data collection, when data is collected for first time for specific purpose through observations, experiments, surveys and interviews. But there are various types of techniques to collect the data. Primary data is collected with specific purpose at hand. For this research we shall use interview technique to collect the primary data.

3.4.2. Interview

For this thesis, primary data is collected through interviews from the employees of Tekniska Verken and its subsidiaries. According to Kvale the "research interview is a specific form of conversation" (Kvale, 1996). Case study interviews are "open-ended character" and "you may even ask the respondent to propose his or her own insights into certain occurrences and may use such propositions as the basis for further inquiry." (Yin R. K., 2003).

Generally, there are three types of interviews that can be conducted: structured interview, semi-structured interview, and unstructured interview. For this research, interview is conducted as semi-structure interview. The advantage of semi-structured interview is that it is different from both unstructured and structured interviews. From the unstructured interviews, the topics and issues to be covered, and the people to be interviewed and questions to be asked have been determined beforehand, but in a more flexible way than the structured interview (Ghauri & Gronhaug, 2005).

For this thesis semi-structured interviews is chosen because it enables the study of new discoveries within the borders of the research topic. The aim is to find the drivers of eco-innovation in Tekniska Verken. Since the eco-innovation is relatively new term and broad area so for this research we communicate with the CEO of Tekniska Verken. With his experience and knowledge of environmental field he referred two persons who are fit for this interview. Before carrying out the interview we sent a draft to the respondent of our

interview questions for better understanding of our thesis. This was to ensure that the interview process is clear and open. Initial suggestions of our tutor, during the interviews respondents were asked whether they knew anybody else who might be able to contribute to our research. With that reference we conducted further two interviews with employees of Tekniska Verken subsidiaries.

All the interviews were conducted during the month of April and each interview lasted 20 to 30 minutes. During all of the interviews one of us took notes and the other one interviewed. This enabled us to concentrate on different parts of the interview, one on asking questions, listening and following up interesting answers, and the other on taking notes. Two interviews were face to face interviews, two over the telephone and by mail interview. The interview followed the semi structured way. The interview was started with brief description of our topic and our selected definition. During the interview with consent of respondent the interview had been recorded. And after the interview all data is transcribed.

3.4.3. Case Study

Yin (2003) defines case study is the method of choice when the phenomenon under study is not readily distinguishable from its context. Interaction of phenomenon and context may differ by many reasons. For example, interaction of firms and market for eco-innovation. This types of interactive and context specific phenomenon warrants the use of case study. So it seems that the case study method presents a portrait of different behavioral, procedural or driving forces that affect a particular situation. On the other hand, theory and theoretical constructs are useful in all kinds of case studies (Yin R. K., 2003) and useful for theory development and testing. Our case studies accomplished it's research queries, aims and objectives through interviews, review of existing materials, records, observation and interaction.

A case study research design entails the detailed and intensive analysis of a single case (Bryman & Bell, 2007). According Ghauri and Gronhaug (2005), case study research in business studies is particularly useful when the phenomenon under investigation is difficult

to study outside its natural setting and also when the concepts and variables under study are difficult to quantify.

As our aim was to find the drivers of eco-innovation in organization so we gave emphasis on understanding the phenomenon of case company. A case can be of a single organization or a location, person or event (Bryman & Bell, 2007). Such as Pettigrew's (1985) research a single organization at Imperial Chemical Industries (ICI), Born's (2004) study of managerialism in the BBC. But a common characteristic of case study relies on ability and integrative power to study an object to draw an integrative interpretation of research. Therefore, we consider that our single case study research design need not rely on the sample size, but need the quality and depth of the investigation and interpretation of one company.

From above viewpoint, we think qualitative single case study is suitable for our research problem and objective. According to our purpose, we aim to conduct single case study research on a Swedish regional company, Tekniska Verken Linkoping in order to find the drivers of eco-innovation. Although single case study has many limitations, but we believe our in depth analysis would be satisfactory enough to help answer our research queries, fill up the research purpose and enable us to ensure our contribution to body of knowledge.

3.4.4. Secondary data sources

Secondary data can be collected in a number of different ways. For this research secondary data is collected from articles, journals, reports, book sections, conference proceedings, current researches, books, websites and documents from websites. We use mostly Linkoping University (LiU) Library, electronic press which is a leading Swedish open access publisher of dissertations, researches and student theses, use European Commission websites and Tekniska Verken websites and reports. Some of the Tekniska Verken information which were not in English used Google translator to translate the information.

3.5. Credibility of the study

Our chosen research approach allows us to present a reliable and valid picture of the drivers of eco-innovation based on the empirical insights gained from the study of Tekniska Verken.

3.5.1. Reliability

Reliability is fundamentally concerned with issues of consistency of measures. (Bryman & Bell, 2007, s. 162). Bryman & Bell (2007, s. 410) defined external reliability by which they mean the degree to which a study can be replicate. And internal reliability by which they mean whether or not, when there is more than one observer, members of research team agree about what they see and hear.

To define external reliability is difficult in qualitative research. About the external reliability of our research we may say that until and unless there is no technological breakthrough or no major changes in regulation or no significant organizational changes occur within the case company for eco-innovation then we predict other researcher would get the same answer as our empirical study. Another factor should be considered during future research for example if any natural disaster occurs then demand for eco-innovation will be changed which might affect the drivers.

This thesis work conducted by two people with the instruction from the tutor ensured comparatively high internal reliability. This internal reliability also expanded with the help of primary sources materials from interviewing and other secondary materials.

3.5.2 Validity

Validity is defined by Bryman and Bell (2007, s. 165) “validity refers to the issue of whether or not an indicator (or set of indicators) that is devised to gauge a concept really measures that concept” and “internal validity by which they mean whether or not there is a good match between researchers’ observations and the theoretical ideas they develop” and

"external validity which refers to the degree to which findings can be generalized across the social settings. (Bryman & Bell, 2007, s. 410)

Since the primary materials were collected by face to face interviews. But with the limited number of interviews the empirical information might not well represent the whole situation for drivers of eco-innovation and could not achieve a high level of external validity. Though, attempts were made to conduct interviews with those who have corresponding rich experience in the case company. The focus was to dig deep into conversation with the interviewees in order to achieve quality materials for better external validity.

3.5.3 Generalisability

Hussey & Hussey (1997) stated that generalisation is concerned with the application of research results to case or situations beyond those examined in the study. Mills et al (2010) defined generalisability refers to the ability of extending the validity of one's case study conclusions to other cases of the kind. With the line of Gummesson (2000) argument on number of studies as he said it is not obvious that properly devised statistical studies based on large numbers of observations will lead to meaningful generalizations. Generalizing from statistical samples is just one type of generalization. About this, Normann (1970) viewed that it is possible to generalize from a very few cases, or even a single case, if the analysis has captured the interactions and characteristic of the phenomena being studied, cited in (Hussey & Hussey, 1997, p. 58). Quality and depth of the investigation and interpretation of one company is much more important than the sample size. As research in social areas is a continuing, eternal process of understanding that never actually reaches the final "truth" and generalizing from statistical samples is just one type of generalization (Gummesson, 2000, p. 90). The other lies in in-depth investigation and analysis. We could therefore say results of our case study can be applied in other environments and other cases.

3.6. Criticism

As no approach is perfect, this approach has some limitations and weakness. With the method and techniques we chose to implement the empirical study, there are some limitations and potential problems. First, this research was to find out the driver of eco-innovation in general. But drivers of eco-innovation can be differed by the several factors. It could be sectoral or firm specific, or could be product, process, and market specific. Second, we categorized that three side drivers of eco-innovation in conceptual model but these categorization were not universal. Thus to quantify the number of drivers is difficult and impossible. What we tried to analyze in the existing literature, was to find drivers within our limit and knowledge and investigate it from our case company.

4. Data Collection

In this chapter we present the results from our empirical study. We start by introducing the case company Tekniska Verken, Linköping including general information about its services and several activities. In line with the conceptualization model we deduced at the end of chapter 2 (figure 2.4), this chapter is structured as below: first, eco-innovation in Tekniska Verken, second the definition of eco-innovation in tekniska Verken and third the drivers of eco-innovation in Tekniska Verken (supply side drivers, demand side drivers and regulation) are describe separately. In each phase, information from interviews, websites and research papers are compiled to outline the situation.

The interview conducted in April, Tekniska Verken and with two other subsidiaries (Usitall and Bixie) of Tekniska Verken facilitated us to conduct our research.

To make a better understanding, the general information of Tekniska Verken is given below in table 4:

Table-4: General information of Tekniska Verken

Full name:	Tekniska Verken i Linköping AB (publ)
Subsidiaries:	Bixie AB,Usitall AB,Utsikt Nät AB,Utsikt Katrineholm Elnät AB,Stadspartner AB, Svensk Biogas.
Number of employees:	984 people
Income:	5385 million in 2008

4.1. An Introduction of Tekniska Verken

Tekniska Verken is a distinct environmental company. The activities of this company are to create sustainable solutions for a well-functioning society with the least possible burden on the environment. The company was founded in 1902 by entrepreneur Jonn O Nilson as Linköpings Elektriska Kraft och Belysnings AB, later that went under the name of Tekniska Verken in Linkoping AB (publ) (Financial year 2008 Tekniska verken I

Linkoping AB (publ), 2009). The company turned to the municipal property December 31, 1921. (Linden, 2000).

The overall environmental objective of the Tekniska Verken Group is to offer cost-effective products and services that reduce environmental impact. Moreover, it focuses on environmental impact of reduced emissions and additional emphasis on climate impact. It maintains close dialogue with the suppliers regarding Tekniska Verken environmental standards.

The company offer environmentally friendly products and services to inhabitants of the municipality of Linkoping Sweden. Tekniska Verken is wholly or partly owned many company like Utsikt Nat AB, Stadspartner AB, Svensk Biogas, Bixie AB, Usitall AB.

The major production plants of Tekniska Verken are to conserve natural resources, inter alia through the production of district heating from waste and biomass, the production of biogas to vehicle fuel and the production of electricity with hydropower and cogeneration. Distributing drinking water, taking care of waste and purifying water.

In 1998, the production department was chosen to certify the entire department in EMAS systems. The whole group is certified since 2001 under the international standard ISO 14001. This means that they have a common environmental policy and systematically working with environmental issues. They develop an overall environmental goal which is broken down within each business line and company.

Tekniska Verken has worked with environmental issues for a long time. They are involved in many activities in society with environmental promise in mind. For instance, they started early to develop the district heating network in 1954 at Linköping, which was the second municipality in Sweden that got heating. They were the first in Sweden with production of biogas to vehicle fuel.

In addition, climate Vision of Tekniska Verken is “Your everyday is our driving force” . With this vision, Tekniska Verken is to provide a good living environment for the future. They believe sustainable environment is a precondition for this. Therefore, they provide the

region with climate infrastructure and flexible energy solutions for heating, electricity and transport.

4.2. Eco-innovation at Tekniska Verken

In the following part the eco-innovation concept at Tekniska Verken, Linköping is described. The source of these results is mainly interviews performed with the management body and employee of Tekniska Verken, Bixie and Usitall. Other sources to complement the results were official information posted at Tekniska Verken website, reports and previous research on Tekniska Verken.

4.2.1. Definition of eco-innovation at Tekniska Verken

In the literature review we stated that Sweden do not have any specific definition of eco-innovation. So we shall use our working definition of eco-innovation for this research as stated in 2.1.1. At the beginning of interview we asked about the definition of the eco-innovation and tried to match the answers with our selected definition. For better understanding we provided our selected definition to the respondants beforehand and sought their answers and opinions. We found the term of eco-innovation was new to them. Having read the selected definition, the reaction of one respondant was

> "*This company is full of eco-innovation"*
> (Jakobsson Stefan, Business area manager of Tekniska Verken)

Thus we can assume that the selected definition is in perfect match with our case company. We have found similar reaction to the eco-innovation definition from all other respondants.

4.2.2. Types of eco-innovation at Tekniska Verken

Tekniska verken is an eco-innovative company, owned by municipility and holds many suibsidiaries. Environmental sustainability is at the center of all descriptions of Tekniska

Verken. They are producing district electricity, heating and cooling in energy sector, distributing drinking water, purifying water and develops processes, treat, recycle and dispose everyday waste, offer services to building owners, produce biogas and distribute for vehicles, trade electricity, offer broadband services, outdoor lighting, provide technological infrastructure in construction sector with environmental promise. Types of eco-innovations at Tekniska Verken, according to the respondants perception are as follows:

> *"All the things we do have some kind of impact upon the environment. So we are wholly working on reducing the environmental impact"*
>
> (Moritz Anders, Division chief of Tekniska Verken)

> *"Shift from waste water to slaughter wastage for big scale eco-innovation in biogas plant"* (Moritz Anders, Division chief of Tekniska Verken)

> *"We are infrastructure and multiutility company"*
>
> (Moritz Anders, Division chief of Tekniska Verken)

> *"We taking care of waste water"*
>
> (Moritz Anders, Division chief of Tekniska Verken)

> *"We built system from technology"*
>
> (Jakobsson Stefan, Business area manager of Tekniska Verken)

> *"Other companies develop and we put them together"*
>
> (Jakobsson Stefan, Business area manager of Tekniska Verken)

Additionally for electricity production one respondant said

> *"The origin is very important when it comes to eco-thinking, for less use of electricity and the use of better, more environmental friendly electricity. According to that we support new inventions, ideas and innovations in small scale, renewable and locally produced electricity from water, sun and wind"*
>
> (Dortz Anna, Product development manager of Bixie)

4.3. Drivers of eco-innovation at Tekniska Verken

In the following sections the results regarding the drivers of eco-innovation at Tekniska Verken, Linköping are outlined. Primary source of information is taken from the interviews and e-mail, and the secondary sources are the official web site of Tekniska Verken, annual reports and earlier research on Tekniska Verken.

4.3.1. Supply side drivers

This section presents the supply side drivers that were found from the empirical and secondary study of case company Tekniska Verken. Tekniska Verken has ambition to achieve cutting edge technology to develop and commercialize innovative concepts which take account of the environment. Achieving cutting edge technology research and development is important. The research and development (R&D) in Tekniska Verken are driven by environment oriented objective, for instance in 2006, Tekniska Verken investigated the feasibility of producing diesel from recycled plastic waste. Preliminary studies on environmental and energy aspects were favourable. (Tekniska Verken, 2006).

One respondant said,

> *"We support new inventions, ideas and innovations in small scale, renewable and locally produced electricity from water, sun and wind. We have established a solar energy installation which we use as demo in the concept where we offer solar energy packages to customers."*

(Dortz Anna, Product development manager of Bixie)

In financial year 2008 report, about cost savings, Stig Holm, General Manager and CEO of Tekniska Verken said ,

> *"We must remember that one of the aims of the new organisation was to generate savings of SEK 100 million".*
>
> (Holm Stig, General Manager and CEO of Tekniska Verken)

When we asked about the cost benefit of environmental product of Tekniska Verken, as environmental technology and product are more expensive then any other technology or product in general. One respondant replied,

> *"You know we get paid for to take waste who wants to get rid of it then we burn it and we get pay once again when we sell it".*
>
> (Jakobsson Stefan, Business area manager of Tekniska Verken)

Moreover, he added that

> *"The economic reality is that is better for us to use some kind of eco-innovation like waste to energy or bio gas because other way to use coal oil its economical situation for coal and oil much worst then bio energy"*

Productivity and sustainability has been found as the Tekniska Verken Group's general increased sustainability target areas. Several noteworthy of improvements were carried out in 2008. To generate forward development, they continued to aim to become more resource-efficient and to keep their prices competitive. Investment in infrastructure and production plants were planned to achieve optimum cost-efficiency in relation to the development and environmental demands of the community. Regarding development (Tekniska Verken, 2009) Stig Holm's said,

> "We are pushing developments forward".
>
> (Holm Stig, General Manager and CEO of Tekniska Verken)

On the other hand, environmental management system (EMS) is another supply side driver for eco-innovation. When we look at Tekniska Verken, the whole Tekniska Verken Group has obtained environmental certification in accordance with ISO 14001. This means that they meet larger number of standards when it comes to risk assessment, familiarity with legal requirements and constant improvements to environmental performance. Improvements are carried out primarily through the identification of important target areas, and the identification and follow-up of concrete targets and key ratios. They have a new purchasing system that facilitates better management and control of the company's purchases. Stadspartner's instructions and templates have been linked to process charts, which provides a clear general view of flows and working methods. A new staff function for environmental and quality management has been created. Its task is to coordinate and improve the efficiency of the operational systems.

At the same time, Tekniska Verken has long been involved in creating a sustainable society which helps them to maintain key relationship and networking. They are constantly involved in social issues, such as the working environment, leadership, diversity and crisis management. In Linghem, Tekniska Verken is working in partnership with E.ON and Rörvik Timber on a district heating power plant run on bio fuel. They also work to promote their visions for sustainable development, and run a substantial study visit operation for schools, businesses and other stakeholders. Consumer expect environmental solution from them and one respondant said,

> *"Consumers expect us to sell energy that is better for the environment."*
>
> (Dortz Anna, Product development manager of Bixie)

Corporate citizenship at Tekniska Verken is connected with sustainable society, eco-innovation, promise of offering infrastructure and essential resources, offering an excellent everyday environment now and in the future. Their corporate citizenship concept dates long time back, for example, the replacement of individual heating systems with district

heating in Linköping started back in 1954. Over time, they have become more and more aware of how different fuels impact the environment and climate, the plants have been converted to run on bio fuels and waste rather than oil. In addition, one of our respondant said,

> *"Initially the driver for eco-innovation was that slaughter waste which has impact to the city air"*
>
> (Moritz Anders, Division chief of Tekniska Verken)

Slaughtering waste supplies make the raw materials available for the biogas gas plant. The activities of Tekniska Verken are aimed at a continuous minimization of environmental impact, as a major, long term responsibility to manage the environment for future generation (Gooch, 2002).

As a regional company and active in energy, waste management, water purification, heating, broadband, networking and other various activities they have a strong corporate image and stable brand identity in various sectors. They have also set up an environmental fund for further support of environmental businesses. Moreover, one respondent replied to answer the question of drivers of eco-innovation is as follows:

> *"We also have an investment fund where inventors and others can apply for capital to invest in new ideas for a more environmental friendly situation at the electricity market. From this fund´s applications, we establish a lot of good new contacts, which from time to time lead us to good innovation ideas that we can bring to market some times"*
>
> (Dortz Anna, Product development manager of Bixie)

Tekniska Verken is well known nationally and internationally. Tekniska Verken's solution for more effective waste management and energy production has attracted a lot of

international interest, including the Peking region in China and from Toronto and Vancouver in Canada. Tekniska Verken can provide advice, design plants and staff training. In this regard one respondent replied,

> *"Become an interesting employer and attractive company for young and skilled people".*
>
> (Nordeno Anders, International project developer of Usitall)

With the same line, he also mentioned that

> *"Become an interesting employer and attractive company ,export environmental knowledge and know how"(IBID)*

Östkraft has set up an Environmental Fund in partnership with SERO. The fund is aimed at promoting the establishment of renewable energy production operations in Sweden. Firm size is one of the supply side drivers from our literature review. We found that the Tekniska Verken is one of the world's leading players in waste incineration for energy recovery, and one of Europe's largest producers of biogas for vehicle fuel. (Tekniska Verken, 2009)

4.3.2 Demand side drivers

Tekniska Verken continuously works on customer awareness to environment. The Market and Communications Department of Tekniska Verken has launched a new customer magazine, Leva Nära, to provide information and tips on the environment and climate. They are active on social networking websites like twitter, blog, facebook and other online platforms to create awareness. Customer awareness is necessary for eco-innovation. Awareness of customer about the environment can create demand in market. Once the customer is more demanding for the eco-product, they involve themselves with various social activities with this objective. One respondant said

> *"Public opinion, knowledge and actions"*

(Nordeno Anders, International project developer of Usitall)

Which are drivers of Tekniska Verken. That respondant also mentioned

"Global economy, open markets and business opportunities"(IBID)

Another respondant focused on market demand

"The customer wishes and behavior always come first" and *"heavy pressure on the market"*.

(Dortz Anna, Product development manager of Bixie)

In addition, the respondant said about,

"Struggling to get new and keep old customers",

"drivers for us are absolutely the customer focus and the aim to stand for a better choice" and *"make the customers part of us".*

(Dortz Anna, Product development manager of Bixie)

One recent report on 2009 shows, Tekniska verken has nearly 280000 residential and business customers.

In addition, about competition the same respondent also mentions about "change". Climate issues are high on the agenda, players with an eye to the future have an advantage in the electricity, heating and waste industry. As the largest biogas producer, they introduce new materials for biogas production. New materials for biogas production have been successfully tested, with the aim of securing production. Biogas production has been fine-tuned to increase the gas output from the same amount of material which is significant as eco-innovation.

Tekniska Verken also follow the win-win situation concept, they help other players to reduce their environmental impact. For instance, Stadspartner has developed the world's

first car to run on biogas as well as ethanol and petrol, and has been awarded the 2008 Grönt Föredöme Award. Linköping is part of Svensk Fjärrvärme's project "Energy supply for sustainable cities", which compares the energy improvement efforts of four European cities. The Nordic Climate Cluster (NoCC) network discusses climate issues from a Nordic perspective. It is made up of 16 major Swedish and Norwegian companies. New Markets constitutes the export company Usitall, providing expert advice on waste management and energy recovery in Canada and the town of Tartu in Estonia. Utsikt Nät's efforts to provide its customers with remotely read electricity meters is progressing, and at the end of 2008, only a small number of old meters still remained in Linköping and Katrineholm. Although they shared the same technology with each other and some times complement each other in the market. For example, Bixie is one of Sweden's largest electricity supplier owned by the Tekniska Verken together with several other energy companies in Sweden. But one of respondant stated in different

> *"What our competitors are doing – we all look at each other to find out where the market is about to turn next".*
>
> (Dortz Anna, Product development manager of Bixie)

Division chief of Tekniska Verken emphasized on *"city air"* and *"availability of organic waste like slaughter's waste"* which creates a demand for solution. Moreover according product development manager of Bixie AB, "*renewable energy is soon to be a market hygiene factor".* In 2006, global climate and environmental issues came into focus-future energy supply, dependence on fossil fuels and their impact on the planet. The greatest challenge, both locally and globally, is how to conserve energy (Tekniska Verken, 2006) and in renewable sector product development manager of Bixie AB emphasize that, "*we try to make a real change instead by taking actions such as the fond".*

4.3.3. Regulation and policy side drivers

As mentioned before, Tekniska Verken is committed to the environment. It aims to create long-term sustainable solutions for an effective society with minimal impact on the environment. Their plants follow large number of laws, environmental permits, conditions and rules. Each of their business area has its own environmental engineer who ensures efficient compliance with all laws and other requirements. In addition, the whole group has been environmentally certificated under international standard ISO 14001 since 2001. This means that they have a common environmental policy and routines to ensure a systematic approach to environmental issues. Their environmental management system is reviewed regularly, both internally and by an external audit company. Tekniska Verken has a clear and user-friendly operating system with appropriate follow up. During the interview all of the respondant pointed out that legislation is an important driver for the Tekniska Verken.

When we asked the respondant about major drivers of eco-innovation, most of the respondant replied,

> *'Legislation is always a driver'*
>
> (Division chief and Business area manager of Tekniska Verken)

Another respondant says in different way

> *"In Europe energy sector are driven by legislation, which provide the companies to implement project by themselves. Normally customer makes the project but now legislation takes the business organization towards eco-innovation."*
>
> (Nordeno Anders, International project developer of Usitall)

In the same line another respondant said,

> *"Legislation very important driver off course"*
>
> (Moritz Anders, Division chief of Tekniska Verken)

5. Analysis

This chapter presents analysis of data collected from Tekniska Verken (presented in 4.Data Collection) and conceptual model of eco-innovation drivers (2.Frame of reference). It is structured in two parts: eco-innovation in organization and drivers of eco-innovation and organized as per frame of reference.

5.1. Eco innovation in organization

In order to analyse eco-innovation in organization the definition of eco-innovation and types of eco-innovation existing in our case company Tekniska Verken should be set and the analysis continued with respect to the drivers of eco-innovation.

5.1.1. Definition of eco-innovation

For research purpose we defined eco-innovation as 'innovations that consist of new or modified products, processes, techniques, practices, organizations, markets and systems to avoid or reduce environmental harms'. As mentioned earlier in chapter 2.1.1 that there is no generally accepted definition of eco-innovation; existing literature at academic level are still trying to define eco-innovation in various ways. This variation has also been noticed at country level eco-innovation definition (see appendix 11.2). In addition, it was mentioned in 1.1.1. that the term 'eco-innovation' has evolved at academic level but companies are still not aware of the eco-innovation term. Companies do not see environmental initiatives as distinct from their normal innovation process see (OECD, 2008).

Although Tekniska Verken is indeed an environmental company, but no specific definition of 'eco-innovation' or 'environmental innovation' both in our secondary and empirical study was found. When asked the definition of eco-innovation to the respondents, all responded initially that they are not well aware of the term but after reading the provided definition they all agreed to the fact that Tekniska Verken is highly eco-innovative. Since Tekniska Verken is totally committed to achieving its environment oriented goals to create

a long-term sustainable solution for an effective society with minimal impact on the environment and follow large number of laws, environmental permits, conditions and rules. Their environmental management system (EMS) is actively ensuring the environmental performance of the organization. Each business area has its own environmental engineer who ensures efficient compliance with all laws and other requirements. Interestingly the term eco-innovation was not properly understood by Tekniska Verken themselves although they have regional championed the concept of eco-innovation.

5.1.2. Types of eco-innovation

Tekniska Verken being environmentally focused in all of its undertakings motivated us to examine its degree of technological and non-technological nature, environmental impacts, functional and operational dimensions. Tekniska Verken is less focus on add-on eco-innovation rather than integrated and alternative product innovations. Because add-on eco-innovations are added on to existing production and consumption but Tekniska Verken is active in such eco-innovative solution which consider the overall environmental impact of the technical change in product and services. Such innovations enable energy and resource efficiency, enhance recycling or enable the substitutions of toxic materials.

Tekniska Verken provides various integrated and macro–organizational eco-innovative solution in various areas. Among their subsidiaries, Svensk Biogas AB operates in the regional market produce biogas from waste and control the whole chain from process development of gas to the end customer. Its aim is to make biogas a competitive and easily-accessible vehicle fuel, and to establish more filling stations. Usitall AB is an export company set up in 2007 for the purpose of selling advanced concepts for waste management and energy recovery. The Energy and Waste division is an integrated area for waste management and energy production. District heating and district cooling are distributed via separate networks, and electricity from hydro power plants and combined heat and power plants is traded on the Nordic electricity exchange. Utsikt Nät AB supplies the region with first-class electricity and broadband networks, as well as complete outdoor lighting solutions. Östkraft AB is an electricity trading and telephony Group, generates

value for its clients by offering attractive energy and communications products, as well as personal service. Stadspartner AB operates in the area of dynamic infrastructure. Stadspartner AB which provide converting vehicles to run on biogas, efficient building technology, business area infrastructure technology, provide networks for water, sewerage, district heating, electricity, gas and optic fibre. Division Water is responsible for the production and supply of high-quality drinking water, for ensuring that waste water is purified before it is returned to the natural cycle, and for the function and expansion of the drinking water, waste water and rainwater networks – almost 2 000 km in total.

Tekniska Verken's functions and operations are more centered in macro organizational innovations. They are more concentrated in new ways of organizing society, new ways of organizing cities with its environment focus technology such as conserving natural resources, transparent business system, complying with laws, regulations and requirements, prevent environmental accidents, dialogue with their partners on the environment, quality and safety requirements etc. Moreover, in their metrology they support other companies to provide better service to the customer. As the functional and operational area is more focused on macro organizational innovations it affects the driving force for eco-innovation leading towards the new structure, new way.

From the current discussion we could conclude that Tekniska Verken is actively integrated in eco-innovations, alternative eco-innovation and macro-organizational eco-innovation area than add-on eco-innovation and general purpose eco-innovation area.

5.2. Drivers of eco-innovation

As mentioned before Tekniska Verken is highly eco-innovative in various level. Most of their eco-innovations exist in integrated eco-innovations, alternative eco-innovation and macro-organizational eco-innovation. On the other hand, existing literature has shown that there is a connection with supply and demand side factors to induce general innovation (section 2.2) and eco-innovations are induced by other factors such as regulation and policy. Hence, drivers of eco-innovation are categorized in three broad categories: drivers

of supply side eco-innovation, drivers of demand side eco-innovation and drivers of regulation and policy side drivers.

The data collected in chapter 4 have been compared to the literature review in chapter 2. With the literature knowledge on drivers of eco-innovation at Tekniska Verken we can categorize the drivers as the following sub sections.

5.2.1. Supply side drivers

In our conceptual model of supply side drivers of eco-innovation we have introduced various drivers in section 2.2.1. The data collected on drivers of eco-innovation from Tekniska Verken indicates similarities with previous supply side drivers and also provide two new drivers. When asked about the drivers of eco-innovation, respondents explained the phenomenon of corporate responsibility to create a solution for environmental impact through a municipality owned and operated organization. It is strongly connected with environmental motive and aims to create an efficient community which is sustainable in the long term**.** Environmental responsibility is a significant issue for them to make eco-innovative solutions. Their eco-innovative force and motive might overcome the techno-institutional barriers to bring about their anticipated solution.

Regarding research and development (R&D), they mentioned about available fund, support to new inventions. An availability of investment fund for inventors and for others to apply for capital for investment on new ideas was also expected. How such research and development fund influence eco-innovation? To this question, one respondent replied that this type of R&D initiative may help to get new eco-innovative ideas to move ahead. In addition, Stg Holm, CEO said, *"real driving force comes from inside"*. In annual report 2009 they said, when we say "green is our colour", we mean that the environment as a crucial factor in all issues, and also that we give big, new and creative ideas the green light. As eco-innovation is more complex than innovation so it does not only depend on available fund it also depends on how employees trigger the environment. This type of corporate environmental attitude diffuses during R&D and provides more efficient eco-innovation.

Their corporate citizenship ensures lowering environmental impact in every stage. First reducing own discharge and shifting to biogas energy, ensuring internal and external environmental information in waste and recycling, constructing more drains and cease discharging latrine contents, ensuring emissions of ammonia from district heating plant does not to increase from 2004 level and to meet all promised values on emissions to atmosphere, in water management target for nitrogen reduction, converting biogas vehicles. It is evident that Tekniska Verken fulfilled their corporate citizenship from various dimensions of eco-innovation such as products, process, systems, models, techniques and reorganization.

Secondary empirical study shows that EMS is positively connected to eco-innovation. EMS at Tekniska Verken include written environmental policy, procedure for identification and evaluation of legal requirements, initial environmental review, measurable environmental goals, programme to attain measurable environmental goals, clearly defined responsibilities, environmental training programme, environmental goals are part of a continuous improvement process, separate environmental/health/safety report or environmental statement and audit system to check environmental programmes. This type of active presence enables them to achieve their environmental target and aligned with common laws.

Cost savings at Tekniska Verken's was vivid in its environmental policy which claimed that 'our activities contribute to a more resource saving way of solving several environmental problems'. Tekniska Verken has various cost-savings approach for instance, during reorganization they eco-innovate with the parallel aim to generate savings of SEK 100 million by several initiatives.

Another interesting point we find from primary data is that they get paid by the waste producer to get relief from the waste and again they sale it to the customer. This factor influenced Tekniska Verken to make environmental solution for the customer and make profit from that eco-innovation. The phenomenon we could say that polluter will pay positively influence the eco-innovation and firm may enjoy financial benefit.

Tekniska Verken is aware of how to exploit and explore their environmental image and brand identity They took several eco-innovative awareness initiative such as active participation on social networking sites such as Twitter, facebook, blog and other online networking platforms and worked with a range of associations. They have partnerships with the sports i.e. LHC, LFC, etc and other areas such as study, research, cultural. They also have collaborations on studies, research and humanitarian relief works.

Another driver of supply side is the supply chain pressure. This was reflected by one of the respondent when he stated that *energy supply is changing. The reason behind this due to oil is more or less disappearing so it should be replace anything else*. This type of effect encourages them to shift to biogas. It could be said that some certain supply chain characteristics may affect the firm's eco-innovative practice such as threat of source scarcity can influence eco-innovative solution.

Tekniska Verken is a regional company. As we stated before size has both positive and negative influence to eco-innovation but any negative influence has been hardly noted in Tekniska Verken's practice of eco-innovation. Although Tekniska Verken is one of the world's leading players in waste incineration for energy recovery, and one of the Europe's largest producers of biogas for vehicle fuel but it is clearly evident that they are dynamic enough to avoid any kinds of size effect like routine resistance and rigidity. For example, they made radical reorganization during 2008, to look things afresh, and used company's young talents for that change. This type of dynamic initiative helped them remove their size inertia and gave advantage for eco-innovation. But we did not found firm size directly influence eco-innovation at Tekniska Verken.

When it came to knowing about networking and relationship drivers we found that Tekniska Verken kept close relationship with customer, supplier and maintained networking to develop new eco-innovative ideas and share information.

We have found presence of R&D, cost savings, EMS, networking and relationships, corporate citizenship, and supply chain pressure from our empirical and secondary investigation. But our empirical study did not find any direct relation with firm size and

productivity improvement. Because only for productivity improvement Tekniska Verken not go for the eco-innovation.

Compare to our conceptual frames of supply side drivers, we found that one of our respondent focused on eco-expertise, eco-knowledge and technology export. It reflects that exportable eco-technological competence is a new driver for the firms. Rising environmental competition may influence other firms to gain eco-technological competence. Tekniska Verken's one of subsidiaries Usitall export eco-technology to other firms to be eco-innovative. They export their technological know-how to support other companies so that a new company can start business in this eco-innovation field. But to develop eco-technological competence any firm requires time, knowledge and resources availability. Tekniska Verken's position essentially is to support these three criteria to develop eco-technological competence and make a supply side core competence for eco-innovation. It also stands as a barrier to competitors.

We also found from our empirical data, availability of eco-innovation fund for eco-solution investment is another driving factor to be eco-innovative. The reason behind this eco-fund encouraged companies to appreciate the environment and provide support for its implementation. Eco-fund may also help the company generate new ideas.

Therefore we could say that our empirical and secondary study on Tekniska Verken provided us two new supply side drivers for eco-innovation: eco-innovation fund and eco-technological competence. And not shown positive correlation with firm size and productivity improvement for eco-innovation.

5.2.2. Demand side drivers

We have shown demand side drivers of eco-innovation in our conceptual model which is empirically investigated at Tekniska Verken. In this empirical research study, one respondent mentioned about *"public opinion, knowledge and actions*" as important drivers for eco-innovation. This sort of statement shows the correlation between Tekniska Verken activities and customer awareness. According to Green et. al. (1994) customer related

pressure and demand can influence environmental innovation. This correlation was also found in our empirical analysis. Tekniska Verken internally and externally targeted to raise the level of public environmental knowledge. To achieve that target they developed linkage with customer, developed web pages, intranet and company magazines. We found customer awareness is one of the necessary demand side drivers for eco-innovation.

Another demand side driver is customer share in development which is also reflected by a statement of a respondent *"struggling to get new and keep old customers"*. Customer preference is an important factor for development. According to our observation Tekniska Verken followed long tail theory, where one product supports another. Since they expanded themselves in several business areas which complement each other to keep their customer share development with eco-innovative solution. For example, Svensk Biogas AB which is active in biogas sector, Usitall AB is active in selling advanced concepts for waste management and energy recovery, energy and waste division is an integrated area for waste management and energy production. District heating and district cooling are distributed via separate networks, Utsikt Nät AB supplies the region with first-class electricity and broadband networks, Östkraft AB is an electricity trading and telephony Group, Stadspartner AB and Division Water all are active in their business. This type of regional setup provides them with larger acceptance of the customer but also demand innovative solution to meet the customer expectations.

Regarding competition, a respondant said that "*global economy, open markets and business opportunities".* In demand pull innovation all these are interrelated factors. On one hand public knowledge and awareness creates a general situation to develop eco-innovation, and open market and opportunity to enable eco-innovation to diffuse to increase market share and growth. Thus customer demand is in a sense a factor of public knowledge and action. Here one is a pre-factor or precondition to develop eco-innovation and another is the catalyst of diffusion to increase market share. But both customer demand and market share are potential factors for eco-innovation (see 2.2.2). We found from literature competition is one of the driver for eco-innovation (see 2.2.2). In this view one respondent said that "*what our competitors are doing – we all look at each other to find out where the market is about to turn next".* This type of competition sensing may influence Tekniska Verken create more

eco-innovative solution to stay ahead and positively encourage the eco-innovation at organization.

From respondent view and opinion we found that demand side drivers are correlated with eco-innovation as drivers. In addition we found that one of our respondents said, "renewable energy is soon to be a market hygiene factor" so we assume that eco-innovation could be the differentiation strategy for some companies thus influencing to create a difference as a respondent said, '*we should try to make a real change*'. Finally in demand side we did not find any new driver than existing driving factors for eco-innovation.

5.2.3. Regulation and policy drivers

After more than one decade of Porter & Linde's (1995) argument on stringency of environmental regulation can correct innovation and provide competitiveness. But still eco-innovation in most of the industrial sector is driven by whipping boy. About regulation and policy, in section 2.2.3, we demonstrated that beside supply and demand push pull factor, regulation is another driving factor for eco-innovation. Correlation of regulation and policy with eco-innovation is emphasized in several literature and empirical study.

At Tekniska Verken during the interview most of the respondents pointed out that legislation is more important as a driver for their company. When we asked respondent about major drivers of eco-innovation they replied *'legislation is always a driver',* on the same issue another respondent said *'in Europe energy sector are driven by legislation, which provide the companies to implement project by themselves. Normally customer makes the project but now legislation take the business organization towards eco-innovation.'* These types of words clearly mention the connection between regulation and policy drivers with eco-innovation. Analysis of eco-innovation practice at Tekniska Verken shows that to develop eco-innovation in firm both external and internal regulation and policy is necessary to create the environment and condition for eco-innovation.

We found that external regulation and policy (i.e. legislation, public policy) is mostly focused on adoption and diffusion of eco-innovation but firm's internal regulation and

policy (i.e. EMS) is focused on development of eco-innovation. Because external policy and regulation are built on the existing technological change and development which may not predict the future innovation so may be some of the external regulations are not flexible or deep enough to open the door for radical eco-innovation. Specifically existing regulation and policy may support the incremental eco-innovation but create some difficulties for radical innovation.

On the other hand a firm's internal regulation and policy always maintain the right alignment with the external regulation and create the platform for both incremental and radical eco-innovation. We found Tekniska Verken is an unique example which shows how to follow the regulation and policy both internally and externally .We also observed that they established several incremental and radical eco-innovation within existing stringency of regulations and kept themselves competitive in energy, water, waste and several other sectors. As a concluding remark we could say that we did not find any major dissimilarity with our conceptual frames on regulation and policy drivers.

5.3. Summary and conceptual model for drivers of eco-innovation

In section 5.2 we analysed our empirical data we collected. We found two new drivers in supply side, which are eco-innovation fund and eco-technological competence. In addition we do not find any empirical reason how firm size and productivity improvement act as drivers of eco-innovation. On the other hand , we do not find major dissimilarity in demand side, and regulation and policy side driver framework.

Moreover we found Tekniska Verken is following a proactive approach instead of reactive approach. With respect to proactive approach, Stig Holm , the General Manager and Group Director of Tekniska Verken said (Tekniska Verken, 2006), "*in the past, we have discussed visions and threats, but we now see the need of a proactive approach. There are many excellent ideas for sustainable solutions for the future, and I am convinced that Tekniska Verken has the ability and the resources to realise these.*"

With their proactive approach, they are searching new ideas to use their resources, competencies and capabilities for eco-innovation. In support we found new drivers are eco-innovation fund and eco-technological competence which are connected with the proactive approach of the company. So, with our empirical findings and analysis we could say that Tekniska Verken is proactive in eco-innovation.

6. Result

This chapter outlines the answer of research question as mentioned in chapter 1 section 1.4 and the modified conceptual model presented.

During data collection, we found drivers of eco-innovation from our case company, Tekniska Verken, through the qualitative semi-structure interview process. This info was found in their company report, information and on their web page (www.tekniskaverken.se). These drivers are categorized and analyzed in three major areas 1.supply side, 2.demand side and 3.regulation and policy side drivers. The results we have found from this case company have enabled us to provide the answer to our research question below:

Research question: What are the drivers of eco-innovation in organization?

Drivers of eco-innovation in supply side from primary and secondary study summarizes a range of drivers such as R&D activities, cost savings, environmental management systems, relationship & networking, corporate citizenship, corporate image and brand and supply chain pressure. Our empirical case study research on Tekniska Verken found additional two supply side drivers, which are eco-innovation fund and eco-technological competence and not shown positive correlation with firm size and productivity improvements.

In demand side, we found from literature customer demand, customer awareness and pressure, market share increase and competition are the major drivers for eco-innovation. Our empirical research also unchanged with this result. We did not find any additional drivers in demand side.

In regulation and policy side, secondary study found implementation of environmental policy, existence and anticipation of environmental regulations and regulatory design are important drivers. Empirical research on this side also provides the similar result.

With our empirical findings the modified conceptual model to show drivers of eco-innovation is presented in figure 6.1:

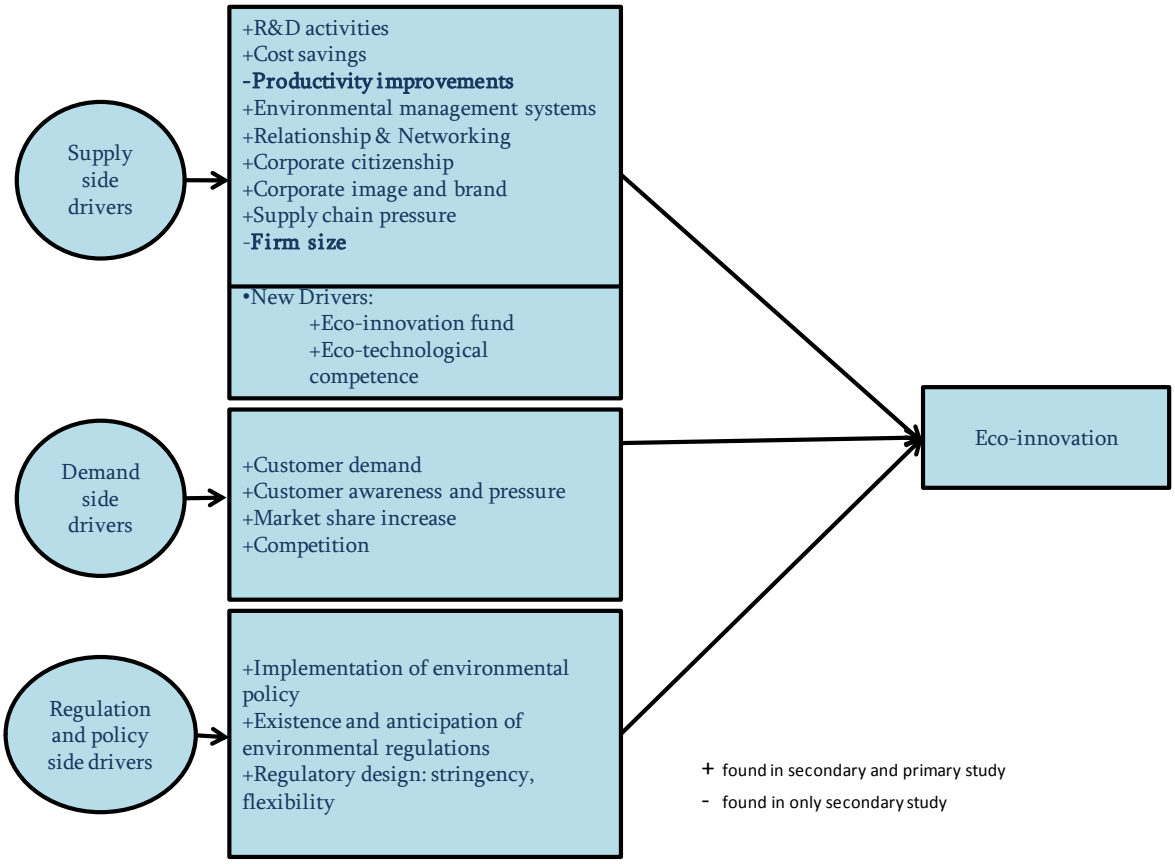

Figure-6.1: Modified conceptual model of drivers of eco-innovation

Our literature review shows that regulation, environmental management system, customer demand and R&D are major drivers for eco-innovation. But the empirical study shows that economic factor, image, competition and legislation are the most important drivers. There is a changing pattern is found between literature study and primary study about the major drivers. Although regulation is found common in both secondary and empirical study but we found that economic factor, image, competition as most important drivers for our case company than the other. The main achievement of this study is additional supply side drivers of eco-innovation.

Municipality owned environmental company, Tekniska Verken is mainly active in integrated eco-innovations, alternative product eco-innovations, macro-organizational eco-innovations. The drivers of eco-innovation and our result are correlated with this type of

eco-innovations. Thus it should be noted that we want to identify, compare and analyze the case company drivers with current research studies and present our results in the above figure 6.1.

7. Conclusion

This chapter presents the summary of this thesis and the conclusions from the analyses. Succinct explanations were given where necessary.

Our aims and objectives in this research were to find drivers of eco-innovation. In order to fulfill the purpose of this research we reviewed existing literatures, current researches and carried an empirical study. Following general innovation theory, eco-innovation development has been categorized in supply side, demand side and regulation and policy side drivers. We have seen supply side and regulation side drivers in the energy company were more emphasized than demand side drivers. We have identified that Tekniska Verken is proactive to eco-innovation, and supply and regulation side drivers played important role for this company.

We also found, among three catagories of the drivers, supply side drivers are important for energy industry company. One possible reason is the resistancy and rigidity is high and flexibility is low in this sectoral company. Complex technical set up of the energy sector are not flexible enough to change their entire process with the change of demand. May be other types of company (bakery) can change themselves much faster with the demand change than energy company. So they may follow the demand push strategy and their drivers could be more demand side focused. But those companies which has high resistance and rigidity (due to technology, capabilities, routines) they normally choose proactive approach to develop eco-innovation. Hence supply side drivers are becoming important driver for them.

Moreover we found, proactive company which has capabilities and resources they are searching new usable ideas to make environmental solution. Those types of firms create an eco-innovation platform to get new ideas to achieve their objectives. From our case

company we found that eco-innovation fund and eco technological competence enhance eco-innovation and helps firm proactive approach of the firm.

We also deduced that types of eco-innovation such as add-on eco-innovations, integrated eco-innovations, alternative product eco-innovations, macro-organizational eco-innovations, general purpose eco-innovations has each types of eco-innovation drivers because each types of eco-innovation has specific mechanisms and focus. In addition environmental regulation and policy side drivers are positively correlated with both supply side and demand side drivers of eco-innovation.

On the other hand, it is also important to note that supply side, demand side and regulation and policy side drivers of eco-innovation are not only possible classification of eco-innovation drivers. It could be distinguished according to exogeneous and endogeneous factors of eco-innovation. Moreover factors internal to the firm, factors external to the firm are characteristics of eco-innovations (Hermosilla, Gonzalez, & Konnola, 2009) . From our understanding of this analysis we realize that eco-innovation is innovation which has environmental promise so we followed the general innovation development theory and followed supply and demand pull theory for our research.

Moreover, today world is at the brink of environmental revolution. In this context, some organizations are emphasized on executing eco-innovations while others are still far away or trying to seize the new environment related business opportunity. Some organization oscillates during the time of decision for eco-innovation if their competitive advantage is unseen. In this situation, drivers of eco-innovation may help the organization to adopt eco-innovation.

8. Discussion

This part presents the discussion upon methods and results alternatives.

In the end of this research we find that there are several points need to make clear for the reader. Firstly we found existing literature on environmental innovation, cleaner technology, end-of pipe technology, sustainable innovation, green innovation provide us some factors or determinants which may act as drivers of eco-innovation. But those studies are not focused on drivers of eco-innovation. We use their study results with the mind that they are focused in various environmental innovations and not specifically on the drivers of eco-innovation.

Secondly, it can be claimed that if another person conduct this research there is opportunity to get more drivers for eco-innovation. Like that we also believe there is a possibility to get more drivers if we have more time to do this research. In addition we would like to mention that more interviews with Tekniska Verken and its subsidiaries or comparative study can give more drivers to eco-innovation or new category for eco-innovation. To get a more detailed and an even more accurate picture of the reality it would be interesting to do the study once more. As we said in conclusion the research on drivers of eco-innovation can carry from other various aspects that may give other results on drivers of eco-innovation.

9. Future Research

This part presents the suggestion and recommendations for further research on eco-innovation area.

This thesis has emphasized on finding the drivers of eco-innovation and found a vast area of future research in this area. Our suggestion for future research is obviously to study the drivers of eco-innovation in different context and develop further more. Therefore we suggest continuing this research by carrying out longitudinal studies in order to know the evolution of drivers of eco-innovation in various contexts. We also recommend to carry out further researches on developing and non developing country specific drivers of eco-innovation in different industry. Identifying the major technological competencies and path dependencies of eco-innovation are necessary to create competitive advantage for the firm. In addition, the necessity to identify drivers of eco-innovation and how those drivers help regulatory bodies to design right regulations and policy for eco-innovation should be given further emphasis.

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10.1 Primary sources:

Interviews

No	Name	Position
1	Anders Moritz	Division Chief
2	Jakobsson Stefan	Business area Manager
3	Anders Nordenö	International Project Developer
4	Anna Drotz	Product Development Manager

10.2 Secondary Sources:

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11. Appendix

Appendix 11.1 Definitions of eco-innovation and sustainable innovation.
Source (Carrillo, Río, & Könnölä, 2010)

_ "Eco-innovation is any form of innovation aiming at significant and demonstrable progress towards the goal of sustainable development, through reducing impacts on the environment or achieving a more efficient and responsible use of natural resources, including energy" (European Commission, 2007).
_ Environmental innovation is innovation that serves to prevent or reduce anthropogenic burdens on the environment, clean up damage already caused or diagnose and monitor environmental problems" (VINNOVA, 2001)
_ "Eco-innovation is the creation of novel and competitively priced goods, processes, systems, services, and procedures designed to satisfy human needs and provide a better quality of life for all, with a life-cycle minimal use of natural resources (materials including energy, and surface area) per unit output, and a minimal release of toxic substances" (Europa INNOVA, 2006).
_ "Eco-innovation is the process of developing new products, processes or services which provide customer and business value but significantly decrease environmental impact" (Fussler and James, 1996).
_ "[Eco-innovation is] Innovation which is able to attract green rents on the market" (Andersen, 2002).

_ "Sustainability-driven" innovation is "the creation of new market space, products and services or processes driven by social, environmental or sustainability issues" (Little, 2005).

_ "Sustainable innovation as a process where sustainability considerations (environmental, social, financial) are integrated into company systems from idea generation through to research and development (R&D) and commercialisation. This applies to products, services and technologies, as well as new business and organisation models" (Charter and Clark,2007).

_ Environmental innovations are new and modified processes, equipment, products, techniques and management systems that avoid or reduce harmful environmental impacts (Kemp and Arundel, 1998; Rennings and Zwick, 2003).

_ "Eco-innovation is the production, assimilation or exploitation of a product, production process, service or management or business method that is novel to the organisation (developing or adopting it) and which results, throughout its life cycle, in a reduction of environmental risk, pollution and other negative impacts of resources use (including energy use) compared to relevant alternatives" (Kemp and Pearson, 2008).

_ "Eco-innovations are innovation processes toward sustainable development" Environmental innovations are ". Measures of relevant actors (firms, ., private households), which: (i) develop new ideas, behaviour, products and processes, apply or introduce them, and (ii) contribute to a reduction of environmental burdens or to ecologically specified sustainability targets" (Rennings, 2000).

_ In a broad sense, environmental innovations can be defined as innovations that consist of new or modified processes, practices, systems and products which benefit the environment and so contribute to environmental sustainability (Oltra and Saint Jean, 2009).

_ Eco-innovations are all measures of relevant actors (firms, politicians, unions, associations, churches, private households) which develop new ideas, behaviour, products and processes, apply or introduce them and which contribute to a reduction of environmental burdens or to ecologically specified sustainability targets (Klemmer et al., 1999).

_ Technological environmental innovations (TEIs) may help to reduce the quantities of resources and sinks used, be they measured as specific environmental intensity per unit of output, or as average consumption per capita, or even in absolute volumes. Overriding priority, however, is given to improving the qualities and to changing the structures of the industrial metabolism. Rather than doing less of something, TEIs are designed to do it cleaner and better by implementing new structures rather than trying to increase eco-productivity of a suboptimal structure which has long been in place. TEIs are about using new and different technologies rather than using old technologies differently. TEIs can be characterised as being upstream rather than downstream, i.e., upstream in the manufacturing chain or product chain respectively, as well as upstream in the life cycle of a technology (Huber, 2004).

_ Innovation is "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations" (OECD, 2005).

Eco-innovation is generally the same as other types of innovation but with two important distinctions: 1) Eco-innovation represents innovation that results in a reduction of environmental impact, whether such an effect is intended or not; 2) The scope of eco-innovation may go beyond the conventional organisational boundaries of the innovating organisation and involve broader social arrangements that trigger changes in existing socio-cultural norms and institutional structures (OECD, 2009a,b).

_ Eco-innovation is "the production, assimilation or exploitation of a novelty in products, production processes, services or in management and business methods, which aims, throughout its lifecycle, to prevent or substantially reduce environmental risk, pollution and other negative impacts of resource use (including energy)" (European Commission, 2008).

-Eco-innovation is defined an innovation that improves environmental performance (Carrillo, Río, & Könnölä, 2010).

_ Environmental technologies include all those whose use is less environmentally harmful than relevant alternatives (European Commission, 2004).

Appendix 11.2 Countrywide eco-innovation definition
Source: (OECD , 2009)

In **Canada**, eco-innovation refers to science and technology work on clean energy research, development, demonstration and deployment. It also refers to the creative process of applying knowledge and the outcome of that process (OECD , 2009, p. 222).

In **Denmark**, uses the definition of the EU Environmental Technology Action Plan(ETAP) : "the production, assimilation or exploitation of a novelty in products, production processes, services or in management and business methods, which aims, throughout its lifecycle, to prevent or substantially reduce environmental risk, pollution and other negative impacts of resource use (including energy)" (OECD , 2009, p. 226).

In **France**, does not have strict definition, in narrow sense the eco-innovation definition means innovation on technologies directly linked to environmental protection (OECD , 2009, p. 229)

In **Germany**, eco-innovation is not confined to environmental goods and efficient technologies, sustainable energy generation, waste reduction and treatment technology, but also includes business models, services and consulting activities which bring environmental and economic progress (OECD , 2009, p. 233).

In **Japan**, eco-innovation is for founding a sustainable economic society by reforming technical innovation and creating a social system that ensures minimum impact on the environment (OECD , 2009, p. 240)

In **United States**, 'environmental innovation', 'clean technology' or 'clean tech' or 'sustainable manufacturing' are the terms more often used. And the department of commerce (DOC) defines sustainable manufacturing as the creation of manufactured products that use processes that are non-polluting, conserve energy and natural resources, and are economically sound and safe for employees, communities and consumers (OECD publishing, 2009, p. 253).

Appendix 11.3 Interview information for respondents at Tekniska Verken

Interview details:

- Respondant's name:
- Occupation/Job/position: Duration of Position:
- Education:
- Gender:
- Time & Place of interview:
- Time start and end:
- Interview Type: Semi structure

Interview Questions:

1. Could you please tell little about eco-innovation?
2. Why organizations go for eco-innovation?
3. Could you please tell about eco-innovation in your organization?
4. Why Tekniska Verken start to practice eco-innovation?
5. What are the drivers of eco-innovation?
6. In your view, are there any specific priorities among these drivers?
7. Why are they main reasons for practicing eco-innovation?
8. Could you please tell me any specific drivers for other organizations?
9. In summary what do you consider to the major drivers of eco-innovation?

Thanks that's all for our questions. Do you have any more things to say?

- Interviewers: Shohana Ahmed, 0700360965 &
  Mohammad Kamruzzaman, 0762335544
- Thesis topic: Drivers of eco-innovation
- Thesis type: Master thesis of 30 ECTS credits
- Program: Business Administration-Strategy and Management in International Organizations, M.Sc.
- University: Linköping University